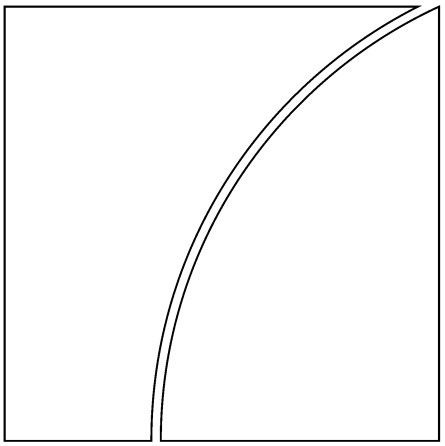
BANK FOR INTERNATIONAL SETTLEMENTS



BIS Papers

No 10

Central bank intervention and market expectations

by Gabriele Galati and Will Melick

Monetary and Economic Department

April 2002

Requests for copies of publications, or for additions/changes to the mailing list, should be sent to:

Bank for International Settlements
Press & Communications
CH-4002 Basel, Switzerland

E-mail: publications@bis.org

Fax: +41 61 280 9100 and +41 61 280 8100

This publication is available on the BIS website (www.bis.org).

ISSN 1609-0381

ISBN 92-9131-633-4

Abstract

In this paper we illustrate a new analytical method and present new results on the relationship between foreign exchange market intervention and market expectations in the dollar/mark and dollar/yen markets between 1985 and 1996, and 1991 and 1996, respectively. The paper improves on previous work in several important respects. First, we use official data on intervention carried out by the G10 central banks in the dollar/mark and dollar/yen markets from 1985 to 1996 and from 1991 to 1996, respectively. Second, we also consider data on market expectations of intervention derived from press reports to investigate the extent to which markets were driven by perceptions of intervention as well as actual intervention. Third, we broaden the perspective on the relationship between intervention and market expectations by looking at the entire expected distribution of future exchange rates. The four moments of estimated probability density functions (PDFs) allow a more complete characterisation of the state of market expectations on a particular day. Fourth, we use a data set on macroeconomic variables that allows for the influence of factors other than intervention on exchange rates.

We follow two complementary approaches to analyse the relationship between intervention and market expectations. The first is based on an event analysis, and investigates how the moments of the PDFs changed around a number of important intervention episodes. The main advantage of this approach is that it can identify the context in which each particular intervention episode occurred and the objectives that central banks were actually pursuing. The second approach looks at averages over episodes and uses econometric techniques to reveal broad average tendencies. It has the advantage that it can summarise results for a large number of individual episodes, while at the same time controlling for the influence of factors other than intervention.

Based on the event study methodology, we conclude that, depending on circumstances, particular interventions did succeed in affecting traders' expectations of future exchange rate movements in line with policymakers' objectives. We also find that the impact of interventions varies considerably across episodes. By contrast, when using econometric techniques to look at the average experience for different sub-periods, we find no evidence that intervention on its own had a statistically significant, systematic impact on expected future exchange rates, where statistical significance is measured at the usual significance levels. Likewise, while there is some evidence that for the period 1992-96 concerted interventions may have had a stronger impact on market expectations, econometric results suggest that different intervention strategies did not seem to have systematically dissimilar effects at the 95% or 90% confidence level. Hence, the interpretation of our results depends in part on the reader's views on the two approaches that we use, as well as the ultimate objectives of intervention in particular circumstances.

Table of contents

1. Introduction[1]

The efforts to stem the decline of the yen in 1998 and to support the euro in autumn 2000 have brought the issue of the effects of foreign exchange intervention back to prominence. The context in which intervention is carried out has changed markedly since the time of the Plaza and Louvre Accords. Moreover, the analytical tools for studying this relationship have evolved considerably since the time of the Jurgensen Report. This study illustrates a new method and presents new results on the relationship between foreign exchange market intervention and market expectations. It looks at the period from 1985 to 1996 and focuses exclusively on intervention with respect to the dollar, mark and yen in a floating exchange rate regime.

While a number of studies have considered the impact of intervention on exchange rates, focusing on the level and the variance of exchange rate changes, and more recently, data on the volatility implied in option prices have been used to measure the effect of intervention on market uncertainty, this study extends on previous work in several important aspects. First, it uses a unique set of official data on intervention carried out by the G10 central banks in the dollar/mark and dollar/yen markets from 1985 to 1996 and from 1991 to 1996, respectively. Second, this study also considers data on market expectations of intervention derived from press reports, to throw further light on the extent to which the market is driven by perceptions of intervention as well as actual intervention. Third, the study broadens the perspective on the relationship between intervention and market expectations by looking for the first time at the entire expected distribution of future exchange rates. The four moments of this distribution - mean, variance, skewness and kurtosis - allow a more complete characterisation of the state of market expectations on a particular day. Estimates of these moments therefore provide a new tool to analyse the relationship between intervention and market expectations in a more comprehensive way. Together with other tools, it may help inform central banks' decisions on intervention. Fourth, this study uses a data set on macroeconomic variables that allows for the influence of factors other than intervention on exchange rates and that is richer than data sets used in previous studies.

The study utilises two complementary approaches to analyse the relationship between intervention and market expectations. The first is based on an event analysis, and investigates how the moments of estimated probability density functions (PDFs) changed around a number of important intervention episodes. The main advantage of this approach is that it can identify the context in which each particular intervention episode was carried out and the objectives that central banks were actually pursuing. The second approach looks at averages over episodes to uncover broad average tendencies. It has the advantage that it can summarise results for a large number of individual episodes, while at the same time controlling for the influence of factors other than intervention.

Based on the event study methodology, the study finds that, depending on circumstances, particular interventions did succeed in affecting traders' expectations of future exchange rate movements. It also finds that the impact of interventions varies considerably across episodes. By contrast, when using econometric techniques to look at the average experience for each sub-period the study finds no evidence that intervention on its own had a statistically significant, systematic impact on expected future exchange rates, where statistical significance is measured at the usual significance levels. Likewise, while there is some evidence that for the period 1992-96 concerted interventions may have had a stronger impact on market expectations, econometric results suggest that different intervention strategies did not seem to have systematically dissimilar effects at the 95% or 90% confidence level. Hence, the interpretation of the results of this study depends in part on the reader's views on the two approaches that are used, as well as the ultimate objectives of intervention in particular circumstances.

The study starts in Section 2 with an overview, with reference to a floating exchange rate regime, of how objectives and practices of intervention have adapted to changes in the financial and economic environment that have taken place since the mid-1980s. The following section then illustrates with some examples how probability density functions (PDFs) can serve as a tool to analyse the impact of intervention on market expectations. In order to use the information contained in empirical PDFs to analyse the effects of intervention, this study proceeds in three steps. In Section 3, it investigates

[1] The authors would like to thank Marian Micu for excellent research assistance.

general regularities in the relationship between market expectations and intervention by looking at daily time series of intervention and of the moments of the risk neutral PDFs over the sample 1985-96 for dollar/mark interventions and from 1991 to 1996 for dollar/yen interventions. Since the objectives of intervention and the context in which it has been carried out have changed over time, Section 4 analyses how the effect of intervention on market expectations has evolved. The study looks at four sub-periods: the period of the Plaza Accord (1985); the period around the Louvre Accord (1986-88); the period 1988-92, during which central banks aimed at moderating excessive fluctuations of the dollar; and the period of support for the dollar (1992-96).

Section 5 investigates whether the effect of intervention differs according to the strategy followed, distinguishing between intervention which was carried out unilaterally or in a coordinated fashion, involved large or small amounts, was officially announced or conducted discreetly, and occurred on single days or in a repeated fashion. This section focuses on a particular period, August 1992 to December 1996, during which the objectives of intervention and the context in which intervention took place were broadly consistent but different intervention strategies were applied at various times.

The Annex contains a review of the literature on the impact of FX intervention. It also provides a description of the methodology used to estimate probability density functions, the approach followed to test the impact of intervention on market expectations and details about the empirical results.

2. Evolution of objectives, transmission channels and tactics of FX intervention

The efforts to stem the decline of the yen in 1998 and the depreciation of the euro in autumn 2000 have again raised the issue of the effects of FX intervention. The context in which intervention is carried out has changed markedly since the time of the Plaza and Louvre Accords. Most notably, turnover in foreign exchange markets grew very rapidly in the 1990s and now outweighs by far the official foreign exchange reserves of central banks. According to the 1998 Central Bank Survey of Foreign Exchange and Derivatives Market Activity, global foreign exchange markets turnover increased by 76% between 1992 and 1998, from $820 to $1,500 billion per day (BIS (1999a)). Even though average daily foreign exchange market turnover fell to $1,210 billion in April 2001, it still remains very large compared to central banks' foreign exchange reserves.[2] At the same time, a trend towards greater transparency and accountability of central bank actions has taken hold. This may imply that central banks may in the future come under increased pressure to provide information to outside bodies about the effectiveness of their intervention strategies. Pressure is also mounting on the authorities in some countries to release in a timely fashion information about ongoing intervention as well as more accurate information about overall FX exposures, including off-balance sheet positions.[3] This section describes, with reference to a floating exchange rate regime, how objectives and practices of intervention have adapted to these changes.[4]

2.1 Objectives

As emphasised by the Plaza and Louvre Accords, intervention in the 1980s was mainly directed at the level of the exchange rate. In September 1985, the G5 authorities announced in the Plaza Accord their goal of achieving "an orderly appreciation of the main non-dollar currencies against the dollar". In February 1987, G6 authorities declared in the Louvre Accord their desire to "foster the stability of exchange rates around current levels". At the same time, the prevailing official view, documented in

---

[2] See BIS (2002) and Galati (2001).

[3] In 1998, the BIS released a report entitled *Enhancing transparency regarding the authorities' foreign currency liquidity position*, prepared by a working group established by the Committee on the Global Financial System, then called Euro-currency Standing Committee. The report proposed a template for the disclosure of this position. A very similar template was prepared by the IMF in the context of the Special Data Dissemination Standard (SDDS), and in early 1999 a template produced jointly by the CGFS and the IMF was released and became part of the SDDS.

[4] The objective of keeping a currency within an exchange rate arrangement like the ERM is beyond the scope of this study.

the 1983 Jurgensen Report,[5] was that, without any accompanying policy changes, intervention alone could not have a systematic impact on the level of the exchange rate.

Perhaps reflecting this view, intervention has more recently been aimed at the (current and expected) variability of the exchange rate. On the one hand, it can be desirable to reduce short-term exchange rate fluctuations. This view is shared not only among G10 central banks, but also by some central banks in emerging economies that have recently stated that their primary aim is to curb excessive exchange rate volatility. On the other hand, central banks may at times prefer an increase in short-term exchange rate variability if they face a market dominated by an undesired exchange rate trend. In this case, intervention may act as a tactical "circuit breaker", by restoring a sense of "two-way risk" in the market.

2.2 Transmission channels

Traditional economic theory suggests that intervention can affect exchange rates through three different, but not mutually exclusive, channels - the monetary, the portfolio and the signalling channel. The monetary channel operates if the central bank decides not to offset completely the effect of intervention on the level of domestic bank reserves. In this case, intervention will influence the exchange rate through its effect on short-term interest rates. While standard economics textbooks discuss the monetary channel in the context of the dichotomy between sterilised and non-sterilised intervention, in practice the relevant distinction appears to be whether or not intervention is accompanied by a change in domestic interest rates.[6]

Intervention can also directly influence the exchange rate through the portfolio channel if investors consider foreign and domestic assets to be imperfect substitutes. By altering the relative supply of assets denominated in domestic and foreign currencies, central banks may induce investors to demand a higher expected return on the asset whose outstanding stock has increased, thereby leading to a change in the exchange rate. At the same time, for most actively traded floating currencies, the portfolio channel seems to have become less relevant over recent decades as the scale of possible intervention has declined relative to the size of rapidly growing foreign exchange markets. It is sometimes argued that this channel may still be relevant in the context of emerging markets, since the reserves held by central banks are large relative to the amount of turnover in local foreign exchange markets (Table 1). The table reports flows in the absence of data on stocks, which would be more appropriate given that the portfolio channel operates by altering the currency composition of stocks. A counterargument, however, is that official reserves in these countries may be small relative to the size of foreign exchange exposures. Sterilised intervention may therefore not be effective on its own in resisting speculative attacks on such currencies.

Even when intervention is sterilised and foreign and domestic assets are perfect substitutes, intervention may still have an indirect impact on the exchange rate. Intervention may convey a signal to market participants about future changes in monetary or exchange rate policy, or that the central bank views exchange rates to be out of line with economic fundamentals. If monetary authorities are viewed to be credible, this signal will induce traders to "bet with the central bank", and hence influence the exchange rate in the desired direction. A signal may also be used to reduce market expectations of future short-term volatility. The view that intervention operates mainly through this signalling channel seems widely shared by central banks and analysts. This said, the high number of "verbal" interventions in the dollar/mark or dollar/yen market in 1996 and 1997 suggests that policymakers may at times consider these to be more effective ways of signalling intentions than outright interventions.

Recent work on the microstructure of foreign exchange markets and the role of imperfect information has highlighted the existence of a fourth channel through which intervention might influence exchange rates (Peiers (1997); Lyons (2001)). This channel can operate even when intervention is carried out discreetly and hence does not provide a signal to market participants, or when it is not large enough to alter the relative supply of assets denominated in domestic and foreign currencies in a significant way. The idea underlying this channel is that there are two types of foreign exchange traders (Lyons

[5] BIS (1983).

[6] A discussion of liquidity management and interest changes at times of exchange rate pressure can be found in Borio (1997).

(1997)). Informed or "speculative" traders can distinguish between orders from their customers that reflect the arrival of private news about fundamentals and orders that are driven by liquidity needs. By contrast, uninformed or "liquidity" traders are driven by customer needs for financing international trade and corporate transactions. The interaction of informed and uninformed traders can give rise to exchange rate dynamics that allow for an influence of official foreign exchange market intervention. For example, as a result of an official forex market transaction, an informed trader may experience a change in order flow and bring about a small change in the exchange rate. If other traders interpret this in turn as the result of a change in market sentiment, it could cause a further exchange rate change. One consequence will be that intervention will be followed by higher exchange rate volatility.

2.3 Tactics

The changes in the context in which intervention has been conducted since the Plaza and Louvre Accords, and in particular the rapid growth of foreign exchange markets, have induced central banks to change their intervention practices in a number of ways. In general, central banks appear to have intervened less frequently in floating currency markets in the 1990s than in the 1980s.[7] Press reports have emphasised that there have been relatively few episodes of intervention in the main currency markets in the second half of the 1990s. At the same time, the fraction of intervention episodes that involve large amounts seems to have risen.

There has also been a tendency over the last few years for central banks to increase the frequency of interventions conducted by leaning with the wind rather than against the wind. A typical example is the episode of concerted intervention by Japanese, German and US authorities on 15 August 1995, which has been described as "pushing on an open door".[8] On that day, central banks purchased dollars in thin markets when the US currency was appreciating against the background of heavy Japanese buying of US bonds and evidence from options markets indicating that dealers were trying to hedge short dollar positions. The intervention was followed by a further appreciation of the dollar.

In recent years, some central banks have abandoned high-profile intervention in favour of discreet buying and selling. One way to view this strategy is one of standing ready to intervene without drawing obvious "lines in the sand" for the market to challenge. Intervention could then have an impact on the exchange rate through the imperfect information/order flow channel.

In contrast, other central banks have responded by making intervention more visible and transparent, as, for example, in the case of the Bank of Canada. This reorientation has coincided with the broader trend towards central banks being more transparent and accountable. Should such trends strengthen, it would not be implausible that central banks might be asked in the future to provide information to outside bodies about the effectiveness of their intervention strategies given the potential for large gains and losses.

One way that intervention can be made more visible is through concerted efforts by a number of different central banks. To the extent that signalling is the main channel through which intervention affects exchange rates, a concerted intervention effort may be more effective, as it can convey a strong signal about central banks' commitments to subsequent policy changes to affect exchange rates. However, as the number of participating central banks increases, the signal may become less credible insofar as economic fundamentals in a wide range of countries may point to different domestic policy requirements. While intervention in floating currency markets was often concerted among a number of central banks in the 1980s, intervention in the 1990s was to a large degree unilateral or concerted among very few central banks.

In response to the recent currency attacks in Asia, there has been significant recourse to intervention in the forward market. Intervention in the forward market has the advantage that the effect on domestic liquidity (and therefore the need for sterilisation) is delayed for the period until the maturity of these operations. Also, before the new template proposed by the IMF and the Committee on the Global Financial System (CGFS), it was easier to keep this type of operation discreet. Moreover, the magnitude of the intervention is not immediately constrained by the size of available reserves. The

---

[7] See, for example, Board of Governors (1996a,b,c,d, 1997a,b,c,d) and Bonser-Neal and Tanner (1996).

[8] BIS (1996b, p 101). See also Board of Governors (1995b).

downside is that central banks may in this case run the risk of becoming highly exposed to possibly sizeable exchange rate changes.

In recent years, some central banks have contemplated the use of options to intervene in the exchange market. In August 1996, for example, the Bank of Mexico set up a scheme of auctions in the options market with the main purpose of acquiring reserves. As with forward rate operations, interventions in derivatives markets have the advantage that they do not change the volume of reserves and therefore do not require sterilisation. Moreover, given the counterparties' continuous need for hedging, the effect of such operations could last longer than outright purchases or sales. However, the spot market is still preferred by most central banks because of the high risks associated with the non-linear payoff of options. In addition, options may be less useful for intervention to the extent that the market on which they are traded lacks depth. Furthermore, inasmuch as intervention operates through signalling the central bank's intentions, transactions involving options may not be visible enough to have such an impact.[9]

3. Using information derived from option prices to analyse FX intervention

This section illustrates the method for assessing the relationship between foreign exchange market intervention and market expectations and presents a first set of results. A number of studies have looked at the impact of intervention on exchange rates, focusing on exchange rate levels and the variance of exchange rate changes. More recently, data on the volatility implied in option prices have been used to measure the effect of intervention on market uncertainty.[10] The method used in this study broadens the analysis of market expectations by looking for the first time at the entire expected distribution of future exchange rates. The four moments of this distribution - mean, variance, skewness and kurtosis - allow a more complete characterisation of the state of market expectations on a particular day.

We first use some examples to illustrate how PDFs can serve as a tool to analyse the impact of intervention on market expectations. We then look at averages over episodes and try to uncover some average tendencies. In this analysis we present graphical evidence on the average behaviour of the moments of PDFs around intervention episodes over the period 1985 to 1996. In addition, we provide results of statistical tests that control for the influence of other factors.

3.1 Intervention and PDFs

Figures 1 to 3 illustrate how the moments of an empirical PDF can be used to describe market expectations. Each figure plots two hypothetical PDFs that have the same mean (the first moment), ie the same expected spot exchange rate at expiration of the contract, but differ with respect to one of the moments. As an illustration, we consider the dollar/yen exchange rate.[11]

The variance of a PDF (the second moment) can be interpreted as providing a measure of how uncertain the market is on a particular day about the exchange rate that will prevail over the near future.[12] The higher the variance of the PDF, the greater the uncertainty of market participants will be on that day. The PDFs in Figure 1 have the same mean, but one of the PDFs (case A) has a high variance while the other (case B) has a low variance. We interpret the figure as indicating that, on a day on which the PDF looks like A, market participants are more uncertain about future exchange rate movements than on a day on which the PDF takes the form B.

---

[9] This was discussed in BIS (1995), also known as the Hannoun Report.

[10] A review of the literature on foreign exchange intervention is provided in Appendix 1 of this report.

[11] The PDFs are expressed in yen per dollar.

[12] In the case of the American options traded on the CME that were used to estimate the PDFs, expectations are formed over a horizon of up to six months.

The third moment of a PDF, skewness, can be interpreted as the weight that market participants put on a higher and a lower yen/dollar exchange rate in the near future with respect to the forward rate. We define a PDF to be skewed to the left (or negatively skewed) when, compared with the forward rate, market participants assign more weight to a weaker dollar rather than to a stronger dollar against the yen. Similarly, we define a PDF as skewed to the right (or positively skewed) when the market attaches more weight to a stronger dollar than a weaker dollar in the near future.

The PDFs in Figure 2 have the same mean, but one (case A) is skewed to the left while the other (case B) is skewed to the right. These can be interpreted as two situations where market participants expect the same exchange rate to hold at the time the option contract expires, but in one of which (case A) they view a depreciation of the dollar as more likely while in the other (case B) they attach more weight to an appreciation of the dollar.

Kurtosis, which is the fourth moment of a PDF, measures how "fat" the tails of the PDF are. It can be interpreted as indicating how likely market participants view very large exchange rate changes (a big appreciation or depreciation of the dollar with respect to the yen) to be in the near future. The higher the probability that the market assigns to such large changes (in either direction) on a particular day, the higher the kurtosis of the PDF on that day. The two PDFs in Figure 3 have the same mean, but one (case A) has a high kurtosis indicating that market participants attach a high weight to the probability of a large exchange rate move in the near future, while the other (case B) has a low kurtosis, suggesting that the market views a big change in the exchange rate as not very likely.

It is important to keep in mind that the interpretation of the estimated PDFs is not as straightforward as might be hoped, given that the PDFs capture market views as to the likelihood of particular exchange rate outcomes as well as market preferences towards risk. Unfortunately, in the absence of strong assumptions, it is impossible to distinguish between the two. A simple example illustrates the problem. Suppose we observe an increase in the price of fire insurance. This increase might reflect the market view that fires are now more likely, hence there is a greater need for insurance. Alternatively, the price increase might reflect a change in market sentiment regarding potential losses (pecuniary or otherwise) in the event of a fire. The probability of a fire may not have increased; however, the market's risk preference with respect to a given loss associated with a fire may have increased. Thus, the observation that the price of insurance has increased does not allow us to determine whether fires are more likely, whether exposure is perceived as larger, or some combination of both. In the same way, a change in option prices does not allow us to separate out changes in views on future exchange rates from changes in potential exposures. Since intervention might induce a shift in traders' risk preferences, our results need to be interpreted with caution. However, over a short period, it is perhaps more likely that market views with regard to future exchange rate outcomes will change rather than market preferences towards risk, ie the deep parameters of traders' utility function that enter the PDF estimation. If this is the case, comparisons of PDFs across time may reveal some information on movements in market views on likely exchange rate outcomes.

It should be stressed that in our analysis we do not impose a priori restrictions on how traders change their perception of risk and how these changes are reflected in their positions. For example, suppose that in a situation in which the dollar is trending down and positions are leveraged, central banks intervene and their action is followed by a dollar appreciation. In these circumstances, traders may believe that their original views are still correct, but the intervention could induce them to re-establish a sense of two-way risk in the market and hence to reduce their positions. Risk management techniques could in this case play an important role as a transmission mechanism.[13] In our analysis, this case would be captured by the PDFs exhibiting a higher variance and a more neutral skewness. However, risk preferences - the deep parameters of traders' utility function that are used in our PDF estimation - may not be affected in the short run by the intervention.

This study uses settlement futures and option prices from the Chicago Mercantile Exchange to recover the expected distribution of future exchange rates. The details of the technique that has been followed and the assumptions on which it is based are described in Appendix 2. We employ exchange-traded options to recover the PDFs although the volume of exchange-traded FX options is small compared to

[13] The analytical tools used in this study do not allow an identification of the role played by these techniques.

OTC options.[14] However, exchange-traded options are available over a longer period. In addition, they offer the advantages of synchronised price quotes across a greater number of strikes. Moreover, as some market-makers arbitrage between the OTC and exchange markets, they should convey the same information. We also replicated all the tests for a sub-sample for which OTC option data are available. We found that exchange-traded and OTC data gave very similar results.

3.2 The effects of intervention: uncovering average tendencies

As a first step in the analysis of the relationship between market expectations and intervention, this section investigates the existence of general regularities. Daily time series of intervention and of the moments of the risk neutral PDFs can be used to study this relationship. We first use a graphical tool and then econometric procedures for this analysis. In this section, we look at data provided for the period from 1985 to 1996 for dollar/mark interventions and for the period from 1991 to 1996 for dollar/yen interventions.

Figures 4 to 15 provide some information on the average movements of moments of the risk neutral dollar/yen PDFs around all days on which central banks intervened in the dollar/mark and dollar/yen markets from 1985 to 1996 and 1991 to 1996, respectively. For each day up to 10 days before and 10 days after intervention, each figure shows a particular moment of the risk neutral PDF averaged over all days on which central banks entered the market. The value of the moment is normalised at zero on the day preceding the intervention. The grey area gives an indication of the variability of the changes in the moment of the PDF across all interventions.[15]

Figure 4 (Figure 6) shows the mean of the risk neutral PDF, ie the futures rate, averaged over all days on which central banks purchased dollars against yen (against marks). The value of the mean is normalised at zero on the day preceding the intervention. Figures 4 and 6 show that, on average during these sample periods, intervention in support of the dollar occurred when the dollar was trending downwards. The trend continued in the days following intervention, although at a lower rate. The dampening effect on the downward trend was more pronounced in the dollar/mark market.

Figure 5 (Figure 7) shows the mean of the risk neutral PDF averaged over all days on which central banks sold dollars against yen (marks). It shows that, on average, central banks intervened with dollar sales when the dollar was trending up. This trend moderated in the days following intervention.

It should be noted that Figures 4 to 7 look very similar when the spot rate is used instead of the mean of the PDF. Also, the amplitude of the grey areas in Figures 4 to 7 suggests that the behaviour of the mean of the PDFs varied quite substantially across individual episodes.

Figure 8 shows average tendencies for the variance of the PDFs around all days on which central banks intervened in the dollar/yen market between 1991 and 1996. Figure 9 shows the average movements of the variance of dollar/mark PDFs around all days of intervention in the dollar/mark market between 1985 and 1996. Interventions were on average followed by an increase in the variance of the PDFs, suggesting that uncertainty in the market regarding future exchange rate movements tended to be higher after interventions. However, this fact is hardly noticeable in Figures 8 and 9, since the behaviour of the variance of the PDFs varied substantially across intervention episodes, as indicated by the wide shaded areas. This is particularly the case in the dollar/yen market.

Figures 10 and 12 show that, during the above periods, central banks tended to intervene in support of the dollar when the skewness was slightly decreasing. Intervention was on average followed by a slight increase in the value of the skewness, particularly in the dollar/mark market. This suggests that on average option traders' balance of weights was moving towards a weaker dollar before interventions but edged towards a stronger in the days following interventions, as desired. Figures 11 and 13 show that on average the skewness in both the dollar/mark and the dollar/yen markets did not change noticeably around episodes of central bank sales of dollars. As for the first two moments of the PDFs, the shaded areas indicate that there was a lot of variation across individual interventions.

---

[14] As reported to the BIS for the April 1995 survey, of $44.6 billion daily turnover, $3.9 billion was exchange-traded and $40.7 billion was traded OTC.

[15] More specifically, it indicates plus/minus one standard deviation.

Finally, Figures 14 and 15 suggest that the fourth moment of the PDF, kurtosis, tended on average to increase marginally following days on which central banks intervened.

While these graphs are certainly interesting, one should be careful in using them to draw inferences about the impact of intervention for two main reasons. First, intervention could be carried out on several successive days. As a consequence, the average values of the PDF moments on a certain day could reflect not only the effect of intervention that occurred on that day, but also the effect of central bank actions carried out on previous days.

Figures 16 to 27 show the average behaviour of the four moments of PDFs around intervention episodes defined as periods of variable length in which central banks intervened. These graphs are constructed in such a way that in the 10 days before and 10 days after an intervention episode no central bank intervened in the market. Figures 16 to 27 confirm the qualitative results of Figures 4 to 15, but once the effect of intervention on successive days is taken into account, the changes of the moments around intervention episodes appear quantitatively more important.

A second shortcoming of these graphs is that, on the day that central banks intervene, other important macroeconomic or policy news may arrive that could prompt market participants to react. For example, the announcement of an unexpectedly low unemployment figure for the United States could induce traders to revise their expectations of future US interest rates upwards, thereby boosting the dollar. Intervention could also be carried out on the same day on which a participating central bank changes its monetary policy rate. The behaviour of the moments of the PDFs would then reflect the effect of both the arrival of macroeconomic or policy news and central bank intervention. The simple averages reported in Figures 4 to 27 do not allow disentangling of the influence of these different factors.

In order to assess the effect of intervention and control for these two issues, we therefore used daily data to carry out econometric analysis. We estimated the effect of intervention controlling for the effect on exchange rate expectations of releases of important macroeconomic data such as the CPI or the unemployment rate, and the announcement of changes in monetary policy that may occur on the same day, as well as the extent to which the values of these announcements came as a surprise to market participants. We extended on previous studies on intervention by using a more comprehensive set of news variables that includes variables for the United States, Japan and Germany. We also controlled for the effect of interventions that are carried out on successive days.

The reason why we included news variables in our regression analysis was that we were trying in an atheoretic fashion to capture systematic changes in expectations induced by surprises about macroeconomic or policy developments. For example, the dollar might always strengthen when employment data in the United States come in above expectations. If market participants' reaction depends on psychological factors and varies from data release to data release, the coefficients in our regressions will be close to zero, and we will have included some unnecessary variables without affecting the other results. However, if there are systematic patterns in market participants' reaction to news, eg unexpectedly high money growth in the United States leads systematically to a dollar depreciation, we must make sure not to attribute the depreciation to intervention that happened to come on the same day as the money supply data.

The statistical techniques used in this study are explained in detail in Appendix 3. One complication that must be taken into account in analysing the effect of intervention on market expectations within this approach is that both are determined simultaneously. As some of the events described above illustrate, a positive relationship between intervention and exchange rate volatility can mean that intervention increased expected volatility or that central banks intervened to dampen a rise in exchange rate volatility, or both. Appendix 3 presents a simple example that illustrates this issue, which is known in the literature as simultaneity bias, and shows how it can affect the validity of standard econometric tests. Having checked that this simultaneity bias is relevant for the data set we are using, we adopted a strategy that controls for it in the estimation of the effect of intervention on market expectations.

Tables 2 to 5 present the results from estimating the effect of intervention directed at dollar/mark and dollar/yen exchange rates on the mean, the variance and the higher moments of the distribution of expected exchange rates over the periods from 1 January 1985 to 30 August 1996 and from 1 April 1991 to 30 August 1996 respectively, according to the methodology just outlined. The focus here is on "active" intervention, ie intervention carried out with the intent to influence the exchange rate, by the Federal Reserve, the Bank of Japan and the Bundesbank. The results in Table 2 suggest that, on average during these periods, intervention had a positive impact on the dollar/mark and dollar/yen forward exchange rates on that day, though the coefficients do not reach conventional standards of

statistical significance. There is also evidence that on average intervention had a positive but statistically not significant cumulative effect on the expected future exchange rate.[16] These results do not differ significantly for the individual central banks that intervened (Tables 2b and 2d). We also found that estimating the effect of intervention on the spot rate gives the same results as for the mean of the PDFs. These results are in line with the current consensus among central banks that intervention can on particular occasions have an important influence on exchange rate levels but on its own does not have a systematic impact.

While this conclusion is consistent with part of the existing literature, this study can provide a richer description of the effects of intervention. Tests of the average effect of intervention on the skewness of the PDF show that, on average during the period under review, intervention was followed by a change in market participants' balance of weights about the future exchange rate in the desired direction (Table 4). However, this change was not significant at the 95% or 90% confidence level. This is true for both the dollar/mark and the dollar/yen markets. Taken together with the results for the mean of the PDFs, these findings suggest that on average intervention influenced both market expectations about future exchange rate levels and market participants' balance of weights between a stronger and a weaker dollar in the near future in the desired direction. However, this effect was not statistically significant.

Table 3 shows intervention directed at the dollar/mark market was not followed by any statistically significant change in the variance of expected future exchange rates. In the dollar/yen market, there is evidence of a statistically significant cumulative effect on the variance of the expected exchange rate.

Finally, there is also some evidence that intervention directed at the dollar/yen exchange rates on average had no statistically significant effect on the likelihood that market participants assigned to very large movements in either direction of the exchange rate in the future, ie the kurtosis of the PDFs.

We found no evidence of a statistically significant, independent impact of intervention conducted in the dollar/yen market on the moments of the dollar/yen rate. Similarly, intervention in the dollar/yen market did not change market conditions in the dollar/mark market independently of intervention conducted in the latter market. Finally, we found some evidence that news about macroeconomic data releases had some influence on both the level and the variance of expected exchange rates. In particular, a positive surprise on the US trade balance was found to be followed on average by a rise in the expected exchange rate of the dollar against the mark and by a lower expected variance of the expected dollar/yen rate.

3.3 Summary

This section of the study illustrated how data on central bank intervention and on the moments of expected exchange rate distributions can be used to provide information on the effects of intervention on market expectations. We showed how the four moments of this distribution - mean, variance, skewness and kurtosis - allow a more complete characterisation of the state of market expectations on a particular day. We argued that these moments might serve as new financial indicators, which, together with a wide range of other sources of information, may help inform the action of policymakers.

In this section we first presented some examples that show how the moments of the risk neutral PDF can be used to analyse the effect of intervention on market expectations. We then tried to uncover some broad average tendencies in the relationship between intervention and moments of the PDFs. In this analysis we tried to control for the influence of factors other than intervention on exchange rate expectations and for what is known in the literature as simultaneity bias. We presented evidence that, for all periods, on average intervention influenced the expected future exchange rate in the desired direction but by itself did not have a statistically significant effect, where statistical significance is measured at the usual confidence levels. This result is consistent with part of the literature on the effectiveness of FX intervention. With respect to the existing literature, however, our empirical results provide a fuller characterisation of this conclusion. They suggest that on average intervention did not lead to a statistically significant change in expected future exchange rates since it did not cause a

[16] In the statistical test, the cumulative effect of intervention on the expected future exchange rate is measured by the sum of coefficients on contemporaneous and five lags of intervention.

statistically significant shift in market participants' balance of weights between a stronger and a weaker exchange rate with respect to the forward rate. We did not detect any statistically significant effect of intervention in the dollar/mark market on uncertainty, while we found weak evidence that intervention in the dollar/yen market was followed by higher uncertainty. These results are in contrast to recent findings of the literature. We argued that this difference is due to the fact that our study uses a more careful empirical methodology. We found evidence that on average intervention by itself did not have a significant contemporaneous effect on the expected future exchange rate or traders' balance of weights between a stronger and a weaker dollar. We also found no evidence of a statistically significant cumulative effect of intervention. Consistently with these results, we found no significant contemporaneous or cumulative influence of intervention on the skewness of the PDFs. Furthermore, the interventions were not followed on average by any significant increase in uncertainty in the dollar/mark market regarding future movements in the spot rate, as measured by the variance of the PDFs. By contrast, they were followed by an increase in uncertainty prevailing in the dollar/yen market regarding future movements in the spot rate. Our empirical results also suggested that, on average during the sample periods under investigation, intervention had no statistically significant impact on the kurtosis.

We caution that, while this analysis can reveal average tendencies, it cannot by its very nature address the question of the effectiveness of intervention in specific episodes to the extent that the objectives of intervention and the circumstances in which it was carried out have varied over time. We address this issue in the next section by looking at periods over which intervention objectives and circumstances did not change substantially.

4. Intervention and market expectations in different historical contexts

This section carries the analysis further by addressing the issue that the objectives of intervention and the broad context in which it is undertaken changed over time. In order to measure the effect of intervention on market expectations, it is useful to identify periods of time over which objectives and intentions remained roughly constant. We address this issue by analysing the effect of intervention during four sub-periods: the period of the Plaza Accord (1985); the period around the Louvre Accord (1986-88); the period 1988-92, during which central banks aimed at moderating excessive fluctuations of the dollar; and the period of support of the dollar (1992-96). The choice of periods, which is obviously subjective, is based on an analysis of the official intervention data, as well as on accounts of intervention in official sources.

To analyse the relationship between the risk neutral PDFs and intervention over different time periods, we first perform an event analysis and look at changes in the parameters of the PDFs around particular intervention episodes. We then look at averages over episodes and try to uncover average tendencies for that period. The idea is not to provide a history of intervention since 1985 but rather to show how the PDFs can serve as a tool to understand the relationship between intervention and market expectations.

4.1 The period around the Plaza Accord (1985)

In the first half of the 1980s, the dollar appreciated significantly against the mark and the yen. In early 1985, current and relative cyclical positions favoured the United States with respect to Japan and Germany, leading to expectations of a monetary tightening in the United States and stable or easing monetary policy in Japan and Germany. These factors contributed to a further strengthening of the dollar against the yen and the mark. The US currency was also supported by expectations of a higher demand due to a rising US fiscal deficit and booming foreign investment in the United States. While these fundamental economic factors are consistent with the dollar's rise, the extent of the rise raised the question of a dollar bubble.

Following a wave of concerted intervention, the dollar started to decline in March. It stabilised in July, but, after a brief surge in late August, resumed its decline in mid-September, as US output growth turned out to be lower than expected. On 22 September 1985, the G5 authorities announced an agreement (the Plaza Accord) whereby exchange rates should play a role in adjusting imbalances, by better reflecting economic conditions. They expressed the view that some further orderly appreciation of the main non-dollar currencies against the dollar was desirable and that they would stand ready to

cooperate more closely to encourage this. Central banks intervened in the days immediately following the agreement, selling relatively small amounts of dollars in the dollar/mark market.

Figure 28 plots the empirical PDFs for the dollar/mark exchange rate around the days of the agreement. The sharp fall in the mean of the PDF (the forward rate) indicates that traders reacted to the news of the agreement and the concerted intervention by revising their expectations of future dollar/mark rates downwards. The rise in the variance of the PDF during the same period can be interpreted as evidence that market uncertainty about future exchange rate movements increased. While the skewness of the PDF did not change, the kurtosis increased, suggesting that, following the intervention, market participants attached a higher likelihood to big movements (in either direction) of the dollar in the near future.

Over the year as a whole, central banks sold dollars on 61 days, in the dollar/mark market. The interventions were concentrated in the periods January-February and September-October. Figures 29 to 32 report the average movements of the four moments of the PDF around all intervention episodes in the dollar/mark market in 1985. The graphs for the Plaza period should be interpreted with particular caution since during this period intervention was carried out mostly in a repeated fashion.

The statistical technique illustrated in the previous section, which takes account of the fact that intervention may be conducted on successive days, appears therefore to be more useful for uncovering average tendencies in the co-movement of intervention and market expectations. The results, which are reported in Table 6, suggest that intervention did not accelerate the declining trend of the dollar. In line with this finding, intervention turned out on average not to have a statistically significant positive impact on traders' balance of weights as measured by the skewness of the PDFs (Table 8). Moreover, there is evidence that intervention did not lead to an increase in the variance of exchange rate expectations (Table 7). We find that positive surprises about inflation developments in the United States tended to be associated with an increase in the variance of the PDF. Finally, the statistical results suggest that during this period intervention on average tended to reduce the likelihood that traders assigned to future extreme exchange rate movements in either direction, ie the kurtosis of the PDFs (Table 9). However, this effect was not statistically significant.

4.2 The period around the Louvre Accord (1986-88)

Following signs of a weakening economy and a growing trade deficit in the United States, the dollar continued to decline in 1986. By early 1987, it had lost more than 40% of its value against the mark and the yen from its highs in 1985. In the Louvre Accord announced on 22 February 1987, G6 central bank governors and finance ministers stated that the current levels of their currencies were broadly consistent with underlying economic fundamentals and that they agreed to cooperate closely to maintain stable exchange rates around those levels. Remarks by some officials in Paris also suggested that an agreement had been reached for coordinated intervention in the foreign exchange market. The agreement was accompanied by announcements of fiscal initiatives in the United States, Japan and Germany, and by a monetary policy easing in Japan. As a result, markets were reassured about the near-term outlook for the dollar. The dollar traded narrowly against the yen after the Louvre meeting. Figure 33 plots the PDFs for dollar/mark exchange rate changes around the day of the Louvre Accord. The substantial drop in the variance of the PDF on 24 February provides evidence that market sentiment became more focused after the announcement of the agreement.

Around mid-March, however, the dollar started to weaken again. The decline of the dollar reflected and spurred a portfolio shift out of US bonds. The stock market crash in October and the subsequent easing of US monetary policy contributed to a further depreciation of the US currency. On 22 December, G7 authorities again discussed ways to halt the dollar's decline and in the so-called "Telephone Accord" reaffirmed the basic objectives and policy directions set forth in the Louvre Accord. Traders were initially disappointed by the lack of specificity in the authorities' comments. As a result, the dollar was subject to strong downward pressure in thin and one-sided holiday markets, in spite of heavy intervention, which lasted for two full weeks.[17] Market participants remained

[17] Federal Reserve Bank of New York (1988, p 211).

unconvinced about the official commitment to fostering exchange rate stability until central banks intervened when trading resumed in US markets on 4 January 1988.

Figure 34 compares the dollar/yen PDFs for 23 December 1987 and 5 January 1988, showing the change in market sentiment in the days following the Accord. The higher mean of the PDF on 5 January 1988 indicates that traders increased their expected value of the dollar with respect to the yen following the Accord. The rightward shift in skewness suggests that, after the Accord took place, traders assigned more weight to a stronger rather than a weaker dollar with respect to the forward rate.

In total, central banks intervened on 87 days in the dollar/mark market during the period 1986-88. Figures 35 and 36 show that, on average during this period central banks intervened by leaning against the wind: they purchased dollars during times when it was on a declining trend and sold dollars when it was strengthening. On average, following intervention these trends moderated in the dollar/mark. Statistical tests suggest that the impact that intervention on its own had on the trend of the expected future exchange rate was not significant at the 95% or 90% confidence level (Table 10).

Figures 37 and 38 suggest that, around days on which central banks intervened, traders tended to change their balance of weights between a stronger and a weaker dollar. Consistently with the results obtained for the expected exchange rate level, however, statistical tests failed to find a significant impact of intervention on the skewness of the PDF (Table 12).

Figures 39 and 40 show that, on average during this period central banks tended to intervene when the variance of expected exchange rate movements was rising. Following intervention, this trend tended to level off. However, statistical tests show that intervention on its own did not make traders more or less certain about future exchange rate movements (Table 11). Finally, we found no evidence of a statistically significant impact of intervention on the kurtosis of the PDFs (Table 13).

4.3 Moderating excessive fluctuations of the dollar (1988-92)

Bolstered by signs of sustained growth and a tightening of US monetary policy, the dollar strengthened against the mark and the yen over most of 1988 and 1989. Central banks reacted to waves of upward pressure on the US currency by entering the dollar/mark market repeatedly to sell dollars. The US Treasury took a more active stance on its currency by selling dollars in 1989, as the strength of the US currency was seen as a threat to the adjustment of external imbalances in the United States.[18]

At a meeting on 23 September 1989, the G7 finance ministers and governors issued a communiqué in which they stated their view that the rise of the dollar over the preceding months had been inconsistent with longer-run economic fundamentals. In the communiqué they also agreed to cooperate closely in foreign exchange markets. Central banks intervened on the following day with the aim of driving down the value of the dollar. In contrast to earlier occasions, market participants came to believe that the authorities were committed to their stated exchange rate objectives. Figure 41, which plots the dollar/mark PDFs around the day of the meeting, presents evidence consistent with this view. Following the announcement of the agreement, the variance of the PDF actually declined, indicating that market expectations gained focus. At the same time, the skewness of the PDF shifted to the left, suggesting that the balance of expectations around the expected future rate shifted towards a weaker dollar.

The appreciating trend of the dollar subsided in 1990, and the dollar started to fluctuate quite strongly in both directions. As a result, in 1991 and the first part of 1992 central banks both bought and sold dollars. The intervention episode on 20 July 1992 is interesting because it shows how intervention had an impact on the market even though it involved relatively modest amounts. Against the background of a dollar that was approaching historical lows and an easing of US monetary policy, the G7 summit in early July 1992 failed to dispel the market view that officials were content with a weakening dollar. The decision of European monetary authorities to increase short-term interest rates on 16 July contributed to putting downward pressure on the dollar. Anecdotal evidence suggests that, when central banks

[18] See also Pauls (1991, p 907).

intervened in a coordinated fashion in support of the dollar on 20 July 1992, many speculators were caught by surprise. They interpreted the intervention as evidence that monetary authorities preferred a stronger dollar and were committed to cooperating closely in foreign exchange markets. As a result, the dollar/mark spot rate jumped several pfennigs on that day.

Figure 42 plots the PDF for the dollar/mark exchange rate around the 20 July intervention episode. It shows how intervention was followed by a jump in the mean (the forward rate), indicating that traders revised their expectations of future dollar levels sharply upwards. The skewness shifted to the right, suggesting that, in the view of traders, the balance of risks shifted in the direction of a stronger dollar. The variance also increased, indicating that traders became less certain of their expectations of future exchange rate movements.

Central banks intervened on 183 days in the dollar/mark market during the period 1988-92. In about 85% of the cases central banks sold dollars. Figure 43 shows the average changes of the mean of dollar/mark PDFs around all episodes of dollar purchases during this period. They show that central banks bought dollars when the dollar was depreciating. Intervention was on average followed by a reversal of this trend in the dollar/mark. Consistently, intervention tended to be associated with a shift in traders' balance of weights towards a stronger dollar vis-à-vis the mark (Figure 46).

On average, central banks sold dollars when the US currency was on an upward trend (Figure 44). Following intervention, this trend tended to be muted. Figure 47 shows no discernible change in the skewness of the PDFs around days on which central banks intervened.

The regression analysis for this period suggests that on average intervention did not alter expectations of future exchange rates in a statistically significant way (Table 14) nor traders' balance between a stronger and a weaker dollar with respect to the forward rate (Table 16).

Figure 45 shows that, on average during this period, the variance of expected dollar/mark movements did not change noticeably following intervention, suggesting that intervention was not associated on average with an increase in market uncertainty. This result is confirmed by statistical tests presented in Table 15.

Finally, Figure 48 shows that, during the period 1988-92, intervention tended to be followed by some decline in the likelihood that market participants assigned to large dollar/mark movements in either direction (the kurtosis of the PDF). Statistical tests show that, for both exchange rates, intervention did not have a statistically significant impact on the kurtosis (Table 16).

4.4 The period of dollar support (1992-96)

From August 1992 to April 1995, the dollar followed a depreciating trend against the mark and the yen. Against the yen, the dollar weakened from about ¥110 in August 1992 to about ¥80 in April 1995. During the same period, the dollar fell from DM 1.72 to DM 1.36. The dollar depreciated against the background of economic growth differentials favouring Germany and Japan over the United States. Portfolio flows, and in particular the scaling-back of foreign assets by Japanese investors, further added to the dollar's weakness.

During this period, central banks repeatedly entered foreign exchange markets in support of the dollar. On 29 April 1994, for example, the Federal Reserve intervened several times in New York morning trading to counter increasingly volatile market conditions, purchasing dollars against both the mark and the yen.[19] Figure 59 plots the empirical PDFs for the dollar/yen exchange rate around that day. It shows that the variance of the PDF, which had risen over the days preceding the intervention, declined during the following days. This can be interpreted as a case in which a central bank was successful in reducing market uncertainty about future exchange rate movements.

The difficulties that central banks encounter when they try to influence the exchange rate in a situation in which it is sharply declining and markets are very nervous are highlighted in Figure 60, which shows risk neutral PDFs for the dollar/yen exchange rate around 2 and 3 March 1995. On 2 March 1995, US monetary authorities intervened together with the Bank of Japan in support of the dollar as it fell

[19] Board of Governors (1994).

sharply against both the yen and the mark. On the next day, European central banks joined the Federal Reserve and the Bank of Japan in a concerted effort to sustain the dollar.[20] However, the efforts failed to stop the downward trend of the dollar.

Figure 60 shows that the variance of the PDFs rose over the following days, while the skewness was not affected. This suggests that, while market participants were still giving greater weight to a weaker than to a stronger dollar with respect to the forward rate following the intervention, the central banks' actions may have introduced a measure of two-way risk in the market by increasing market uncertainty.

The dollar recovered in the following months, as signs of an economic slowdown emerged in Germany and Japan and a monetary easing in Germany and Japan brought about favourable movements of interest rate differentials. In the second half of 1995 and in early 1996, central banks continued to intervene in support of the dollar but at a much lower frequency than in previous months. The dollar ended 1996 at a rate of ¥118 and DM 1.55, posting a 23 and 12% gain, respectively.

Events on 7 July 1995 highlight the relationship between intervention and the skewness of the risk neutral PDF. On that day the Bank of Japan lowered the overnight call money rate to 0.75%. On the same day, the Federal Reserve and the Bank of Japan intervened in a coordinated fashion to further bolster the dollar.[21] Figure 61 shows that on 7 July 1995 the skewness of the PDFs of the dollar/yen exchange rate shifted from left to right, as market participants switched to view the dollar as being more likely to be stronger with respect to the forward rate in the near future. During the following days, the tilt of market expectations towards a stronger dollar consolidated, as suggested by the increasingly right skewness of the PDFs. Against this background of favourable expectations, the dollar strengthened against the yen on 7 July 1995 and over the following days.

Evidence suggests effectiveness of intervention by "pushing on an open door". On 15 August 1995, US, Japanese and German authorities intervened in a concerted effort in support of the dollar. The central banks purchased dollars when the US currency was appreciating against the background of heavy Japanese buying of US bonds and option dealers' hedging (BIS (1996b)). Figure 62 shows that the PDFs around August 1995 exhibit right skewness, indicating that market participants attached greater weight to a stronger dollar than to a weaker dollar in the near future. The skewness increased on 15 August, suggesting that the intervention induced market participants to attach a higher probability to a stronger dollar over the following months. At the same time, the variance of the PDFs jumped higher on 15 and 16 August 1995 but then declined. This can be interpreted as indicating that intervention was followed by an increase in market uncertainty for a temporary period only. Moreover, the kurtosis of the PDFs increased on the day central banks intervened, suggesting that the concerted effort to boost the already appreciating dollar induced market participants to attach more weight to the possibility of further very large changes in the dollar/yen exchange rate in the near future.

Overall, between August 1992 and December 1996 central banks intervened on 154 days in support of the dollar. In all cases intervention occurred in the dollar/yen market. On 11 days central banks also bought dollars against marks.[22]

Figure 63 shows the average movements of expected dollar/yen rates implied by option prices around all 154 dollar purchases against yen between August 1992 and December 1996. It highlights that, on average, central banks intervened when the expected exchange rate of the dollar was depreciating substantially. After the intervention, the declining trend of the expected future dollar exchange rate moderated.

Statistical tests that take account of news about macroeconomic developments that might have arrived on the same day on which central banks intervened suggest that the average impact of intervention on the expected future dollar/yen rate was positive, though not significant at the 95% or 90% confidence level (Table 18). One interpretation of this result is that the change in traders' expectations varied considerably across intervention episodes, which makes it difficult to find a statistically significant impact of intervention. Consistently with these results, the statistical tests also show that intervention

---

[20] Board of Governors (1995a).

[21] Board of Governors (1995b).

[22] Given that most episodes of intervention were conducted in the dollar/yen market, this section concentrates on that market.

was followed on average by a positive change in the skewness of the PDFs, ie by traders tending to put more weight on a stronger rather than a weaker dollar with respect to the forward rate (Table 20). As with the mean of the PDFs, this effect is not statistically significant. This finding can be interpreted as suggesting that on average intervention on its own did not bring about a change in the trend of expected future exchange rates since it did not cause a significant shift in market participants' balance of weights between a stronger and a weaker dollar in the near future

Table 19 shows that from 1992 to 1996 intervention tended to be followed by some decrease in the variance of the PDFs, although this effect is not found to be statistically significant. This result suggests that, similarly to findings for other periods, intervention on average did not affect market uncertainty about future exchange rate movements. Finally, during the period 1992 to 1996 intervention appears not to have influenced the likelihood that traders assigned to extreme dollar/yen movements in either direction (Table 20).

4.5 Summary

This section investigated the effect of intervention on market expectations during periods for which the objectives and the context of intervention had been roughly constant. We first followed an event study methodology and presented a number of cases, which suggested that, depending on circumstances, particular interventions did succeed in influencing market participants' expectations of future exchange rates. The analysis also highlighted how the impact of interventions varied considerably across episodes. In this section we also used econometric techniques to examine average tendencies for each period and found no evidence that intervention on its own had a statistically significant, systematic impact on expected future exchange rates. Hence, the interpretation of the results of this section depends in part on the reader's views about the informativeness of the two approaches used to identify the impact of intervention.

The event analysis of the period around the Plaza Accord in September 1985 showed that after a series of interventions to sell dollars, the mean of the PDFs (the expected level of the dollar in the near future) fell sharply. This also followed the announcement that some further orderly appreciation of the main non-dollar currencies against the dollar was desirable and that the G5 authorities would stand ready to cooperate more closely to encourage this. By contrast, the skewness, ie market participants balance between a stronger and a weaker dollar with respect to the forward rate, was unaffected by these official actions. At the same time, the variance of the PDFs, which we interpret as a measure of market uncertainty, and kurtosis, ie the likelihood traders assigned to large movements of the dollar in either direction, increased.

The Louvre Accord in February 1987 led to a statement by the G6 central bank governors and finance ministers that the current levels of their currencies were broadly consistent with underlying economic fundamentals and that they had agreed to cooperate closely to maintain stable exchange rates around those levels. The Accord did not seem to affect the mean or the skewness of exchange rate expectations but it was followed by a substantial drop in the variance. Following an agreement by G7 authorities in December 1987 (the "Telephone Accord"), in which authorities reaffirmed the basic objectives of the Louvre Accord, the dollar declined markedly in spite of heavy, concerted intervention. Moreover, PDFs remained skewed to the left, suggesting that traders continued to assign more weight to a weaker rather than a stronger dollar with respect to the dollar/mark forward rate. In contrast, heavy intervention in January 1988 affected both traders' expectations of future exchange rates and the skewness of these expectations in the desired direction.

The episode in September 1992 highlighted how coordinated intervention in support of the dollar was successful even though it involved only small amounts. Following the dollar purchases, traders expected a stronger dollar in the near future and the skewness of expectations moved more in favour of the dollar. We then presented two cases in which central banks purchased dollars in 1994 and early 1995 to illustrate how intervention had different effects on market uncertainty during this period. The analysis of the successful concerted intervention in support of the dollar in August 1995 emphasised how central banks purchased dollars when the skewness was already moving in favour of the dollar. At the same time, intervention also raised both the variance and the kurtosis of market expectations.

As a complement to the event study approach, we looked at averages over episodes to uncover broad average tendencies for each sub-period, controlling for the influence of factors other than intervention and for the simultaneity bias. When we followed this approach, extending on empirical methodologies commonly followed in the literature, we found no statistically significant contemporaneous or

cumulative effect of intervention on the expected future exchange rate level (the mean of the PDFs). The results for the period around the Plaza Accord, for example, suggest that intervention per se did not determine any statistically significant change in market participants' expected future dollar/mark rate. We argued that this these results could be explained by the fact that changes in traders' expectations varied considerably across intervention episodes, which makes it difficult to find a statistically significant impact of intervention. This conclusion is in line with a consensus that has emerged among central banks and part of the literature on the effectiveness of intervention.

However, while all previous studies on intervention focused only on the mean and the variance of market expectations, this study also investigated the effect of intervention on the higher moments of expectations and hence provided a fuller characterisation of this conclusion. We found that the evidence for the skewness was generally consistent with the results for the expected exchange rate level. This suggests that on average intervention did not produce a significant change in the trend of the expected future exchange rate since it did not cause a shift in market participants' balance of weights between a stronger and a weaker exchange rate with respect to the forward rate.

We also examined the average impact of intervention on the variance of the PDFs during different periods. Statistical tests that control for the effect of macroeconomic factors show that, on average during all periods, intervention tended to respond to an increase in market uncertainty but did not lead to higher market uncertainty. This result is in clear contrast with most of the recent studies of intervention, which concluded that intervention causes an increase in the variance of expected future exchange rates. Statistical tests show that the difference in results can be explained by the fact that we adopted a more accurate empirical methodology to address the simultaneity issue discussed in Section 3.2. Appendix 3 contains a detailed analysis of this issue, our approach to tackling it and how it differs from other methods that have been used in the literature.

Finally, we presented evidence that the effect of intervention on market participants' assessment of the likelihood of large future exchange rate movements in either direction, ie the kurtosis of the PDFs, varied over time and across markets. Statistical tests showed that in all the different periods, the average impact of intervention on the kurtosis was not significant.

It is important to keep in mind that our results need to be interpreted with caution since the estimated PDFs capture both market views as to the likelihood of particular exchange rate outcomes and market preferences towards risk. As Section 3.1 has highlighted, in the absence of strong assumptions, it is impossible to distinguish between the two.

5. Impact of different intervention strategies

Different intervention strategies may affect market expectations in different ways. The impact may depend on whether intervention is carried out unilaterally or in cooperation with other central banks, whether it is publicly announced or carried out discreetly, whether it involves small or large amounts, or whether it is carried out on a single day or repeatedly over successive days.

In this section we investigate whether the effect of intervention differs according to the strategy that is followed. In order to compare the effect of these different intervention strategies, we focus on a particular period, August 1992 to December 1996. During this period, the objectives of intervention and the context in which intervention took place were broadly consistent, but different intervention strategies were applied at various times. Moreover, since all episodes of intervention involved dollar purchases in the dollar/yen market, the analysis in this section will concentrate on that market.

Table 34 reports the frequency with which the different intervention strategies were followed in the dollar/mark and in the dollar/yen market during this period. In 88% of cases, intervention in support of the dollar was conducted unilaterally by the Bank of Japan. In the other cases, at least one other central bank entered the market on the same day. Table 33 shows that almost all interventions during the 1992-96 period were conducted discreetly, while intervention was officially announced only about 5% of the cases.

The definition of an intervention as “heavy” or “light” is necessarily arbitrary and obviously depends on the time period that is considered. For the purpose of this analysis we define an intervention as “heavy” (“light”) when it involves at least (less than) $1 billion. About 20% of the interventions that were carried out during the period from August 1992 to December 1996 were heavy (Table 34).[23]

Finally, we distinguish intervention that occurs only on a single day from intervention that is carried out repeatedly. In this study we define an intervention as “single-day” when central banks abstained from entering the markets during the five preceding and the five following business days. We classify an intervention as “repeated” if central banks entered the markets at least twice within a period of 10 days. Between 1992 and 1996 intervention was carried out mostly in a repeated fashion. In only about 6% of all cases did central banks intervene no more than once within a time span of 10 business days. In all other cases intervention was conducted at least twice within that span. There are altogether 15 “clusters” of intervention, ie episodes during which central banks intervened more than once within 10 days.

Figures 67 to 70 show that on average the change in the mean of the PDFs around episodes of intervention is only slightly dissimilar for different intervention strategies. Concerted and officially announced interventions in support of the dollar appear to have a marginally bigger impact on expected future dollar/yen rates. Consistently with this result, Figures 75 to 78 show that the average change in the skewness of the PDF appeared to be somewhat more sizeable for concerted and officially announced interventions. While these results appear to provide some support for the signalling channel, in line with the general consensus in the literature on the effectiveness of intervention, statistical tests that control for policy changes and surprises about macroeconomic news indicate that this difference is not statistically significant (Tables 22 and 24). Based on these tests we conclude that, for the period 1992-96, the existence of a signalling channel is not evident in the data for the dollar/yen market. One interpretation of this result is that, although only a small fraction of interventions conducted between 1992 and 1996 were officially announced, in all cases traders noticed when central banks entered the dollar/yen market.[24]

Figures 71 to 74 indicate that, during the period 1992-96, following intervention the variance of the PDFs tended to increase when the intervention was concerted, officially announced and large. However, as in the case of the mean of the PDF, statistical tests suggest that these differences are not statistically significant (Table 23). Finally, Figures 79 to 82 reveal that on average different intervention strategies had a very similar impact on the likelihood assigned by market participants to extreme changes in the dollar/yen rate in the near future, ie the kurtosis of the PDFs. The only exception appears to be intervention that is officially announced, which seemed to be followed by a somewhat more pronounced rise in the kurtosis. However, statistical tests indicate that this difference is not statistically significant (Table 25).

In conclusion, while there is some evidence that for the period 1992-96 concerted interventions may have had a stronger impact on market expectations, econometric results suggest that different intervention strategies did not seem to have systematically dissimilar effects at the 95% or 90% confidence level. This result casts doubts on the importance of the signalling channel, which predicts that intervention has a more pronounced effect when it is conducted in a more visible way.

However, we caution the reader that the power of the statistical tests that we used is weakened because the sample period is quite short and hence there are not many observations on the different intervention strategies. Extending the sample period could circumvent this problem but would violate the assumption of constant context of intervention. A solution to this problem would require a rigorous approach to modelling separately the decision to intervene and choice of a particular strategy given the decision to intervene. This appears to be an interesting area for future research.

---

[23] A threshold of $5 billion for large interventions would appear more appropriate if this analysis were carried out for the last two to three years. During this period, the size of interventions in the major foreign exchange markets increased markedly.

[24] During this period, traders actually tended to overestimate the number of interventions in the dollar/yen market. On about 40 days market participants thought that central banks had entered the market even though this was actually not the case.

References

Aguilar, Javiera and Stefan Nydahl (1998): "Central bank intervention and exchange rates: the case of Sweden", *Sveriges Riksbank Working Paper Series*, no 54.

Almekinders, Geert J (1995): *Foreign Exchange Intervention. Theory and Evidence*, Edward Elgar.

Almekinders, Geert J and Sylvester Eijffinger (1991): "Empirical Evidence on Foreign Exchange Market Intervention: Where Do We Stand?", *Weltwirtschaftliches Archiv*, pp 645-77.

——— (1996): "A friction model of daily Bundesbank and Federal Reserve intervention", *Journal of Banking and Finance*, vol 20, pp 1365-80.

Baillie, Richard and Owen Humpage (1992): "Post-Louvre intervention: Did target zones stabilise the dollar?" *Federal Reserve Bank of Cleveland Working Paper*, no 9203.

Baillie, Richard, Owen Humpage and William Osterberg (1999): "Intervention as information: a survey" *Federal Reserve Bank of Cleveland Working Paper*, no 9918.

Baillie, Richard and William P Osterberg (1997a): "Why do central banks intervene?" *Journal of International Money and Finance*, vol 16, no 6, pp 909-19.

——— (1997b): "Central bank intervention and risk in the forward market". *Journal of International Economics*, vol. 43, pp 483-97.

Bank for International Settlements (1998): *Report of the Working Group on Exchange Market Intervention*, January.

——— (1995): *The macroeconomic and monetary policy implications of the growth of derivatives markets*.

——— (1996a): *Central bank survey of foreign exchange and derivatives markets activity 1995*.

——— (1996b): *66th Annual Report*.

——— (1999a): *Central bank survey of foreign exchange and derivatives markets activity 1998*.

——— (1999b): *Estimating and interpreting probability density functions*, proceedings of the workshop held at the BIS on 14 June 1999.

——— (2002): *Central bank survey of foreign exchange and derivatives markets activity 2001*.

Board of Governors of the Federal Reserve (1994): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, July.

——— (1995a): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, June.

——— (1995b): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, December.

——— (1996a): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, March.

——— (1996b): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, June.

——— (1996c): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, September.

——— (1996d): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, December.

——— (1997a): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, March.

——— (1997b): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, June.

——— (1997c): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, September.

——— (1997d): "Treasury and Federal Reserve foreign exchange operations", *Federal Reserve Bulletin*, December.

Bonser-Neal, Catherine (1996): "Does central bank intervention stabilize foreign exchange rates?" *Federal Reserve Bank of Kansas City Economic Review*, vol.81, no 1.

Bonser-Neal, Catherine and Glenn Tanner (1996): "Central bank intervention and the volatility of foreign exchange rates: evidence from the options market", *Journal of International Money and Finance*, vol 15, no 6, pp 853-78.

Borio, Claudio (1997): "The implementation of monetary policy in industrial countries: a survey", *BIS Economic Papers*, no 47.

Catte, Pietro, Giampaolo Galli and Salvatore Rebecchini (1994): "Concerted interventions and the dollar: an analysis of daily data", in Kenen, Papadia and Saccomanni (eds.) *The international monetary system*, Cambridge University Press, Cambridge.

Chang, P H Kevin and William R. Melick (1999): "Background note", in *Estimating and interpreting probability density functions*, proceedings of the workshop held at the Bank for International Settlements on 14 June 1999.

Chang, Yuanchen and Stephen J Taylor (1998): "Intraday effects of foreign exchange intervention by the Bank of Japan". *Journal of International Money and Finance*, vol 17, pp 191-210.

Chaudury and Wei (1994): "Upper bounds for American futures options: a note", *Journal of Futures Markets*, 14, February, pp 111-16.

Connolly, Robert and William Taylor (1994): "Volume and intervention effects of yen/$ exchange rate volatility, 1977-1979", in *Advances in Financial Planning and Forecasting*, vol 5, JAI Press, Greenwich, Connecticut.

Dominguez, Kathryn (1993): "Does central bank intervention increase the volatility of foreign exchange rates?" *NBER Working Paper* no 4532.

——— (1996): "The international evidence: an assessment of experience with foreign exchange intervention in the G-3", mimeo, Kennedy School of Government, Harvard University.

——— (1998): "Central bank intervention and exchange rate volatility", *Journal of International Money and Finance*, vol 17, pp 161-90.

Dominguez, Kathryn and Jeffrey Frankel (1993a): *Does foreign exchange intervention work?*", Institute for International Economics, Washington.

——— (1993b): "Does foreign exchange intervention matter? The portfolio effect", *American Economic Review*.

Edison, Hali (1993): "The effectiveness of central bank intervention: a survey of the literature after 1982", *Princeton University Special Papers in International Economics* no 18.

Eijffinger, Sylvester and Noud Gruijters (1991): "On the short term objectives of daily intervention by the Deutsche Bundesbank and the Federal Reserve System in the US dollar/Deutsche mark exchange market", *Kredit und Kapital*, 24, March, pp 50-72.

Fatum, Rasmus (2000): "On the effectiveness of sterilized foreign exchange intervention", *European Central Bank Working Paper Series*, February.

Federal Reserve Bank of New York (1988): "Foreign exchange operations of the Treasury and the Federal Reserve", *FRBNY Quarterly Review*, April.

Figlewski, Stephen (1997): "Forecasting volatility", *Financial Markets, Institutions & Instruments*, 6 (1), New York University Salomon Center.

Frankel, Jeffrey and Charles Engel (1984): "Do asset demand functions optimize over the mean and variance of real returns? A six-currency test". *Journal of International Economics*, 17, pp 309-23.

Funabashi, Yoichi (1988): *Managing the dollar: from the Plaza to the Louvre*, Institute for International Economics, Washington.

Gaiotti, E, P Giucca and S Micossi (1989): "Cooperation in managing the dollar (1985-87): Interventions in foreign exchange markets and interest rates", Bank of Italy, *temi di Discussione del Servizio Studi*, no 119, June.

Galati, Gabriele (2001) "Why has global FX turnover declined? Explaining the 2001 triennial survey", *BIS Quarterly Review*, December, pp 39-47.

Goodhart, Charles A E and T Hesse (1993): "Central bank forex intervention assessed in continuous time", J*ournal of International Money and Finance*, vol 12, pp 386-9.

Humpage, Owen (1999): "US intervention: assessing the probability of success", *Journal of Money, Credit and Banking*, vol 31, no 4.

Hung, Juann H (1997): "Intervention strategies and exchange rate volatility: A noise trading perspective", *Journal of International Money and Finance*, vol. 16, no 5, pp 779-93.

Kaminsky, Graciela and Karen Lewis (1996): "Does foreign exchange intervention signal future monetary policy?" *Journal of Monetary Economics*, vol 37, pp 285-312.

Klein, Michael and Karen Lewis (1991): "Learning about intervention target zones". *National Bureau of Economic Research Working Paper*, no 3674.

Klein, Michael and Eric Rosengren (1991): "Foreign exchange intervention as a signal of monetary policy", *New England Economic Review*, May/June, pp 39-50.

Leahy, Michael (1995): "The profitability of US intervention in the foreign exchange markets", *Journal of International Money and Finance*, vol 14, no 6, pp 823-44.

Lewis, Karen (1988): "Testing the portfolio balance model: a multi-lateral approach", *Journal of International Economics*, 24 (February), pp 109-27.

——— (1995): "Are foreign exchange interventions and monetary policy related, and does it really matter?" *Journal of Business*, 68, no 2, pp 185-214.

Lyons, Richard (1997): "A simultaneous trade model of the foreign exchange hot potato", microstructure *Journal of Financial Economics*.

——— (2001): *The microstructure approach to exchange rates*, MIT Press.

Malz, Alan (1996): "Over-the-counter currency option markets", mimeo, Federal Reserve Bank of New York.

McCauley, Robert and William Melick (1996a): "Risk reversal risk", *Risk*, vol 9, no 11, November.

——— (1996b): "Propensity and Density", *Risk*, vol 9, no 12, December.

Melick, William and Charles Thomas (1997): "Using option prices to infer PDFs for asset prices: an application to oil prices during the gulf crisis". *Journal for International Money and Finance*.

Murray, John, Mark Zelmer and Des McManus (1996): "The effect of intervention on Canadian dollar volatility", paper presented at the conference on Exchange Rates and Monetary Policy held by the Bank of Canada, October.

Pauls, Diane (1991): "US exchange rate policy: Bretton Woods to present", *Federal Reserve Bulletin*, November.

Peiers, Bettina (1997): "Informed traders, intervention, and price leadership: a deeper view of the microstructure of the foreign exchange market", *The Journal of Finance*, vol LII, no 4, September.

Ramaswamy, Ramana and Hossein Samiei (2000): "The yen/dollar rate: have interventions mattered?" *IMF Working Paper* WP/00/95.

Rogoff, Kenneth (1984): "On the effects of sterilized intervention: an analysis of weekly data", *Journal of Monetary Economics*, vol 14, September.

Sweeney, Richard (1997): "Do central banks lose on foreign-exchange intervention? A review article", *Journal of Banking and Finance*, 21, pp 1667-84.

Zurlinden, Mathias (1996): "Devisenmarktinterventionen der Schweizer Nationalbank 1986-1994", *Quartalsheft SNB*, 2/96.

Tables and graphs

Table 1

Foreign exchange turnover and official reserves in G10 and emerging market countries

	Foreign exchange turnover (local turnover of the domestic currency)[1,2]	Foreign exchange reserves	Foreign exchange turnover (local turnover of the domestic currency)[1,2]	Foreign exchange reserves
	billions of US dollars			
	Daily averages	End-of-month	Daily averages	End-of-month
	April 1995		October 1997	
US dollar/United States	210.2	51.8	–	32.6
Japanese yen/Japan	130.7	143.1	–	217.4
Deutsche mark/Germany	57.9	74.6	–	70.6
Pound sterling/United Kingdom	74.2	40.1	–	30.8
French franc/France	32.5	22.4	–	26.3
Canadian dollar/Canada	20.9	12.1	–	19.5
Italian lira/Italy	19.0	25.4	–	52.6
Dutch guilder/Netherlands	10.5	34.8	–	24.1
Belgian franc/Belgium	9.3	15.2	–	15.5
Swedish krona/Sweden	10.0	23.7	–	13.6
Swiss franc/Switzerland	35.5	29.8	–	33.5

[1] Estimates as reported by the respective central banks for a period as near as possible to April 1995 and October 1997 respectively. [2] Net of local double-counting unless otherwise specified.

Sources: BIS; National central banks; IMF.

Table 2a

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1991-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	1.23497	0.32	0.75	0 to 5	0.8357	0.31	0.76
DM/$ int. Fed	0	139.4029	0.29	0.77	–	–	–	–
DM/$ int. Buba	0	51.60135	0.21	0.83	–	–	–	–
Concert. dummy	0	– 1578.91	– 0.3	0.77	–	–	–	–
CPI	0	– 439.998	– 0.25	0.8	0 to 5	546.578	0.17	0.86
PPI	0	– 393.193	– 0.29	0.77	0 to 5	– 92.1518	– 0.08	0.94
IP US	0	47.99063	0.09	0.92	0 to 5	– 2829.17	– 0.3	0.76
TRADE US	0	– 95.4358	– 0.35	0.73	0 to 5	143.6193	0.26	0.79
UNEMP	0	– 221.781	– 0.27	0.79	0 to 5	1910.259	0.32	0.75
TANKAN	0	– 2.63921	– 0.24	0.81	0 to 5	– 16.6781	– 0.33	0.74
IP JP	0	89.05944	0.31	0.75	0 to 5	105.1548	0.32	0.75
RETAIL JP	0	– 52.7989	– 0.32	0.75	0 to 5	– 201.313	– 0.34	0.74
TRADE JP	0	0.28489	0.09	0.93	0 to 5	3.21697	0.28	0.78

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 April 1991 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 2b

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1991-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	0.1925	0.47	0.64	0 to 5	0.08355	0.27	0.79
Fed intervention	0	– 1.06811	– 0.15	0.88	0 to 5	– 0.83547	– 0.11	0.91
DM/$ int. Fed	0	142.9977	0.26	0.8	–	–	–	–
DM/$ int. Buba	0	– 121.369	– 0.31	0.76	–	–	–	–
Concert. dummy	0	26.72432	0.01	0.99	–	–	–	–
CPI	0	383.1763	0.53	0.6	0 to 5	– 26.0899	– 0.02	0.99
PPI	0	– 101.868	– 0.23	0.81	0 to 5	– 140.746	– 0.16	0.87
IP US	0	130.5026	0.27	0.79	0 to 5	– 716.541	– 0.48	0.63
TRADE US	0	– 22.139	– 0.56	0.58	0 to 5	75.30881	0.44	0.66
UNEMP	0	– 201.735	– 0.48	0.63	0 to 5	– 372.352	– 0.19	0.85
TANKAN	0	0.48137	0.13	0.9	0 to 5	– 3.10884	– 0.46	0.65
IP JP	0	– 55.2112	– 0.79	0.43	0 to 5	– 58.7511	– 0.59	0.56
RETAIL JP	0	– 12.62	– 0.34	0.73	0 to 5	– 24.5505	– 0.3	0.77
TRADE JP	0	– 0.25464	– 0.18	0.85	0 to 5	0.80774	0.3	0.76

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 April 1991 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 2c

Estimates of the effect of intervention on the mean of the PDF, dollar/mark, 1985-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.02	0.20	0.84	0 to 5	0.05	1.05	0.29
Concert. dummy	0	26.13	1.98	0.05	–	–	–	–
CPI	0	59.19	0.75	0.45	–	130.92	0.72	0.47
PPI	0	28.74	0.95	0.34	0 to 5	100.04	1.38	0.17
IP	0	52.72	1.50	0.13	0 to 5	– 50.21	– 0.57	0.57
TRADE	0	13.62	2.60	0.01	0 to 5	6.38	0.46	0.64
UNEMP	0	– 76.93	– 1.46	0.14	0 to 5	113.83	0.90	0.37

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1985 to 30 August 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 2d

Estimates of the effect of intervention on the mean of the PDF, dollar/mark, 1985-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	– 6.51	– 0.38	0.70	0 to 5	– 3.94	– 0.40	0.69
Fed intervention	0	1.34	0.40	0.69	0 to 5	1.51	0.45	0.65
Concert. dummy	0	– 259.38	– 0.34	0.73	0 to 5	–	–	–
CPI	0	– 181.45	– 0.25	0.80	0 to 5	216.33	0.28	0.78
PPI	0	137.94	0.45	0.65	0 to 5	231.46	0.50	0.61
IP	0	158.54	0.49	0.63	0 to 5	– 121.77	– 0.30	0.76
TRADE	0	0.00	0.00	1.00	0 to 5	27.88	0.34	0.73
UNEMP	0	– 38.92	– 0.17	0.87	0 to 5	– 106.47	– 0.15	0.88

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1985 to 30 August 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 3a

Estimates of the effect of intervention on the variance of the PDF, dollar/yen,1991-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 0.33317	– 0.27	0.79	0 to 5	– 0.04403	– 0.07	0.95
DM/$ int. Fed	0	– 375.13	– 0.79	0.43	–	–	–	–
DM/$ int. Buba	0	– 183.702	– 0.7	0.48	–	–	–	–
Concert. dummy	0	1832.568	0.94	0.35	–	–	–	–
CPI	0	323.6789	0.22	0.82	0 to 5	3141.426	0.78	0.43
PPI	0	– 470.509	– 0.64	0.52	0 to 5	769.624	0.35	0.72
IP US	0	668.2235	0.76	0.45	0 to 5	2173.069	0.52	0.61
TRADE US	0	– 24.3624	– 0.22	0.82	0 to 5	– 318.708	– 1.16	0.25
UNEMP	0	– 515.054	– 0.47	0.64	0 to 5	378.0907	0.14	0.89
TANKAN	0	– 4.73743	– 0.53	0.6	0 to 5	– 8.21351	– 0.43	0.67
IP JP	0	144.805	0.83	0.41	0 to 5	36.63269	0.2	0.84
RETAIL JP	0	– 144.553	– 1.35	0.18	0 to 5	152.4295	0.5	0.61
TRADE JP	0	– 2.71218	– 0.67	0.5	0 to 5	– 6.40471	– 1.09	0.28

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 April 1991 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 3b

Estimates of the effect of intervention on the variance of the PDF, dollar/yen, 1991-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 2.33115	– 0.25	0.80	0 to 5	– 1.80281	– 0.28	0.78
Fed intervention	0	– 19.1526	– 0.37	0.71	0 to 5	– 11.872	– 0.22	0.83
DM/$ int. Fed	0	– 240.365	– 0.04	0.97	–	–	–	–
DM/$ int. Buba	0	– 667.905	– 0.26	0.79	–	–	–	–
Concert. dummy	0	11741.95	0.55	0.58	–	–	–	–
CPI	0	2574.024	0.39	0.69	0 to 5	2199.266	0.14	0.89
PPI	0	– 1066.02	– 0.38	0.70	0 to 5	2103.934	0.28	0.78
IP US	0	– 1807.98	– 0.32	0.75	0 to 5	7003.648	0.24	0.81
TRADE US	0	– 270.9	– 0.38	0.70	0 to 5	– 405.179	– 0.35	0.73
UNEMP	0	– 536.132	– 0.14	0.89	0 to 5	– 2146.82	– 0.21	0.83
TANKAN	0	3.2751	0.09	0.93	0 to 5	9.48912	0.12	0.91
IP JP	0	877.9407	0.39	0.70	0 to 5	842.5885	0.38	0.70
RETAIL JP	0	– 342.721	– 0.55	0.58	0 to 5	– 9.20131	– 0.01	0.99
TRADE JP	0	– 0.81183	– 0.05	0.96	0 to 5	– 6.06235	– 0.30	0.76

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 April 1991 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 3c

Estimates of the effect of intervention on the variance of the PDF, dollar/mark, 1985-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	1.04	0.50	0.62	0 to 5	0.61	0.36	0.72
Concert. dummy	0	– 59.63	– 0.10	0.92	–	–	–	–
CPI	0	– 1468.35	– 1.16	0.24	0 to 5	– 2297.14	– 0.74	0.46
PPI	0	– 547.75	– 1.00	0.32	0 to 5	– 2600.35	– 1.81	0.07
IP	0	784.67	1.28	0.20	0 to 5	– 2755.63	1.57	0.12
TRADE	0	– 97.19	– 1.15	0.25	0 to 5	– 386.01	– 1.63	0.10
UNEMP	0	647.78	0.71	0.48	0 to 5	– 769.68	– 0.34	0.73

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1985 to 30 August 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 3d

Estimates of the effect of intervention on the variance of the PDF, dollar/mark, 1985-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	147.72	0.28	0.78	0 to 5	111.96	0.28	0.78
Fed intervention	0	– 13.55	– 0.27	0.79	0 to 5	– 8.58	– 0.25	0.81
Concert. dummy	0	– 19102.91	– 0.27	0.78	–	–	–	–
CPI	0	– 1344.25	– 0.21	0.83	0 to 5	– 28354.47	– 0.30	0.77
PPI	0	3607.00	0.23	0.82	0 to 5	4598.57	0.17	0.86
IP	0	– 3545.25	– 0.22	0.83	0 to 5	518.35	0.04	0.97
TRADE	0	– 412.68	– 0.33	0.74	0 to 5	– 1346.24	– 0.36	0.72
UNEMP	0	6088.55	0.31	0.76	0 to 5	10652.67	0.25	0.80

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1985 to 30 August 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 4a

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1991-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.15474	0.63	0.53	0 to 5	0.09331	0.67	0.50
DM/$ int. Fed	0	–16.0302	– 0.32	0.75	–	–	–	–
DM/$ int. Buba	0	–3.57202	– 0.08	0.94	–	–	–	–
Concert. dummy	0	–122.191	– 0.37	0.71	–	–	–	–
CPI	0	145.6627	0.60	0.55	0 to 5	573.9685	1.08	0.28
PPI	0	–5.89579	– 0.05	0.96	0 to 5	–242.311	– 0.92	0.36
IP US	0	–1.24796	– 0.01	0.99	0 to 5	–254.539	– 0.33	0.74
TRADE US	0	–9.16198	– 0.48	0.63	0 to 5	30.22595	0.57	0.57
UNEMP	0	–69.4217	– 0.46	0.65	0 to 5	706.2211	1.54	0.12
TANKAN	0	0.48374	0.33	0.74	0 to 5	–3.52511	– 0.95	0.34
IP JP	0	20.33432	0.89	0.37	0 to 5	41.83709	1.32	0.19
RETAIL JP	0	13.31115	0.88	0.38	0 to 5	–19.1005	– 0.48	0.63
TRADE JP	0	0.0688	0.11	0.91	0 to 5	–0.26974	– 0.24	0.81

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 April 1991 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 4b

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1991-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	0.09482	0.34	0.73	0 to 5	0.02211	0.21	0.83
Fed intervention	0	–0.53858	– 0.21	0.83	0 to 5	–0.16666	– 0.08	0.94
DM/$ int. Fed	0	19.80906	0.10	0.92	–	–	–	–
DM/$ int. Buba	0	–47.2576	– 0.37	0.71	–	–	–	–
Concert. dummy	0	135.7265	0.19	0.85	–	–	–	–
CPI	0	259.3289	1.11	0.27	0 to 5	718.7085	1.18	0.24
PPI	0	41.52302	0.26	0.79	0 to 5	–153.366	– 0.39	0.69
IP	0	58.60457	0.31	0.76	0 to 5	–34.2329	– 0.05	0.96
TRADE	0	–6.32461	– 0.30	0.77	0 to 5	19.97604	0.32	0.75
UNEMP	0	–82.4977	– 0.49	0.63	0 to 5	499.6008	0.94	0.35
TANKAN	0	0.81533	0.55	0.58	0 to 5	–2.27897	– 0.75	0.45
IP JP	0	0.3603	0.02	0.98	0 to 5	18.31487	0.62	0.53
RETAIL JP	0	16.86586	1.06	0.29	0 to 5	–9.46163	– 0.25	0.80
TRADE JP	0	0.01936	0.03	0.97	0 to 5	–0.49428	– 0.47	0.64

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 April 1991 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 4c

Estimates of the effect of intervention on the skewness of the PDF, dollar/mark, 1985-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.07	0.30	0.77	0 to 5	0.05	0.33	0.74
Concert. dummy	0	5.11	0.13	0.89	–	–	–	–
CPI	0	456.03	1.98	0.05	0 to 5	1147.41	2.15	0.03
PPI	0	– 228.40	– 2.57	0.01	0 to 5	57.49	0.27	0.79
IP	0	– 89.43	– 0.87	0.39	0 to 5	41.64	0.16	0.87
TRADE	0	4.81	0.31	0.75	0 to 5	– 18.62	– 0.45	0.65
UNEMP	0	– 278.07	– 1.79	0.07	0 to 5	167.98	0.45	0.65

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1985 to 30 August 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 4d

Estimates of the effect of intervention on the skewness of the PDF, dollar/mark, 1985-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	18.02	0.11	0.91	0 to 5	10.01	0.11	0.91
Fed intervention	0	– 3.63	– 0.11	0.91	0 to 5	– 3.26	– 0.10	0.92
Concert. dummy	0	769.53	0.11	0.91	–	–	–	–
CPI	0	1261.30	0.17	0.86	0 to 5	1177.15	0.56	0.58
PPI	0	– 508.42	– 0.19	0.85	0 to 5	– 207.22	– 0.08	0.94
IP	0	– 419.07	– 0.14	0.89	0 to 5	339.46	0.11	0.91
TRADE	0	41.83	0.12	0.90	0 to 5	– 75.75	– 0.14	0.89
UNEMP	0	– 234.81	– 0.33	0.74	0 to 5	874.32	0.13	0.90

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1985 to 30 August 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 5a

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1991-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 1.46	– 0.94	0.35	0 to 5	– 0.21	– 0.24	0.81
DM/$ int. Fed	0	51.20	0.09	0.93	–	–	–	–
DM/$ int. Buba	0	– 122.14	– 0.35	0.73	–	–	–	–
Concert. dummy	0	2830.93	1.15	0.25	–	–	–	–
CPI	0	– 2209.12	– 1.04	0.3	0 to 5	– 1568.82	– 0.28	0.78
PPI	0	– 1611.90	– 1.56	0.12	0 to 5	1683.07	0.53	0.60
IP	0	– 557.48	– 0.46	0.64	0 to 5	7730.72	1.41	0.16
TRADE	0	– 142.73	– 0.93	0.35	0 to 5	– 216.60	– 0.55	0.59
UNEMP	0	– 424.17	– 0.27	0.79	0 to 5	1111.51	0.29	0.77
TANKAN	0	– 9.87	– 0.77	0.44	0 to 5	– 27.01	– 0.96	0.34
IP JP	0	181.34	0.77	0.44	0 to 5	26.83	0.10	0.92
RETAIL JP	0	– 56.14	– 0.38	0.7	0 to 5	– 316.40	– 0.73	0.47
TRADE JP	0	2.17	0.37	0.71	0 to 5	– 6.99	– 0.84	0.40

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 April 1991 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 5b

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1991-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 1.67	– 0.23	0.82	0 to 5	– 0.67	– 0.13	0.90
Fed intervention	0	– 17.35	– 0.59	0.56	0 to 5	– 12.99	– 0.42	0.68
DM/$ int. Fed	0	803.17	0.25	0.81	–	–	–	–
DM/$ int. Buba	0	– 729.84	– 0.54	0.59	–	–	–	–
Concert. dummy	0	9406.46	0.75	0.45	–	–	–	–
CPI	0	– 526.42	– 0.10	0.92	0 to 5	– 494.55	– 0.05	0.96
PPI	0	– 1909.21	– 1.11	0.27	0 to 5	2385.07	0.51	0.61
IP	0	– 2185.19	– 0.65	0.51	0 to 5	7503.53	0.31	0.75
TRADE	0	– 300.56	– 0.81	0.42	0 to 5	– 312.27	– 0.43	0.67
UNEMP	0	– 312.52	– 0.11	0.92	0 to 5	– 1080.79	– 0.17	0.86
TANKAN	0	– 4.89	– 0.24	0.81	0 to 5	– 12.18	– 0.26	0.79
IP JP	0	468.53	0.26	0.79	0 to 5	437.43	0.29	0.77
RETAIL JP	0	– 140.99	– 0.35	0.73	0 to 5	– 338.70	– 0.43	0.67
TRADE JP	0	2.34	0.22	0.82	0 to 5	– 7.14	– 0.56	0.57

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 April 1991 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 5c

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/mark, 1985-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.96	0.43	0.66	0 to 5	– 0.44	– 0.02	0.98
Concert. dummy	0	307.58	0.48	0.63	–	–	–	–
CPI	0	1750.18	1.31	0.19	0 to 5	5997.28	1.82	0.07
PPI	0	– 129.57	– 0.22	0.82	0 to 5	– 842.81	– 0.55	0.58
IP	0	303.25	0.47	0.64	0 to 5	– 485.48	– 0.26	0.79
TRADE	0	15.93	0.18	0.86	0 to 5	– 261.23	– 1.05	0.30
UNEMP	0	689.11	0.71	0.48	0 to 5	476.64	0.20	0.84

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1985 to 30 August 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 5d

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/mark, 1985-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	5.18	0.02	0.98	0 to 5	4.27	0.02	0.98
Fed intervention	0	– 1.99	– 0.08	0.93	0 to 5	– 2.43	– 0.14	0.89
Concert. dummy	0	26.71	0.00	1.00	–	–	–	–
CPI	0	1678.58	1.18	0.24	0 to 5	4761.66	4804.70	0.11
PPI	0	– 91.70	– 0.01	0.99	0 to 5	34.08	– 665.50	– 0.05
IP	0	295.62	0.03	0.97	0 to 5	– 1644.81	– 389.62	– 0.06
TRADE	0	12.88	0.02	0.98	0 to 5	– 116.83	– 265.49	– 0.19
UNEMP	0	754.84	0.08	0.94	0 to 5	363.18	895.06	0.05

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1985 to 30 August 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Plaza period

Table 6a

Estimates of the effect of intervention on the mean of the PDF, dollar/mark, 1985

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	29.13	0.11	0.91	0 to 5	9.06	0.09	0.93
Concert. dummy	0	5535.64	0.12	0.91	–		–	–
CPI	0	2826.39	0.11	0.91	0 to 5	4910.80	0.10	0.92
PPI	0	394.19	0.13	0.89	0 to 5	– 2321.12	– 0.09	0.93
IP	0	219.47	0.08	0.94	0 to 5	– 544.06	– 0.11	0.91
TRADE	0	– 7.46	– 0.02	0.98	0 to 5	– 773.76	– 0.12	0.91
UNEMP	0	– 93884.35	– 0.12	0.90	0 to 5	–152345.73	– 0.12	0.90

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1985 to 31 December 1985, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 6b

Estimates of the effect of intervention on the mean of the PDF, dollar/mark, 1985

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	– 33.25	– 0.40	0.69	0 to 5	– 59.61	– 0.42	0.68
Fed intervention	0	– 18.21	– 0.14	0.89	0 to 5	– 34.39	– 0.21	0.84
Concert. dummy	0	– 5357.92	– 0.39	0.70	–	–	–	–
CPI	0	– 192.02	– 0.10	0.92	0 to 5	– 4299.68	– 0.48	0.63
PPI	0	1739.08	0.41	0.68	0 to 5	2156.78	0.46	0.65
IP	0	– 497.61	– 0.29	0.77	0 to 5	– 266.75	– 0.10	0.92
TRADE	0	109.00	0.46	0.65	0 to 5	– 76.01	– 0.07	0.95
UNEMP	0	– 44379.50	– 0.37	0.71	0 to 5	– 67132.30	– 0.37	0.71

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1985 to 31 December 1985, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 7a

Estimates of the effect of intervention on the variance of the PDF, dollar/mark, 1985

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	567.26	0.28	0.78	0 to 5	675.02	0.37	0.71
Concert. dummy	0	– 92272.89	– 0.27	0.79	–	–	–	–
CPI	0	11445.29	0.17	0.87	0 to 5	5822.25	0.04	0.97
PPI	0	26615.26	0.22	0.82	0 to 5	12692.81	0.12	0.91
IP	0	– 14662.10	– 0.18	0.86	0 to 5	– 33625.05	– 0.14	0.89
TRADE	0	951.10	0.36	0.72	0 to 5	7772.68	0.42	0.67
UNEMP	0	1214822.83	0.25	0.80	0 to 5	1831774.35	0.25	0.80

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1985 to 31 December 1985, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 7b

Estimates of the effect of intervention on the variance of the PDF, dollar/mark, 1985

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	– 1279.40	– 0.18	0.86	0 to 5	1811.80	0.23	0.82
Fed intervention	0	– 2577.93	– 0.21	0.84	0 to 5	– 548.21	– 0.06	0.95
Concert. dummy	0	296678.74	0.22	0.82	–	–	–	–
CPI	0	– 40432.11	– 0.19	0.85	0 to 5	84664.84	0.13	0.90
PPI	0	87533.51	0.23	0.82	0 to 5	– 9167.54	– 0.04	0.97
IP	0	45832.43	0.21	0.83	0 to 5	145310.34	0.22	0.83
TRADE	0	– 901.61	– 0.11	0.91	0 to 5	7951.34	0.10	0.92
UNEMP	0	– 1824862.13	– 0.17	0.86	0 to 5	– 8616715.26	– 0.22	0.82

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1985 to 31 December 1985, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 8a

Estimates of the effect of intervention on the skewness of the PDF, dollar/mark, 1985

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 27.59	– 0.98	0.33	0 to 5	– 25.91	– 1.00	0.32
Concert. dummy	0	– 4800.74	– 0.99	0.33	–	–	–	–
CPI	0	216.46	0.08	0.94	0 to 5	7293.49	1.10	0.28
PPI	0	1880.02	1.07	0.29	0 to 5	961.54	0.23	0.82
IP	0	– 2622.63	– 1.09	0.28	0 to 5	1710.90	0.38	0.71
TRADE	0	– 62.61	– 0.56	0.58	0 to 5	– 650.06	– 1.12	0.26
UNEMP	0	77965.52	0.68	0.50	0 to 5	120198.97	0.69	0.50

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1985 to 31 December 1985, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 8b

Estimates of the effect of intervention on the skewness of the PDF, dollar/mark, 1985

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	– 79.78	– 0.28	0.78	0 to 5	– 160.78	– 0.29	0.77
Fed intervention	0	23.30	0.08	0.94	0 to 5	103.46	0.36	0.72
Concert. dummy	0	– 11344.25	– 0.37	0.71	–	–	–	–
CPI	0	1739.82	0.13	0.89	0 to 5	10108.00	0.61	0.54
PPI	0	3586.33	0.30	0.77	0 to 5	1606.60	0.10	0.92
IP	0	– 2758.48	– 0.46	0.65	0 to 5	1915.07	0.16	0.87
TRADE	0	– 115.53	– 0.46	0.65	0 to 5	– 2277.70	– 0.39	0.70
UNEMP	0	– 55279.73	– 0.13	0.90	0 to 5	– 67154.00	– 0.12	0.90

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1985 to 31 December 1985, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 9a

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/mark, 1985

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 609.59	– 0.12	0.91	0 to 5	– 768.57	– 0.12	0.90
Concert. dummy	0	114799.30	0.12	0.90	–	–	–	–
CPI	0	– 24173.34	– 0.09	0.93	0 to 5	– 36839.41	– 0.10	0.92
PPI	0	– 66629.71	– 0.13	0.89	0 to 5	– 1866.44	– 0.02	0.99
IP	0	53654.23	0.13	0.89	0 to 5	82836.61	0.13	0.90
TRADE	0	– 818.26	– 0.09	0.93	0 to 5	– 5100.44	– 0.10	0.92
UNEMP	0	– 2484130.26	– 0.13	0.90	0 to 5	– 3416352.94	– 0.13	0.90

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1985 to 31 December 1985, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 9b

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/mark, 1985

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	– 1339.67	– 0.003	0.998	0 to 5	4407.339	0.003	0.997
Fed intervention	0	– 6227.3	– 0.003	0.998	0 to 5	– 4561.75	– 0.003	0.997
Concert. dummy	0	524911.9	0.003	0.998	–	–	–	–
CPI	0	– 25939	– 0.002	0.998	0 to 5	334764.237	0.003	0.997
PPI	0	80108.1	0.003	0.998	0 to 5	64595.561	0.003	0.998
IP	0	80806.33	0.003	0.997	0 to 5	162047.158	0.003	0.997
TRADE	0	– 450.981	– 0.002	0.999	0 to 5	24241.845	0.004	0.997
UNEMP	0	– 1042375	– 0.003	0.997	0 to 5	11242529.006	– 0.003	0.998

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1985 to 31 December 1985, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

The period around the Louvre Accord

Table 10a

Estimates of the effect of intervention on the mean of the PDF, dollar/mark, 1986-88

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 0.64	– 0.85	0.39	0 to 5	– 0.20	– 1.05	0.29
Concert. dummy	0	12.40	0.33	0.74	–	–	–	–
CPI	0	– 207.41	– 1.08	0.28	0 to 5	45.05	0.11	0.91
PPI	0	70.63	1.12	0.26	0 to 5	266.51	1.76	0.08
IP	0	108.18	1.15	0.25	0 to 5	61.99	0.27	0.79
TRADE	0	20.61	1.54	0.12	0 to 5	41.09	1.36	0.17
UNEMP	0	– 24.65	– 0.24	0.81	0 to 5	447.42	1.52	0.13

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1986 to 30 June 1988, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 10b

Estimates of the effect of intervention on the mean of the PDF, dollar/mark, 1986-88

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	– 0.74	– 0.40	0.69	0 to 5	– 1.06	– 1.37	0.17
Fed intervention	0	0.06	0.08	0.94	0 to 5	1.71	1.78	0.08
Concert. dummy	0	78.00	1.40	0.16	–	–	–	–
CPI	0	– 185.93	– 0.77	0.44	0 to 5	145.33	0.27	0.79
PPI	0	45.57	0.62	0.53	0 to 5	162.76	0.93	0.35
IP	0	178.39	1.59	0.11	0 to 5	378.08	1.07	0.28
TRADE	0	13.71	0.81	0.42	0 to 5	34.36	0.86	0.39
UNEMP	0	– 56.47	– 0.42	0.68	0 to 5	227.30	0.60	0.55

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1986 to 30 June 1988, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 11a

Estimates of the effect of intervention on the variance of the PDF, dollar/mark, 1986-88

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 144.77	– 0.14	0.89	0 to 5	– 70.55	– 0.14	0.89
Concert. dummy	0	23738.53	0.14	0.89	–	–	–	–
CPI	0	– 6125.54	– 0.11	0.91	0 to 5	31391.30	0.13	0.89
PPI	0	4624.64	0.15	0.88	0 to 5	4700.15	0.08	0.94
IP	0	14412.79	0.16	0.88	0 to 5	15544.81	0.18	0.85
TRADE	0	1484.28	0.13	0.90	0 to 5	2245.56	0.10	0.92
UNEMP	0	– 4326.45	– 0.14	0.89	0 to 5	– 17597.36	– 0.16	0.87

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1986 to 30 June 1988, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 11b

Estimates of the effect of intervention on the variance of the PDF, dollar/mark, 1986-88

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	37.17	0.37	0.71	0 to 5	14.02	0.35	0.72
Fed intervention	0	17.38	0.30	0.76	0 to 5	24.21	0.38	0.70
Concert. dummy	0	– 4598.77	– 0.33	0.74	–	–	–	–
CPI	0	2597.30	0.39	0.69	0 to 5	– 9460.15	– 0.37	0.71
PPI	0	– 148.54	– 0.05	0.96	0 to 5	– 4422.77	– 0.73	0.47
IP	0	– 1485.90	– 0.17	0.86	0 to 5	608.97	0.05	0.96
TRADE	0	– 579.17	– 0.50	0.62	0 to 5	– 2016.43	– 0.76	0.45
UNEMP	0	274.57	0.08	0.93	0 to 5	– 928.30	– 0.10	0.92

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1986 to 30 June 1988, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 12a

Estimates of the effect of intervention on the skewness of the PDF, dollar/mark, 1986-88

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	2.54	0.73	0.46	0 to 5	0.89	1.13	0.26
Concert. dummy	0	31.15	0.19	0.85	–	–	–	–
CPI	0	1127.44	1.61	0.11	0 to 5	2573.50	1.71	0.09
PPI	0	– 408.11	– 1.68	0.09	0 to 5	– 46.15	– 0.08	0.93
IP	0	– 65.10	– 0.19	0.85	0 to 5	281.53	0.32	0.75
TRADE	0	40.87	0.84	0.40	0 to 5	137.82	1.19	0.23
UNEMP	0	– 277.60	– 0.74	0.46	0 to 5	604.07	0.55	0.58

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1986 to 30 June 1988, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 12b

Estimates of the effect of intervention on the skewness of the PDF, dollar/mark, 1986-88

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	4.67	0.43	0.66	0 to 5	– 0.20	– 0.04	0.97
Fed intervention	0	3.03	1.00	0.32	0 to 5	4.27	1.07	0.29
Concert. dummy	0	153.23	0.65	0.52	–	–	–	–
CPI	0	1302.93	1.25	0.21	0 to 5	3274.15	1.26	0.21
PPI	0	– 492.87	– 1.41	0.16	0 to 5	– 295.99	– 0.39	0.70
IP	0	172.60	0.36	0.72	0 to 5	525.71	0.36	0.72
TRADE	0	26.37	0.39	0.70	0 to 5	74.74	0.42	0.68
UNEMP	0	– 378.92	– 0.71	0.48	0 to 5	66.38	0.04	0.96

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 January 1986 to 30 June 1988, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 13a

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/mark, 1986-88

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 158.48	– 0.17	0.87	0 to 5	– 66.56	– 0.17	0.87
Concert. dummy	0	25298.54	0.18	0.86	–	–	–	–
CPI	0	– 8138.54	– 0.14	0.89	0 to 5	38582.73	0.23	0.82
PPI	0	1921.88	0.13	0.90	0 to 5	8801.00	0.20	0.84
IP	0	7557.06	0.16	0.88	0 to 5	– 2686.71	– 0.08	0.93
TRADE	0	1154.24	0.17	0.87	0 to 5	2007.01	0.15	0.88
UNEMP	0	– 6112.18	– 0.14	0.89	0 to 5	– 16676.66	– 0.13	0.90

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1986 to 30 June 1988, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 13b

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/mark, 1986-88

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	51.77	1.04	0.30	0 to 5	32.65	1.30	0.20
Fed intervention	0	2.69	0.10	0.92	0 to 5	– 1.10	– 0.05	– 0.96
Concert. dummy	0	– 5199.50	– 0.79	0.43	–	–	–	–
CPI	0	3918.58	0.59	0.56	0 to 5	3626.30	0.22	0.83
PPI	0	– 1216.80	– 0.42	0.67	0 to 5	1255.91	0.19	0.85
IP	0	– 1019.29	– 0.24	0.81	0 to 5	– 1885.23	– 0.19	0.85
TRADE	0	– 190.47	– 0.35	0.73	0 to 5	– 784.98	– 0.59	0.55
UNEMP	0	3387.77	0.86	0.39	0 to 5	15336.26	1.30	0.20

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 January 1986 to 30 June 1988, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

The period 1988-92

Table 14a

Estimates of the effect of intervention on the mean of the PDF, dollar/mark, 1988-92

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 0.24	– 0.80	0.42	0 to 5	– 0.06	– 0.43	0.67
Concert. dummy	0	– 4.58	– 0.09	0.93	–	–	–	–
CPI	0	165.26	1.03	0.30	0 to 5	– 61.52	– 0.19	0.85
PPI	0	19.45	0.33	0.74	0 to 5	– 45.28	– 0.38	0.71
IP	0	18.77	0.35	0.72	0 to 5	7.65	0.05	0.96
TRADE	0	10.18	0.78	0.43	0 to 5	– 32.83	– 0.88	0.38
UNEMP	0	– 127.21	– 1.21	0.23	0 to 5	– 199.30	– 0.70	0.48

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 July 1988 to 31 July 1992, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 14b

Estimates of the effect of intervention on the mean of the PDF, dollar/mark, 1988-92

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	– 0.47	– 1.11	0.27	0 to 5	– 0.49	– 1.26	0.21
Fed intervention	0	– 0.16	– 0.21	0.84	0 to 5	0.26	0.91	0.37
Concert. dummy	0	– 32.25	– 0.47	0.64	–	–	–	–
CPI	0	163.05	0.94	0.35	0 to 5	19.28	0.06	0.95
PPI	0	7.12	0.11	0.91	0 to 5	– 55.91	– 0.43	0.66
IP	0	– 0.56	– 0.01	0.99	0 to 5	– 0.85	– 0.01	1.00
TRADE	0	7.40	0.55	0.58	0 to 5	– 51.60	– 1.08	0.28
UNEMP	0	– 119.08	– 1.09	0.27	0 to 5	– 275.81	– 0.87	0.39

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 July 1988 to 31 July 1992, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 15a

Estimates of the effect of intervention on the variance of the PDF, dollar/mark, 1988-92

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 0.23	– 0.09	0.93	0 to 5	– 0.19	– 0.12	0.90
Concert. dummy	0	362.45	0.57	0.57	–	–	–	–
CPI	0	– 434.01	– 0.29	0.77	0 to 5	– 2969.35	– 0.88	0.38
PPI	0	867.89	1.39	0.16	0 to 5	1060.07	0.73	0.47
IP	0	29.72	0.06	0.95	0 to 5	– 1696.73	– 0.90	0.37
TRADE	0	91.16	0.74	0.46	0 to 5	1161.90	2.54	0.01
UNEMP	0	508.17	0.50	0.62	0 to 5	– 181.72	– 0.06	0.95

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 July 1988 to 31 July 1992, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 15b

Estimates of the effect of intervention on the variance of the PDF, dollar/mark, 1988-92

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	– 0.79	– 0.29	0.77	0 to 5	1.53	0.37	0.71
Fed intervention	0	4.89	0.44	0.66	0 to 5	0.88	0.21	0.84
Concert. dummy	0	– 90.02	– 0.07	0.95	–	–	–	–
CPI	0	– 366.32	– 0.23	0.82	0 to 5	– 3006.26	– 0.87	0.39
PPI	0	733.02	1.15	0.25	0 to 5	1112.65	0.75	0.45
IP	0	21.45	0.04	0.97	0 to 5	– 1969.52	– 0.96	0.34
TRADE	0	116.35	0.82	0.41	0 to 5	1144.24	2.19	0.03
UNEMP	0	477.94	0.46	0.65	0 to 5	– 645.46	– 0.18	0.86

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 July 1988 to 31 July 1992, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 16a

Estimates of the effect of intervention on the skewness of the PDF, dollar/mark, 1988-92

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 0.14	– 0.24	0.81	0 to 5	– 0.18	– 0.80	0.43
Concert. dummy	0	– 28.30	– 0.30	0.76	–	–	–	–
CPI	0	502.09	1.65	0.10	0 to 5	574.63	0.94	0.35
PPI	0	– 34.92	– 0.32	0.75	0 to 5	143.07	0.64	0.52
IP	0	– 54.84	– 0.55	0.58	0 to 5	– 181.56	– 0.64	0.52
TRADE	0	– 23.04	– 0.94	0.35	0 to 5	– 39.28	– 0.57	0.57
UNEMP	0	– 131.99	– 0.66	0.51	0 to 5	964.50	1.81	0.07

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 July 1988 to 31 July 1992, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 16b

Estimates of the effect of intervention on the skewness of the PDF, dollar/mark, 1988-92

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	0.87	1.02	0.31	0 to 5	0.16	0.21	0.83
Fed intervention	0	– 1.19	– 0.70	0.49	0 to 5	– 0.64	– 1.14	0.25
Concert. dummy	0	– 7.60	– 0.05	0.96	–	–	–	–
CPI	0	689.84	2.02	0.04	0 to 5	466.06	0.72	0.47
PPI	0	24.52	0.18	0.86	0 to 5	194.85	0.78	0.44
IP	0	– 37.67	– 0.35	0.73	0 to 5	– 307.11	– 0.90	0.37
TRADE	0	– 9.99	– 0.37	0.71	0 to 5	44.73	0.48	0.63
UNEMP	0	– 159.93	– 0.75	0.45	0 to 5	1262.57	1.85	0.06

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 July 1988 to 31 July 1992, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 17a

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/mark, 1988-92

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	1.65	0.43	0.67	0 to 5	1.12	0.48	0.63
Concert. dummy	0	– 384.91	– 0.41	0.69	–	–	–	–
CPI	0	1906.33	0.88	0.38	0 to 5	7998.22	1.66	0.10
PPI	0	1523.35	1.63	0.10	0 to 5	– 2499.73	– 1.16	0.25
IP	0	849.05	1.10	0.27	0 to 5	326.55	0.12	0.91
TRADE	0	91.73	0.51	0.61	0 to 5	29.43	0.04	0.97
UNEMP	0	– 915.90	– 0.62	0.54	0 to 5	– 5115.62	– 1.16	0.25

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 July 1988 to 31 July 1992, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form

Table 17b

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/mark, 1988-92

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Buba intervention	0	– 1.71	– 0.39	0.69	0 to 5	1.79	0.42	0.67
Fed intervention	0	2.82	0.19	0.85	0 to 5	– 0.53	– 0.09	0.93
Concert. dummy	0	– 52.91	– 0.03	0.97	–	–	–	–
CPI	0	2198.79	0.92	0.36	0 to 5	8584.09	1.71	0.09
PPI	0	1296.32	1.40	0.16	0 to 5	– 2797.87	– 1.33	0.18
IP	0	864.37	1.08	0.28	0 to 5	354.67	0.12	0.91
TRADE	0	140.77	0.64	0.52	0 to 5	251.10	0.34	0.73
UNEMP	0	– 865.03	– 0.58	0.56	0 to 5	– 4503.55	– 0.87	0.39

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 July 1988 to 31 July 1992, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

The period of dollar support, 1992-96

Table 18a

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	1.10	0.33	0.74	0 to 5	0.75	0.32	0.75
DM/$ int. Fed	0	754.63	0.27	0.78	–	–	–	–
DM/$ int. Buba	0	– 49.71	– 0.06	0.96	–	–	–	–
Concert. dummy	0	– 2129.02	– 0.31	0.76	–	–	–	–
CPI	0	– 57.78	– 0.05	0.96	0 to 5	720.58	0.18	0.86
PPI	0	– 238.51	– 0.26	0.79	0 to 5	– 326.74	– 0.21	0.84
IP US	0	774.50	0.41	0.68	0 to 5	– 3348.67	– 0.33	0.74
TRADE US	0	– 176.79	– 0.35	0.73	0 to 5	68.17	0.22	0.83
UNEMP	0	– 211.72	– 0.24	0.81	0 to 5	1612.67	0.31	0.76
TANKAN	0	0.46	0.05	0.96	0 to 5	– 9.41	– 0.38	0.70
IP JP	0	65.46	0.33	0.74	0 to 5	87.98	0.34	0.74
RETAIL JP	0	– 99.25	– 0.33	0.74	0 to 5	– 245.01	– 0.34	0.73
TRADE JP	0	– 0.02	– 0.01	1.00	0 to 5	3.12	0.30	0.76

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 18b

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	0.29	0.23	0.82	0 to 5	0.10	0.35	0.72
Fed intervention	0	0.69	0.02	0.98	0 to 5	1.24	0.04	0.97
DM/$ int. Fed	0	284.44	0.02	0.98	–	–	–	–
DM/$ int. Buba	0	– 267.19	– 0.02	0.98	–	–	–	–
Concert. dummy	0	– 910.42	– 0.09	0.93	–	–	–	–
CPI	0	444.73	0.48	0.63	0 to 5	35.69	0.01	1.00
PPI	0	– 90.75	– 0.23	0.82	0 to 5	– 333.76	– 0.13	0.89
IP US	0	515.29	0.64	0.52	0 to 5	– 1368.88	– 0.40	0.69
TRADE US	0	– 66.99	– 0.48	0.63	0 to 5	39.19	0.27	0.79
UNEMP	0	– 222.65	– 0.43	0.67	0 to 5	– 88.73	– 0.04	0.96
TANKAN	0	0.21	0.04	0.97	0 to 5	– 3.03	– 0.27	0.79
IP JP	0	– 43.10	– 0.65	0.51	0 to 5	– 72.07	– 0.41	0.68
RETAIL JP	0	– 36.66	– 0.18	0.86	0 to 5	– 4.12	– 0.01	0.99
TRADE JP	0	– 0.39	– 0.24	0.81	0 to 5	0.93	0.36	0.72

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 19a

Estimates of the effect of intervention on the variance of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 0.47	– 0.39	0.70	0 to 5	– 0.12	– 0.17	0.87
DM/$ int. Fed	0	– 1741.66	– 0.81	0.42	–	–	–	–
DM/$ int. Buba	0	640.96	0.40	0.69	–	–	–	–
Concert. dummy	0	2855.43	0.98	0.33	–	–	–	–
CPI	0	246.58	0.13	0.90	0 to 5	2515.19	0.45	0.66
PPI	0	– 533.40	– 0.66	0.51	0 to 5	125.46	0.04	0.96
IP US	0	1103.83	0.91	0.36	0 to 5	4443.10	0.83	0.41
TRADE US	0	– 30.94	– 0.23	0.82	0 to 5	– 250.14	– 0.80	0.42
UNEMP	0	– 2316.15	– 1.39	0.17	0 to 5	– 1772.91	– 0.50	0.62
TANKAN	0	– 6.45	– 0.53	0.59	0 to 5	– 12.73	– 0.51	0.61
IP JP	0	138.49	0.70	0.48	0 to 5	141.01	0.58	0.56
RETAIL JP	0	– 249.06	– 1.28	0.20	0 to 5	– 436.85	– 0.77	0.44
TRADE JP	0	– 3.50	– 0.74	0.46	0 to 5	– 8.05	– 1.23	0.22

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 19b

Estimates of the effect of intervention on the variance of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 7.41	– 0.28	0.78	0 to 5	– 2.19	– 0.25	0.80
Fed intervention	0	261.30	0.29	0.77	0 to 5	274.81	0.29	0.77
DM/$ int. Fed	0	– 97689.99	– 0.29	0.77	–	–	–	–
DM/$ int. Buba	0	87287.85	0.29	0.77	–	–	–	–
Concert. dummy	0	– 79100.05	– 0.28	0.78	–	–	–	–
CPI	0	– 6793.10	– 0.25	0.80	0 to 5	590.69	0.02	0.99
PPI	0	– 1769.76	– 0.25	0.80	0 to 5	13829.10	0.28	0.78
IP US	0	10247.74	0.32	0.75	0 to 5	35560.87	0.30	0.77
TRADE US	0	1199.95	0.29	0.77	0 to 5	730.78	0.19	0.85
UNEMP	0	– 2207.96	– 0.22	0.83	0 to 5	11670.86	0.22	0.83
TANKAN	0	– 0.79	– 0.01	0.99	0 to 5	– 102.54	– 0.29	0.78
IP JP	0	445.78	0.22	0.82	0 to 5	911.08	0.27	0.79
RETAIL JP	0	1547.02	0.25	0.80	0 to 5	317.72	0.08	0.94
TRADE JP	0	– 0.91	– 0.03	0.98	0 to 5	– 5.18	– 0.12	0.90

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 20a

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.08	0.41	0.68	0 to 5	0.08	0.61	0.54
DM/$ int. Fed	0	– 32.27	– 0.18	0.86	–	–	–	–
DM/$ int. Buba	0	12.43	0.10	0.92	–	–	–	–
Concert. dummy	0	– 77.20	– 0.18	0.86	–	–	–	–
CPI	0	187.73	0.82	0.41	0 to 5	744.35	1.25	0.21
PPI	0	49.65	0.46	0.64	0 to 5	– 32.36	– 0.12	0.90
IP US	0	137.22	0.99	0.32	0 to 5	– 79.37	– 0.10	0.92
TRADE US	0	– 8.22	– 0.26	0.80	0 to 5	24.95	0.65	0.51
UNEMP	0	– 75.22	– 0.42	0.67	0 to 5	357.35	0.88	0.38
TANKAN	0	– 0.31	– 0.20	0.84	0 to 5	– 3.41	– 0.93	0.35
IP JP	0	15.48	0.90	0.37	0 to 5	42.99	1.41	0.16
RETAIL JP	0	– 0.22	– 0.01	0.99	0 to 5	– 39.54	– 0.62	0.54
TRADE JP	0	0.22	0.40	0.69	0 to 5	0.05	0.05	0.96

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 20b

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	0.05	0.12	0.90	0 to 5	0.04	0.25	0.81
Fed intervention	0	– 1.79	– 0.12	0.90	0 to 5	– 1.78	– 0.12	0.91
DM/$ int. Fed	0	573.49	0.11	0.91	–	–	–	–
DM/$ int. Buba	0	– 601.22	– 0.13	0.90	–	–	–	–
Concert. dummy	0	632.22	0.13	0.90	–	–	–	–
CPI	0	300.09	0.97	0.33	0 to 5	1008.73	0.70	0.48
PPI	0	73.97	0.70	0.48	0 to 5	91.21	0.11	0.91
IP	0	84.02	0.19	0.85	0 to 5	57.29	0.04	0.97
TRADE	0	11.90	0.14	0.88	0 to 5	27.75	0.42	0.68
UNEMP	0	– 86.01	– 0.47	0.64	0 to 5	274.73	0.48	0.63
TANKAN	0	0.02	0.02	0.99	0 to 5	– 2.97	– 0.45	0.65
IP JP	0	2.86	0.19	0.85	0 to 5	19.32	0.44	0.66
RETAIL JP	0	14.87	0.18	0.86	0 to 5	6.56	0.03	0.97
TRADE JP	0	0.21	0.37	0.71	0 to 5	– 0.20	– 0.20	0.84

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 21a

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 1.44	– 1.00	0.32	0 to 5	– 0.30	– 0.36	0.72
DM/$ int. Fed	0	– 1841.70	– 0.71	0.48	–	–	–	–
DM/$ int. Buba	0	1481.98	0.77	0.44	–	–	–	–
Concert. dummy	0	3661.53	1.05	0.30	–	–	–	–
CPI	0	– 791.32	– 0.31	0.75	0 to 5	– 1182.85	– 0.16	0.87
PPI	0	– 1592.97	– 1.52	0.13	0 to 5	2192.11	0.59	0.56
IP	0	– 324.54	– 0.22	0.83	0 to 5	11979.02	1.81	0.07
TRADE	0	– 237.61	– 1.36	0.17	0 to 5	– 223.71	– 0.55	0.58
UNEMP	0	– 2651.89	– 1.25	0.21	0 to 5	– 971.85	– 0.21	0.83
TANKAN	0	– 13.76	– 0.87	0.38	0 to 5	– 26.67	– 0.81	0.42
IP JP	0	114.41	0.47	0.64	0 to 5	93.88	0.30	0.76
RETAIL JP	0	112.21	0.43	0.67	0 to 5	– 151.92	– 0.20	0.84
TRADE JP	0	0.86	0.14	0.89	0 to 5	– 8.29	– 0.99	0.32

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 21b

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 5.77	– 0.29	0.77	0 to 5	– 0.95	– 0.15	0.88
Fed intervention	0	174.15	0.29	0.77	0 to 5	179.49	0.29	0.78
DM/$ int. Fed	0	– 65583.24	– 0.29	0.77	–	–	–	–
DM/$ int. Buba	0	60075.36	0.29	0.77	–	–	–	–
Concert. dummy	0	– 51731.38	– 0.28	0.78	–	–	–	–
CPI	0	– 4934.92	– 0.30	0.76	0 to 5	556.06	0.02	0.98
PPI	0	– 2134.17	– 0.45	0.65	0 to 5	12361.98	0.35	0.73
IP	0	6374.40	0.28	0.78	0 to 5	33169.36	0.36	0.72
TRADE	0	479.70	0.20	0.84	0 to 5	404.56	0.16	0.87
UNEMP	0	– 3205.90	– 0.40	0.69	0 to 5	7431.88	0.21	0.83
TANKAN	0	– 1.72	– 0.03	0.98	0 to 5	– 87.01	– 0.34	0.74
IP JP	0	146.52	0.08	0.94	0 to 5	633.73	0.20	0.84
RETAIL JP	0	1350.22	0.36	0.72	0 to 5	270.44	0.10	0.92
TRADE JP	0	2.95	0.12	0.91	0 to 5	– 10.02	– 0.33	0.74

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Regressions with different strategies

Table 22a

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.88	0.42	0.68	0 to 5	0.59	0.39	0.70
DM/$ int. Fed	0	502.67	0.31	0.76	–	–	–	–
DM/$ int. Buba	0	– 120.51	– 0.15	0.88	–	–	–	–
Concerted	0	– 1707.80	– 0.37	0.71	–	–	–	–
Official	0	312.51	0.37	0.71	–	–	–	–
CPI	0	– 94.19	– 0.10	0.92	0 to 5	515.68	0.17	0.86
PPI	0	– 184.04	– 0.29	0.77	0 to 5	– 296.01	– 0.24	0.81
IP US	0	617.66	0.53	0.60	0 to 5	– 2673.40	– 0.40	0.69
TRADE US	0	– 145.19	– 0.44	0.66	0 to 5	49.98	0.23	0.82
UNEMP	0	– 202.17	– 0.29	0.77	0 to 5	1308.51	0.37	0.71
TANKAN	0	0.27	0.04	0.97	0 to 5	– 7.99	– 0.46	0.65
IP JP	0	53.17	0.41	0.68	0 to 5	83.19	0.42	0.68
RETAIL JP	0	– 83.16	– 0.41	0.68	0 to 5	– 225.97	– 0.43	0.67
TRADE JP	0	– 0.04	– 0.02	0.99	0 to 5	2.45	0.36	0.72

Note: The table reports the estimation results for equation (4) in App99endix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 22b

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	0.22	0.25	0.80	0 to 5	0.07	0.37	0.71
Fed intervention	0	2.17	0.09	0.93	0 to 5	2.71	0.11	0.91
DM/$ int. Fed	0	– 381.92	– 0.04	0.96	–	–	–	–
DM/$ int. Buba	0	195.34	0.02	0.98	–	–	–	–
Concerted	0	– 1341.92	– 0.17	0.87	–	–	–	–
Official	0	280.19	0.23	0.82	–	–	–	–
CPI	0	349.16	0.51	0.61	0 to 5	– 294.96	– 0.07	0.94
PPI	0	– 83.89	– 0.22	0.83	0 to 5	– 443.45	– 0.23	0.82
IP US	0	475.70	0.56	0.58	0 to 5	– 1189.43	– 0.47	0.64
TRADE US	0	– 70.52	– 0.59	0.55	0 to 5	26.96	0.24	0.81
UNEMP	0	– 190.36	– 0.41	0.68	0 to 5	– 125.73	– 0.07	0.94
TANKAN	0	0.03	0.01	1.00	0 to 5	– 2.50	– 0.27	0.79
IP JP	0	– 39.88	– 0.61	0.54	0 to 5	– 49.75	– 0.55	0.58
RETAIL JP	0	– 45.93	– 0.30	0.76	0 to 5	– 43.68	– 0.18	0.86
TRADE JP	0	– 0.39	– 0.26	0.79	0 to 5	0.80	0.35	0.72

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 23a

Estimates of the effect of intervention on the variance of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 0.44	– 0.38	0.70	0 to 5	– 0.10	– 0.14	0.89
DM/$ int. Fed	0	– 1610.13	– 0.83	0.51	–	–	–	–
DM/$ int. Buba	0	743.05	0.42	0.67	–	–	–	–
Concerted	0	2847.48	0.99	0.32	–	–	–	–
Official	0	– 396.38	– 0.40	0.69	–	–	–	–
CPI	0	245.03	0.13	0.90	0 to 5	2508.33	0.45	0.66
PPI	0	– 525.27	– 0.66	0.51	0 to 5	91.65	0.03	0.97
IP US	0	1162.36	1.00	0.32	0 to 5	4339.06	0.84	0.40
TRADE US	0	– 30.98	– 0.23	0.82	0 to 5	– 256.73	– 0.83	0.41
UNEMP	0	– 2266.98	– 1.38	0.17	0 to 5	– 1777.20	– 0.51	0.61
TANKAN	0	– 6.25	– 0.52	0.60	0 to 5	– 12.53	– 0.50	0.62
IP JP	0	139.83	0.70	0.48	0 to 5	140.34	0.58	0.56
RETAIL JP	0	– 249.97	– 1.28	0.20	0 to 5	– 438.54	– 0.77	0.44
TRADE JP	0	– 3.53	– 0.75	0.45	0 to 5	– 7.95	– 1.22	0.22

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 23b

Estimates of the effect of intervention on the variance of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 10.75	– 0.19	0.85	0 to 5	– 2.42	– 0.17	0.86
Fed intervention	0	390.73	0.20	0.84	0 to 5	406.17	0.20	0.84
DM/$ int. Fed	0	– 138607.27	– 0.20	0.84	–	–	–	–
DM/$ int. Buba	0	139429.51	0.20	0.84	–	–	–	–
Concerted	0	– 115154.65	– 0.19	0.85	–	–	–	–
Official	0	– 28921.06	– 0.20	0.84	–	–	–	–
CPI	0	– 9667.05	– 0.18	0.85	0 to 5	– 3370.37	– 0.05	0.96
PPI	0	– 2311.75	– 0.19	0.85	0 to 5	16581.48	0.19	0.85
IP US	0	18232.46	0.21	0.83	0 to 5	52878.12	0.20	0.84
TRADE US	0	1673.41	0.20	0.84	0 to 5	694.45	0.13	0.90
UNEMP	0	1019.71	0.05	0.96	0 to 5	18638.72	0.17	0.87
TANKAN	0	12.26	0.09	0.93	0 to 5	– 139.47	– 0.20	0.84
IP JP	0	1112.65	0.19	0.85	0 to 5	1924.09	0.20	0.84
RETAIL JP	0	2069.10	0.18	0.86	0 to 5	18.53	0.00	1.00
TRADE JP	0	0.59	0.01	0.99	0 to 5	2.63	0.03	0.97

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form

Table 24a

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.10	0.50	0.62	0 to 5	0.09	0.72	0.47
DM/$ int. Fed	0	– 8.10	– 0.05	0.96	–	–	–	–
DM/$ int. Buba	0	34.08	0.26	0.79	–	–	–	–
Concerted	0	– 93.66	– 0.22	0.82	–	–	–	–
Official	0	– 65.27	– 0.56	0.57	–	–	–	–
CPI	0	188.03	0.80	0.43	0 to 5	757.95	1.24	0.21
PPI	0	45.69	0.43	0.67	0 to 5	– 28.59	– 0.11	0.92
IP US	0	148.39	1.08	0.28	0 to 5	– 121.34	– 0.16	0.87
TRADE US	0	– 9.48	– 0.30	0.76	0 to 5	26.18	0.68	0.50
UNEMP	0	– 81.00	– 0.45	0.65	0 to 5	364.56	0.88	0.38
TANKAN	0	– 0.35	– 0.22	0.83	0 to 5	– 3.55	– 0.97	0.33
IP JP	0	16.40	0.97	0.33	0 to 5	42.14	1.32	0.19
RETAIL JP	0	– 0.83	– 0.03	0.97	0 to 5	– 37.18	– 0.55	0.58
TRADE JP	0	0.23	0.40	0.69	0 to 5	0.10	0.09	0.93

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 24b

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	0.05	0.10	0.92	0 to 5	0.04	0.24	0.81
Fed intervention	0	– 2.00	– 0.10	0.92	0 to 5	– 1.98	– 0.10	0.92
DM/$ int. Fed	0	636.94	0.09	0.92	–	–	–	–
DM/$ int. Buba	0	– 683.44	– 0.10	0.92	–	–	–	–
Concerted	0	689.85	0.11	0.91	–	–	–	–
Official	0	46.94	0.05	0.96	–	–	–	–
CPI	0	297.63	1.07	0.29	0 to 5	1015.18	0.64	0.52
PPI	0	76.35	0.59	0.55	0 to 5	97.43	0.10	0.92
IP US	0	73.22	0.11	0.91	0 to 5	30.95	0.02	0.99
TRADE US	0	12.18	0.14	0.89	0 to 5	27.83	0.40	0.69
UNEMP	0	– 79.67	– 0.35	0.73	0 to 5	287.55	0.36	0.72
TANKAN	0	0.04	0.02	0.98	0 to 5	– 3.02	– 0.39	0.70
IP JP	0	3.21	0.21	0.84	0 to 5	20.54	0.73	0.46
RETAIL JP	0	15.62	0.15	0.88	0 to 5	5.52	0.03	0.97
TRADE JP	0	0.21	0.36	0.72	0 to 5	– 0.20	– 0.19	0.85

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 25a

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 1.37	– 1.02	0.31	0 to 5	– 0.25	– 0.33	0.74
DM/$ int. Fed	0	– 1589.84	– 0.69	0.49	–	–	–	–
DM/$ int. Buba	0	1632.91	0.79	0.43	–	–	–	–
Concerted	0	3607.50	1.07	0.29	–	–	–	–
Official	0	– 663.18	– 0.55	0.58	–	–	–	–
CPI	0	– 842.97	– 0.34	0.73	0 to 5	– 1205.43	– 0.17	0.87
PPI	0	– 1581.74	– 1.54	0.12	0 to 5	2112.65	0.57	0.57
IP US	0	– 233.41	– 0.16	0.87	0 to 5	11772.87	1.86	0.06
TRADE US	0	– 236.42	– 1.38	0.17	0 to 5	– 234.78	– 0.59	0.56
UNEMP	0	– 2561.14	– 1.24	0.21	0 to 5	– 968.01	– 0.21	0.83
TANKAN	0	– 13.57	– 0.87	0.38	0 to 5	– 26.30	– 0.81	0.42
IP JP	0	112.52	0.47	0.64	0 to 5	88.67	0.29	0.77
RETAIL JP	0	112.66	0.44	0.66	0 to 5	– 150.34	– 0.21	0.84
TRADE JP	0	0.80	0.13	0.89	0 to 5	– 8.10	– 0.98	0.33

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 25b

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 6.44	– 0.26	0.80	0 to 5	– 0.72	– 0.12	0.91
Fed intervention	0	205.27	0.25	0.80	0 to 5	209.79	0.25	0.80
DM/$ int. Fed	0	– 73405.07	– 0.26	0.80	–	–	–	–
DM/$ int. Buba	0	74767.86	0.26	0.80	–	–	–	–
Concerted	0	– 59576.45	– 0.25	0.80	–	–	–	–
Official	0	– 14286.62	– 0.25	0.80	–	–	–	–
CPI	0	– 6059.39	– 0.27	0.78	0 to 5	– 1432.51	– 0.05	0.96
PPI	0	– 2267.66	– 0.40	0.69	0 to 5	11595.57	0.31	0.75
IP	0	9206.48	0.25	0.80	0 to 5	38224.97	0.31	0.76
TRADE	0	552.36	0.19	0.85	0 to 5	262.89	0.11	0.91
UNEMP	0	– 1725.04	– 0.20	0.84	0 to 5	9469.88	0.20	0.84
TANKAN	0	3.15	0.04	0.97	0 to 5	– 94.84	–0.30	0.77
IP JP	0	425.67	0.14	0.89	0 to 5	1024.47	0.20	0.84
RETAIL JP	0	1378.28	0.32	0.75	0 to 5	3.68	0.00	1.00
TRADE JP	0	3.65	0.12	0.90	0 to 5	– 6.25	– 0.18	0.86

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 26a

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.25	1.48	0.14	0 to 5	0.24	1.25	0.21
DM/$ int. Fed	0	162.79	0.64	0.52	–	–	–	–
DM/$ int. Buba	0	– 66.02	– 0.32	0.75	–	–	–	–
Concerted	0	– 89.90	– 0.43	0.67	–	–	–	–
Heavy	0	– 601.13	– 1.49	0.14	–	–	–	–
CPI	0	– 35.33	– 0.14	0.89	0 to 5	– 186.01	– 0.27	0.79
PPI	0	6.66	0.06	0.95	0 to 5	– 104.35	– 0.34	0.73
IP US	0	149.50	1.01	0.31	0 to 5	– 651.34	– 1.10	0.27
TRADE US	0	– 25.26	– 1.36	0.17	0 to 5	– 33.18	– 0.64	0.53
UNEMP	0	– 110.65	– 0.56	0.57	0 to 5	620.82	1.01	0.31
TANKAN	0	– 1.19	– 0.68	0.50	0 to 5	– 5.17	– 1.35	0.18
IP JP	0	– 4.52	– 0.38	0.70	0 to 5	8.33	0.32	0.75
RETAIL JP	0	– 10.96	– 0.53	0.60	0 to 5	– 60.90	– 0.98	0.33
TRADE JP	0	0.13	0.20	0.84	0 to 5	0.89	0.81	0.42

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 26b

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	0.10	0.20	0.84	0 to 5	0.12	0.78	0.44
Fed intervention	0	4.46	0.30	0.86	0 to 5	4.69	0.33	0.74
DM/$ int. Fed	0	– 1215.83	– 0.23	0.82	–	–	–	–
DM/$ int. Buba	0	1092.33	0.23	0.82	–	–	–	–
Concerted	0	– 1531.10	– 0.32	0.75	–	–	–	–
Heavy	0	– 447.59	– 1.09	0.28	–	–	–	–
CPI	0	80.10	0.22	0.82	0 to 5	– 465.22	– 0.18	0.85
PPI	0	29.60	0.12	0.90	0 to 5	– 326.70	– 0.27	0.79
IP US	0	350.21	0.82	0.41	0 to 5	– 261.54	– 0.27	0.78
TRADE US	0	– 47.00	– 0.66	0.51	0 to 5	12.71	0.20	0.84
UNEMP	0	– 150.32	– 0.59	0.55	0 to 5	188.22	0.17	0.87
TANKAN	0	– 1.01	– 0.44	0.66	0 to 5	– 1.95	– 0.37	0.71
IP JP	0	– 20.27	– 0.52	0.60	0 to 5	– 13.67	– 0.26	0.80
RETAIL JP	0	– 33.28	– 0.33	0.74	0 to 5	– 80.26	– 0.46	0.65
TRADE JP	0	– 0.13	– 0.16	0.88	0 to 5	0.52	0.45	0.65

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 27a

Estimates of the effect of intervention on the variance of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 0.79	– 0.45	0.65	0 to 5	– 0.65	– 0.40	0.69
DM/$ int. Fed	0	– 2332.36	– 0.75	0.45	–	–	–	–
DM/$ int. Buba	0	1059.50	0.48	0.63	–	–	–	–
Concerted	0	2363.82	1.16	0.25	–	–	–	–
Heavy	0	2364.39	0.57	0.57	–	–	–	–
CPI	0	185.36	0.10	0.92	0 to 5	1978.11	0.33	0.74
PPI	0	– 384.76	– 0.50	0.62	0 to 5	– 22.72	– 0.01	0.99
IP US	0	1542.71	1.45	0.15	0 to 5	4711.82	0.82	0.41
TRADE US	0	6.96	0.06	0.95	0 to 5	– 162.15	– 0.45	0.65
UNEMP	0	– 1745.95	– 1.06	0.29	0 to 5	– 1102.50	– 0.29	0.77
TANKAN	0	– 6.77	– 0.56	0.58	0 to 5	– 15.49	– 0.59	0.56
IP JP	0	98.04	0.70	0.49	0 to 5	142.62	0.59	0.56
RETAIL JP	0	– 186.85	– 1.22	0.22	0 to 5	– 417.11	– 0.76	0.45
TRADE JP	0	– 4.71	– 1.03	0.30	0 to 5	– 9.44	– 1.27	0.20

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 27b

Estimates of the effect of intervention on the variance of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 6.97	– 0.18	0.86	0 to 5	– 2.31	– 0.15	0.88
Fed intervention	0	230.22	0.09	0.93	0 to 5	241.92	0.09	0.93
DM/$ int. Fed	0	– 87203.32	– 0.10	0.92	–	–	–	–
DM/$ int. Buba	0	77710.69	0.09	0.92	–	–	–	–
Concerted	0	– 69208.06	– 0.08	0.94	–	–	–	–
Heavy	0	1228.00	0.01	0.99	–	–	–	–
CPI	0	– 5872.70	– 0.07	0.94	0 to 5	328.77	0.01	0.99
PPI	0	– 1486.80	– 0.06	0.95	0 to 5	12225.96	0.09	0.93
IP US	0	9262.25	0.11	0.92	0 to 5	32941.98	0.15	0.88
TRADE US	0	1061.10	0.09	0.93	0 to 5	661.46	0.10	0.92
UNEMP	0	– 1915.43	– 0.08	0.94	0 to 5	10663.12	0.11	0.91
TANKAN	0	– 1.93	– 0.02	0.99	0 to 5	– 93.19	– 0.12	0.91
IP JP	0	430.95	0.30	0.76	0 to 5	857.53	0.20	0.84
RETAIL JP	0	1343.17	0.07	0.94	0 to 5	180.95	0.01	0.99
TRADE JP	0	– 1.48	– 0.03	0.98	0 to 5	– 6.32	– 0.06	0.95

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 28a

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.05	0.48	0.63	0 to 5	0.07	0.68	0.50
DM/$ int. Fed	0	– 29.59	– 0.17	0.87	–	–	–	–
DM/$ int. Buba	0	– 21.06	– 0.16	0.88	–	–	–	–
Concerted	0	27.43	0.20	0.84	–	–	–	–
Heavy	0	– 98.56	– 0.38	0.71	–	–	–	–
CPI	0	216.70	1.06	0.29	0 to 5	733.61	1.32	0.19
PPI	0	66.70	0.76	0.45	0 to 5	– 23.63	– 0.10	0.92
IP US	0	106.35	0.88	0.38	0 to 5	61.58	0.15	0.88
TRADE US	0	– 0.71	– 0.05	0.96	0 to 5	25.57	0.70	0.48
UNEMP	0	– 51.23	– 0.33	0.74	0 to 5	374.22	0.94	0.35
TANKAN	0	– 0.29	– 0.20	0.84	0 to 5	– 3.12	– 1.01	0.31
IP JP	0	9.34	1.03	0.30	0 to 5	35.30	1.65	0.10
RETAIL JP	0	4.85	0.29	0.77	0 to 5	– 29.29	– 0.63	0.53
TRADE JP	0	0.23	0.43	0.67	0 to 5	– 0.08	– 0.10	0.92

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 28b

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	0.05	0.11	0.91	0 to 5	0.03	0.12	0.90
Fed intervention	0	– 1.73	– 0.12	0.91	0 to 5	– 1.69	– 0.11	0.91
DM/$ int. Fed	0	541.10	0.10	0.92	–	–	–	–
DM/$ int. Buba	0	– 569.07	– 0.12	0.91	–	–	–	–
Concerted	0	588.47	0.12	0.90	–	–	–	–
Heavy	0	45.39	0.10	0.92	–	–	–	–
CPI	0	300.38	0.96	0.34	0 to 5	1016.44	0.69	0.49
PPI	0	66.86	0.56	0.58	0 to 5	85.29	0.10	0.92
IP	0	99.05	0.26	0.80	0 to 5	44.73	0.03	0.97
TRADE	0	10.29	0.14	0.89	0 to 5	25.94	0.37	0.71
UNEMP	0	– 98.64	– 0.43	0.67	0 to 5	242.10	0.35	0.72
TANKAN	0	0.07	0.04	0.96	0 to 5	– 2.88	– 0.44	0.66
IP JP	0	2.85	0.18	0.85	0 to 5	18.40	0.40	0.69
RETAIL JP	0	13.22	0.17	0.87	0 to 5	6.96	0.04	0.97
TRADE JP	0	0.21	0.36	0.72	0 to 5	– 0.20	– 0.20	0.84

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 29a

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 2.03	– 0.94	0.35	0 to 5	– 1.27	– 0.66	0.51
DM/$ int. Fed	0	– 2933.73	– 0.76	0.44	–	–	–	–
DM/$ int. Buba	0	2278.81	0.83	0.40	–	–	–	–
Concerted	0	2569.76	1.02	0.31	–	–	–	–
Heavy	0	4615.71	0.91	0.36	–	–	–	–
CPI	0	– 1171.04	– 0.45	0.65	0 to 5	– 2465.99	– 0.31	0.76
PPI	0	– 1326.27	– 1.26	0.21	0 to 5	1919.96	0.49	0.63
IP	0	468.70	0.31	0.75	0 to 5	12895.49	1.65	0.10
TRADE	0	– 155.31	– 1.03	0.30	0 to 5	– 37.31	– 0.08	0.94
UNEMP	0	– 1536.63	– 0.72	0.47	0 to 5	386.82	0.07	0.94
TANKAN	0	– 15.57	– 0.93	0.35	0 to 5	– 32.65	– 0.90	0.37
IP JP	0	14.30	0.08	0.94	0 to 5	75.60	0.24	0.81
RETAIL JP	0	232.45	1.06	0.29	0 to 5	– 164.45	– 0.21	0.83
TRADE JP	0	– 1.43	– 0.23	0.82	0 to 5	– 11.21	– 1.18	0.24

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 29b

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 3.38	– 0.35	0.72	0 to 5	– 2.28	– 0.30	0.76
Fed intervention	0	– 7.71	– 0.01	0.99	0 to 5	– 9.47	– 0.01	0.99
DM/$ int. Fed	0	– 4866.55	– 0.02	0.98	–	–	–	–
DM/$ int. Buba	0	3773.13	0.02	0.99	–	–	–	–
Concerted	0	5932.70	0.02	0.98	–	–	–	–
Heavy	0	8047.25	0.23	0.82	–	–	–	–
CPI	0	26.90	0.00	1.00	0 to 5	– 3114.32	– 0.15	0.88
PPI	0	– 530.22	– 0.08	0.94	0 to 5	2260.70	0.05	0.96
IP	0	359.95	0.01	0.99	0 to 5	17840.34	0.30	0.77
TRADE	0	– 188.48	– 0.06	0.95	0 to 5	101.59	0.07	0.94
UNEMP	0	– 657.45	– 0.06	0.95	0 to 5	2563.11	0.12	0.91
TANKAN	0	– 17.43	– 0.25	0.80	0 to 5	– 30.51	– 0.13	0.90
IP JP	0	112.84	0.19	0.85	0 to 5	201.50	0.13	0.90
RETAIL JP	0	172.16	0.03	0.97	0 to 5	– 407.05	– 0.12	0.91
TRADE JP	0	– 1.63	– 0.09	0.93	0 to 5	– 13.29	– 0.73	0.46

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 30a

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	1.35	0.29	0.77	0 to 5	0.63	0.28	0.78
DM/$ int. Fed	0	248.11	0.17	0.87	–	–	–	–
DM/$ int. Buba	0	343.22	0.27	0.79	–	–	–	–
Concerted	0	–1777.66	– 0.27	0.79	–	–	–	–
One-shot	0	–3441.66	– 0.28	0.78	–	–	–	–
CPI	0	– 70.06	– 0.05	0.96	0 to 5	1469.94	0.22	0.82
PPI	0	– 283.89	– 0.24	0.81	0 to 5	– 321.18	– 0.18	0.86
IP US	0	625.98	0.37	0.71	0 to 5	–2033.93	– 0.29	0.78
TRADE US	0	– 162.02	– 0.31	0.76	0 to 5	7.32	0.03	0.97
UNEMP	0	– 438.97	– 0.32	0.75	0 to 5	1367.37	0.26	0.79
TANKAN	0	0.60	0.06	0.95	0 to 5	– 10.64	– 0.34	0.73
IP JP	0	89.65	0.29	0.77	0 to 5	– 29.89	– 0.15	0.88
RETAIL JP	0	– 177.07	– 0.29	0.77	0 to 5	– 544.57	– 0.30	0.77
TRADE JP	0	– 0.79	– 0.19	0.85	0 to 5	0.60	0.12	0.90

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 30b

Estimates of the effect of intervention on the mean of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	1.76	0.06	0.95	0 to 5	0.41	0.07	0.94
Fed intervention	0	10.59	0.13	0.90	0 to 5	14.20	0.13	0.90
DM/$ int. Fed	0	–1072.99	– 0.03	0.98	–	–	–	–
DM/$ int. Buba	0	910.26	0.03	0.98	–	–	–	–
Concerted	0	–7122.09	– 0.11	0.91	–	–	–	–
One-shot	0	–4624.53	– 0.06	0.95	–	–	–	–
CPI	0	1808.88	0.07	0.94	0 to 5	1163.43	0.03	0.98
PPI	0	– 649.44	– 0.08	0.94	0 to 5	–1867.62	– 0.11	0.91
IP US	0	2016.96	0.09	0.93	0 to 5	–4574.41	– 0.07	0.94
TRADE US	0	– 343.18	– 0.08	0.93	0 to 5	83.40	0.07	0.94
UNEMP	0	– 376.67	– 0.10	0.92	0 to 5	39.80	0.00	1.00
TANKAN	0	3.10	0.05	0.96	0 to 5	– 2.87	– 0.06	0.95
IP JP	0	– 128.20	– 0.10	0.92	0 to 5	– 498.80	– 0.07	0.95
RETAIL JP	0	– 299.10	– 0.09	0.93	0 to 5	– 489.67	– 0.08	0.94
TRADE JP	0	– 2.64	– 0.07	0.94	0 to 5	0.73	0.07	0.95

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 31a

Estimates of the effect of intervention on the variance of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 0.48	– 0.38	0.70	0 to 5	– 0.11	– 0.16	0.87
DM/$ int. Fed	0	– 1419.16	– 1.12	0.26	–	–	–	–
DM/$ int. Buba	0	408.63	0.37	0.71	–	–	–	–
Concerted	0	2622.96	1.22	0.22	–	–	–	–
One-shot	0	988.64	0.30	0.77	–	–	–	–
CPI	0	160.13	0.09	0.93	0 to 5	2339.38	0.40	0.69
PPI	0	– 544.17	– 0.66	0.51	0 to 5	188.41	0.07	0.95
IP US	0	1128.69	0.95	0.34	0 to 5	3821.95	1.01	0.31
TRADE US	0	– 19.69	– 0.17	0.87	0 to 5	– 253.62	– 0.81	0.42
UNEMP	0	– 2265.56	– 1.39	0.17	0 to 5	– 1813.30	– 0.51	0.61
TANKAN	0	– 6.53	– 0.53	0.59	0 to 5	– 13.72	– 0.52	0.60
IP JP	0	134.10	0.72	0.47	0 to 5	102.00	0.50	0.61
RETAIL JP	0	– 262.53	– 1.16	0.25	0 to 5	– 511.42	– 0.70	0.48
TRADE JP	0	– 3.47	– 0.72	0.47	0 to 5	– 7.75	– 1.20	0.23

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 31b

Estimates of the effect of intervention on the variance of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 4.76	– 0.52	0.60	0 to 5	– 1.44	– 0.43	0.67
Fed intervention	0	133.13	0.49	0.62	0 to 5	140.20	0.50	0.62
DM/$ int. Fed	0	– 49817.55	– 0.51	0.61	–	–	–	–
DM/$ int. Buba	0	44305.65	0.50	0.62	–	–	–	–
Concerted	0	– 39197.20	– 0.45	0.65	–	–	–	–
One-shot	0	7195.73	0.44	0.66	–	–	–	–
CPI	0	– 3726.43	– 0.35	0.73	0 to 5	– 249.44	– 0.01	0.99
PPI	0	– 1314.97	– 0.39	0.70	0 to 5	7356.50	0.43	0.67
IP US	0	5635.97	0.54	0.59	0 to 5	18691.51	0.58	0.56
TRADE US	0	644.25	0.46	0.65	0 to 5	269.31	0.18	0.85
UNEMP	0	– 2024.32	– 0.35	0.72	0 to 5	5096.95	0.27	0.79
TANKAN	0	– 5.43	– 0.12	0.90	0 to 5	– 67.40	– 0.48	0.63
IP JP	0	381.98	0.38	0.70	0 to 5	442.16	0.41	0.68
RETAIL JP	0	494.26	0.26	0.80	0 to 5	– 737.53	– 0.28	0.78
TRADE JP	0	– 1.15	– 0.06	0.95	0 to 5	– 4.64	– 0.20	0.84

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in log-difference form.

Table 32a

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	0.13	0.04	0.67	0 to 5	0.08	0.57	0.57
DM/$ int. Fed	0	– 63.97	– 0.43	0.67	–	–	–	–
DM/$ int. Buba	0	35.53	0.25	0.80	–	–	–	–
Concerted	0	– 80.37	– 0.18	0.86	–	–	–	–
One-shot	0	– 410.84	– 0.49	0.62	–	–	–	–
CPI	0	171.70	0.67	0.50	0 to 5	824.12	1.26	0.21
PPI	0	35.31	0.27	0.79	0 to 5	– 58.60	– 0.20	0.84
IP US	0	130.20	0.92	0.36	0 to 5	6.82	0.01	0.99
TRADE US	0	– 8.72	– 0.25	0.80	0 to 5	21.69	0.57	0.57
UNEMP	0	– 102.30	– 0.48	0.63	0 to 5	399.69	0.86	0.39
TANKAN	0	– 0.40	– 0.24	0.81	0 to 5	– 3.70	– 0.88	0.38
IP JP	0	18.71	0.78	0.44	0 to 5	29.68	1.19	0.23
RETAIL JP	0	– 11.11	– 0.25	0.80	0 to 5	– 80.39	– 0.58	0.56
TRADE JP	0	0.12	0.19	0.85	0 to 5	– 0.13	– 0.13	0.89

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 32b

Estimates of the effect of intervention on the skewness of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	0.06	0.13	0.90	0 to 5	0.03	0.25	0.80
Fed intervention	0	0.30	0.02	0.98	0 to 5	0.46	0.04	0.97
DM/$ int. Fed	0	– 117.80	– 0.03	0.98	–	–	–	–
DM/$ int. Buba	0	29.01	0.01	0.99	–	–	–	–
Concerted	0	– 108.69	– 0.03	0.98	–	–	–	–
One-shot	0	– 202.28	– 0.19	0.85	–	–	–	–
CPI	0	262.09	0.89	0.37	0 to 5	909.73	0.79	0.43
PPI	0	57.73	0.45	0.65	0 to 5	– 35.12	– 0.05	0.96
IP	0	160.69	0.33	0.74	0 to 5	135.65	0.14	0.89
TRADE	0	– 3.26	– 0.03	0.97	0 to 5	21.37	0.42	0.68
UNEMP	0	– 105.95	– 0.51	0.61	0 to 5	264.68	0.49	0.63
TANKAN	0	– 0.05	– 0.03	0.97	0 to 5	– 2.25	– 0.39	0.70
IP JP	0	4.59	0.23	0.81	0 to 5	13.28	0.19	0.85
RETAIL JP	0	– 3.84	– 0.04	0.97	0 to 5	– 39.67	– 0.18	0.86
TRADE JP	0	0.15	0.25	0.80	0 to 5	– 0.22	– 0.24	0.81

Note: The table reports the estimation results for equation (4) in Appendix 3. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 33a

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
Intervention	0	– 1.47	– 1.00	0.32	0 to 5	– 0.22	– 0.29	0.77
DM/$ int. Fed	0	– 485.25	– 0.31	0.75	–	–	–	–
DM/$ int. Buba	0	451.22	0.33	0.74	–	–	–	–
Concerted	0	2652.64	1.05	0.29	–	–	–	–
One-shot	0	4055.42	1.03	0.31	–	–	–	–
CPI	0	– 1215.75	– 0.49	0.62	0 to 5	– 1871.32	– 0.25	0.80
PPI	0	– 1602.47	– 1.53	0.13	0 to 5	2481.08	0.67	0.50
IP	0	– 166.60	– 0.12	0.91	0 to 5	9604.69	1.98	0.05
TRADE	0	– 188.36	– 1.24	0.21	0 to 5	– 248.48	– 0.62	0.54
UNEMP	0	– 2517.58	– 1.22	0.22	0 to 5	– 1072.29	– 0.23	0.82
TANKAN	0	– 14.16	– 0.90	0.37	0 to 5	– 33.03	– 0.97	0.33
IP JP	0	102.53	0.44	0.66	0 to 5	– 44.52	– 0.17	0.87
RETAIL JP	0	49.82	0.17	0.87	0 to 5	– 475.17	– 0.52	0.61
TRADE JP	0	0.84	0.14	0.89	0 to 5	– 7.57	– 0.91	0.37

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

Table 33b

Estimates of the effect of intervention on the kurtosis of the PDF, dollar/yen, 1992-96

	Lag	Coefficient	t-statistic	Signif. level	Lag	Coefficient	t-statistic	Signif. level
BoJ intervention	0	– 4.03	– 0.54	0.59	0 to 5	– 0.74	– 0.25	0.80
Fed intervention	0	71.33	0.41	0.68	0 to 5	73.63	0.41	0.68
DM/$ int. Fed	0	– 27340.33	– 0.43	0.67	–	–	–	–
DM/$ int. Buba	0	25207.16	0.44	0.66	–	–	–	–
Concerted	0	– 19548.83	– 0.36	0.72	–	–	–	–
One-shot	0	8123.23	0.53	0.60	–	–	–	–
CPI	0	– 2533.64	– 0.37	0.71	0 to 5	– 1675.32	– 0.11	0.91
PPI	0	– 1801.45	– 0.80	0.43	0 to 5	7140.78	0.59	0.56
IP	0	2551.36	0.36	0.72	0 to 5	19434.78	0.76	0.45
TRADE	0	114.78	0.14	0.89	0 to 5	53.96	0.06	0.96
UNEMP	0	– 2841.05	– 0.70	0.49	0 to 5	2612.79	0.20	0.84
TANKAN	0	– 9.52	– 0.30	0.76	0 to 5	– 64.41	– 0.60	0.55
IP JP	0	217.40	0.20	0.84	0 to 5	243.77	0.23	0.82
RETAIL JP	0	421.75	0.34	0.73	0 to 5	– 728.66	– 0.28	0.78
TRADE JP	0	2.43	0.18	0.85	0 to 5	– 8.07	– 0.49	0.62

Note: The table reports the estimation results for equation (4) in Appendix 3. Intervention and the macroeconomic control variables enter the equation in absolute values. The equation is estimated over the sample period 1 August 1992 to 31 December 1996, using daily data. The table reports the coefficient on current intervention, its t-statistic and significance level. It also reports the cumulative sums of coefficients, their t-statistic and significance level. The variables are explained in Appendix 6. The dependent variable enters the regression equation in difference form.

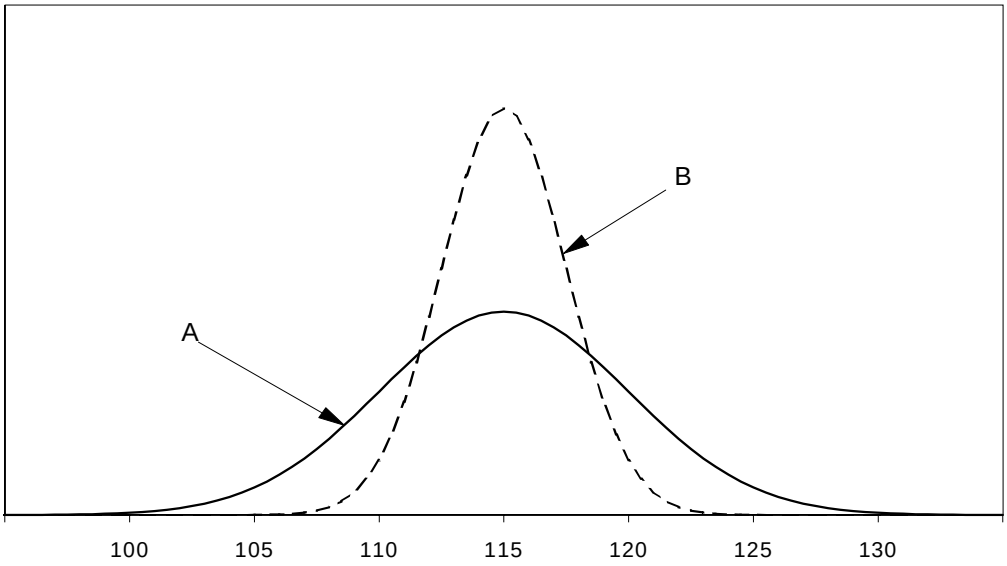
Table 34

Intervention strategies followed during the period 1992-96

Strategy	DM/$	Yen/$
Number of intervention episodes	11	154
Unilateral	5	136
Concerted	6	18
Officially announced	7	8
Discreet	4	146
Light	8	125
Heavy	3	29
Single-day	3	9
Repeated	8 (4)	145 (15)

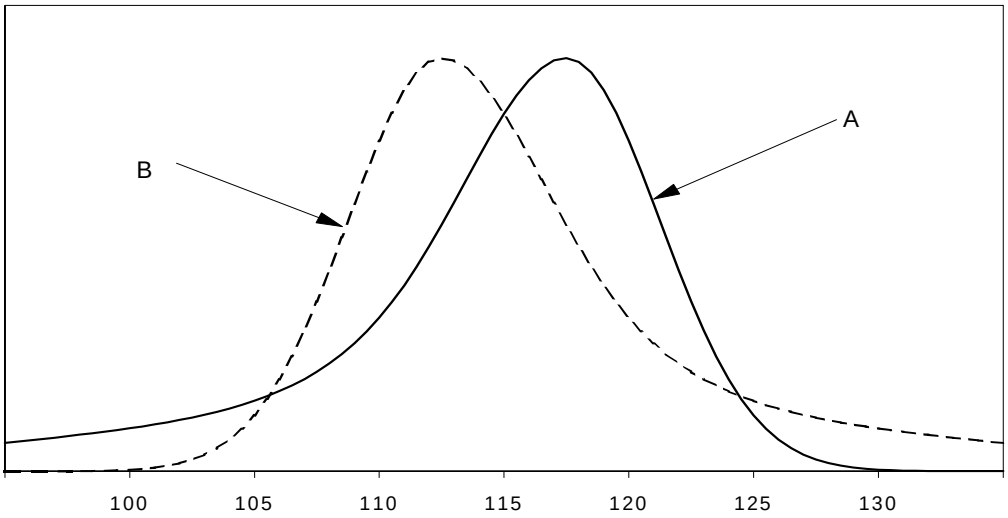
Figure 1

Variance of a PDF



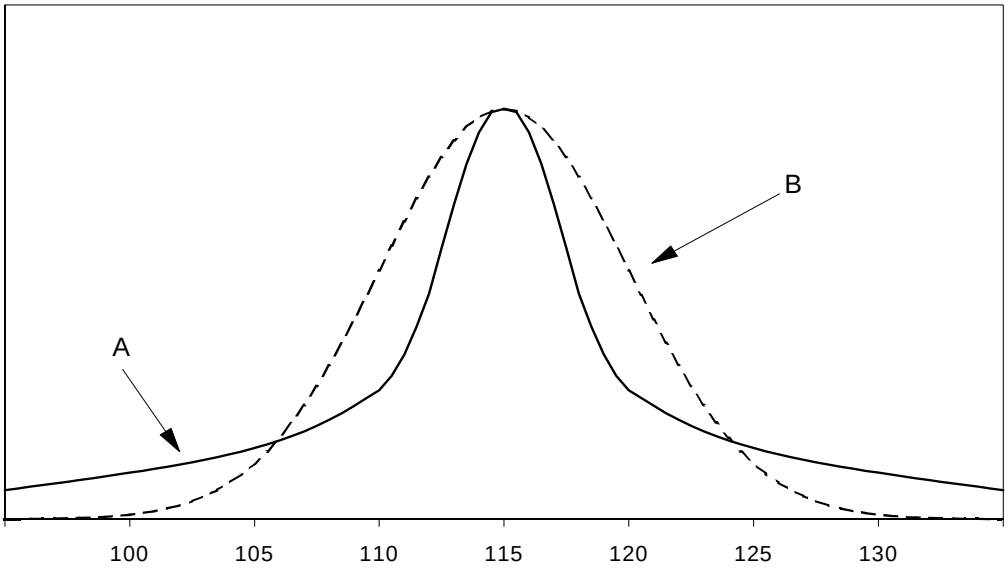
Note: The PDFs are expressed in yen per dollar. The PDFs in Figure 1 have the same mean but PDF A has a higher variance than PDF B.

Figure 2
Skewness of a PDF



Note: The PDFs are expressed in yen per dollar. The PDFs in Figure 2 have the same mean and variance but a different skewness. PDF A is skewed to the left and PDF B is skewed to the right.

Figure 3
Kurtosis of a PDF



Note: The PDFs are expressed in yen per dollar. The PDFs in Figure 3 have the same mean and variance but PDF A has a higher kurtosis than PDF B.

Figure 4: Mean of dollar/yen PDFs around all days of dollar purchases

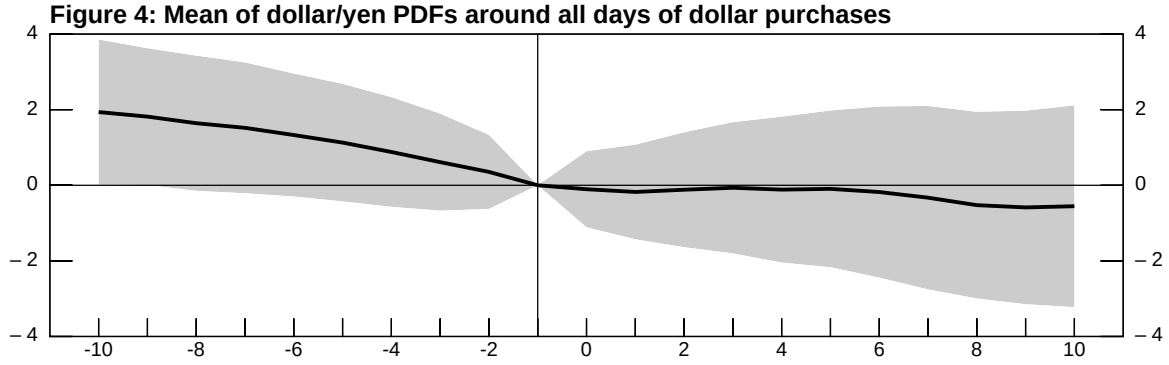


Figure 5: Mean of dollar/yen PDFs around all days of dollar sales

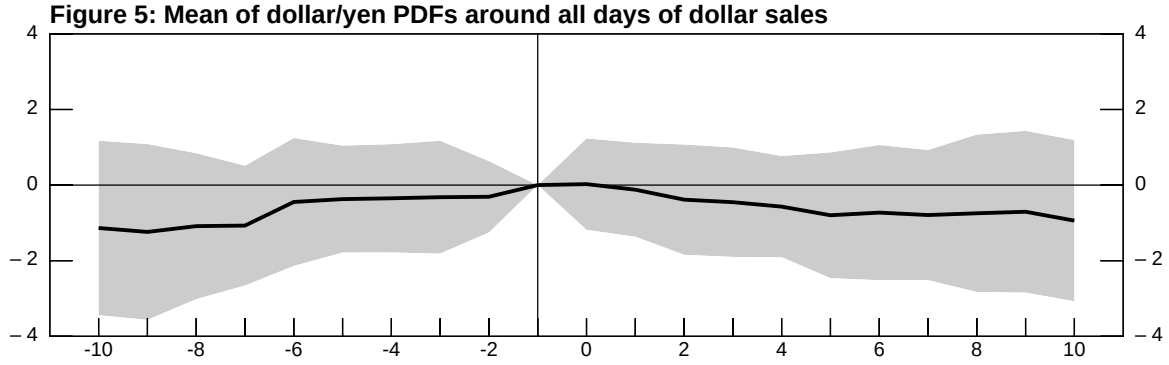


Figure 6: Mean of dollar/mark PDFs around all days of dollar purchases

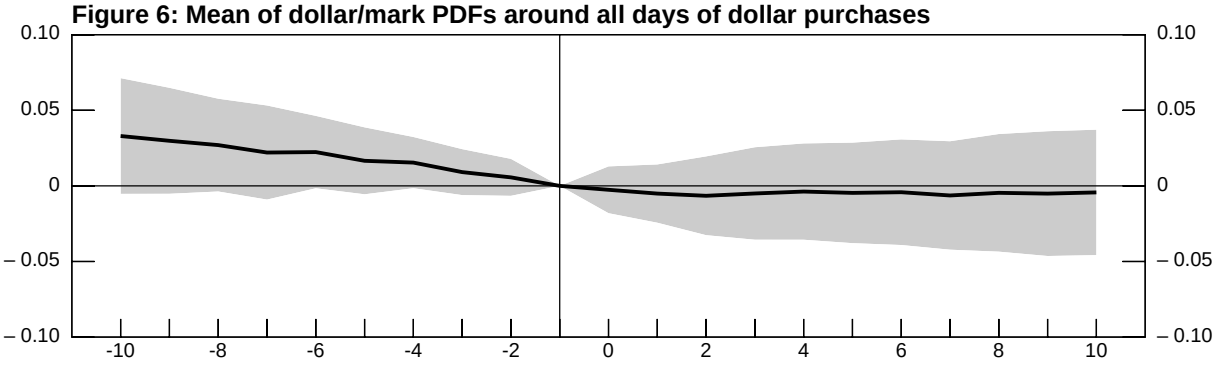


Figure 7: Mean of dollar/mark PDFs around all days of dollar sales

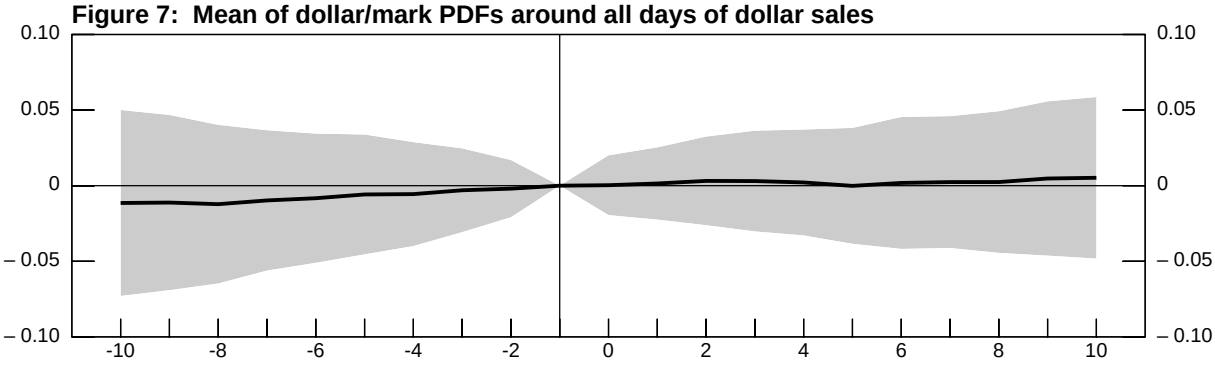


Figure 8: Variance of dollar/yen PDFs around all days of intervention

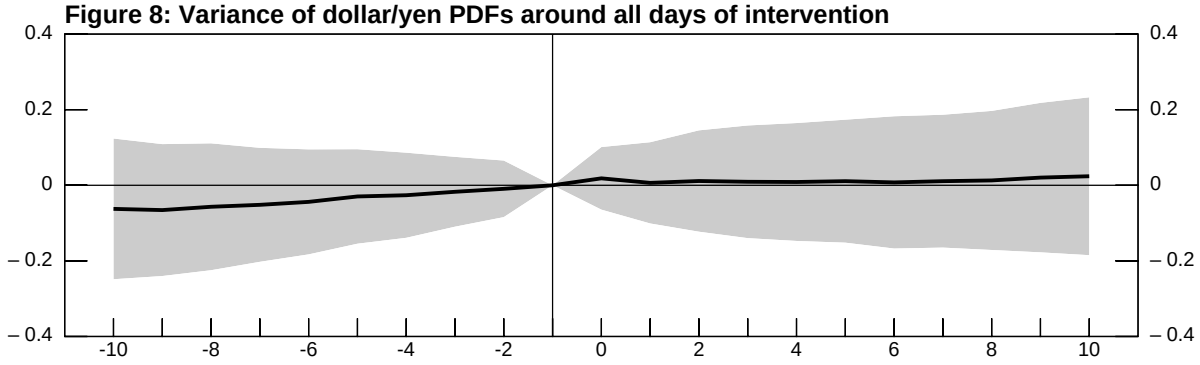


Figure 9: Variance of dollar/mark PDFs around all days of intervention

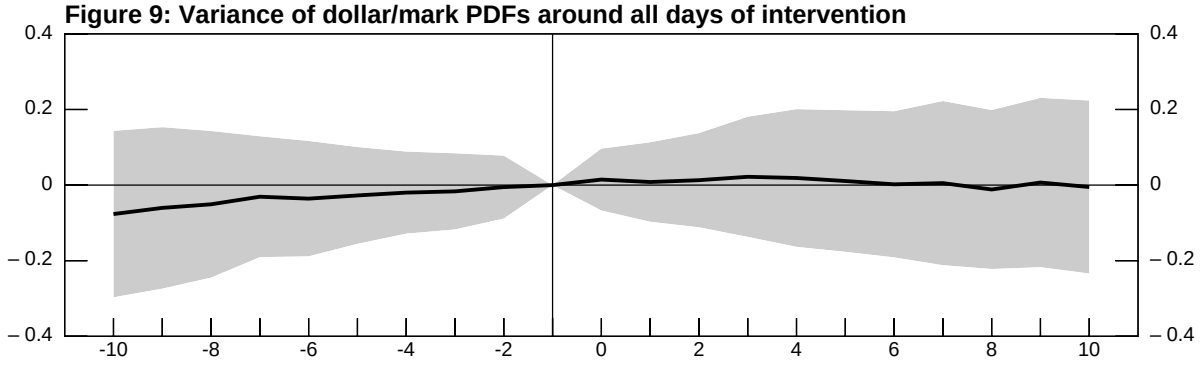


Figure 10: Skewness of dollar/yen PDFs around all days of dollar purchases

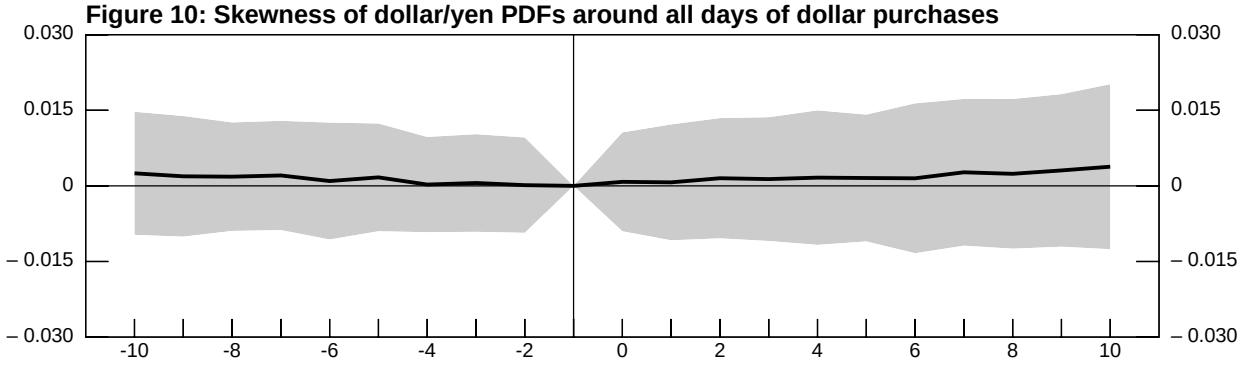


Figure 11: Skewness of dollar/yen PDFs around all days of dollar sales

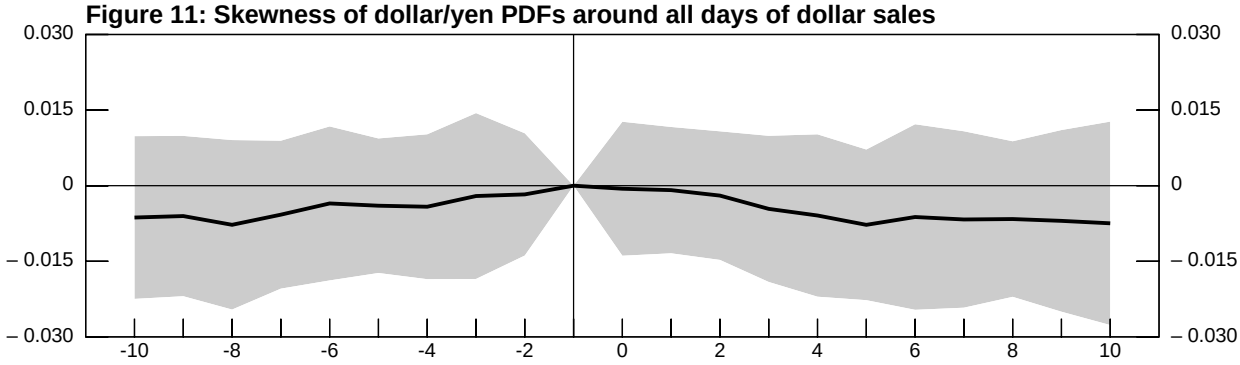


Figure 12: Skewness of dollar/mark PDFs around all days of dollar purchases

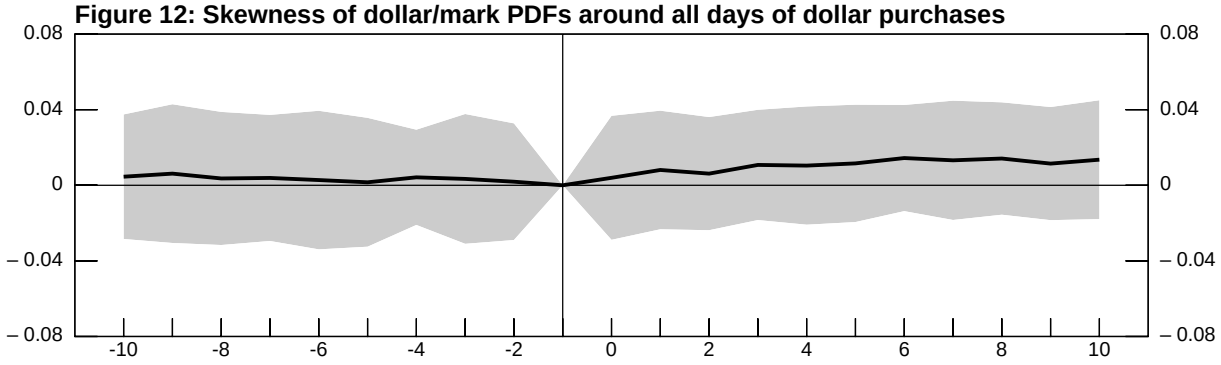


Figure 13: Skewness of dollar/mark PDFs around all days of dollar sales

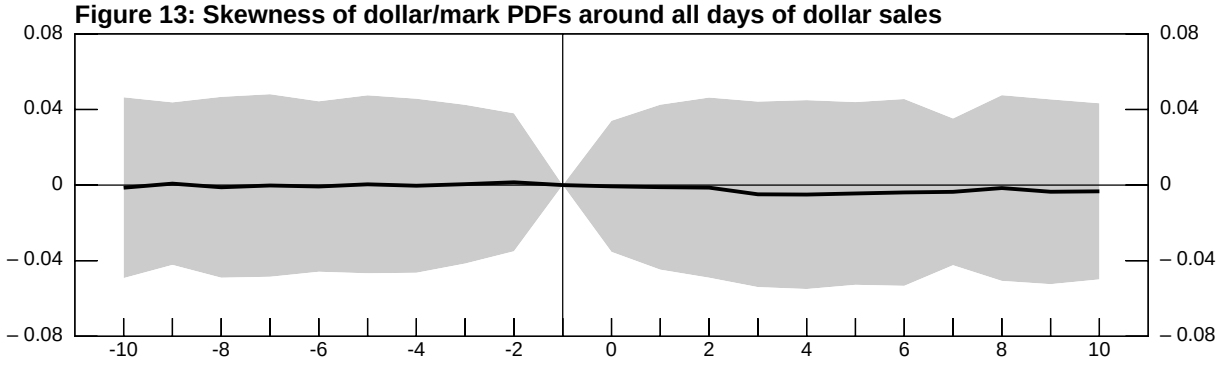


Figure 14: Kurtosis of dollar/yen PDFs around all days of intervention

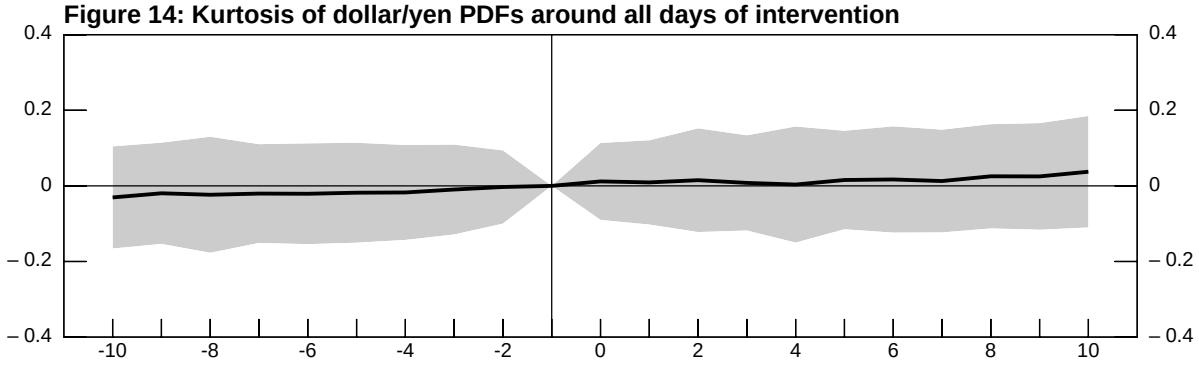


Figure 15: Kurtosis of dollar/mark PDFs around all days of intervention

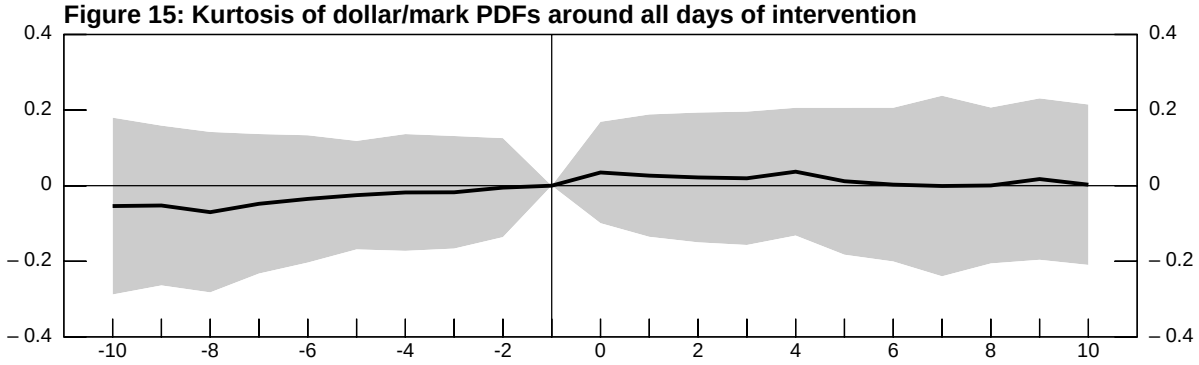


Figure 16: Mean of dollar/yen PDFs around all episodes of dollar purchases

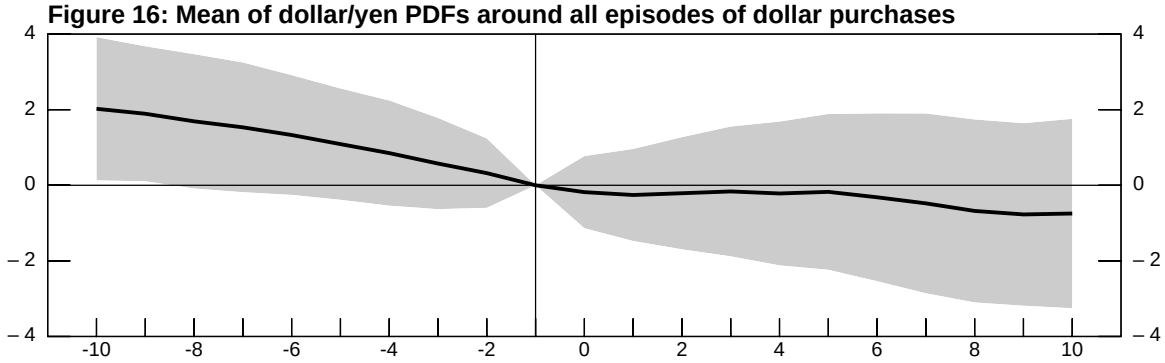


Figure 17: Mean of dollar/yen PDFs around all episodes of dollar sales

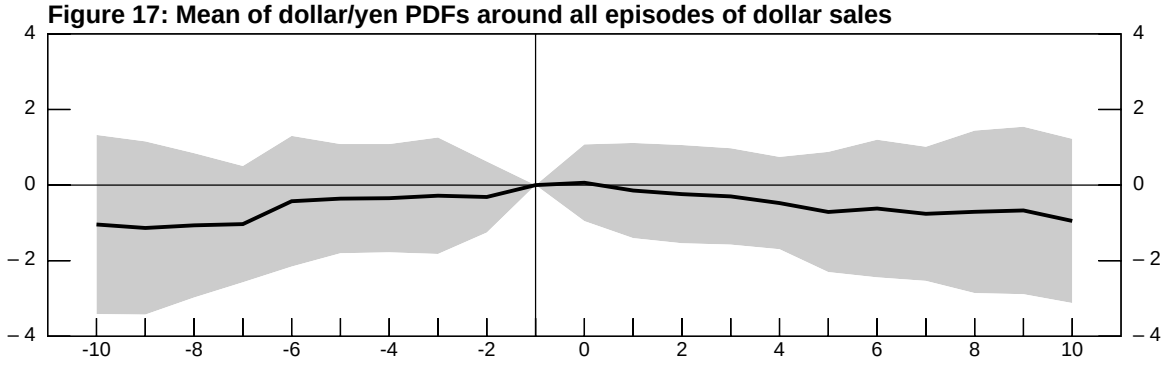


Figure 18: Mean of dollar/mark PDFs around all episodes of dollar purchases

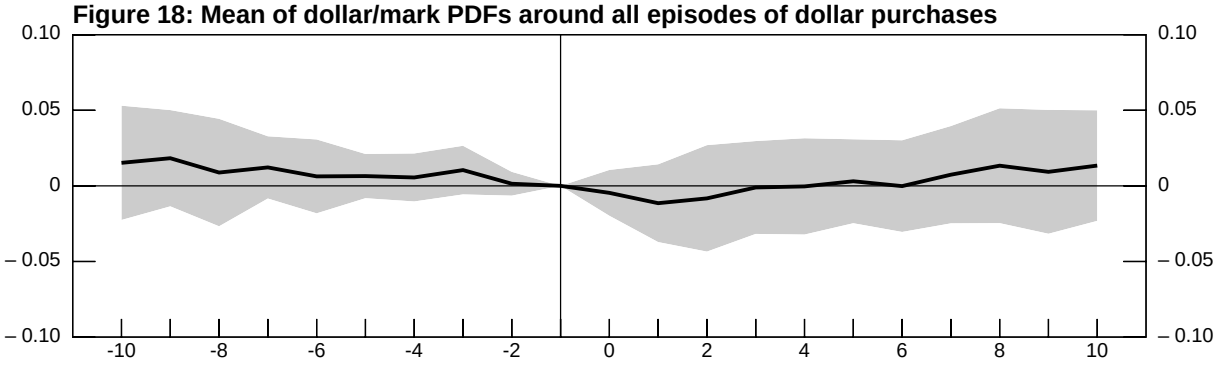


Figure 19: Mean of dollar/mark PDFs around all episodes of dollar sales

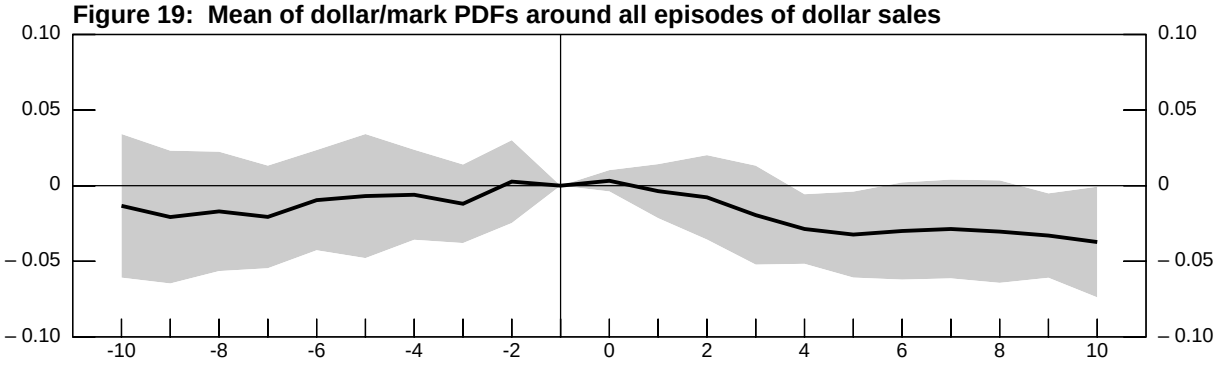


Figure 20: Variance of dollar/yen PDFs around all episodes of intervention

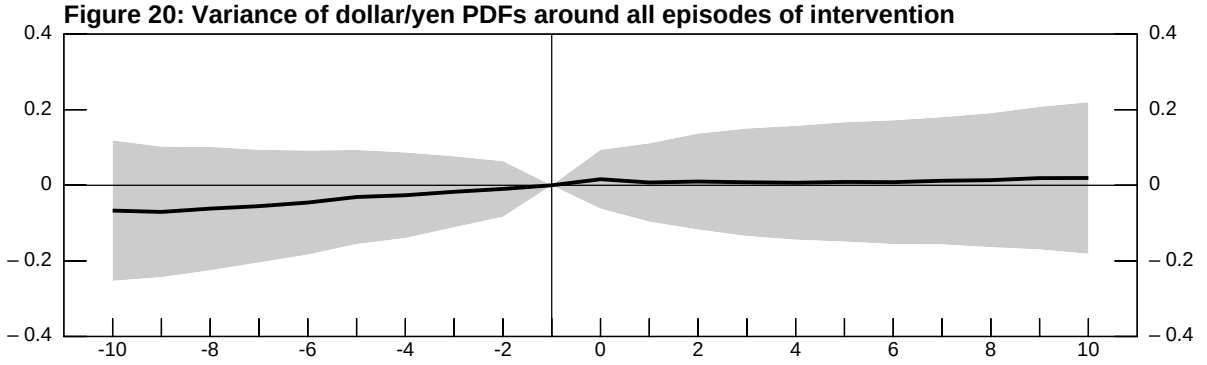


Figure 21: Variance of dollar/mark PDFs around all episodes of intervention

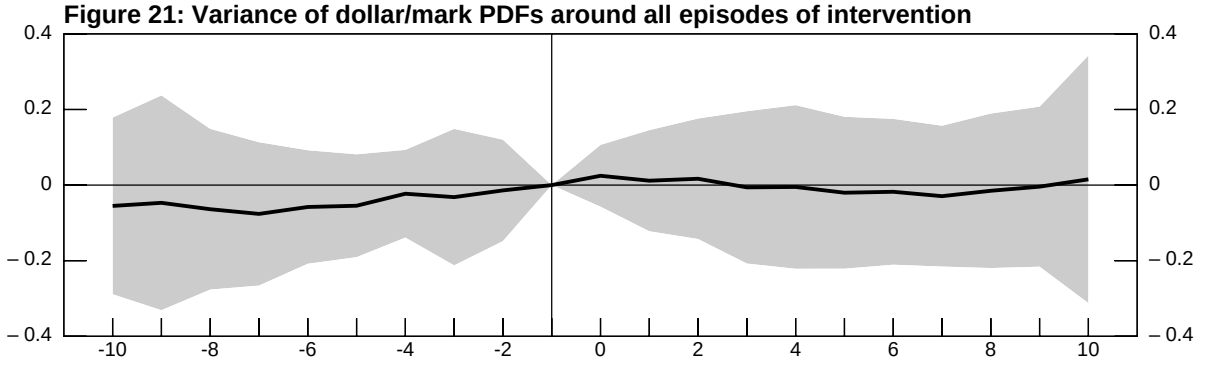


Figure 22: Skewness of dollar/yen PDFs around all episodes of dollar purchases

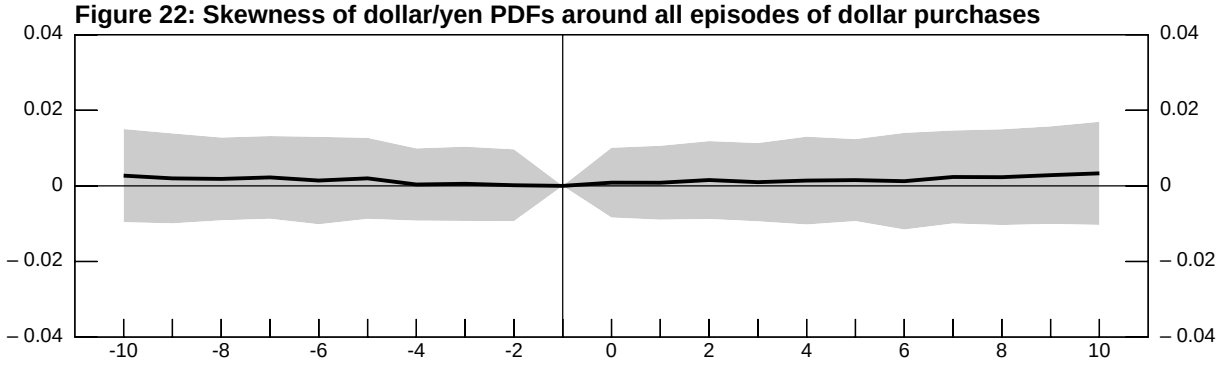


Figure 23: Skewness of dollar/yen PDFs around all episodes of dollar sales

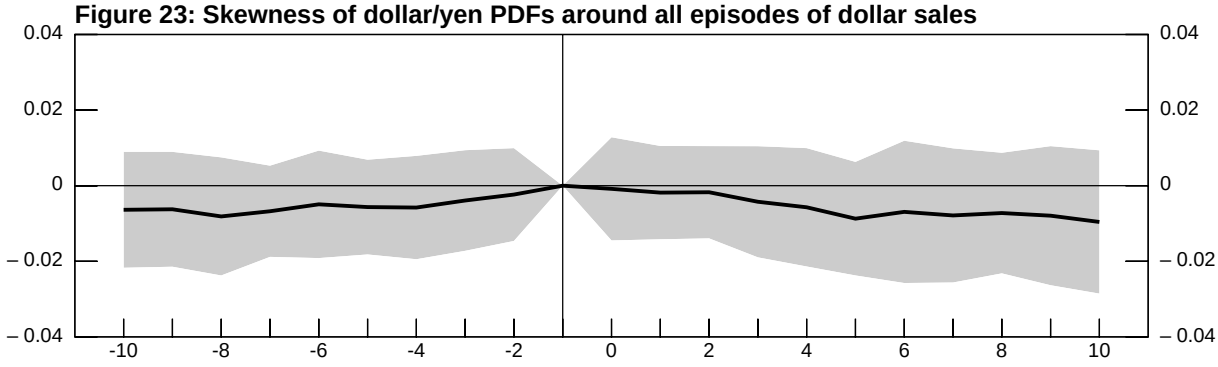


Figure 24: Skewness of dollar/mark PDFs around all episodes of dollar purchases

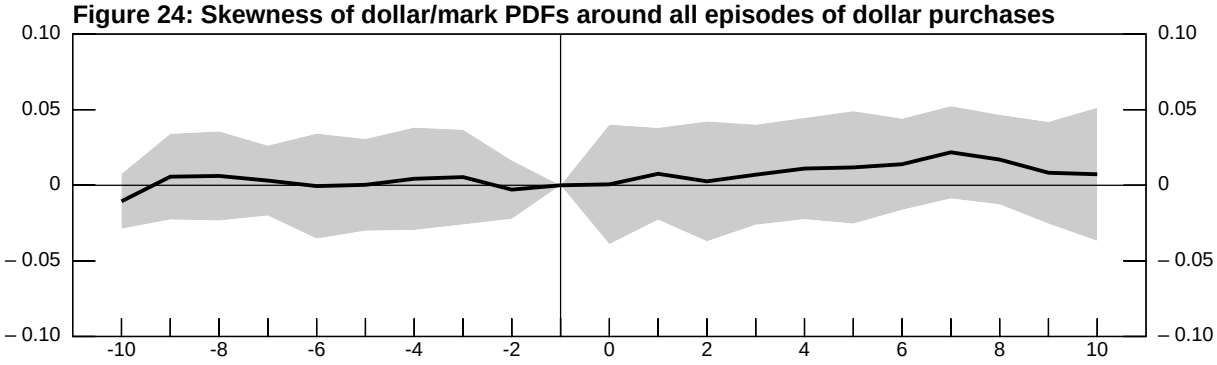


Figure 25: Skewness of dollar/mark PDFs around all episodes of dollar sales

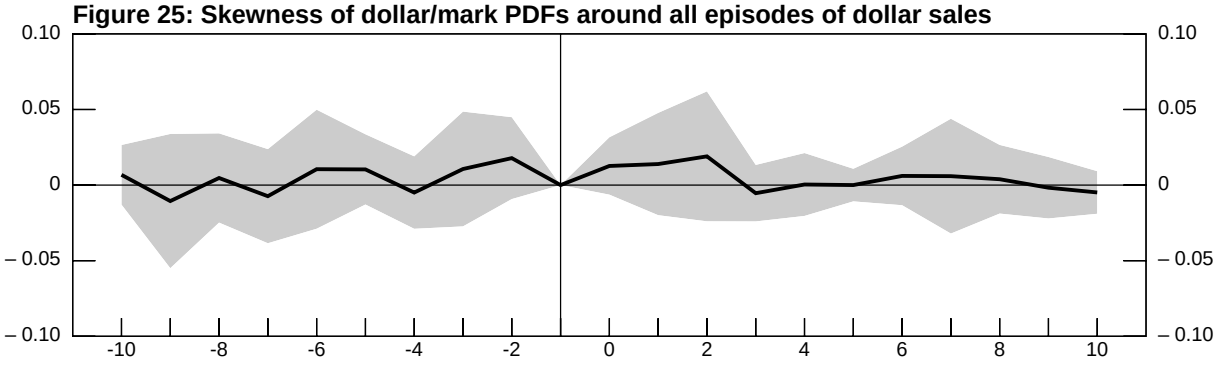


Figure 26: Kurtosis of dollar/yen PDFs around all episodes of intervention

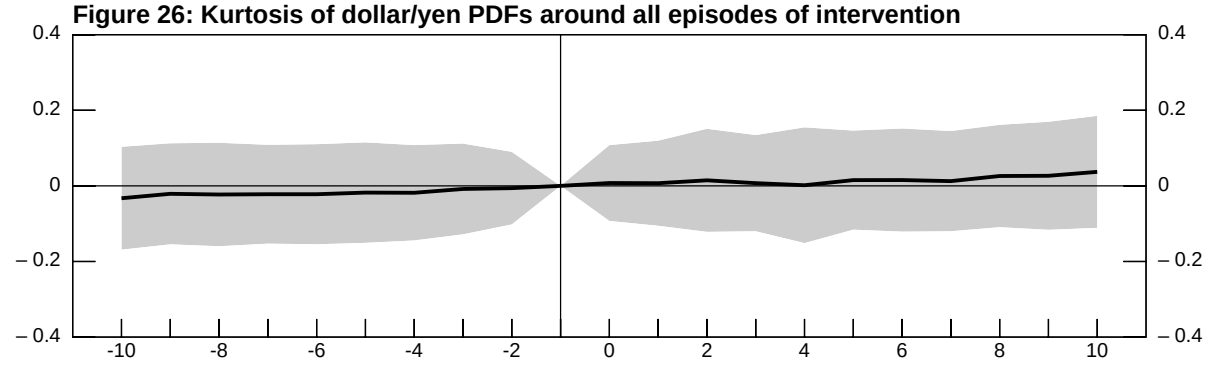


Figure 27: Kurtosis of dollar/mark PDFs around all episodes of intervention

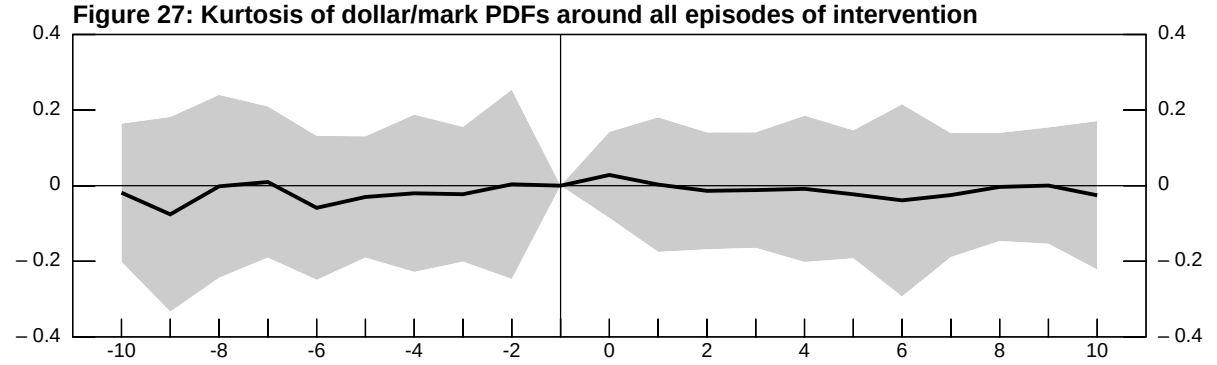


Figure 28

Probability density function of the Deutsche mark against the dollar around the Plaza Accord

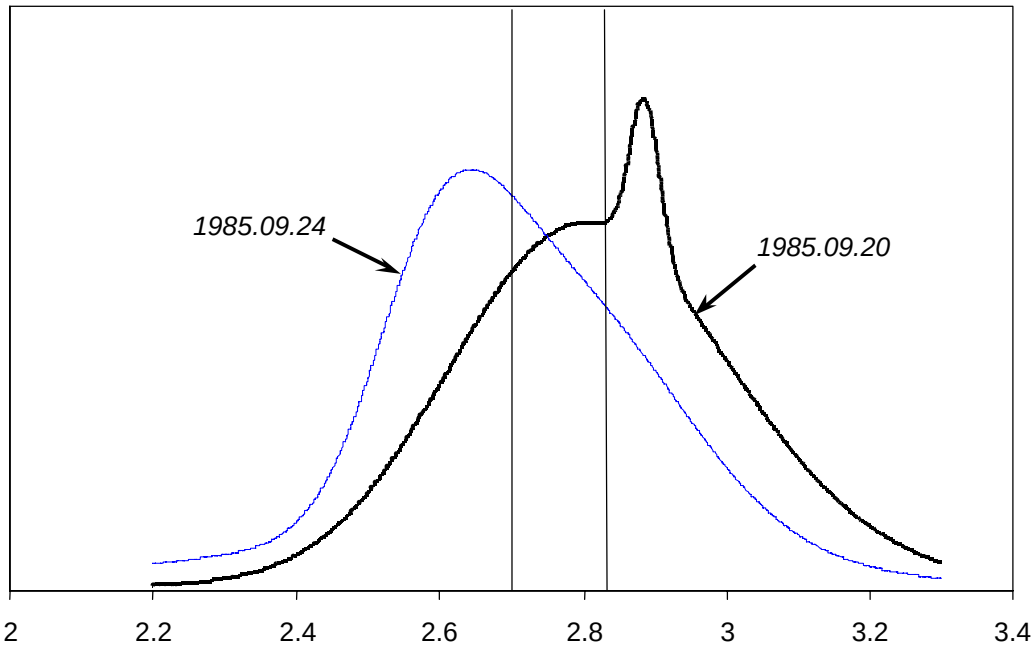


Figure 29: Average movements of the mean of dollar/mark PDFs around all intervention days in 1985

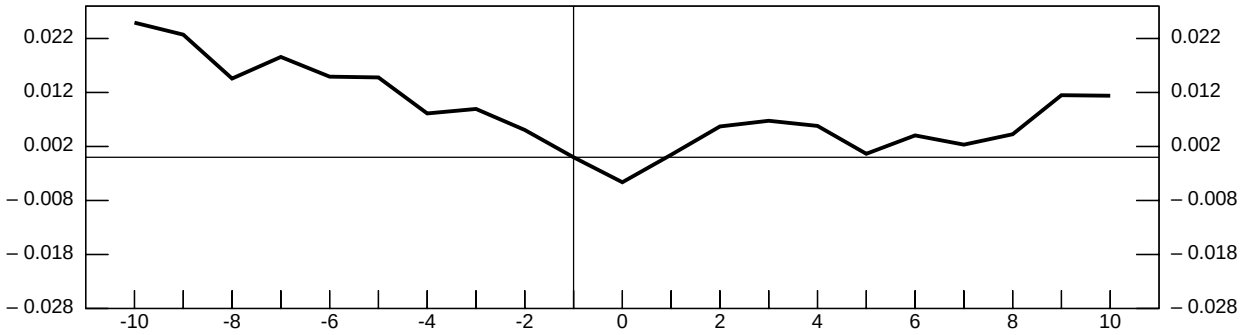


Figure 30: Average movements of the variance of dollar/mark PDFs around all intervention days in 1985

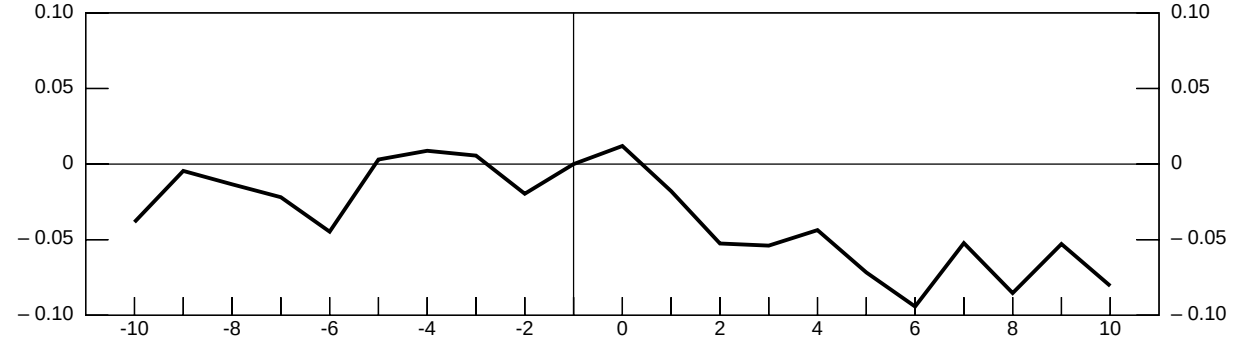


Figure 31: Average movements of the skewness of dollar/mark PDFs around all intervention days in 1985

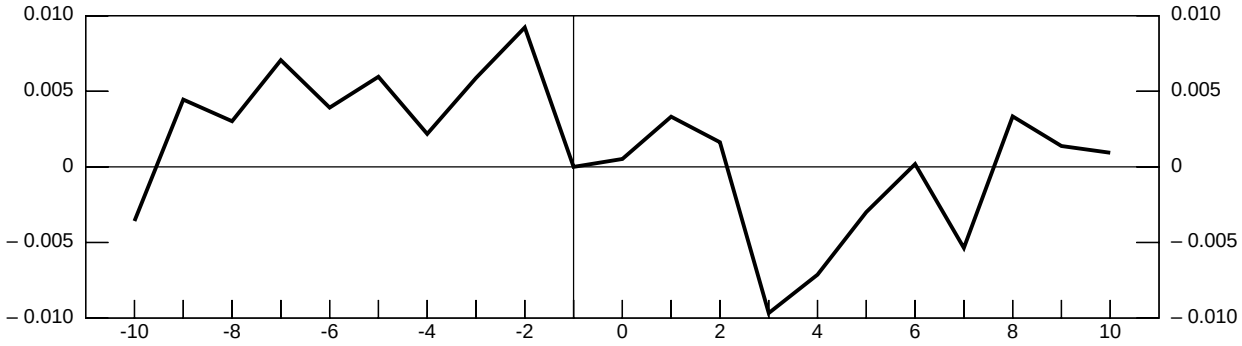


Figure 32: Average movements of the kurtosis of dollar/mark PDFs around all intervention days in 1985

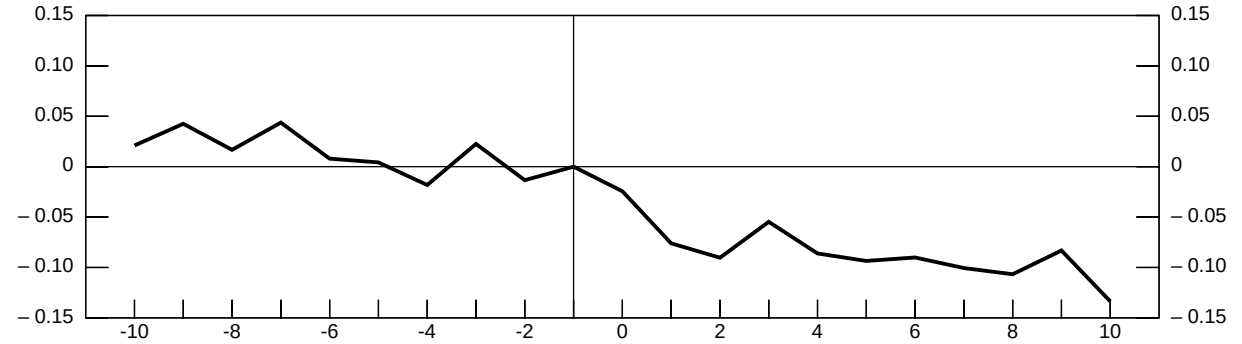


Figure 33

Probability density function of the Deutsche mark against the dollar around the Louvre Accord

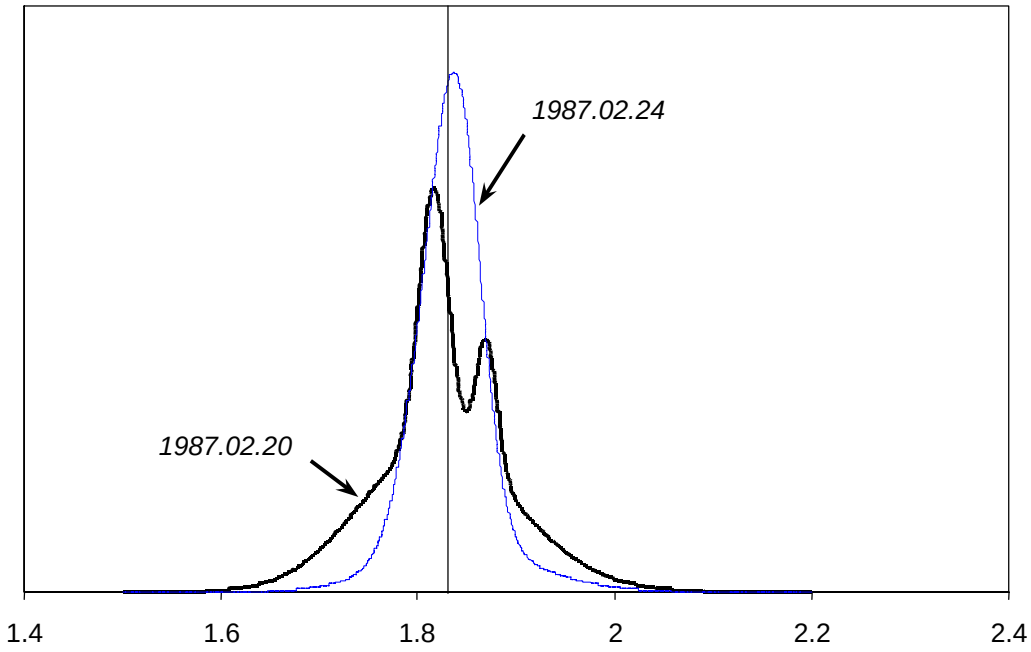
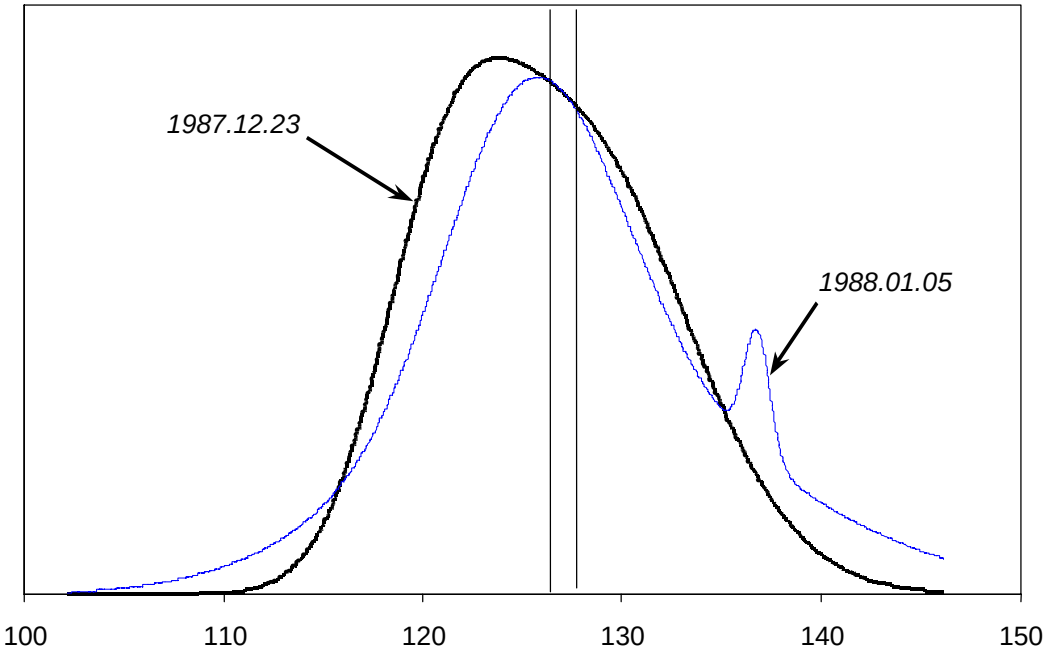


Figure 34

Probability density function of the yen against the dollar following the "Telephone Accord", 23 December 1987-5 January 1988



Average movements of dollar/mark PDF moments during the Louvre period

Figure 35: Mean of dollar/mark purchases

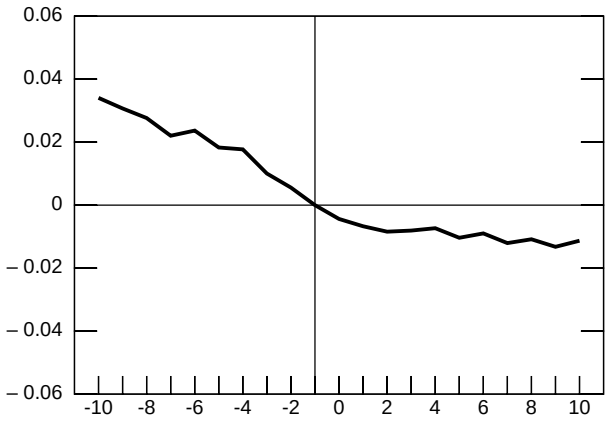


Figure 36: Mean of dollar/mark sales

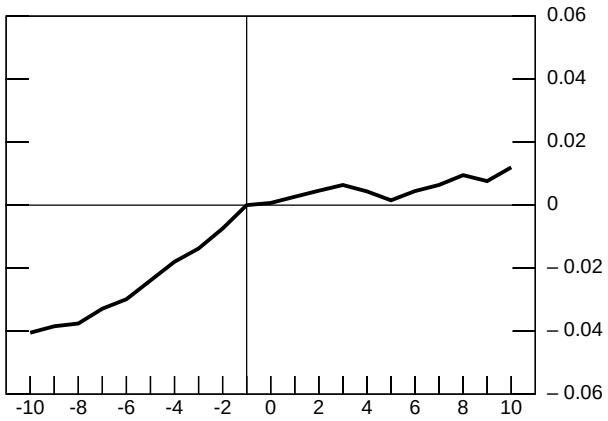


Figure 37: Skewness of dollar/mark purchases

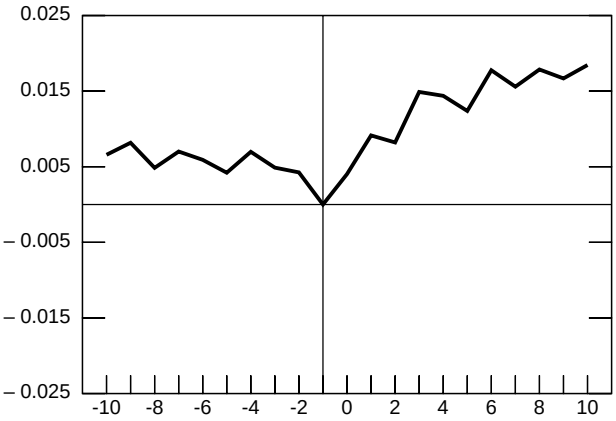


Figure 38: Skewness of dollar/mark sales

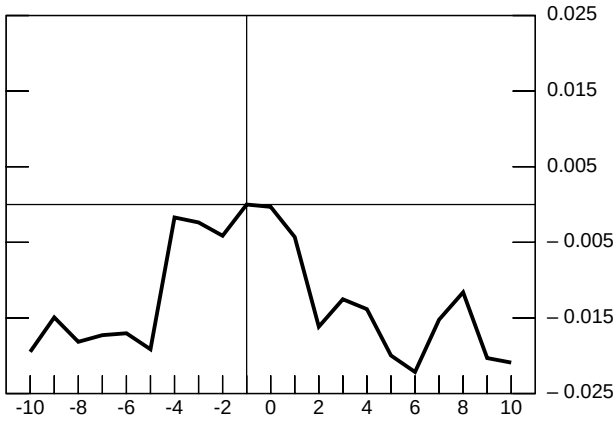


Figure 39: Variance of dollar/mark PDFs

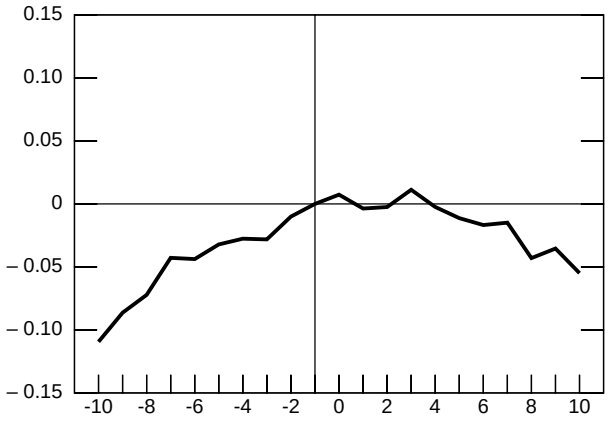


Figure 40: Kurtosis of dollar/mark PDFs

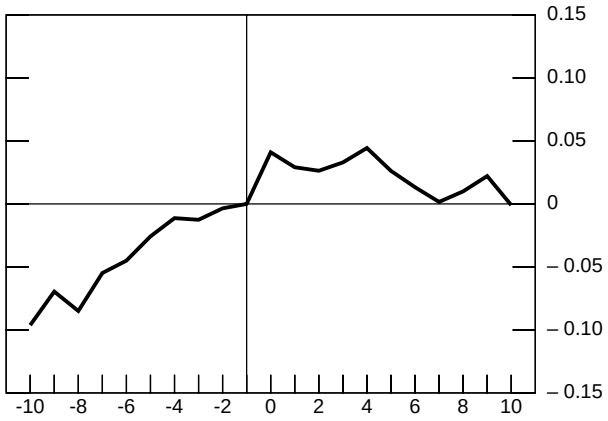


Figure 41

Probability distribution of the mark against the dollar, 23 September 1989

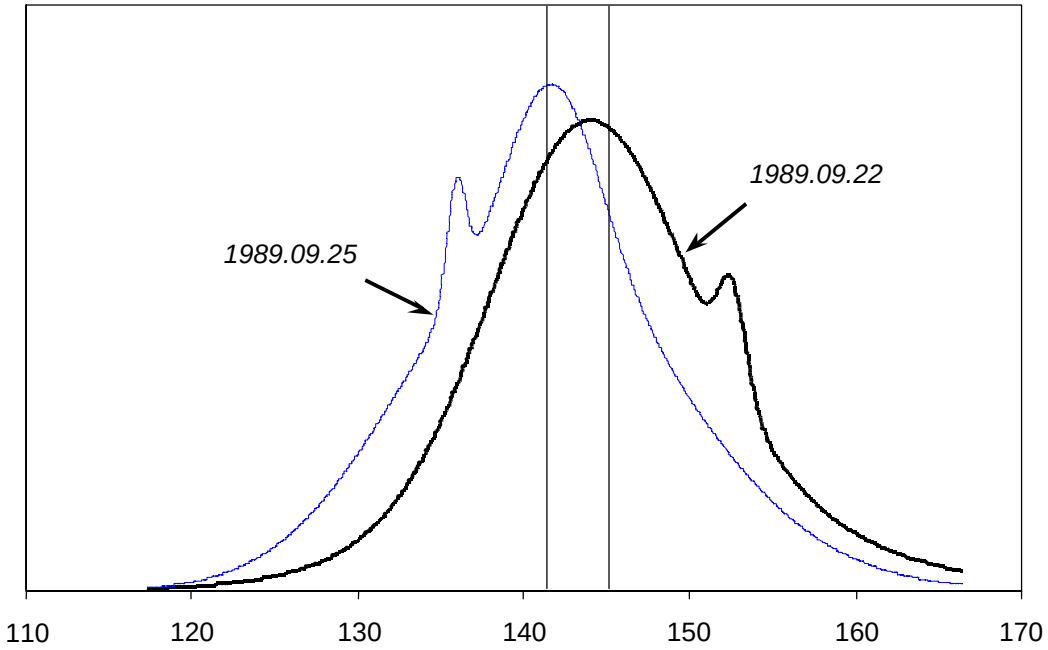
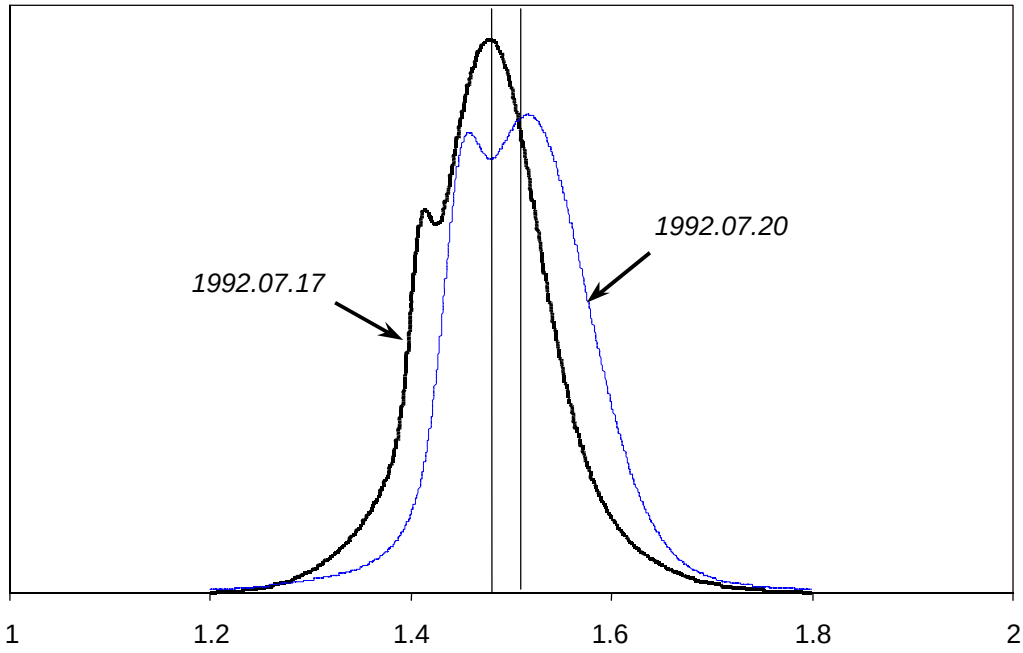


Figure 42

Probability distribution of the Deutsche mark against the dollar, July 1992



Average movements of dollar/mark PDF moments during the period 1988-92

Figure 43: Mean of dollar/mark purchases

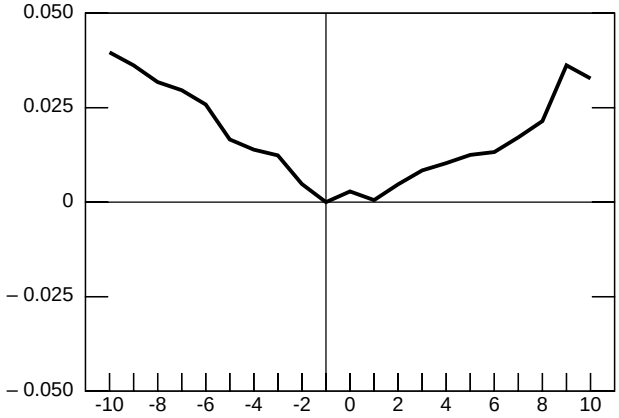


Figure 44: Mean of dollar/mark sales

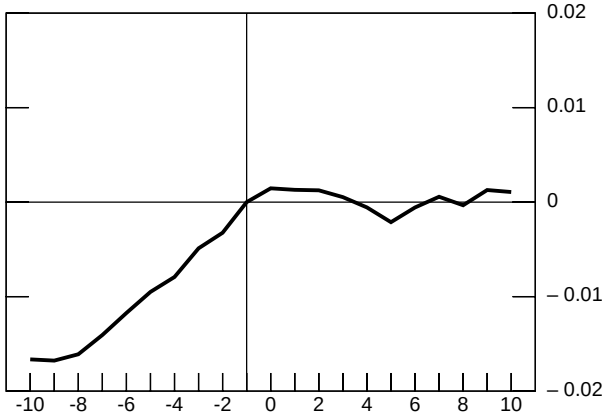


Figure 45: Variance of dollar/mark PDFs

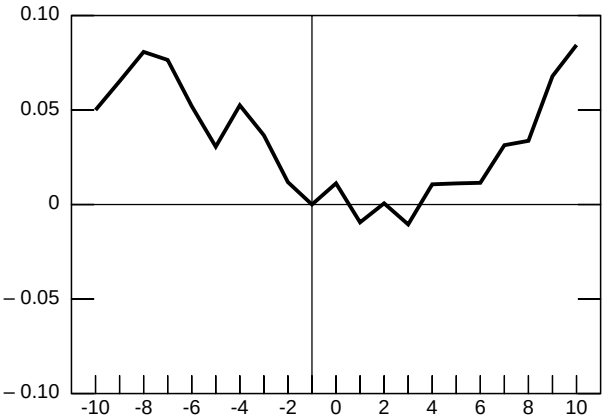


Figure 46: Skewness of dollar/mark purchases

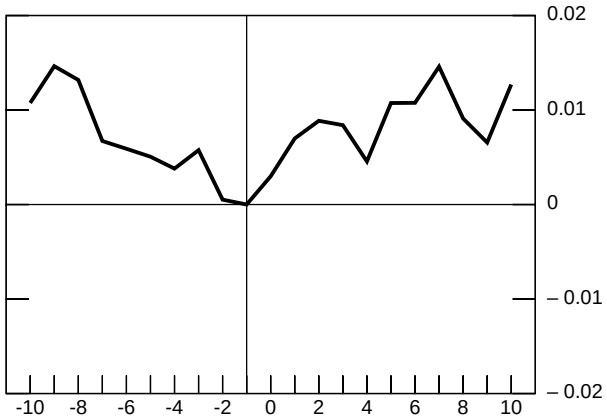


Figure 47: Skewness of dollar/mark sales

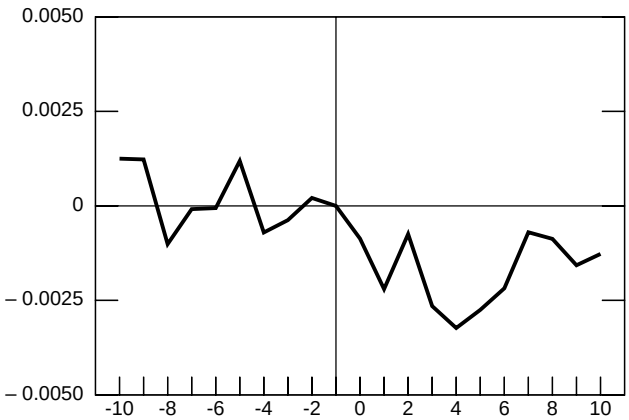


Figure 48: Kurtosis of dollar/mark PDFs

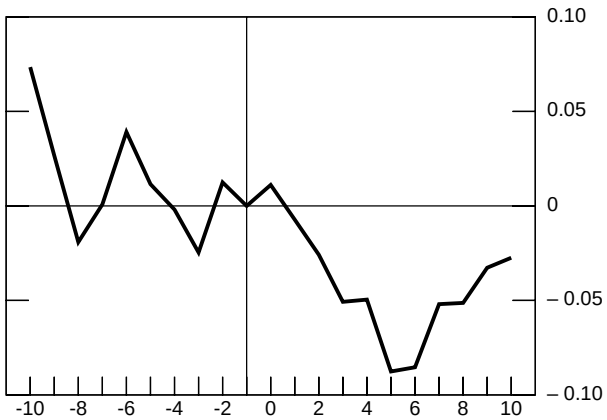


Figure 49

Probability distribution of the yen against the dollar: end-April/early May 1994

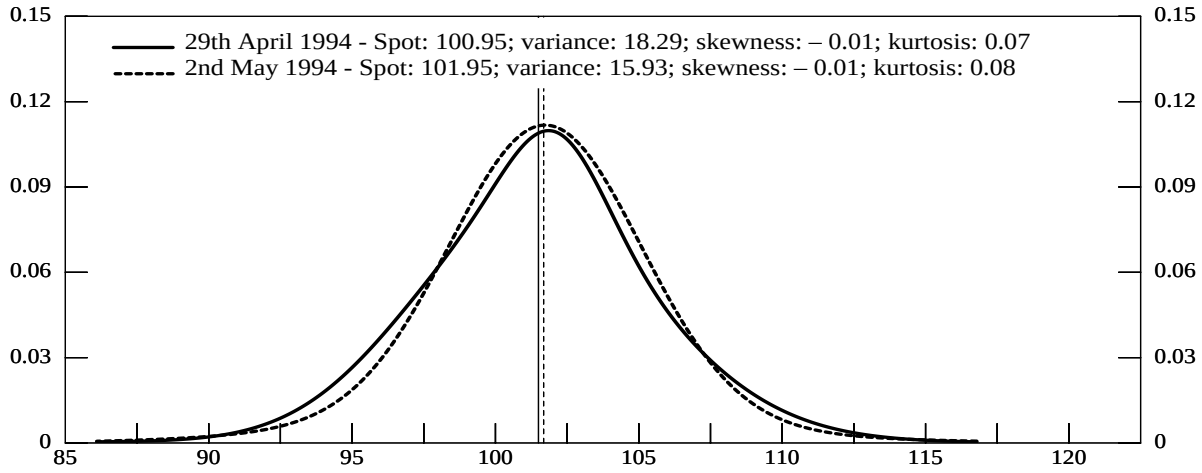


Figure 50

Probability distribution of the yen against the dollar: early March 1995

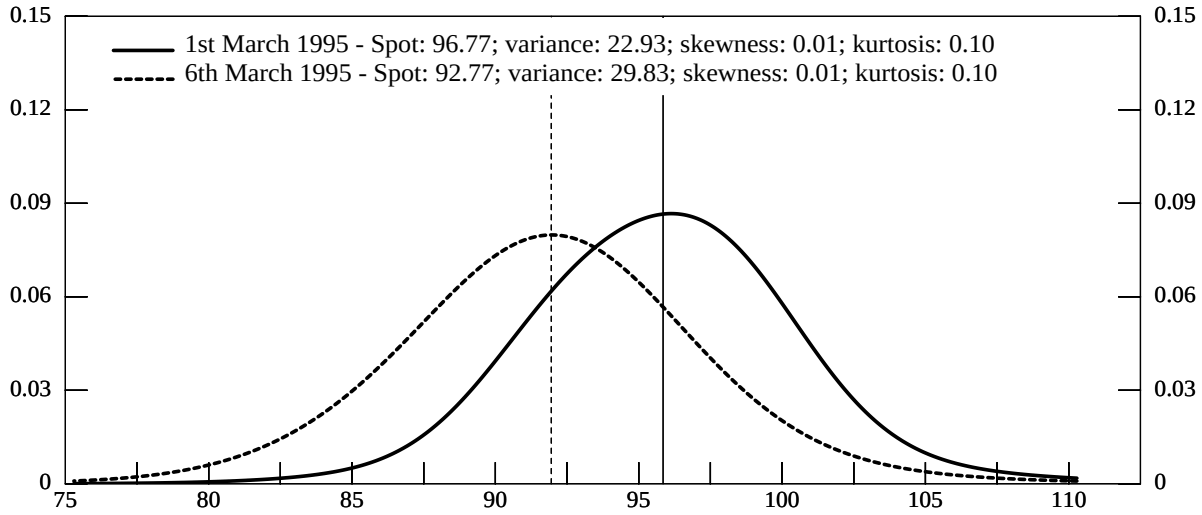


Figure 51

Probability distribution of the yen against the dollar: early July 1995

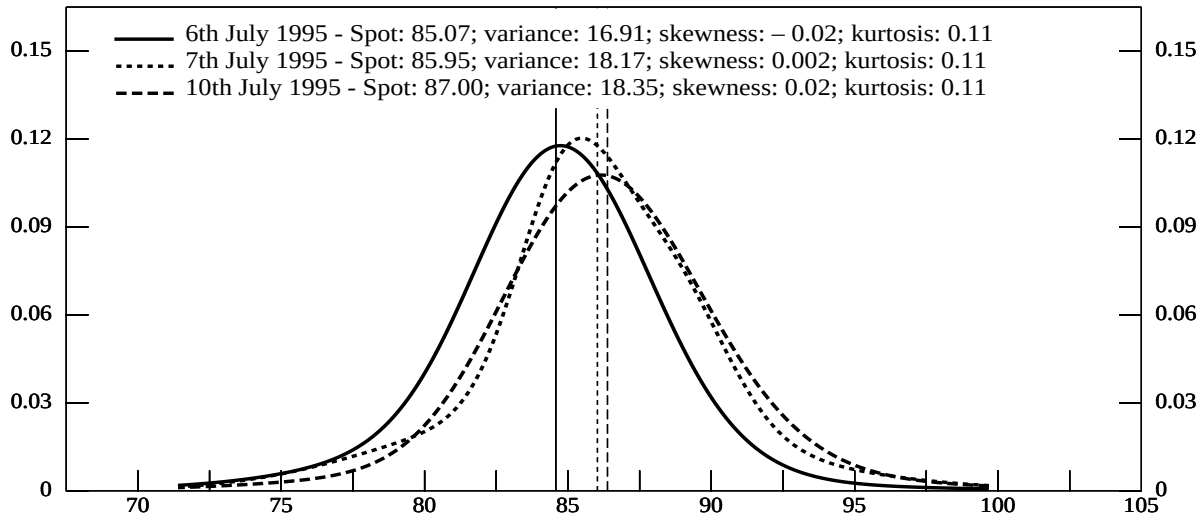


Figure 52

Probability distribution of the yen against the dollar: mid-August 1995

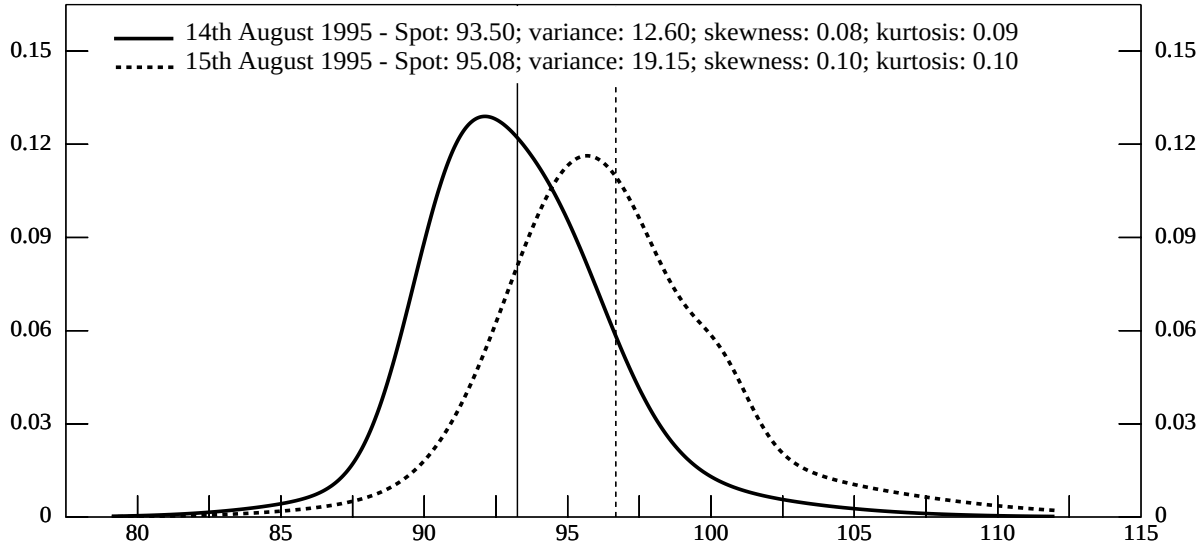


Figure 53: Mean of dollar/yen PDFs around the days of dollar purchases during the period 1992-96

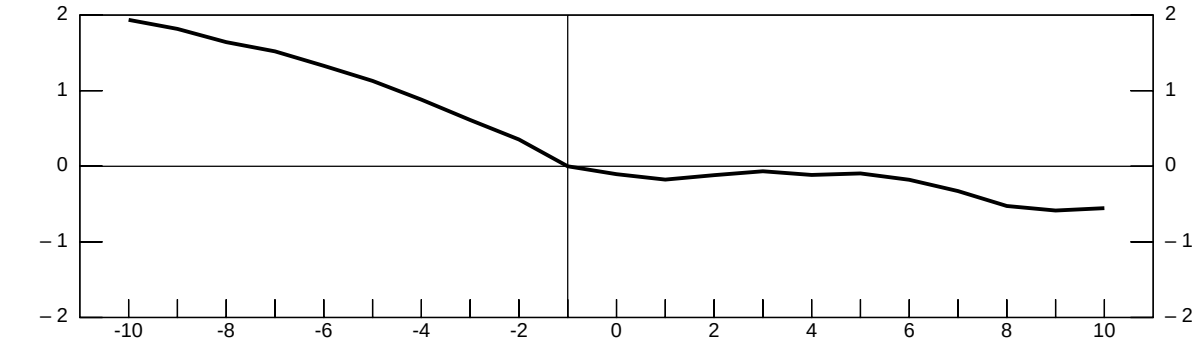


Figure 54: Variance of dollar/yen PDFs around the days of dollar support during the period 1992-96

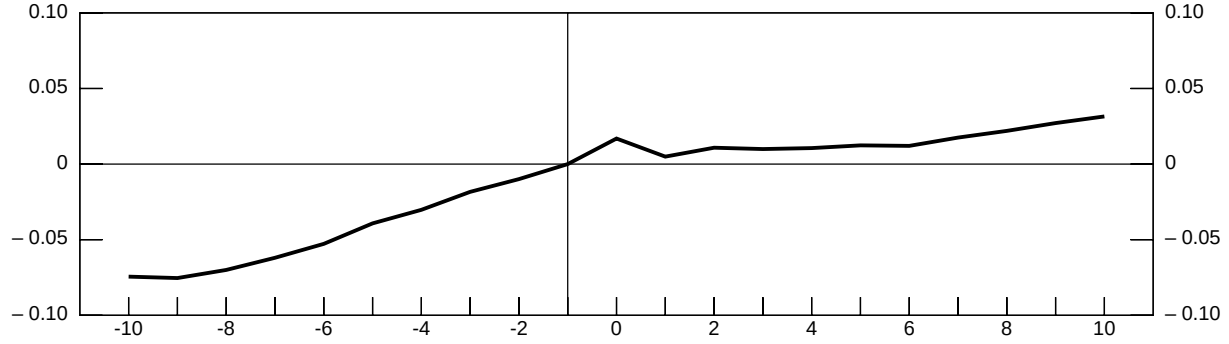


Figure 55: Skewness of dollar/yen PDFs around the days of dollar purchases during the period 1992-96

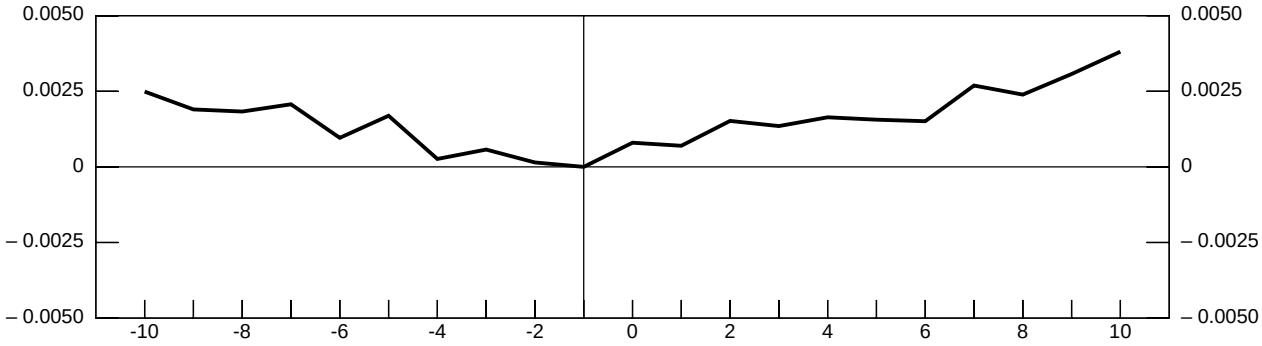
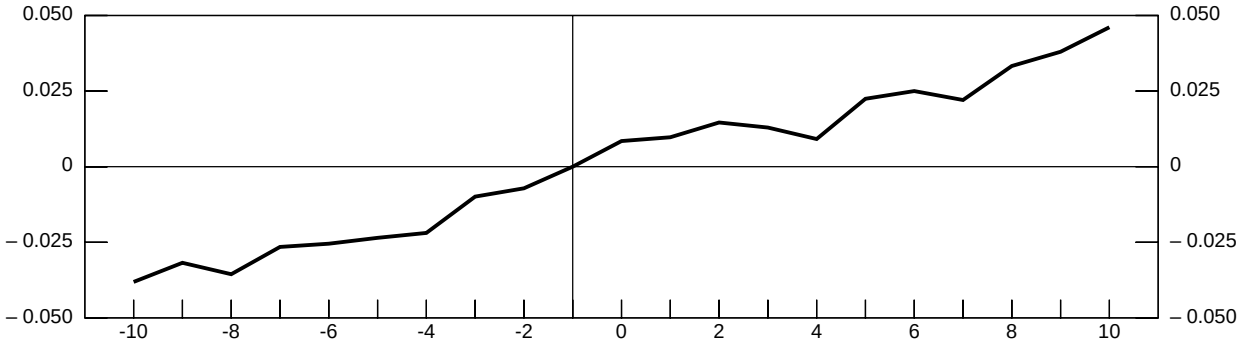


Figure 56: Kurtosis of dollar/yen PDFs around the days of dollar support during the period 1992-96



Mean of dollar/yen PDFs during the period of dollar support, 1992-96

Figure 57: Mean of dollar/yen PDFs around days of unilateral and concerted interventions

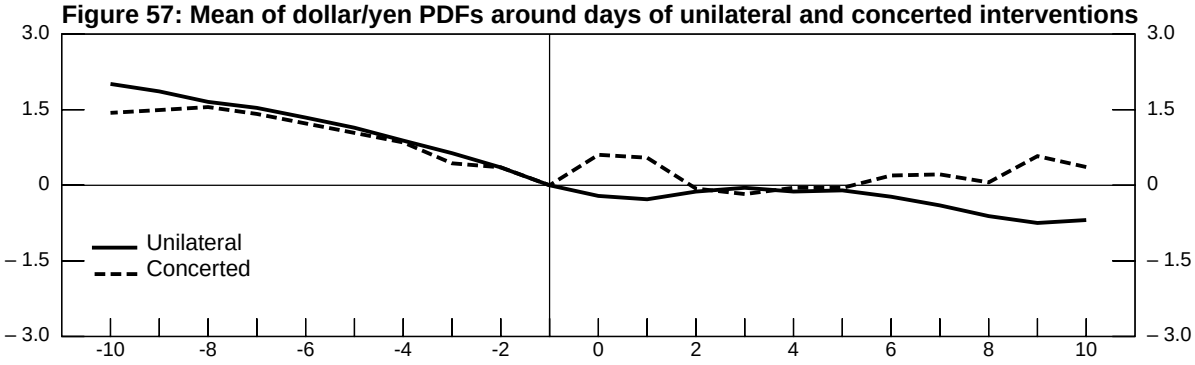


Figure 58: Mean of dollar/yen PDFs around days of official and discreet interventions

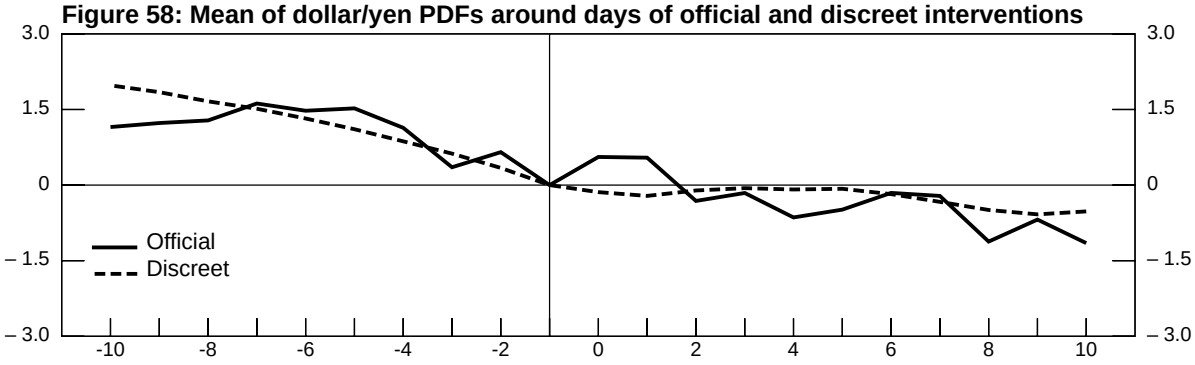


Figure 59: Mean of dollar/yen PDFs around days of large and small interventions

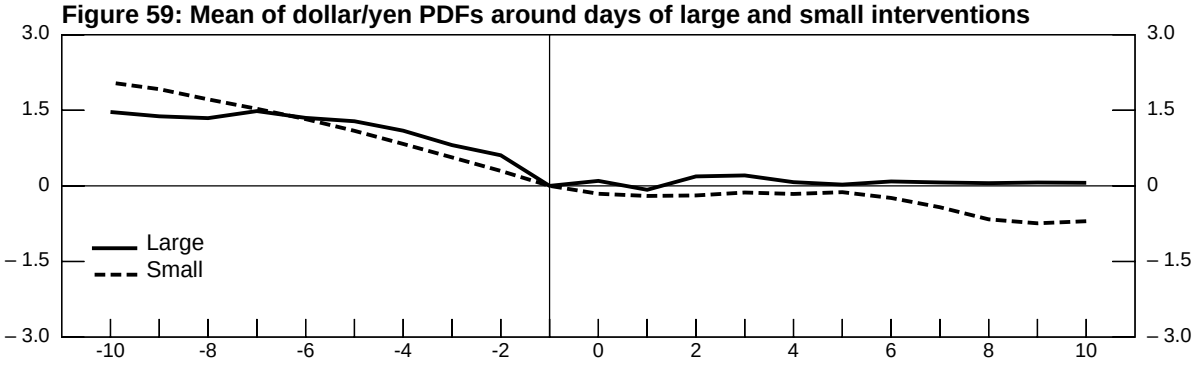
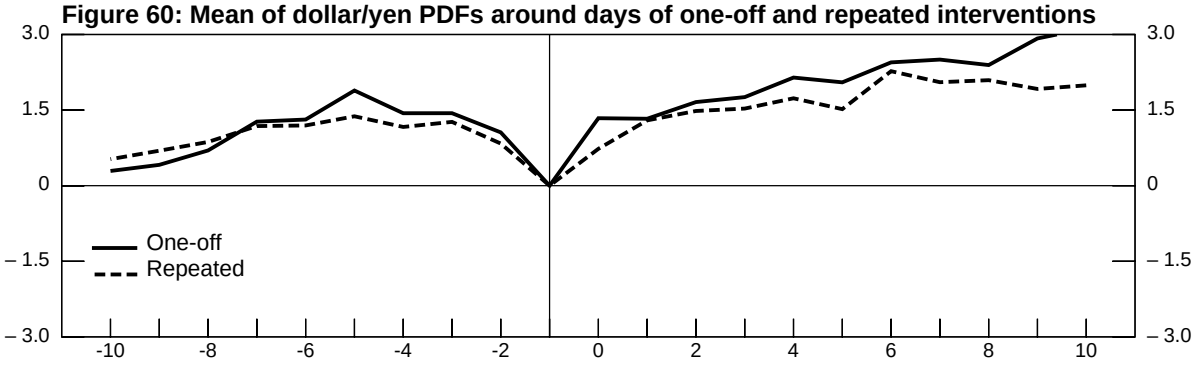


Figure 60: Mean of dollar/yen PDFs around days of one-off and repeated interventions



Skewness of dollar/yen PDFs during the period of dollar support

Figure 61: Skewness of dollar/yen PDFs around days of unilateral and concerted interventions

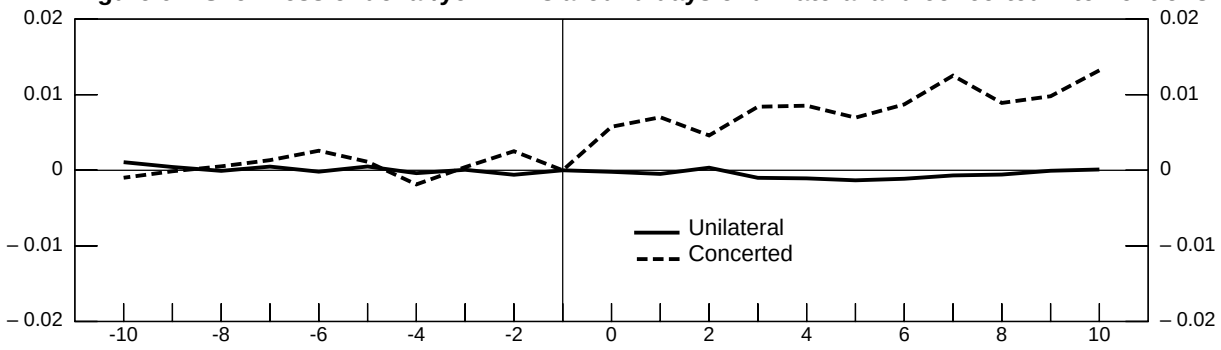


Figure 62: Skewness of dollar/yen PDFs around days of official and discreet interventions

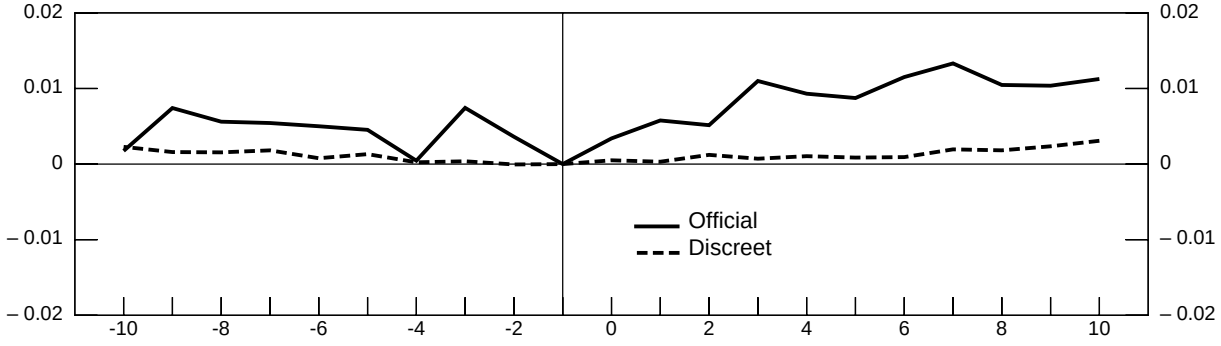


Figure 63: Skewness of dollar/yen PDFs around days of large and small interventions

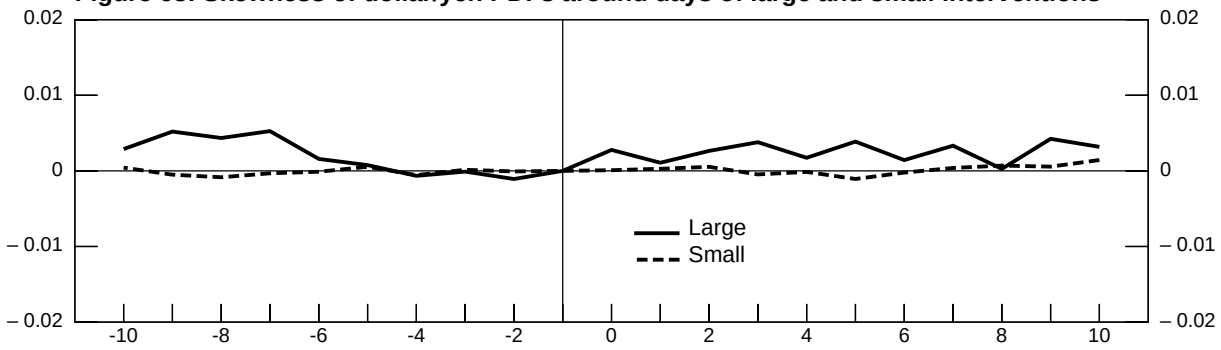
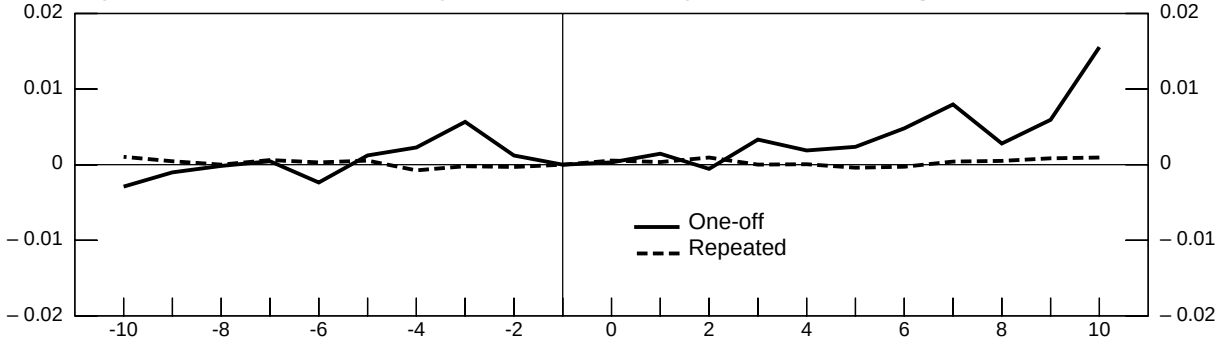


Figure 64: Skewness of dollar/yen PDFs around days of one-off and repeated interventions



Skewness of dollar/yen PDFs during the period of dollar support

Figure 65: Skewness of dollar/yen PDFs around days of unilateral and concerted interventions

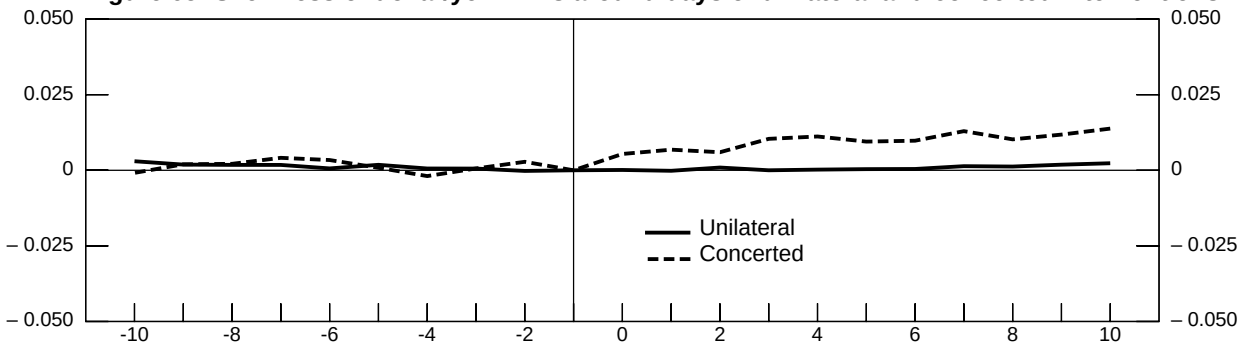


Figure 66: Skewness of dollar/yen PDFs around days of official and discreet interventions

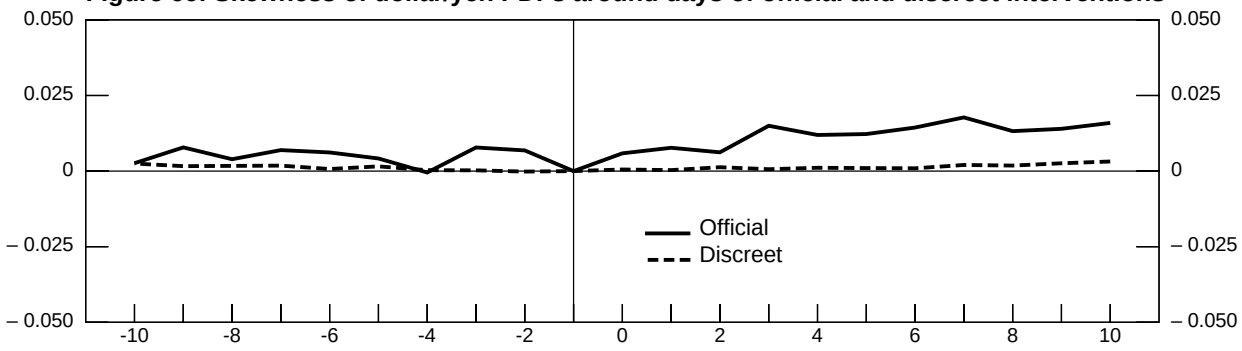


Figure 67: Skewness of dollar/yen PDFs around days of large and small interventions

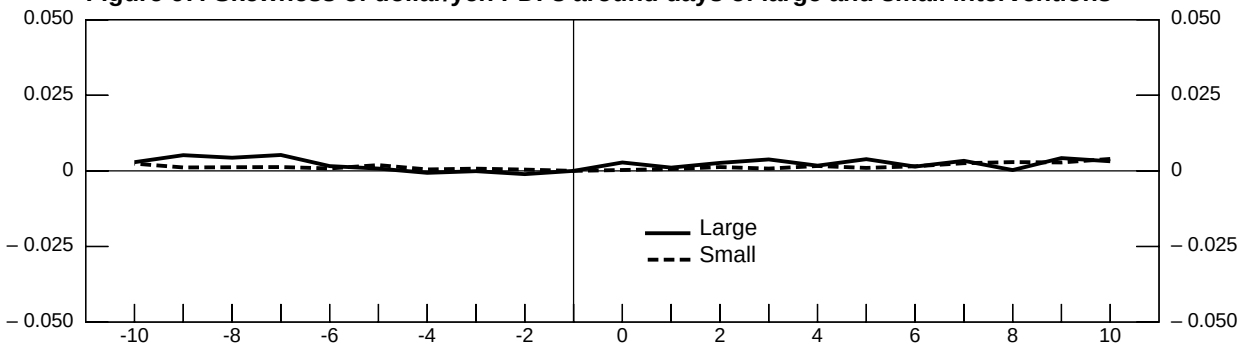
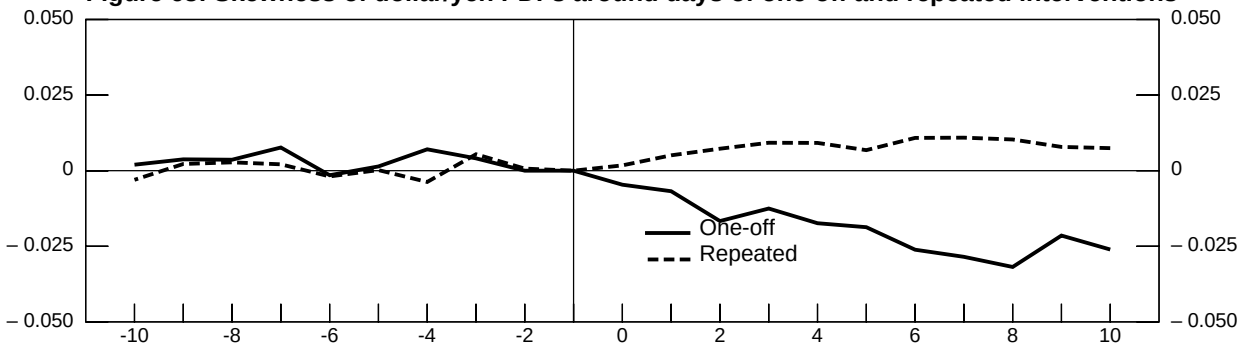


Figure 68: Skewness of dollar/yen PDFs around days of one-off and repeated interventions



Kurtosis of dollar/yen PDFs during the period of dollar support

Figure 69: Kurtosis of dollar/yen PDFs around days of unilateral and concerted interventions

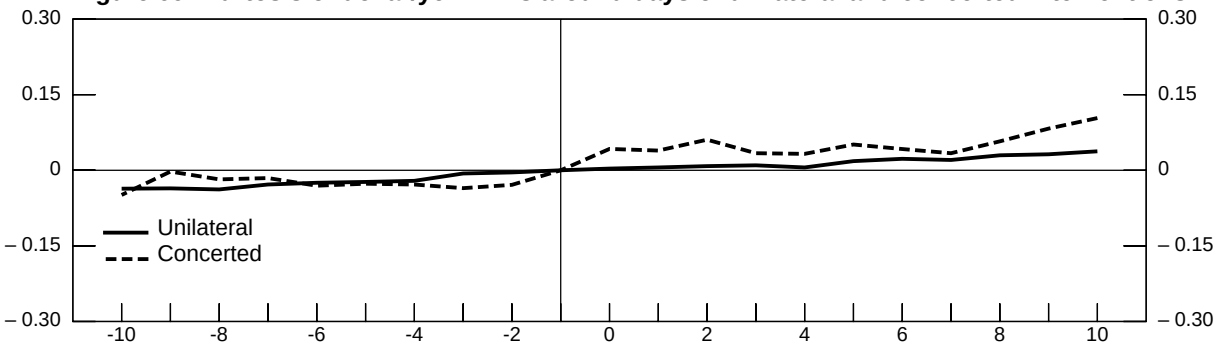


Figure 70: Kurtosis of dollar/yen PDFs around days of official and discreet interventions

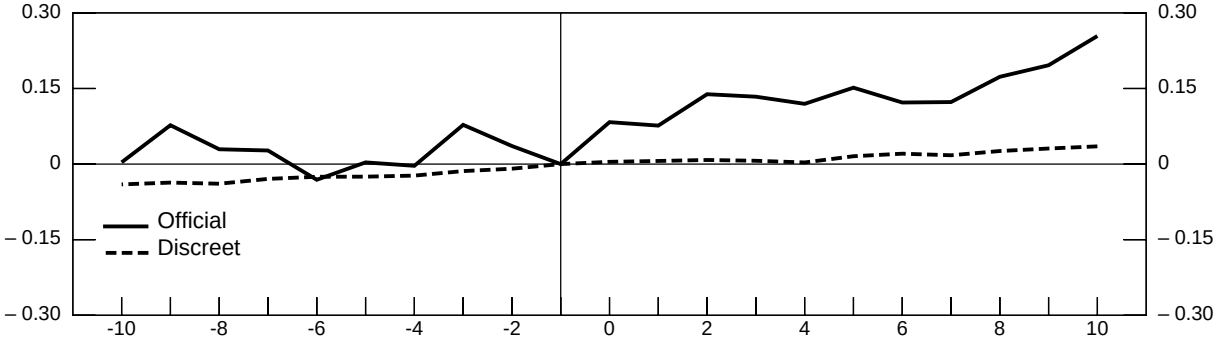


Figure 71: Kurtosis of dollar/yen PDFs around days of large and small interventions

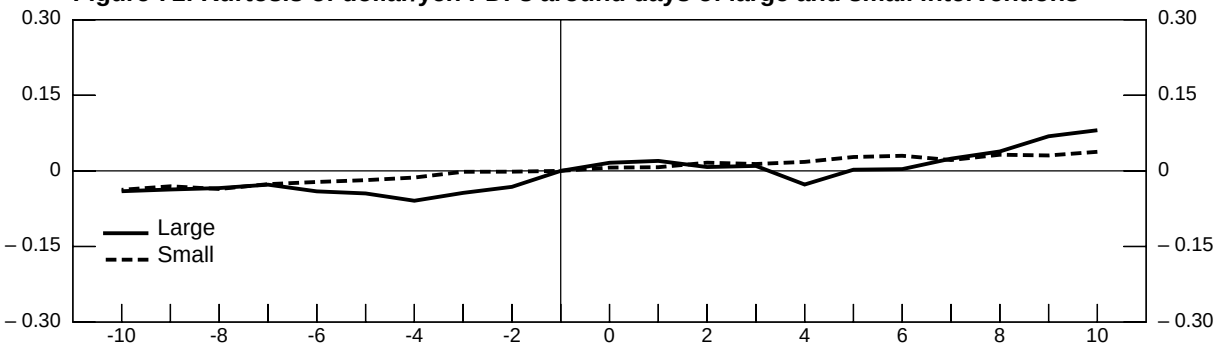
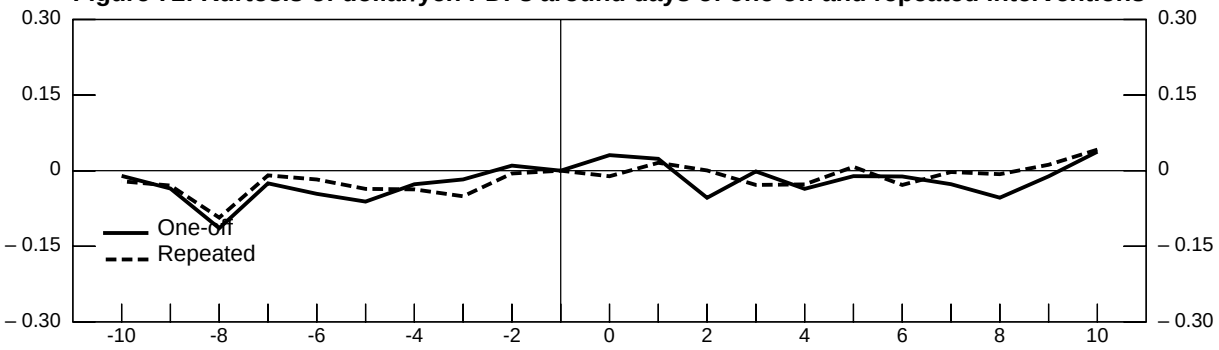


Figure 72: Kurtosis of dollar/yen PDFs around days of one-off and repeated interventions



Appendix 1:
Literature review

Since the Jurgensen Report was written in 1983, there has been an extensive literature on the effect of intervention in foreign exchange markets. This appendix reviews some of the main contributions - for a comprehensive survey, refer to Edison (1993).[25] In the 1980s and early 1990s, attention focused on the effect of sterilised intervention on the level of the exchange rate and on the channels through which intervention might work. The results on the effectiveness of intervention are mixed and depend on which exchange rate is analysed, what sample period is studied and the intervention strategy that was used. The same is true for more recent studies of the effect of intervention on the level of the exchange rate.

In the 1980s and early 1990s, the bulk of empirical literature on the effect of intervention was directed at testing the validity of the portfolio and the signalling channels. There is now a general consensus in the literature that intervention does not affect exchange rates through the portfolio channel, ie by changing the relative outstanding supply of domestic and foreign assets and thereby the expected relative returns on these assets. Rogoff (1984) was among the first to test the importance of the portfolio balance channel. He finds no significant effects of sterilised intervention through this channel. Frankel and Engel (1984), Lewis (1988) and a number of other studies, which are reviewed in detail in Edison (1993), reach a similar conclusion. By contrast, Dominguez and Frankel (1993b) find some supportive evidence for the portfolio channel.

There is some, but no conclusive, evidence that intervention mainly works through the signalling channel, ie by the central bank conveying a signal to market participants about information on future fundamentals that they do not have.[26] Studies that find a significant effect of intervention through this channel include Klein and Rosengren (1991), Dominguez (1993), Kaminsky and Lewis (1996) and Lewis (1995). On the other hand, evidence provided by Dominguez (1996) suggests that intervention does not serve exclusively as a consistent signal of future monetary policy changes.

One standard method that has been employed since the late 1980s uses regression analysis with daily data. Changes in the spot rate or in the forward rate are regressed on a variable measuring intervention, a series of variables measuring surprises about macroeconomic data announcements and short-term interest rates. Intervention is measured either with official data on actual operations or by a dummy variable capturing press reports about intervention. This method can be found in an influential study by Dominguez and Frankel (1993a). Using daily and weekly official and press report data on intervention directed at the dollar/mark exchange rate between 1984 and 1990, they find that intervention had a statistically significant impact on the exchange rate. Moreover, they find no clear pattern that can help discriminate between the effectiveness of coordinated and that of non-coordinated intervention. One problem with this strand of the literature is that it does not address in a satisfactory way the simultaneity bias discussed in Appendix 3, that is, the fact that intervention may be a response to exchange rate movements as well as having an effect on such movements. The effect of intervention is tested either with ordinary least squares or by lagging intervention relative to the exchange rate. This problem appears particularly relevant for empirical tests that used data at weekly or lower frequencies.[27]

Another problem is that these studies had to proxy for official intervention by the Bank of Japan with data taken from newspaper articles that measure traders' perceptions of intervention conducted by the Bank of Japan. As official data on on Japan's intervention have become available recently, it was possible for the first time to gauge the accuracy of traders' perceptions of intervention and test the completeness of data sets used in the literature. A comparison for the year 1991 shows that the data sets based on newspaper articles used in the literature missed about two thirds of all Bank of Japan

---

[25] A review of the literature on the profitability of intervention is beyond the scope of this section. An overview of this strand of the literature can be found in Leahy (1995) and Sweeney (1997).

[26] An overview of the literature on this channel is provided by Baillie, Humpage and Osterberg (1999).

[27] For a critique of these approaches to the simultaneity bias, see Humpage (1999).

interventions. Moreover, these data sets report a number of interventions that actually did not occur.[28] This data problem could make the findings of the empirical literature on foreign exchange intervention less reliable.

Some later studies, which followed different methods, confirmed Dominguez and Frankel's finding that intervention has an impact on exchange rate levels. Using a case study approach for the dollar/yen and mark/dollar exchange rates during the period 1985-91, Catte et al (1994) find that this result holds particularly for coordinated interventions. Baillie and Osterberg (1997b) test an intertemporal asset pricing model in which intervention has a direct impact on the risk premium in the forward market. They use daily data on actual intervention by the Federal Reserve in the dollar/mark and dollar/yen markets between 1985 and 1990. In this paper intervention is found to have an impact on excess returns from uncovered interest rate parity. Ramaswamy and Samiei (2000) derive an error correction model in which the exchange rate depends on its own lags and lags of interest rate differentials and intervention. Intervention is measured by dummy variables constructed with press report data. The authors test this model with daily data from 1995 to 1999 and find that intervention had small but persistent effects on the dollar/yen rate. Fatum (2000) starts from the observation that intervention is often conducted on successive days and identifies episodes of Federal Reserve and Bundesbank intervention directed at the dollar/mark rate. Using non-parametric tests for the period 1985 to 1995, he finds evidence of a statistically significant impact of intervention on the dollar/mark rate. He then applies a binary choice model to estimate the conditional probability that interventions with different strategies turn out to be successful. His results suggest that concerted interventions were more likely to be successful than unilateral interventions.

Other papers that use different methods do not support the conclusion that intervention is effective. Baillie and Osterberg (1997a), for example, test a Martingale model with time-dependent conditional heteroskedasticity. They find that, over the period August 1985 to March 1990, Federal Reserve intervention did not influence the mark/dollar or dollar/yen exchange rates.[29]

Over the past few years, attention has shifted to studying the effects of intervention on exchange rate volatility.[30] Most of these studies have looked at the conditional exchange rate volatility, usually estimated with GARCH models. Empirical evidence suggests that central bank intervention tends to increase the conditional exchange rate volatility. Connolly and Taylor (1994), for example, use a GARCH model to describe conditional dollar/yen volatility and use market data on intervention by the Bank of Japan. They present evidence that, between 1977 and 1979, Bank of Japan intervention was associated with an increase in conditional dollar/yen volatility. By contrast, Baillie and Humpage (1992) find mixed results about the relationship between Federal Reserve, Bank of Japan and Bundesbank intervention and the conditional volatility of the dollar/mark and dollar/yen exchange rates for the period February 1987 to February 1990. Dominguez (1993), however, argues that the impact on exchange rate volatility depends on how central banks conduct intervention. Looking at daily and weekly data for 1985-91, she finds that intervention that is officially announced reduces volatility while intervention that is not detected by the market increases volatility. Finally, Hung (1997) finds that intervention can affect exchange rate volatility through the noise-trading channel, ie by inducing noise traders to react to changing market conditions.

In recent years, data on volatility implied by options have been used to study the effect of intervention on market participants' assessments of future exchange rate volatility.[31] Measures of expected volatility derived from option prices have two important advantages over measures of volatility computed from actual exchange rate realisations, such as those based on GARCH models. First, they

---

[28] By contrast, the data set on traders' perceptions of intervention by the Bank of Japan which we constructed with Reuters articles contains all episodes of actual intervention during this period, although it also misreports some cases of interventions.

[29] The conclusion that intervention did not have a systematic effect on exchange rate levels is also supported by studies on other forex markets. Zurlinden (1996) looks at intervention conducted by the Swiss National Bank between 1984 and 1996 and finds no significant impact on the levels of the Swiss franc/mark or Swiss franc/dollar exchange rates. Aguilar and Nydahl (1998) report that intervention conducted by the Riksbank between 1993 and 1996 did not have a significant influence on the krona/mark or krona/dollar rates.

[30] Dominguez (1998) provides a good overview of this literature.

[31] The usefulness of implied volatility from currency options as a forecast of future exchange rate movements has been documented in Figlewski (1997).

do not require long time series of data to be estimated. In addition, they incorporate a market assessment of future volatility that is not directly observable.

Studies that use implied volatility test the idea that intervention on a particular day may send a signal to market participants about the future exchange rate policy and hence influence the market's forecasts of future exchange rate volatility. The evidence on the impact of intervention on implied volatility is mixed. Bonser-Neal and Tanner (1996) use data on implied volatilities from exchange-traded options from 1985 to 1991 together with official data on intervention by the Federal Reserve and the Bundesbank. They also recover data on perceived intervention by the Bank of Japan from newspaper articles. They find that intervention had a different impact on volatility over different time periods. Between February 1987 and December 1989 (the "Louvre period"), intervention actually increased implied volatility, while there is some, although not much, evidence that intervention reduced exchange rate volatility between 1990 and 1991. Over the period 1985 to 1991 as a whole, there is no evidence that central bank intervention reduced exchange rate volatility.[32] Bonser-Neal and Tanner (1996) also examine whether changes in implied volatility help predict intervention by the Federal Reserve (ie whether implied volatility "Granger-causes" intervention) and find little evidence of predictive power ("Granger causality") from implied volatility to intervention. Murray et al (1996) investigate the effect of different intervention strategies by the Bank of Canada on the implied volatility of the Canadian/US dollar exchange rate. They find that the effect of intervention on implied volatility depends on the intervention strategy that is followed. Intervention that was expected or that was unexpectedly light was found to have no effect on implied volatility, while intervention that was unexpected and heavy significantly tended to reduce implied volatility. Dominguez (1998) looks at the effect of intervention on both GARCH volatility and implied volatility. She finds that the effect depends on both the sample period and the intervention strategy. An interesting result is that intervention can lead to an increase in volatility even if market participants do not perceive it. Similarly to Bonser-Neal and Tanner (1996), she also finds that volatility does not Granger-cause intervention.

Edison (1993) and Almekinders (1995) survey empirical work on the determinants of intervention. The approach that is generally followed in the literature consists in specifying and estimating a reaction function for central banks. The objectives being considered include "leaning against the wind", minimising deviations of exchange rates from some implicit target levels and reducing uncertainty. Eijffinger and Gruijters (1991) find that, between 1985 and 1987, the Federal Reserve and the Bundesbank intervened mainly to reduce erratic exchange rate movements and "lean against the wind". Dominguez and Frankel (1993a) find that between September 1985 and December 1990 the Federal Reserve and the Bundesbank mainly intervened when the dollar deviated from its implicit targets. They specify these targets based on Funabashi's (1988) analysis of central bank intervention and, alternatively, by assuming that the targets equal the exchange rate level implied by purchasing power parity. Goodhart and Hesse (1993) reach a similar conclusion based on an analysis of intraday data between 9 April and 30 June 1989. Almekinders and Eijffinger (1996) present evidence that, from 1987 to 1989, the Federal Reserve intervened also with the intention of lowering exchange rate uncertainty. Baillie and Osterberg (1997a) find that, between 1985 and 1990, spot exchange rate volatility Granger-causes intervention in the dollar/yen market, while the forward premium's conditional volatility does not. They conclude that intervention is motivated by increases in spot rather than forward market volatility.

[32] This result is also found in Bonser-Neal (1996).

Appendix 2:
Estimating empirical density functions

The moments used in the study were calculated using probability density functions (PDFs) estimated from settlement option prices from the Chicago Mercantile Exchange (CME). This appendix provides a description of both the option price data and the technique for estimating the PDFs.[33]

A complete history of daily settlement prices for options on dollar/mark and dollar/yen futures traded on the CME was obtained from the Futures Industry Association. Settlement prices are recorded at the end of each trading session mainly to aid in margin calculations. These prices are set by a committee, usually based on the trades recorded in the last few minutes of the day's session. Therefore, across strike prices, they have the advantage of reflecting market conditions at the same point in time. However, they are not transaction prices. From this large data set (434,388 records) any option for which volume, open interest and number of exercises equalled zero was dropped. In addition, option prices which (after allowing for transactions costs) (1) violated put-call parity, (2) were not monotonic and concave with regard to strike price, or (3) were worth less than their intrinsic value were also dropped from the data set. This left a data set with 434,334 records covering 17,200 contract/trading days. On average, then, each contract/trading day had 25 option prices. Finally, any contract/trading day with fewer than six days to expiration or less than 12 option prices was dropped, leaving a data set with 14,430 contract/trading days. For the dollar/mark the data set spans the period 24 February 1984 (June 1984 contract) to 30 August 1996. For the dollar/yen the data set spans the period 17 March 1986 (June 1986 contract) to 30 August 1996.

It is certainly true that volume in the over-the-counter (OTC) foreign exchange options market is many times larger than that on the CME, which itself is quite a bit larger than that of the currency options traded on the Philadelphia exchange (PHLX). In addition, the OTC market quotes prices at constant maturities for European options, unlike exchange-traded options, which approach a fixed expiration date and are American options. For these reasons, a convincing case can be made that OTC option prices are to be preferred to those from the CME. However, the OTC data suffer from several drawbacks. First, time series of OTC data do not usually begin until the early 1990s. Second, available OTC data only have option prices at three or six different strike prices, greatly limiting the amount of probability information that can be extracted from them. Finally, large trading houses do arbitrage between the OTC and CME markets, so it is unlikely that information present in one market will not be reflected in the other. In any event, the available OTC data were used to corroborate any findings from the CME data set.

With the CME data set, a PDF was estimated for each contract/trading day using the techniques of Melick and Thomas (1997). The intuition behind the technique is fairly straightforward. The value of any European option can be thought of as the product of the probability that the option will finish in the money and the value of the option given that it finishes in the money. For a call option, this is just the probability that the underlying price will lie above the strike price multiplied by the difference between the expectation for the underlying price (conditional on its being above the strike price) and the strike price. This valuation can be written as (denoting the underlying price, the futures, as F, and the strike price as X):

$$C = \Pr[F > X] \times (E[F \mid F > X] - X)$$

A similar formula can be written for puts.[34] That is, each call price gives information about the probability mass above its strike, while each put price gives information about the probability mass below its strike. The more put and call prices that are available, the finer the tracing-out of this information can be. Given an assumed PDF for the underlying price, the probability calculations in the call and put valuation formulae can be replaced with functions of the parameters of the PDF. The

[33] For an overview of different PDF estimation techniques, see Chang and Melick (1999).

[34] As shown in Chaudhury and Wei (1994), similar formulae can be used to bound the price of American call and put options. Melick and Thomas (1997) weight the upper and lower bounds to derive a pricing formula for calls and puts.

parameters of the distribution are then estimated by minimising the sum of squared differences between predicted and observed settlement option prices.

For each contract/trading day in the data set, PDFs were estimated under three distributional assumptions: (1) the PDF is lognormal, (2) the PDF is a mixture of two lognormals, and (3) the PDF is a mixture of three lognormals. The term "mixture" means weighted average. Thus, a mixture of two lognormals is a weighted average of two lognormals, where the weights can be thought of as the probability of being drawn from one of the two lognormals. Such a mixture might involve a 10% chance of being drawn from the first lognormal and a 90% chance of being drawn from the second. The PDF that best fits the observed settlement prices, in terms of a minimum sum of squared errors, was then chosen. Typically, this was the mixture of three lognormals (13,580 out of the 14,403 contract/trading days). This is not surprising, since the mixture of three lognormals is a very flexible functional form, able to accommodate many possible probability patterns contained in the option prices.

Moments were then calculated from the estimated PDFs as follows, where percentile points are represented by Pxx and the mixing probabilities by P_i. For example, the median is the point at which the probability of falling above or below is 50%. Thus the median is denoted by P50. The point below which there is a 5% chance of falling is denoted by P05.

M1 = mean = $\sum_{i=1}^{3} \pi_i \exp(u_i + \frac{\sigma_i^2}{2})$

M2 = variance = $\sum_{i=1}^{3} \pi_i \exp(2u_i + 2\sigma_i^2) - (M1)^2$

M3 = skewness measure = (mean-P50)/sqrt(M2)

M4 = kurtosis measure = ((P05-P01)+(P99-P95))/mean

Figures 1 to 3 illustrate some of these concepts, contrasting several PDFs that share the same mean, but differ with respect to one of their higher moments.

However, over a short time period, it is perhaps more likely that market views with regard to future exchange rate outcomes will change than market preferences towards risk. If this is the case, comparisons of PDFs across time may reveal some information on movements in market views on likely exchange rate outcomes.

Before estimating our regression equations, we "cleaned" our measures of moments of influence of the time to maturity of the option contracts that were used to estimate the empirical PDFs as well as the effect of switches between contracts.[35] It is intuitive, for example, that the variance of the expected future exchange rate movements embodied in the price of an option declines as the contract approaches maturity. Since this effect is not strictly related to the relationships that we are investigating, we filtered it out of the measures of moments.

[35] A description of the filtering method is given in Appendix 5.

Appendix 3:
Estimating the effect of intervention on expectations in the presence of simultaneity bias

A simple example can be used to illustrate the simultaneity problem. Consider the case where a central bank intervenes to smooth volatility. To simplify the exposition, we ignore here the role of other central banks and other moments of the expected distribution of future exchange rates. We can then write the following system of equations:

(A1) $$M_t = a_1 + a_2 I_t + a_3 X_t + \varepsilon_t$$

(A2) $$I_t = b_1 + b_2 M_t + b_3 Y_t + \eta_t$$

where M_t measures volatility, I_t captures intervention, and X_t and Y_t capture other factors that influence volatility and intervention. ε_t and η_t are error terms.

Estimating the effect of intervention on volatility implies estimating the coefficient a_2 in equation (A1), while the effect of volatility on intervention is captured by the coefficient b_2. This would require solving the simultaneous system for M_t and I_t in terms of X_t, Y_t, and ε_t and η_t. If standard OLS procedures are applied to estimate equations (A1) and (A2) separately, they will yield biased and inconsistent estimates of a_2 and b_2 because $\text{cov}(I_t, \varepsilon_t) \neq 0$ and $\text{cov}(M_t, \eta_t) \neq 0$.

The causality tests reported in Appendix 4 provide a method commonly used in the literature to verify the existence of simultaneity bias. The finding that the moments of the PDFs cause intervention in a statistical sense implies that simultaneity bias is present.

A method that has been used in the literature consists in lagging the intervention variable by one period in equation (A1) and then estimating that equation directly with OLS.[36] However, this method will misrepresent the true effect of intervention on market expectations because part of this effect may be already captured in lagged values of the dependent variable (the moment), which are introduced among the explanatory variables.

It was therefore decided to deal with the simultaneity bias by using an Instrumental Variables (IV) estimator. Following previous work that used the IV procedure, estimates of a reaction function for the Federal Reserve, the Bank of Japan and the Bundesbank were used as instruments for actual intervention.[37] Intervention was expressed in terms of deviations of the spot rate and the moments of exchange rates from target values. It was assumed that these central banks decided to intervene when either the spot rate or the variance, skewness or kurtosis deviated from target ranges. It was also assumed that the amount of intervention depended on the distance from these targets. In the choice of the targets for the spot rate, the work by Baillie and Humpage (1992) was followed, while the targets for the higher moments were as a first approximation set equal to their historical average. As a first approximation, central banks were assumed to tend to intervene whenever the variance, skewness or kurtosis of market expectations deviated from their historical average.

Formally, the reaction function that was estimated was of the following form:

(3) $$YENINTUS_t = a + b \times DMINTUS_t + \sum_{i=1}^{5} c_i \times YENINTUS_{t-i} + d \times YENHDIS_t + e \times YENLDIS_t + \sum_{i=1}^{5} f_i \times DVARCHA_{t-i}$$

$$+ \sum_{i=1}^{5} g_i \times DVARCHD + \sum_{i=1}^{5} h_i DSKEWCHD_{t-i} + \sum_{i=1}^{5} k_i DSKEWCLA_{t-i} + \sum_{i=1}^{5} l_i \times DKURCHA_{t-i} + \sum_{i=1}^{5} m_i \times DKURCHD_{t-i} + \varepsilon_t$$

where *yenhdis* measures the distance of the dollar/yen spot rate from the top of its target range when the exchange rate exceeds the range and, similarly, *yenldis* measures the distance from the bottom of the target range when the exchange rate is below that limit. *dvarcha* and *dvarchd* measure how distant

[36] Studies that followed this method include Dominguez (1993), Bonser-Neal and Tanner (1996) and Murray et al (1996).

[37] Baillie and Humpage (1992) and Almekinders and Eijffinger (1991) followed this method for Federal Reserve and Bundesbank intervention.

the variance is from its historical average when the dollar is, respectively, appreciating or depreciating. *dskewchd* gives the distance of skewness from its historical average when the yen is depreciating and the market is skewed towards a further yen depreciation. Similarly, *dskewcla* measures the distance from the average of skewness when the yen is strengthening and the market is biased towards further yen appreciation. Finally, *dkurcha* (*dkurchd*) is the distance of kurtosis from its historical average when the yen is appreciating (depreciating).

An alternative to the Instrumental Variables method we chose would be to use a Full Information Maximum Likelihood (FIML) estimator, which, unlike the IV, is efficient. We decided, however, against using the FIML estimator because, unlike the IV estimator, it is very sensitive to specification errors in one of the equations of the system.

In order to assess the effect of intervention over the period 1985 to 1996 for the dollar/mark and over the period 1991 to 1996 for the dollar/yen exchange rate, daily data were used to estimate regression equations that explain each moment in terms of current and lagged intervention and a set of other explanatory variables. Since each moment exhibits persistence, lagged values of the moment were included among the explanatory variables. In order to distinguish the effect of intervention from the effect of news about relevant macroeconomic variables that may arrive on the same day, we also included a set of variables that measure the unanticipated component of announcements of major macroeconomic variables for the United States, Japan and Germany.[38] We measured the unexpected component of news by the difference between official data announcements and the results of opinion surveys conducted during the days preceding the announcements. Unfortunately these data are available for the whole sample period only for the United States. Survey data for Japan and Germany are available only since the early 1990s. For those series for which survey data were not available, we included a variable that captures the occurrence and actual value of an official announcement. In addition, we introduced the short-term interest rate differential among the explanatory variables to represent the influence of all other macroeconomic factors.[39] We also used a dummy variable to capture day-of-the-week effects since there is evidence that asset prices follow intraweekly patterns. Finally, we again introduced variables that control for the effect of length to maturity and a dummy variable for contract switches, in order to be certain that these factors did not affect our results.

The regression equations take the following form:

$$(4) \quad M_t^j = a + \sum_{i=1}^{5} b_i \times M_{t-i}^j + \sum_{i=1}^{5} c_i \times INT_{t-i} + \sum_{i=1}^{5} d_i \times X_i + \varepsilon_t$$

where M_t^j is the *j*-th moment at time t, INT_t is the amount of intervention at time t, X_t is a vector of macroeconomic variables and ε_t is an error term. When the dependent variable is either the spot rate or the variance, it enters the regression equation in difference of logarithm form because both series are non-stationary. In addition to lags of the dependent variable (also in difference of logarithm form), the lagged level is then also included to take account of the case in which the dependent variable does not have a unit root. In the regression equations for the variance and the kurtosis, intervention and all other explanatory variables enter in absolute values, as it is assumed that their effect on intervention depends only on their size and not their sign.

The equations were estimated for dollar/mark intervention over the sample period 1 January 1985 to 30 August 1996 and for dollar/yen intervention over the period 1 April 1991 to 30 August 1996.[40] Each equation was also estimated after splitting the total amount of intervention into the contributions of the participating central banks (Bundesbank and Federal Reserve for dollar/mark intervention and Bank of Japan and Federal Reserve for dollar/yen intervention). The results are presented in Table 1.

---

[38] Appendix 6 provides a description of these news variables.

[39] The short-term interest rate differential has been commonly used in previous studies, such as Dominguez (1993).

[40] Since volatility is very persistent, we estimated the effect of intervention on the percentage change in volatility. For the equations of volatility and kurtosis, we used the absolute value of intervention as an explanatory variable.

Appendix 4:
Granger causality tests

We considered three alternative methods to test for causality in the statistical sense. The test for Granger causality considers the equation

$$INT_t = \alpha + \sum_{i=1}^{5} \beta_i INT_{t-i} + \sum_{i=1}^{5} \gamma_i M_{t-i}^j + \varepsilon_t$$

and tests (with an F-statistic) the hypothesis that all the coefficients γ_i are not statistically different from zero. If the hypothesis is rejected, the *j*-th moment Granger-causes intervention.

The Sims test is based on the equation

$$M_t^j = \alpha + \sum_{i=-5}^{5} \beta_i INT_{t-i} + \varepsilon_t$$

and tests the hypothesis that the coefficients on all the leads of intervention are not significantly different from zero. A rejection of this hypothesis implies causality from the *j*-th moment to intervention.

Finally, the Geweke-Meese-Dent tests check again for the significance of the leads of intervention, but in the more comprehensive equation

$$M_t^j = \alpha + \sum_{i=-5}^{5} \beta_i INT_{t-i} + \sum_{i=1}^{5} M_{t-i}^j$$

Similarly to the Sims test, a rejection of the hypothesis that all the coefficients on the leads are not significant implies causality from the j-th moment to intervention.

The results of these three tests are reported in Table A1.

Table A1

Causality tests

Dollar/mark

	Moment	**F-statistic Granger test**	**F-statistic Sims test**	**F-statistic G-M-D test**
Intervention	Mean	5.04**	6.02**	3.65**
Intervention	Variance	4.57**	0.27	5.29**
Intervention	Skewness	2.81*	4.70**	1.76
Intervention	Kurtosis	2.60*	1.04	2.76*

Note: * = significant at 5% level. ** = significant at 1% level.

The equations are estimated over the sample period from 1 January 1985 to 30 August 1996. Intervention enters in absolute value terms in the regressions for the variance and the kurtosis.

Dollar/yen

	Moment	**F-statistic Granger test**	**F-statistic Sims test**	**F-statistic G-M-D test**
Intervention	Mean	6.84**	11.18**	6.89**
Intervention	Variance	0.55	0.11	0.71
Intervention	Skewness	2.32*	3.68**	1.21
Intervention	Kurtosis	1.33	2.85*	1.46

Note: * = significant at 5% level. ** = significant at 1% level.

The equations are estimated over the sample period from 1April 1991 to 30 August 1996. Intervention enters in absolute value terms in the regressions for the variance and the kurtosis.

Appendix 5:
Filtering the effect of time to maturity and contract switches out of the measures of moments

In order to filter out from the measures of moments the effect of time to maturity and switches of contract, we estimated for each moment the following equation:

$$MOMENT_t = a + \beta_1 \log(DAYS1_t) + \beta_2 \log(DAYS1_t) + \beta_3 SWITCH_t + \varepsilon_t$$

where

$$DAYS1_t = \begin{cases} \text{days to maturity if no contract switch on day t} \\ \text{0 otherwise} \end{cases}$$

$$DAYS2_t = \begin{cases} \text{days to maturity if contract switch on day t} \\ \text{0 otherwise} \end{cases}$$

$$SWITCH_t = \begin{cases} \text{1if switch on day t} \\ \text{0 otherwise} \end{cases}$$

We then assigned the error of this equation to a new variable measuring the filtered moment:

$$MOMENTC_t = \varepsilon_t$$

The results for these regressions for the periods 1985 to 1996 and 1991 to 1996 are given in Table A2.

Table A2

Filtering the effect of time to maturity and contract switches out of the measures of moments

Dollar/mark, 1985–96			
Moment	**log(Days1)**	**log(Days2)**	**Switch dummy**
Variance	– 0.30	1.04**	6.36
Skewness	– 0.03	0.02**	0.24
Kurtosis	0.22	0.47**	1.20
Dollar/yen, 1991–96			
Moment	**log(Days1)**	**log(Days2)**	**Switch dummy**
Variance	0.48	0.95**	2.34
Skewness	0.01	0.02**	0.06
Kurtosis	0.72**	0.38**	– 1.64

Note: * = significant at the 5% level. ** = significant at the 1% level.

Appendix 6:
Description of variables

The macroeconomic series for which both official announcement dates and survey data of expectations were included in the regression equations are the CPI, the PPI, industrial production, the unemployment rate, and the trade balance for the United States. These data are available for the whole sample period 1985 to 1996. For the United States, M1 and the targeted Federal funds rate are also available but only since 1987. Survey data for both Japan and Germany are available only since the early 1990s. For Japan, they cover data releases on the *Tankan*, retail sales, industrial production, the trade balance, and the job offers/seekers ratio. For Germany, survey data cover industrial production, unemployment, the preliminary cost of living, M3, and quarterly GDP. The data source is Money Market Services.

These surveys are conducted every week, usually Fridays, except holidays, by fax or phone. They cover a broad range of economic indicators due to be released over the two weeks following the survey date. Survey participants are bond traders and forex traders with major commercial banks, and economists with brokerage houses, consulting firms, certain major universities and some fund management companies. Total responses to economic indicator questions, interest rate questions and Fed policy questions range from 15 to 40 each week. Total responses to forex questions numbered about 15 each week.

The explanatory variables of the regressions comprise:

STDIFF	differential of three-month eurorates (US minus Germany or US minus Japan)
CPI	actual minus expected CPI for the United States
PPIUS	actual minus expected PPI for the United States
IP US	actual minus expected industrial production for the United States
TRADE US	actual minus expected trade balance for the United States
UNEMP	actual minus expected unemployment rate for the United States
TANKAN	actual value of the *Tankan* survey
IP JP	actual minus expected industrial production for Japan
RETAIL JP	actual minus expected retail sales for Japan
TRADE JP	actual minus expected trade balance for Japan