MACROECONOMIC NEWS AND THE DM/$ EXCHANGE RATE: 1980-1998[♣]

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ABSTRACT

Empirical confirmation that the effect of macroeconomic fundamentals on exchange rates is economically important has been scarce. This paper employs a general GARCH specification with asymmetric responses to investigate the effect of 35 U.S. and German macroeconomic news announcements on the daily DM/$ exchange rate over the 1980-1998 period. We conclude that FX rates are strongly connected to real and nominal sector developments in both countries, and that real sector announcements influence the exchange rate more strongly than money or inflation announcements. We find that surprisingly high real growth appreciates the exchange rate and raises yields.

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We are grateful to Andy Naranjo for his input during the initial phases of this project. Before withdrawing to pursue other projects, his insights were important in designing the paper's initial structure. In addition, he collected a substantial amount of data, including hand-collected information on German macro announcement values. He also computed the corresponding announcement surprise series we use. He is not listed as a co-author because he had no input to the final results or their presentation. We also thank Gayle DeLong for institutional information about *FX* settlement, Aaron Gubin for research assistance, and Ralf Edelman for hand-collecting the German announcement data. Any remaining errors are unfortunately entirely our own.

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A long-standing puzzle in international economics is the difficulty of tying floating exchange rates to macroeconomic fundamentals such as money supplies, outputs, and interest rates. (Engel and West (2005), P. 485.)

1. INTRODUCTION

Macroeconomic fundamentals play a prominent role in all theoretical models of foreign exchange (FX) rates. We would then expect that changes in at least some fundamentals ought to move FX rates, either because these changes trigger a reassessment of the future path of the economy or because they trigger changes in FX risk premia. Yet researchers have struggled to document a reliable impact of real sector economic variables on FX rates. Meese and Rogoff (1983) and Mark (1995) find scant evidence that macroeconomic changes influence FX rates. Frankel and Rose (1995) lament that the literature provides little evidence that macroeconomic variables reliably affect floating FX rates, except during extraordinary circumstances, such as hyperinflations. Andersen et al. (2007, page 252) comment that, "The notable difficulty of empirically mapping the links between economic fundamentals and asset prices is indeed striking." What explains the paucity of evidence of a robust connection? Engel and West (2005) argue that rational expectations and serially correlated fundamental factors make it difficult to detect causal effects of macro variables on FX rates. Killian and Taylor (2003) contend that linear models are poorly suited to detecting these effects. It may also be that the monthly (or quarterly) data used in many previous studies make for weak statistical tests.

The literature suggests that studying the effect of surprises in macroeconomic announcements offers a better chance of identifying variables that influence FX rates, because macro announcements release a significant quantity of information in a single day, and the surprise component can be measured using available data on forecasters' pre-announcement expectations.[1]

Neely and Dey (2010) survey the literature and argue that, even though previous researchers have identified significant effects of macro announcements on FX rates, those studies are fragmented and inadequately related to one another. Many of the surveyed papers evaluate transactions data for relatively short time periods and identify rapid responses of the FX rate to selected macro announcements (e.g., Andersen and Bollerslev (1998), Ederington and Lee (2001), Andersen et al. (2003, 2007), Love and Payne (2008)). These and other studies show that, consistent with efficient markets, the associated price changes occur rapidly – within a few minutes. From both an asset-pricing and a macroeconomic perspective, these short-term price movements seem insufficient to conclude that macroeconomic conditions have economically significant effects on FX rates. Unless the impact of an announcement on the FX rate is apparent in at least daily data, it seems unlikely that it represents an important influence on the asset's value. Also, most of the high-frequency studies don't control for interest rates or other potential influences on the FX rate. Few studies evaluate more than a few years of data, and nearly all specify a linear, symmetric effect of announcements on the FX rate. Virtually none evaluate the determinants of the volatility of FX rate changes or even control for it.

The objective of this paper is to identify macro announcements that significantly affect the FX rate and to understand the economics of the effects. We study these announcements in conjunction with their effects on the money markets to enrich our understanding of the economics of the FX responses. We study the DM/$ market because of its depth and liquidity,

[1] Prior studies on bond and stock markets have concluded that scheduled government announcements provide a discrete signals that affect prices significantly (e.g. Fleming and Remolona (1999), Goldberg and Leonard (2003), Flannery and Protopapadakis (2002)).

and because both the U.S. and German authorities publicize macro news according to a pre-announced calendar.[2]

Although the existing literature is substantial, this paper adds to it in several ways. First, our daily DM/$ rate data span a long time period (1980-1988), which includes several business cycles, the German unification, and some periods of extreme turmoil in foreign currency markets.[3] Second, we examine the impact of 35 U.S. and German macroeconomic announcements using jointly estimated equations for the FX rate and the U.S. and German money market returns. The complementary evidence from the yields helps sharpen our understanding and offers fresh insights on how announcement surprises affect the FX rate. Third, we allow for asymmetric responses to positive and negative surprises; the estimation results support this choice. Fourth, we model time variation in the FX rate's conditional volatility, which allows us to identify influential announcements not captured by a linear FX returns specification. Fifth, we account for the effects of trading volume and money market innovations on FX rate volatility. Finally, we include an extensive set of control variables in all the regressions.

If the macro surprises are sufficiently large compared to the typical quantity of information that moves FX rates daily, the effect of the new information of important announcements on the FX rate should be statistically detectable. In the raw data, the *FX* rate's volatility is 7% higher (p = 0.22%) on days with at least one U.S. or German macro announcement than on days with no announcements. In our GARCH model, twenty macro

[2] The DM was the second most-traded currency behind the U.S. dollar while it existed.

[3] Unlike recent studies (e.g., Faust et al. (2007), Ehrmann and Fratzscher (2005), Cialenco and Protopapadakis (2011)), we don't concatenate the euro data to the DM after the initiation of the common currency, because even though the euro (more than) replaced the DM, it represents a much wider economic area than the DM, and in principle its reaction to U.S. news ought to have changed. Further, the euro ought to react to all the currency countries' announcements, which are difficult or impossible to collect from public sources.

announcements significantly affect the growth rate and/or the volatility of the daily DM/$ rate (fourteen U.S. and six German). We find that all announcement surprises together account for 52.5% of the model's explanatory power. Furthermore, unlike some previous research, we find that German announcements have important effects on the DM/$ rate; they account for 9.5% of the model's explanatory power. These effects are economically significant.

Our main finding is that surprises that signal higher-than-expected real growth appreciate the home currency and almost always raise the real home yield. This finding contradicts uncovered interest parity, which says that an appreciation of the FX rate must be accompanied by a decline in the home yield. We also find that the effects of U.S. nominal variables vary with the monetary policy rules being pursued by the Fed, while the effects of German nominal announcements reflect the Bundesbank's unwavering focus on price stability. Finally, we show that our results are remarkably stable to significant specification changes.

The remainder of the paper is organized as follows. Section 2 motivates and describes our methodology and the empirical specification. Section 3 describes the data. Section 4 reports univariate volatility statistics for the DM/$ rate and the estimation results for our GARCH model. Section 5 describes the sensitivity tests. The last section summarizes and concludes by noting some implications for future research.

2. METHODOLOGY AND EMPIRICAL SPECIFICATION

We specify the theoretical determinants of the FX rate and then describe our empirical implementation.

2.1. Theoretical Framework

Let s_t be the log of the spot FX rate (DM/$), and let i_t and i_t^* be the US$ and DM yields at the close of date t. Arbitrage ensures that the data obey Covered Interest Rate Parity (CIRP) up to transactions costs, which are very small in these markets, $f_{t,t-1} - s_{t-1} = i_{t-1}^* - i_{t-1}$, where $f_{t,t-1}$ is the log of the forward rate quoted at t-1 for delivery at t.[4] Risk-averse investors may require an expected risk premium, rp_{t-1}^e, to compensate for any systematic risk in the realized spot rate at t. Thus, the relation between the expected spot rate and the forward rate quoted at time t-1 is $s_{t,t-1}^e = f_{t,t-1} + rp_{t-1}^e$. Combining the two equations yields an expression for the expected FX rate appreciation:

$$s_{t,t-1}^e - s_{t-1} = \left(i_{t-1}^* - i_{t-1}\right) + rp_{t-1}^e. \qquad (1)$$

Under rational expectations, $s_t = s_{t,t-1}^e + \tilde{\delta}_t$ and we can re-write equation (1) as the FX return-generating function as $gs_t \equiv s_t - s_{t-1} = \left(i_{t-1}^* - i_{t-1}\right) + rp_{t-1}^e + \tilde{\delta}_t$. Note that this is the risk-adjusted version of Uncovered Interest Rate Parity (UIRP). Decomposing $\tilde{\delta}_t$ into the effects of concurrent macro information surprises and a noise term yields:

$$gs_t = \left(i_{t-1}^* - i_{t-1}\right) + rp_{t-1}^e + \sum_{US,BD} \beta_n \left[F_{nt} - E_{t-1}\left(F_{nt}\right)\right] + \tilde{\varepsilon}_t, \qquad (2)$$

where F_{nt} is the value of the n^{th} macroeconomic variable (n = 1, …., N) for the U.S. or Germany (BD), announced at time t.

[4] The "textbook" formulation we discuss here ignores delivery lags we incorporate into our *opcst* variable in equation (3).

2.2 The Empirical Model

Our empirical implementation of equation (2) includes several refinements and additions. First, we modify the $\left(i_{t-1}^{*}-i_{t-1}\right)$ term to incorporate institutional features of the trade settlement process. The opportunity cost of an overnight position in US$ or DM reflects how soon the position can be reversed. The expression $\left(i_{t-1}^{*}-i_{t-1}\right)$ incorrectly implies that all FX positions require financing for one business day; in fact, a trade's opportunity cost varies according to scheduled lags in the trade settlement process, such as weekends. We adjust for these lags as explained in appendix 1.1. Second, we allow positive and negative news realizations to have separate effects on the *FX* rate (e.g., Ehrmann and Fratzscher (2005)). Third, we introduce a set of calendar dummy variables that have been shown to affect daily asset returns significantly. Fourth, we add the Fama-French risk factors (FF_t) and a set of predetermined conditioning variables (X_{t-1}) to proxy for time variation in the expected risk premium, rp_{t-1}^{e}. The model becomes,

$$\begin{aligned} gs_t &= opcst_{t-1} + \sum_{US,BD} \beta_n^{Pos}\left[F_{nt} - E_{t-1}(F_{nt})\right]D_n^{Pos} + \sum_{US,BD} \beta_n^{Neg}\left[F_{nt} - E_{t-1}(F_{nt})\right]D_n^{Neg} \\ &\quad + \Omega DCR_t + \Psi X_{t-1} + \mathrm{B} FF_t + \tilde{u}_t, \end{aligned} \qquad (3a)$$

Where the βs, Ω, Ψ, and B, are coefficients. $D_n^{pos}=1$ if the n^{th} announcement surprise is non-negative, and zero otherwise; $D_n^{neg}=1-D_n^{Pos}$, and,

$opcst_{t-1}$ = The opportunity cost of holding a DM investment overnight, measured as the interest (or yield) differential between the U.S. and German 1-month yields at the beginning-of-transaction date, adjusted for trade timing as discussed in appendix 1.1.

$\boldsymbol{DCR_t}$ = a vector of calendar dummy variables, defined in Section 3.4.

$\boldsymbol{X_{t-1}}$ = a vector of lagged conditioning variables and a constant, defined in section 3.4.

$\boldsymbol{FF_t}$ = the contemporaneous values of the Fama-French market-wide risk factors, defined in section 3.4.

Note that $gs_t - opcst_{t\text{-}1}$ is the return to a one-day zero-net short position in the DM; it is also the ex-post deviation from UIRP.

Unless the effects of macro announcements are perfectly captured by the linear specification (3a), important macro announcements will affect the volatility of $\tilde{u}_t$. For example, a positive U.S. construction (*CONSTR*) surprise in the early part of a cyclical expansion might raise the dollar's value if it is interpreted to signal higher future growth. But the same announcement surprise late in the cycle might depress the dollar's value if analysts believe the Fed will act to dampen demand.[5] In such a scenario the coefficient estimates for the *CONSTR* surprises in equation (3a) would be biased toward zero, and the market's shifting reaction will show up as an unusually large residual. Flannery and Protopapadakis (2002) (FP) take advantage of the unusual residuals associated with this sort of macro announcement by introducing a dummy variable for each announcement variable in their conditional volatility specification and estimating its coefficient.

We follow FP and use a GARCH specification to model volatility that can capture these effects. So, the complete model for the DM/$ rate includes equation (3a) augmented by:

$$\tilde{u}_t \equiv h_t \tilde{\eta}_t, \text{ where } \tilde{\eta}_t \sim N(0,1) \text{ \& i.i.d.} \tag{3b}$$

$$h_t^2 = \left\{ h_0 + \rho_1 \frac{h_{t-1}^2}{\Gamma_{t-1}} + \theta_1 u_{t-1}^2 \right\} \{\Gamma_t\} EXP \left\{ \begin{array}{l} \chi_{E,0} ERVol_t + \chi_{E,1} ERVol_{t-1} \\ + \chi_U^P URVol_{t-1}^P + \chi_U^N URVol_{t-1}^N \\ + \chi_{iDM}^P UIDM_{t-1}^P + \chi_{iDM}^N UIDM_{t-1}^N \\ + \chi_{iUS}^P UIUS_{t-1}^P + \chi_{iUS}^N UIUS_{t-1}^N \end{array} \right\} EXP\{\Xi Z_{t-1}\}, \tag{3c}$$

$$\Gamma_t = EXP \left\{ \sum_{n=US\&BD} \varphi_n DF_{n,t} + \sum_d \delta_d DCV_{d,t} \right\}, \tag{3d}$$

where

h_t = the conditional standard deviation of the error term u_t.

ERVol = the one-day-ahead forecasted trading volume on the DM futures contract. The model used to make this forecast is summarized in appendix 2 and the volume data and the construction of *RVol* are described in section 3.3.

$URVol^{P(N)}$ the positive, $URVol^P$, and negative, $URVol^N$, lagged residuals from the (unreported) *RVol* model.[6]

$UIDM^{P(N)}$ = the signed (positive or negative) lagged residuals from the (unreported) model of the holding period return for 1-year DM instruments, *HIDM*. The models for the holding period returns are shown in appendix 2.

$UIUS^{P(N)}$ = the signed (positive or negative) lagged residuals from the (unreported) model of the holding period return for 3-month T-bills, *HIUS*.

$\boldsymbol{Z}_{t-1}$ = a vector of financial conditioning variables, discussed in section 3.4; this vector need not be identical to $\boldsymbol{X}_{t-1}$ in equation (3a).

$\boldsymbol{DF}_{n,t}$ = a dummy variable for each announcement variable F_n that takes the value of 1 on announcement day; discussed further in section 3.1.

$\boldsymbol{DCV}_{d,t}$ = a set of calendar time dummy variables that capture repeated and predictable calendar time effects, discussed in section 3.4.

In equation (3c) the residual's conditional variance has four components. The first bracketed term is a standard ARMA (1,1) GARCH specification.[7] The second bracketed term allows macro announcements and calendar time to affect the ARMA(1,1) process. Note that the day *t* volatility modeled here reflects predictable, transient events, such as days of the week or the dates of macro announcements. The effects of such predictable events should not carry over to subsequent days. We eliminate these lagged volatility effects from the ARMA structure by deflating by the effect of the *prior* day's predictable events, Γ_{t-1}. The third bracketed term includes FX trading volume terms and money market return innovations for the U.S. and Germany; the last term contains a set of conditioning variables as controls.

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[5] For a similar discussion see Faust et al. (2007)

[6] Allowing up to five additional lags in equation (3c) complicated conversion but did not alter the relevant results.

[7] To assure a positive conditional variance, we constrain the three GARCH parameters (h_0, ρ_l, and θ_l) in equation (3c) to be non-negative. There are no sign restrictions on any other coefficient.

We include expected and unexpected FX trading volume in the determinants of the conditional volatility of gs_t, because trading volume is well known to be positively correlated with absolute security returns (Karpoff (1987)). Evans and Lyons (2005, 2008) and Love and Payne (2008) show that news announcements generate order flow, which amplifies the effect of news on FX rates, and Bessembinder and Seguin (1993) show that expected trading volume is positively correlated with volatility in the JPY/$ and DM/$ markets. In order to partition expected from unexpected volume, we estimate a daily GARCH model very similar to equations (3a, 3b, 3c, 3d) with futures trading volume as the dependent variable (see appendix 2). The model specifies variations in trading volume in part as a function of macroeconomic announcement surprises (we summarize but don't report the estimation results.) We use the estimated model to compute one-day-ahead expected volume (*ERVol*). Contemporaneous unexpected volume requires knowledge of time-*t* information, which cannot appropriately be included in a GARCH model, so we include only the lagged unexpected volume ($URVol_{t-1}$), computed as the difference between the prior day's actual volume and $ERVol_{t-1}$.[8] We enter the positive and negative unexpected volume components, $URVol_{t-1}^{P}$ and $URVol_{t-1}^{N}$ separately.

The direct effect of money market rates on the FX rate is already incorporated in the return equation (3a). However, since these markets are intimately interconnected, volatility in money markets could spill over to the FX market and vice versa. Therefore we add lagged money market innovations to the specification of the FX conditional volatility. These innovations come from the unreported three-equation GARCH system of the FX growth rate and the U.S. and German money market holding period returns (HPRs); the equations and discussion of the estimation method are in appendix 2.

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[8] In a different estimation context, Bessembinder and Seguin (1993) use contemporaneous (time = *t*) information to

3. THE DATA

We describe our data, its sources, and the set of conditioning variables used in the GARCH model briefly here.

3.1. Macroeconomic Announcement Data

The U.S. macroeconomic announcement data are from MMS International, a subsidiary of Standard and Poor's, which provides the release date, the announced series value and the (previous Friday's) median market survey expectation. We collect 23 U.S. announcements that seem the most relevant (see table 1). In addition, we define a dummy variable equal to unity for the dates of one-day Federal Open Market Committee meetings (*FOMCLD*) and an additional dummy variable (*FOMC2D*) for the second day of two-day FOMC meetings. (We don't try to estimate surprise variables associated with the FOMC meetings.) Our 25 U.S. announcement series contain 22 surprise variables (*CCred* has no forecasts) and 19 announcement dummy variables, because some days have announcements for multiple macro series.

During our sample period, the Fed pursued two distinct monetary procedures. From November 1979 through October 29 1982, it used monetary aggregate targets (targeting $M1$ and $M2$ growth jointly) under Federal Reserve chairman Paul Volcker; thereafter it reverted gradually to fed funds rate targeting. Our empirical specification allows for a different response to U.S. money and inflation surprises during the "Volcker" sub-period.

The data on the ten German macro announcements are hand-collected because they are not available from MMS before 1992; we use the residuals of autoregressive models of growth rates as announcement surprises (see appendix 1.2 for more details).

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compute their unexpected volume series.

Table 1 lists the macro announcement variables along with a mnemonic and reports the mean and standard deviation of each surprise series. We find little evidence of the MMS expectations bias noted by some previous researchers, but the surprise series have widely disparate standard deviations.[9] We normalize each surprise series by the standard deviation of its announcement-day values.

3.2. FX Rates and Yields

Data Resources Incorporated (DRI) provided daily spot DM bid-ask midpoint quotes against the U.S. dollar from January 1980 through December 1998. The U.S. and German money market yields are from Datastream. We align all the announcement data so that each announcement corresponds to the time intervals over which the FX returns are computed (see appendices 1.3 and 1.4 for more details).

3.3. Trading Volume

Because over-the-counter FX trading volume data are not available we follow previous research and use daily DM futures volume from the Chicago Mercantile Exchange to proxy for spot DM/$ trading for our entire sample period, 1980 through 1998 (e.g., Glassman (1987)).[10] For our regressions, we create a stationary adjusted volume series, *RVol*, by deflating raw trading volume by the average volume on days $t-5$ through $t-26$.[11]

3.4. Conditioning Variables

In order to measure the effects of macroeconomic announcements properly, we control for other influences on the FX rate, including risk factors; we label these control variables $\boldsymbol{X}_{t-1}$ and $\boldsymbol{Z}_{t-1}$ in

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[9] Among the U.S. announcement surprises used here, 20 of the 22 series' mean surprises are statistically indistinguishable from zero at the 1% significance level. Our German announcement surprises are mean zero by construction.

[10] Bessembinder and Seguin (1992) show that for the S&P 500 cash and futures market volumes are very similar; Galati (2000) finds the same for the FX market.

equations (3a) and (3c) respectively. The vectors $\boldsymbol{X}_{t\text{-}1}$ and $\boldsymbol{Z}_{t\text{-}1}$ include the lagged yield differential (on 1-month euro yields) between the DM and the US$, the term premium (*TPRE-US* and *TPRE-DM*), and the U.S. default premium (*JPRE-US*).[12] We could not find default premium data for Germany.

We include a broad set of calendar time dummy variables $\boldsymbol{DCR}_t$ and $\boldsymbol{DCV}_t$, in equations (3a) and (3d)) that identify days of the week, the January effect, and holidays; these calendar time effects have appeared in the investments literature. Finally, we dummy-out eleven crisis days because our model is not intended to explain returns over such occurrences (see appendix 1.5 for details). As we explain below, some of these variables were culled from the final model in order to obtain reliable estimates.

Finally, we control for the Fama-French and Carhart risk factors (***FF***): the return to the NYSE index less the riskless rate (*ERM*), the return to small cap minus large cap stocks (*SMB*), the return to high book-to-market minus low book-to-market stocks (*HML*), and Carhart's (1997) momentum factor (*UMD*).[13] We also add the aggregate dividend-price ratios for the two countries, *DIVPRI-US* and *DIVPRI-DM*. Table 2 defines these variables, lists their sources, and reports summary statistics.

4. MACRO NEWS EFFECTS ON THE FX RATE

We first discuss briefly the univariate evidence on the relation between macro news and the volatility of the *FX* rates and then report the results from the GARCH model.

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[11] We also tried the fitted values of a 24-day AR process, but the simple trailing average does much better at maintaining the variance of *RVol* through the sample period.

[12] This specification essentially allows for the unconstrained effect of the interest differential on gs_t in spite of the unity constraint on *opcst*. Early experimentation with entering each interest rate separately suggested that the current specification is at least as good.

[13] See Fama (1990), Schwert (1989), and Ferson and Harvey (1991) for important risk factors for asset returns.

4.1. Raw (Univariate) Volatility

The univariate results reported in appendix 3 are consistent with the hypothesis that a number of U.S. and German macro series reliably affect FX rates at the daily level. Three- quarters of the days have at least one announcement and quite a few have several in our 4,561-day sample. The FX volatility is higher on announcement compared to no-announcement days; days with at least one U.S. or German announcement have a return standard deviation of 0.721, 7% higher than in no-announcement days' standard deviation of 0.674 (p-value = 0.22%). FX volatility increases with the number of announcements in a day. Some announcements have large impacts; for example, FX volatility is higher by 23.9% on *INDP-CapUt*, 18.9% on *CONSTR*, 17.7% on *M*1, and 29.4% higher on the German *BOT* announcement days.[14]

4.2. Estimates of the Asymmetric GARCH Model[15]

Our asymmetric FX returns model measures the marginal effect of each series' announcements. We present estimation results after discussing some pertinent estimation details.

4.2.1. Estimation Issues

We report estimation results only for the FX returns model, equations (3a, 3b, 3c, 3d), but these results are obtained from a three-equation system of the FX return and the 1-day holding period returns (HPR) for U.S. and German short-term debt.[16] The three models are essentially identical. Each includes two signed announcement surprises for each of 22 U.S. and ten German series, and their conditional volatilities include nineteen U.S. and ten German announcement dummies.

[14] The univariate statistics don't represent the marginal effect of an individual announcement because several macro series may be announced concurrently.
[15] To conserve space and reader patience in several instances we don't display all or any estimation results. All such results are available on request from the corresponding author.
[16] We report complete results only for the FX model (in Table 3) because our main interest is its behavior. Selected results for the money market models are presented in Table 4, and full results are available upon request.

Each also includes the lagged signed return surprises from the "other two" markets in the conditional variances.

Including conditioning variables, there are 201 possible coefficients in each of the three models. A nonlinear model with this many coefficients is difficult to estimate. To obtain reliable results, we had to cull some variables from the full specification. In each of the three models we started by deleting conditioning variables whose coefficients were estimated very poorly (*p*-values above 98% including some that never moved away from their starting values). The sequence in which these variables were omitted reflects our a priori expectations about their relative economic relevance.[17]

Once we achieved convergence we eliminated additional poorly estimated conditioning variables. In this case, we performed joint Wald tests to ensure that the eliminated variables were not jointly statistically significant. We did not eliminate any announcement surprises or surprise dummies to achieve convergence; furthermore, the set of "significant" announcement surprises did not change at all as we eliminated the poorly estimated conditioning variables. The FX model we present has 137 estimated coefficients; our culling procedure resulted in very similar lists of remaining variables in the companion HPR models.[18]

Table 3 presents the estimation results for the FX returns. In panel A we report tests of the joint significance of interesting combinations of the coefficients, along with the

[17] We started by including both the Bundesbank's and the Federal Reserve's official interventions in the *FX* markets. The literature offers no uniform assessment of intervention's effect. Adding these variables into the complete model yielded some significant coefficients. However, the original coefficient estimate for contemporaneous intervention was negative, perversely implying that intervention in favor of the dollar depreciates it! Clearly, there is a serious simultaneity problem and we were unable to find instruments to construct a credible "unanticipated intervention" proxy variable; see Fatum and Hutchison (2010) for a recent attempt to deal with this issue. The main result of interest to us is that none of the intervention specifications we tried had any substantive effect on inferences regarding macro news. See Neely (2005) for an extensive analysis of the econometric issues related to intervention.

announcement surprises' contributions to the model's overall explanatory power. The first line in panel A shows that the hypothesis that all the announcement surprises and dummies have zero coefficients is rejected ($p \leq 0.01\%$). Likewise, both the U.S. and German announcement coefficients, as groups, reliably differ from zero ($p \leq 0.01\%$, $p = 0.7\%$, respectively). The data reject the hypothesis that the positive and negative surprises have equal effects ($p = 0.8\%$); this suggests one reason why linear models may have failed to identify reliable macro effects on the FX rate. Sheehan and Wohar (1995) find that "only" bad news affects the FX markets. We reject this conclusion here: good news, such as higher-than-expected U.S. *BOT*, *EMPL*, and *LeadI*, and lower-than-expected *UNEM* and Volcker-period *M*1 and *PPI* all significantly affect the DM/$ rate.

The lower part of panel A shows that the model explains 5.1% of the daily variation in *gs*; announcement surprises account for more than half (52.5%) of this explanatory power. The estimated conditional volatility explains 75.7% of the residuals' actual monthly volatility, and the announcement dummies explain 13.5% of the explained conditional volatility. Overall, the results provide strong evidence that the FX rate's response to macro news is economically significant.

Panel B reports the complete set of coefficient estimates for the signed surprises in columns 2 and 4 (equation 3a), and for the conditional volatility in column 6 (equation 3c). Coefficients' *p*-values are reported in brackets to the right of their estimated values (columns 3,5,7). Panel C reports coefficient estimates for the effects of futures trading volume and money market surprises on the FX's conditional volatility, and for the risk factors in the model.

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[18] Many of the time dummy variables' coefficients were statistically insignificant; the final models include only a subset of the dummies initially considered.

In table 4 we report the estimation results of all three markets for *only* the surprises that significantly impact the FX rate (from table 3). We use this table for the detailed analysis that follows because simultaneous responses of FX returns and money market yields help clarify the nature of the FX responses.

We start our detailed analysis of the results by noting four features of the data that will clarify our interpretations of the regression coefficients. First, the coefficients in the even-numbered columns of table 4 measure the impact on *gs* of a one-standard-deviation surprise in the associated macro variable. These effects can be compared across announcements because the announcement variances are standardized to unity. Second, a larger *gs* value implies a stronger dollar (weaker DM), because the FX rate is expressed as DM/$. Third, in the money market specifications, an increase in the HPR implies a fall in the current yield. These last two features are illustrated in the following table:

Effect of Announcement Surprises on the US$ and Yields

	Surprise	
Coefficient	**Negative**	**Positive**
US$		
Positive	$ depreciates	$ appreciates
Negative	$ appreciates	$ depreciates
Yields		
Positive	Yield rises	Yield falls
Negative	Yield falls	Yield rises

Finally, the combined reactions of the exchange rate and yields convey important information. In particular, an appreciating US$ combined with a rising U.S. yield (falling HPR) implies an increase in the real U.S. yield. Alternatively, a depreciating US$ combined with a rising U.S. yield implies that the nominal yield increase reflects higher inflationary expectations.

4.2.2. U.S. Announcements

The U.S. announcement surprises (table 3, panel A) account for 44.5% of the explanatory power of the *gs* model. A total of eleven U.S. announcements significantly affect the FX rate through the return equation (3a) and three more only through the conditional volatility equation (3c) (see table 3, panel B). We discuss first the effects on nominal announcements (money supply and prices) and follow with an analysis of real quantity announcements.

4.2.2.a. Nominal Announcements – the Importance of Monetary Policy

As in table 3, the rows in table 4 labeled *M*1-*Vlck* and *M*2-*Vlck* show the effect of money surprises during the Volcker period, while those labeled *M*1 and *M*2 are for the rest of the sample. Analogous definitions apply to *CPI* and *PPI*.[19]

U.S. money surprises are highly significant during the Volcker period but not for the rest of the sample; also *M*2 surprises show asymmetric effects. Under monetary aggregate targets, surprisingly high money growth in the recent past (but announced today) requires a reversal of money growth and therefore an increase in the fed funds rate. The positive money supply shock thus implies that the real U.S. short term yield will increase and the US$ will appreciate. That is exactly what we find: a positive *M*1 or *M*2 surprise during the Volcker period increases the U.S. yield significantly (the HPR the falls).[20] Among all U.S. announcements, the positive *M*2 surprises during the Volcker period have the largest effect on the FX rate: a one-standard-deviation positive surprise appreciates the dollar by 70 bps – about one standard deviation of gs_t.

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[19] We don't distinguish the Volcker period for the *CCPI* or the *CPPI* announcements because the associated coefficients are very poorly estimated.

[20] These reactions can be interpreted in terms of the fed's "credibility," in that the market appears to have expected the Fed to adhere to its announced monetary targets. Also see Neely and Dey (2010).

*M*1 has similar but smaller effects.[21] These results are consistent with those of Hardouvelis (1988) and later authors.

After October 1982, the Fed reverted to various versions of fed funds targeting, which changed the market's interpretation of a monetary surprise. Under this regime, monetary policy does not automatically reverse money growth surprises because the Fed supplies funds elastically at the fed funds rate. A reported monetary surprise could therefore reflect either a change in money demand (implying a change in real sector activity) or a change in monetary policy. These interpretations would have opposite effects on the FX rate. This ambiguous effect of *M*1 surprises on the FX rate likely explains why money announcements don't significantly affect the FX rate outside the Volcker period. It also explains why the conditional volatility on *M*1 announcement days is elevated by 20.2%.[22]

The U.S. money market furnishes additional information; outside the Volcker period, the U.S. money market yield *rises* significantly on negative *M*1 and *M*2 surprises (not reported), implying that investors on average interpret negative money surprises as indicating tighter monetary policy intentions though it doesn't lead to a statistically significant US$ response.[23]

During the Volcker period, *CPI* news affects neither the FX market nor the U.S. money market, but the FX market reacts strongly to *PPI* surprises. A positive *PPI* surprise appreciates and a negative surprise depreciates the US$. This finding is inconsistent with the strict monetarist view of how inflation affects FX rates. However, to the extent that the Fed's

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[21] To express the effect on the FX rate in bps we multiply the coefficients in Table 3 (in this case 1.035) by the no-announcement standard deviation of the DM/$ growth rate, 0.674 (in Table A-1). We can do this because all announcement standard deviations are 1.0.

[22] In the conditional volatility we don't distinguish between the Volcker and the later period because the Volcker dummy coefficients are estimated very poorly. We attribute the value of the coefficient to the later period because it is by far the longer time period.

[23] U.S. *M1* negative surprises also cause the German yield to fall while that market's conditional volatility is 36% higher.

monetary policy is credible in the marketplace, a positive *PPI* surprise would be interpreted as surprisingly high real activity, rather than an indication of looser Fed inflation policy. There are no detectable effects in the U.S. money markets to corroborate this.[24] After October 1982, the FX rate does not react significantly to U.S. or German inflation news.

4.2.2.b. Real-Sector U.S. Announcements

The real-sector announcements in table 4 display a very strong pattern: surprises that imply stronger economic activity appreciate the US$ and often increase yields. Announcements implying a weaker-than-expected economy depreciate the US$ and often lower yields.

Consistent with this pattern, negative *EMPL* and *INDP* surprises depreciate the US$ and lower yields, while negative *UNEM* (good news) appreciates the US$ and increases yields. These effects are substantial: a negative (one-standard deviation) *EMPL* surprise causes the US$ to depreciate by 20 bps. Negative *CONF* surprises also depreciate the US$ but with no significant effect on yields. Positive *EMPL* surprises appreciate the US$ and increase short term yields, and positive *PInc* and *LeadI* surprises appreciate the US$.[25]

The largest-impact U.S. real sector announcement is the positive *BOT* surprise, where a one-standard-deviation shock depreciates the US$ by 23 bps.[26] Yet the macroeconomic implications of a positive *BOT* surprise are theoretically ambiguous. A positive *BOT* surprise comes from a combination of higher exports and lower imports. While higher exports imply higher foreign *GDP* (and perhaps eventually a higher U.S. *GDP*) lower imports reflect lower U.S. *GDP*, *ceteris paribus*. What then accounts for this large and apparently unambiguous effect? The large positive effect of *BOT* surprises apparently reflects the order in which

[24] However, the German yield falls on negative U.S. PPI news, consistent with the interpretation that it is signaling overall slower economic activity.

announcements occur in the U.S. The *BOT* is among the latest to be announced; it is never earlier than ninth and frequently it is the last one. Thus, the market already has a clear idea about the state of domestic economic activity from the month's previous announcements, and the *BOT* announcement primarily provides information about the state of exports and the financing needs related to the differences between national saving and private investment. A positive *BOT* surprise, at the margin, then, signals higher exports and less foreign borrowing, and therefore it leads to an appreciating US$. This interpretation is supported by the reaction of the U.S. money markets: the yield increases for positive *BOT* surprises, and falls for negative ones. This positive effect of *BOT* on the FX rate contradicts the findings of Kim and Roubini (2008) but is consistent with Ehrmann and Fratzscher (2005).[27]

The *HOURLY* and *UNEM* results don't fit neatly into the general pattern that a stronger real economy appreciates the currency. Note that these two announcements occur simultaneously (along with *EMPL*) as part of the nonfarm employment report so the market must unravel the separate implications of the three announcements. Proper interpretation of one series depends on the other two series' surprises. We already saw that *EMPL* and *UNEM* convey distinct information (they have separately significant effects and their surprise correlation is only -0.23). It is likely that while the growth implied by positive surprises for *EMPL* is good news, a negative *HOURLY* (wage) surprise *at the margin* implies future gains in competitiveness and/or lower inflation; either would tend to appreciate the US$.[28] Oddly, the estimated coefficients on positive

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[25] Negative *HOMESL* and *SALES* decrease the short term yield with no significant effect on the FX rate. Positive *CONF*, *INDP*, and *PCons* increase the U.S. yield with no significant effect on the US$ (not reported in Table 4)
[26] Neely and Dey (2010) discuss the literature on *BOT* surprises.
[27] In a recent paper, Kim and Roubini (2008) build a 5-factor structural VAR model and analyze the effect of the independent shocks. In their model, a positive *GDP* shock has a very small *positive* effect on the current account but causes the dollar to depreciate in real terms. Ehrmann and Fratzscher's (2005) results on the *BOT* are not statistically significant.
[28] The *EMPL* and *HOURLY* surprises are barely correlated (-0.04).

and negative *UNEM* surprises are inconsistent with one another: the negative surprises (higher real activity) appreciate the US$ and increase the U.S. yield consistent with a stronger real sector, while the positive surprises also appreciate the US$ (but with no significant affect in the U.S. money markets). We can offer only a plausible statistical explanation for this behavior.[29]

Columns 6 and 7 of table 4 show that, except for *INDP*, the announcements that have significant coefficients in the returns don't exhibit high residual volatility. This implies that our asymmetric returns specification adequately captures the effects of these announcements. However, the table also identifies announcements whose impact our specification does not capture. Volatility is significantly higher when *CONSTR* and *PCons* are announced. We interpret the high volatility for these announcements as evidence that the information they convey is important but the effect on the US$ depends on the surrounding conditions and on other information.

To conclude: our results indicate that good real sector news in the U.S. predominantly appreciates the home currency. No real sector announcement significantly appreciates the US$ on bad news and none, except *UNEM*, depreciates it on good news. Good news also generally increases U.S. money market yields.[30] This last suggests that good real sector news increases *real* yields. Note that this finding is inconsistent with UIRP, which stipulates that increases in home country yields must be accompanied by a depreciation of the home currency.

[29] The positive coefficient on positive *UNEM* surprises implies that a surprisingly *weak* employment report also appreciates the US$. Although this puzzling result is significant at only the 10% level, we investigated further. The effect of *UNEM* surprises are unusual because, more than most, they drift in and out of significance in response to regression specification changes, as we report in the section on sensitivity. For example, not differentiating the Volcker period or eliminating the auxiliary variables or the conditional variance announcement dummies makes this coefficient insignificant. The *UNEM* surprises may be related to the simultaneous announcement of *EMPL* and *HOURLY*, in that market participants have to extract information about real economic activity from three simultaneous information sources. We are inclined to dismiss the positive coefficient on positive *UNEM* surprises as an aberration, while emphasizing that the coefficient for the *negative* surprise is unwaveringly significant and negative through specification changes, and it is consistent with the *EMPL* implications.

4.2.3. German Announcements

The literature has generally concluded that German (and other foreign country) announcements have weaker impacts on FX rates than their U.S. counterparts. Suggested reasons for this are that foreign announcements come later than the corresponding U.S. announcements, and in the case of Germany, the precise announcement times are not pre-announced during part of the period (Neely and Dey (2010)).[31] We show that the German announcements have a major influence on the DM/$ rate but in several cases the markets' responses have varied over time, masking their importance in linear returns models. In table 3, panel A, we fail to reject the hypothesis that all ten German announcement surprises are jointly significant (p = 29.2%) but we do reject the hypothesis that the German announcements (surprises and dummies) don't significantly affect the FX rate (p = 0.7%).[32]

German announcements jointly account for a statistically significant 9.5% of the explained variation in *gs*. Three individual series' surprises have significant coefficients, and three more surprises have significant impacts on the conditional volatility. Among the nominal German announcements, only *PPI* significantly affects the exchange rate: a one-standard-deviation negative inflation (*PPI*) surprise depreciates the DM by 11 bps. This DM depreciation is consistent with expected monetary loosening and lower yields in the future, in line the Bundesbank's legendary reputation for maintaining price stability. Given this policy, it is to be expected that *M*1 surprises have no uniform and significant effect on the DM/$; German money market volatility is significantly higher for the *M*1 announcement (not reported), which is a manifestation of the response ambiguity. Although German yields don't react concurrently to

[30] Except *PCons*, no real sector announcement significantly increases yield on bad news and none decreases yields on good news.

[31] As we explain in the data section this timing uncertainty does not influence our results.

PPI, a negative German *PPI* surprise is associated with a decline in the U.S. short term yield. This last may be in response to an expected fall in the German yield, but there is once again substantial ambiguity in the U.S. money markets' reaction; U.S. money markets' HPR volatility is 18% higher on days when the German *PPI* is announced.

Two real sector German surprises are significant at the 10% level: a negative *WSAL* surprise depreciates the DM, and a negative *UNEM* surprise appreciates it.[33] These results mirror those of the U.S: a weaker-than-expected real sector depreciates the home currency and vice-versa. The *WSAL* surprise has no significant impact in the German money market but its announcements significantly increase (26.5%) the HPR's conditional volatility.

We reject the hypothesis that the ten announcement dummy variables have no joint effect on the FX rate's conditional volatility ($p \leq 0.01\%$). The *BOT* announcement significantly raises the FX rate's conditional volatility (45%). The ambiguous reaction to *BOT* announcements is consistent with our discussion of the U.S. case: since the *BOT* announcements provide information both about the home country and its trading partners, one might expect ambiguous responses in the FX rate. For the U.S. we argued that because of earlier information releases on the real economy, the market acts as if the *BOT* information primarily concerns exports. The *BOT* is also one of the later-released announcements in Germany (not as late as in the U.S.) but the market's reaction is different; perhaps fewer announcements inform on domestic conditions. Additional insight comes from the German money market. Here there is evidence of ambiguity as well; its volatility is 16% higher on *BOT*-announcement days. At the same time, a negative *BOT* surprise *increases* the German short term yield, consistent with the *BOT* announcement

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[32] The German "surprises" are computed from an econometric model, so that estimating errors would tend to bias their coefficient estimates downwards.

providing new information about *domestic demand* (i.e., imports) rather than foreign (i.e., exports) economic activity.

4.2.4. Low-Volatility Announcement Days

Four announcements significantly reduce the FX rate's volatility: the U.S *EMPL* and the German *INDP, PPI* and *RGDP*. These findings appear counter-intuitive and require some discussion.

An important underlying assumption in all announcement surprise models is that the background information flow is independent of macro announcements.[34] This assumption may be violated at times for several reasons. First, some announcements may displace other news, e.g., the private sector may withdraw or delay some routine information announcements pending the public announcement in question.[35] If so, those days would exhibit lower baseline conditional volatilities. This possibility suggests that those public macro announcements are considered to be very important. The exceptionally low residual volatility for the high-profile U.S. *EMPL/UNEM/HOURLY* report may be just such a case. Unfortunately we don't have the sort of data required to test this hypothesis.

Second, important macro news announcements may tend to diminish the additional information that can be gleaned from concurrent private and public announcements, because in those instances, the information of the private announcements is less relevant for updating broader forecasts. For instance, a Walmart sales announcement is used in part to reassess forecasts of national sales and the likely performance of many other concerns, and even revise some macro variable forecasts. But if Walmart's announcement comes on the same day national sales figures are released, Walmart's announcement will not have the same effect on agents'

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[33] A negative German *UNEM* surprise is associated with a decline in the German short term rate; we have no obvious explanation for this finding.

[34] Rigobon and Sack (2008) emphasize the importance of this independence assumption.

forecasts about other companies and macro variables. Rather, the information in Walmart's sales announcement will be primarily about Walmart's fortunes, and the volatility normally created by the Walmart announcement will be lower, contributing to a lower baseline volatility.[36]

A third possible explanation of low volatility recognizes that an announcement generally has implications for more than one dimension of the economy. The insight that surprises move the market and therefore should result in higher volatility is unassailable when an announcement provides new information about only one variable. However, any variable's announcement surprise may cause investors to update their forecasts of other variables. If some of those forecast revisions are negatively correlated with one another, it is theoretically possible that an important announcement surprise gives rise to lower volatility.

We conclude that "low-volatility" on some announcement days in the FX market results from the interplay of several economic forces and is unlikely to be a statistical aberration.

4.2.5. Three Additional Results

Panel C of table 3 shows that trading volume significantly affects conditional volatility.[37] We reject the hypothesis that the volume residuals are unimportant at $p \leq 0.01\%$. Rather, expected and unexpected volume significantly affect the DM/$'s conditional volatility. A one-standard-deviation increase in *ERVol* increases the FX standard deviation by 29.6% but lagged *ERVol* *decreases* it by 13.1% (both with $p \leq 0.01\%$.); this pattern suggests a lagged but incomplete "correction" to the initial increase in volatility. Negative lagged volume surprises ($URVol^N$)

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[35] We thank Prof. Larry Harris for this insight.

[36] See Ehrmann and Sondermann (2010) and the references therein for a model with a similar idea: markets are less volatile just after major public announcements. Markets interpret private information conditional on the most recent public information, and when that information is fresh, the volatility of the interpretation is small. For a similar point in the context of their model, see Faust et al. (2007).

[37] Bessembinder and Sequin (1993) also report positive effects of expected and unexpected trading volume on the Yen/US$ and DM/US$ return volatility, although their measures of trading volume included contemporaneous information, which we cannot properly include in our GARCH model.

significantly increase FX conditional volatility by 5.1% while positive ones ($URVol^P$) decrease it but not significantly.

Lagged money market residuals modestly impact the FX conditional volatility. The hypothesis that the lagged U.S. and German money market residuals don't affect FX volatility is rejected at p = 6.9% and p = 1.9%, respectively. A one-standard-deviation lagged negative residual in the U.S. money market decreases FX volatility by 3.3%, and a one-standard-deviation positive lagged residual in the German money market increases FX volatility by 3.9%. This shows that money market surprises feed in to next-day's conditional volatility of the FX market.

Finally, panel C shows the effects of contemporaneous Fama-French factors on the FX rate (*gs*). The coefficient on negative ERM (market return) surprises is consistent with our earlier findings that a stronger U.S. economy appreciates the dollar: a one-standard-deviation negative movement of the market (*ERM*) depreciates the US$ by about 6 bps.[38] Excluding these risk factors has no material impact on the announcement results.

4.3. What Can We Learn from Volume?

Prices change when new information about the value of assets arrives. Price changes need not be accompanied by changes in trading volume if investors agree about the implications of the new information Nonetheless the literature shows that private information is transmitted to prices mainly through trades. That is, important news should often generate both relatively large price changes and increased transactions volume. Increased trading may reflect differences of opinion about the new information's implications or a desire for investors to rebalance their portfolios in response to value changes.

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[38] A similar, negative movement of *SMB* depreciates the US$ by 3.3 bps, and a positive movement appreciates the US$ by 2.5 bps. *HML* has no significant effect on the FX rate, but a positive *UMD* surprise for U.S. equity returns tends to appreciate the dollar (at p = 10%).

Appendix 2 describes the empirical model designed to capture the effect of macro announcements on trading volume in the DM futures market. The model's estimation results (which are not reported but only summarized here) permit us to compare the reactions of volume to macro announcements with those of the FX rate. We find that some macro announcements are accompanied by significantly higher trading volume, as expected, and those significant announcements overlap with the ones that affect the FX rate; *BOT*, *CONF*, *EMPL*, *UNEM* for the U.S., and *UNEM* for Germany. *INDP* affects the FX rate and volume's conditional volatility. But other announcements affect the FX rate without affecting trading volume: *LeadI*, *M*1-*Vlck*, *PInc, PPI_Vlck,* for the U.S., and *PPI*, and *WSAL* for Germany. This is consistent with the notion that extraordinary trading volume is not necessary for prices to adjust. Finally, we find four instances in which there is a volume effect but no detectable effect on the FX rate (*CapUt*, *HOMESL*, *M*2, *M*2-*Vlck*). Thirteen surprises have no effect on either FX or trading volume.

5. SENSITIVITY ANALYSIS AND AN EXTENSION

Some of the model's power in identifying influential macro announcements comes at the cost of complexity, which may raise the concern that our results depend on the model's precise specification. A related issue is to what extent this complexity helps reveal additional information. Our results would be suspect if the significant announcements vary a great deal across specifications. If, on the other hand, the results are not affected at all by the variations we study below, the complexity built into our model has questionable value. We examine the extent to which conclusions about specific announcements depend on the specification by estimating several simpler variants of the full model; each variant eliminates a group of variables that are peripheral to our main hypotheses.

We label the variants of the full model as follows:

(i)	No *RVol*:	eliminates all *ERVol*, *URVol*, *UIDM*, and *UIUS* variables in the conditional volatility relation,
(ii)	No *Vlck*:	eliminates the Volcker period dummies,
(iii)	No *Opcst*:	eliminates the *opcst* variable,
(iv)	No *Aux*:	eliminates all auxiliary variables,[39]
(v)	No *ARC*:	eliminates all asymmetric response coefficients, and,
(vi)	No *AnnDums*:	eliminates all announcement dummies from the conditional volatility equation.

The results are summarized qualitatively in table 5, panel A. Although the exact set of "significant" macro announcements varies somewhat across specifications, our main results are reassuringly robust. We list results for all the fifteen U.S. and six German announcements that have at least one significant coefficient in the full model or in at least one of the above variants. The panel shows the patterns of change in each variable's significance across specifications. The significance of each coefficient in the full model is shown in the first (bold-faced) line of each cell. The lines below contain information on which specifications alter the significance, compared to the full model. "No Change" means the significance level of the coefficient remains the same through all the variants (switches between 5% and 10% significance count as no change); when there is a change the table describes the direction of change and which variants are responsible for the change.

The announcements with significant coefficients in the full model retain significant coefficients in most specifications. Inference is unaffected by *any* of the variants for 53% of the U.S. and 67% of the German coefficients; the 21 announcement series in panel A have 56 estimated coefficients, 38 U.S. and 18 German (three coefficients for each, two for those with no

[39] The "Auxiliary" variables are all the interest rate variables save *opcst*, book-to-market ratios, the day-of-the-week and the January effect dummies, the Fama-French risk factors, and the pre- and post-holiday dummies.

distinct volatility coefficient).[40] There are fourteen instances where a significant variable in the full model becomes insignificant in one of the six variants. Conversely, nine coefficients become significant, compared to the full model.

Panel B of table 5 summarizes the patterns of coefficient stability across specifications; it reports how many of the inference changes are "caused" by each variant over all 21 announcements. Twelve inference changes are associated with the "No *ARC*" model variant, which eliminates the full model's asymmetric response feature. This shows the importance of allowing for asymmetric responses. "No *Aux*" produces ten while "No *RVol*" and "No *AnnDums*" produce nine changes each.[41] *Opcst* makes no difference to inference and "No *Vlck*" has very limited effect.

The estimates of the significant coefficients themselves vary relatively little across the seven specifications. For the variables carrying significant coefficients in two or more model variants, the average coefficient of variation of the seven estimated coefficients is 0.21 for the U.S. and 0.23 for Germany in the returns equation, and it is 0.06 for the U.S. and 0.04 for Germany in the conditional volatility equation. These two results show that the coefficient estimates are quite stable across the seven model variations.

Though our results exhibit remarkable stability, they also show that allowing for asymmetric coefficients, entering a rich set of auxiliary variables, and allowing the announcement dummies, volume, and the money market residuals to affect the FX conditional volatility provide substantial value in inference.

[40] Including the coefficients that were never significant under any alternative, there are a total of 101 announcement-related coefficients in the model, 71 for the U.S. and 30 for Germany.
[41] Since inference can change for the same announcement in more than one specification, the sum all the changes is considerably higher than the total number of announcement for which there is an inference change.

A possibility not included in our model so far is that an announcement's impact on security prices varies with the stage of the business cycle.[42] We refine our model further by augmenting the specification of the surprises to separate out recession periods (identified by a dummy called "*Rec*") from normal times ("*NoRec*") while retaining the asymmetric response feature.[43] This new specification requires four rather than two coefficients for each announcement. The announcement surprise specification in equation (3a) therefore becomes:

$$\begin{aligned}&\sum_{US,BD}\beta_n^{PosNR}\left[F_{nt}-E_{t-1}(F_{nt})\right]D_n^{Pos}D^{No\,\mathrm{Re}\,c}+\sum_{US,BD}\beta_n^{PosR}\left[F_{nt}-E_{t-1}(F_{nt})\right]D_n^{Pos}D^{\mathrm{Re}\,c}+\\&\sum_{US,BD}\beta_n^{NegNR}\left[F_{nt}-E_{t-1}(F_{nt})\right]D_n^{Neg}D^{No\,\mathrm{Re}\,c}+\sum_{US,BD}\beta_n^{NegR}\left[F_{nt}-E_{t-1}(F_{nt})\right]D_n^{Neg}D^{\mathrm{Re}\,c}\end{aligned} \tag{4a}$$

When we implemented this specification for all announcement surprises the algorithm would not converge. Therefore, in the full model we implemented this specification just for those announcements that have large effects on conditional volatility (see table 3), because it is the effects of those announcements that appear to be not modeled well. We applied this specification to *CONSTR*, *INDP*, *M*1, for the U.S. and *BOT*, *INDP*, and *PPI* for Germany. We found no substantive difference in the significance or the signs of the announcement coefficients between recession and non-recession periods nor a diminished effect in the conditional volatility. We cannot reject the hypothesis that the "recession" and "no recession" coefficients are equal, and the average absolute change in the values of the conditional volatility coefficients is only 0.8%! We conclude that once the asymmetric response of positive and negative surprises is recognized

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[42] See McQueen and Roley (1983), Veronesi (1999), Boyd et al. (2005), Campbell and Hentschel (1992) study equities; Andersen et al. (2007), Ehrmann and Fratzscher (2005) study foreign exchange markets.

[43] We use the U.S. NBER definition of recessions for the U.S. and we create an analogous recession indicator for Germany, by applying the NBER's approximate *GDP* rule: two consecutive quarters of negative growth. To translate to daily data, we start the recession at the beginning of the 2nd month of the quarter for which recession is declared. The dates are, U.S. (1/2/80 – 5/30/80, 7/1/81 – 12/29/82, 7/2/90 – 1/30/91), and Germany (3/3/80 – 12/30/80, 5/1/81 – 6/30/81, 10/1/81 – 11/30/82, 5/1/90 – 6/29/90, 12/1/91 – 2/28/91).

and announcements are allowed to affect volatility, there is no additional gain in modeling business cycle effects.

6. SUMMARY AND CONCLUSIONS

Researchers have had very limited success in documenting economically important effects of real-economy developments on FX rates. Documented relations between macro surprises and FX rates have generally been confined to very short periods (minutes), in FX transaction data, with the exception of monetary variables. Such small FX effects seem inconsistent with theoretical models that give a prominent role to macroeconomic variables in the determination of FX rates. This paper proposes a relatively complex GARCH model to investigate the extent to which a large number of scheduled macroeconomic announcements affect daily DM/$ returns in the 1980-1998 period. We collect information on 25 U.S. and 10 German scheduled announcements. We allow for separate reactions to positive and negative surprises. Trading volume and unexpected movements in the short-term U.S. and German yields are permitted to affect the FX return volatility. We also include several conditioning variables. We estimate a joint version of the model of the FX market and the holding period returns for the U.S. and German money markets, in which the list of explanatory variables is essentially the same in all three markets.

We conclude that the DM/$ rate is strongly influenced by real and nominal sector developments in both the U.S. and Germany. Twenty of our real and monetary announcements significantly affect the daily DM/$ rate. U.S. announcement surprises are highly significant as a group; they are responsible for almost 45% of the model's explained variation of the FX rate. Although German announcements are responsible for less of the model's explanatory power

(9.5%), we reject the hypothesis that the German announcement surprises have no effect on the DM/$ rate. And, unlike some evidence in the literature, the market doesn't react to just negative surprises. Extensive sensitivity tests indicate that our main conclusions are reassuringly robust to significant specification changes.

Surprises that signal higher-than-expected real activity appreciate the home currency and increase the real yield, and vice versa. This finding contradicts the UIRP proposition that a FX appreciation should be accompanied by falling yields. Of the real economy announcements, the largest effect is from the U.S. balance of trade: a one standard deviation surprise increase in *BOT* raises the dollar's value by 0.4 standard deviations (23 bps) against the DM.

Our asymmetric response specification yields important information. We find that few announcements show significant impacts for both positive and negative surprises, and even more rarely are the effects of similar magnitude; only the U.S. *EMPL* and *M*1 and *PPI* surprises (during the Volcker period) have significant effects regardless of their sign.

We show that the market reacts ambiguously to some announcements, depending on surrounding conditions. This behavior is reflected in significantly higher conditional volatility on those announcement days.

Unexpected changes in trading volume significantly affect FX volatility. There is also substantial evidence of volatility transmission from the countries' money markets to the DM/$ market. We model these effects by incorporating lagged residuals from volume and the two money markets in the FX conditional volatility.

We also provide new information on the relation between trading volume and macro surprises. Several but not all announcements that affect the FX rate also affect trading volume but very few announcements affect volume without affecting the FX rate in some way.

Finally, we find that reactions to money and inflation surprises are consistent with the monetary policy procedures in place at the time at the two central banks. We concur with previous literature that money announcements were important during the fed's *M*1 and *M*2 targeting period (up to October 1982). But for the rest of the sample we find rather limited money (and inflation) announcement effects. This is because under interest rate targeting, money supply surprises come from both the demand and the supply of money. The market's reaction depends on how it interprets each surprise. Therefore, we find that *M*1 announcements are associated with higher volatility after October 1982 in the FX as well as the German money markets.

APPENDICES

Appendix.1.1. The Return to a FX Investment with Payment and Delivery Lags

The usual discussion of FX rate determination, as in equation (1), assumes no delivery lags and no scheduled trading halts for weekends or holidays. Yet the real-world FX market operates with a two-business-day delivery lag, and accrues interest in calendar time. Since we model the return to a one-day, zero-wealth portfolio that is short DM and long US$, it is important to control properly for the financing costs of such a position. This involves accounting for settlement delays, ignored in most standard discussions of FX rates.

The trading conventions create a distinct weekly effect, as Wednesday-Thursday trades typically require three days' financing, compared to one day's financing for trades initiated on other days. Moreover, the normal two-day delivery lag is extended if the banks are closed (e.g., for a holiday) in either currency's home country. National holidays thus affect the duration and financing costs of an "overnight" position.

To understand the impact of the delivery lag and calendar-time calculation of interest, consider first the simplest example of a FX trade that occurs during a business week with no holidays. An investor purchases one dollar for DM in New York on Monday and reverses the transaction –purchasing enough DM to repay his loan plus interest– on Tuesday. The investor receives $US\$_{\text{Monday}}$ on Wednesday (2-day lag) and delivers DM on Thursday, the investor's Tuesday transaction clears and he receives DM and delivers $US\$_{\text{Tuesday}}$. On Wednesday, the investor invests the $US\$_{\text{Monday}}$ receipts in a one-day, dollar-denominated interest-bearing instrument paying an annualized return of $i_{\text{Wednesday}}$. She also borrows at the DM interest rate ($i^*_{\text{Wednesday}}$), to maintain a zero-wealth position. The approximate "carrying cost" of this one-day dollar position is $\frac{1}{360}\left(i^*_{Wednesday} - i_{Wednesday}\right)$, which is the opportunity cost of holding DM over

Monday night. Assuming that a rational investor can predict Wednesday's yields (or make a two-day forward contract on Monday), the total expected return to an overnight Monday portfolio is US$$_{\text{Monday}}$ -US$$_{\text{Tuesday}}$ - $\frac{1}{360}\left(i^{*}_{Wednesday} - i_{Wednesday}\right)$. In the absence of holidays, the same timing characterizes Monday-Tuesday, Tuesday-Wednesday, Thursday-Friday, and Friday-Monday trades, assuming no intervening holidays.

A similar trade initiated on a Wednesday involves a substantially larger financing cost. The investor's transaction selling DM for dollars on Wednesday will clear Friday. However, the reverse transaction on Thursday does not clear until Monday, four calendar days later. This gives her a carrying cost of $\frac{3}{360}\left(i^{*}_{Friday} - i_{Friday}\right)$ for her "overnight" position in the DM.

The computation of the carrying costs is further complicated by bank holidays, which need not be the same in both countries. If *either* country's banks are closed, settlement is postponed to the next business day on which both countries' banks are open for business. We adjust the simple interest differential to reflect the correct carrying cost of each one-business-day *FX* position, which we label *opcst*. Formally, $opcst_t = \Theta \frac{\left(i^{*}_{t-1} - i_{t-1}\right)}{360}$, where Θ takes on the value of the number of calendar days between consecutive settlement days. For example, Θ =1, for a Monday-Tuesday trade if there are no holidays that week but Θ =3, for a Wednesday-Thursday transaction in the absence of holidays.

The variable $\boldsymbol{opcst_{t-1}}$ (in equation 3) corrects for these financing and payment effects and replaces the standard yield differential $(i^{*}_{t-1} - i_{t-1})$.

A.1.2. Macroeconomic Announcements:

We compute each announcement's surprise component as the announced value less the median money market economists' expectation.[44] Some MMS series start after 1980; we identified their announcement dates from newspaper records and entered zeroes for those announcement surprises. MMS never collected survey expectations for Consumer Credit (*CCred*), so we have only announcement dates and times for this series. When series are routinely announced simultaneously, each has its own announcement surprises but a single dummy variable marks their shared announcement dates.

Andy Naranjo graciously provided hand-collected German announcement data for ten series over the 1980-1998 period.[45] We checked the accuracy of our hand-collected values by matching the latter part of each time series against MMS' data, which were available for nine of these ten series. Our hand-collected announcements and their MMS counterparts were identical in the post-1992 period. Announcement surprises are residuals from autoregressive models of each series' growth rate; the monthly series' surprises are computed from AR(12) models; the quarterly German GDP surprises are from an AR(4) model.

A.1.3. FX Rates:

Until October 8, 1986, the DataStream quotes originate from a representative bank reflecting the New York open. Thereafter, the quotes represent the London close, which

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[44] Many announcements are expressed as the month-over-month percentage change in some "stock" variable. We convert the "stock" announcements to growth rates. We use an estimated housing stock to deflate *HOMESL* and *HOMEST* and the sum of exports and imports to deflate *BOT*. We don't scale the unemployment rate, *UNEM*.

[45] Prior to 1994, the German data refer only to West Germany. Beginning in 1994, the data refer to the unified Germany.

generally occurs at 11:30 am New York time.[46] The summary statistics in table 2 indicate that the DM fluctuated between 1.35 and 3.46 to the dollar, with a mean (median) of 1.94 (1.78). Over our nineteen-year period, the DM appreciated a total of 2.3% against the dollar.

It requires some care to align announcement surprises properly with the overnight FX rate changes. Macro announcements occur in both Washington and Frankfurt, and our FX rate data apply to different times of day before vs. after October 8, 1986. The German announcements all occur "overnight" in New York.[47] That is, German news is fully reflected in the New York opening FX rate and in the London closing rate (11:30 New York time). When the FX rate is the New York open, all U.S. announcements on day t are aligned with gs_{t+1}. After 1986, gs_t measures the DM/$ change between 11:30 am (London close) on day t-1 and day t, in New York. For these dates, we assign the morning U.S. announcements to day t and the afternoon announcements to day t+1.

A.1.4. Yields

Ideally, yield data should be one-day (overnight) yields, which are unavailable. We use euroDM and euro$ daily holding period returns (HPR) that we calculate from corresponding yields discussed in section 2.2.[48]

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[46] The London close occurs at 12:30 or 10:30 NY time for a few weeks each year because the UK changes to (away from) daylight savings time about two weeks before the U.S. does. We need not adjust for these time changes, however, since no macro announcements occur in this NY time interval.

[47] See Ehrmann and Fratzscher (2005), Table 2 or Andersen et al. (2003). It is crucial that the time of future announcements is known in advance. This is clearly true of the U.S. announcements but there is some question in the literature about the German announcements. The conclusion is that though the dates of the announcements were always known in advance, the exact time was not known from 1993 to 1998; see Andersen et al. (2003). This ambiguity does not affect our results because the time that our DM/$ data is collected (NY) is after all the release times in Germany.

A.1.5. Control Variables for Time Pattern in FX Returns

We use dummy variables to control for time patterns that have been identified in the literature:

- Four "day of the week" dummy variables (the Thursday dummy is excluded because of the regression constant) identified as significant for U.S. equity returns (Gibbons and Hess (1981), French and Roll (1986)), U.S. Treasury returns (Flannery and Protopapadakis (1988), and DM futures prices (Bessembinder (1994)).

- The turn-of-the-year ("January") effect in equities (Banz (1981), Keim (1983), Gallant, Rossi and Tauchen (1992): each year's final trading days and each of the first four trading weeks of the year.

- Pre- and post-holiday effects found for U.S. equity returns (Ariel (1990)) and DM futures price volatility (Bessembinder (1994)).

- Dummy variables identifying each calendar year except 1980.

- Dummy variables for each day during the ERM crisis period (from 9/92 through 9/93) in DCV_t, to capture possibly elevated volatility due to the crisis. They were all dropped because none were significant.

We also included a set of dummy variables in DCR_t to account for eleven "crisis" events during the sample period, which our model is not intended to explain. Estimating these dummies yielded coefficients with extremely large errors and interfered with the algorithm's convergence. Since their inclusion or exclusion did not affect any inferences about macroeconomic announcements, we inserted constants in place of the Plaza and Kuwait dummies, -4.99% and 1.36% respectively, and dropped the remaining nine.[49]

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[48] These HPRs are calculated from adjacent days' quoted yields. Specifically, we assume that there is a new, 30-day, pure discount bond issued at every date t. We then compute its price at the next (business) day, $t+1$, by discounting its face value by the yield that obtains at date $t+1$, and accounting for the change in its maturity.

[49] The eleven events are: the Plaza Accord (9/23/85), three dates related to the first Gulf War –the invasion of Kuwait (8/2/90), the first air strike (1/17/91) and the land invasion (2/24/91), the start of the EMS crisis (9/17/92) and for each month from September 1992 to September 1993, the Peso Crisis (12/20/94), the Asian Crisis (7/2/97), the Russian Crisis (8/17/98), and the LTCM Crisis (9/23/98). By far the largest two absolute returns occurred for the Plaza Accord (-4.99%) and the land invasion of Kuwait (1.36%). The FX movement for the remaining nine events turned out not to be particularly unusual. We retained the Plaza and Kuwait dummies because we were concerned that the sheer size of the associated returns might distort the estimation, particularly for the conditional variance. The constants are from the OLS estimates of equation (3a), where their estimates had high t-statistics.

The above dummies were all initially included in the model, but many were subsequently dropped in order to facilitate convergence. See Section 4.2.1 for details.

We did not use Federal Reserve and the Bundesbank's FX intervention, because, as we explain in section 4.2.1, there are severe econometric difficulties.

APPENDIX 2

Empirical Specifications for the Trading Volume and Money Market HPR Models

Below are the empirical models we estimate for the FX volume (*RVol*) and for the US$ and the DM money market holding period returns (*HIUS*, *HIDM*). All three models share the same forms as (3b) and (3d) in the text. Equations (3a'), (3a'') and (3a''') replace equation (3a) of the FX returns model and equations (3c'), (3c'') and (3c''') replace its equation (3c).
All the variables are as defined in the text.

Model for FX volume:

$$RVol_t = \sum_{i=1}^{18} \rho_i RVol_{t-i} + \Psi \mathbf{X}_{t-1} + \mathrm{B}FF_t + \Theta DV_t + \sum_{US,BD} \beta_n^{pos} ABS\left[F_{n,t} - E\left(F_{n,t}\right)\right] D_n^{pos} + \sum_{US,BD} \beta_n^{neg} ABS\left[F_{n,t} - E(F_{n,t})\right] D_n^{neg} + \beta_0 + \tilde{u}_t \qquad (3a')$$

$$h_t^2 = \left\{ h_0 + \rho_1 \frac{h_{t-1}^2}{\Gamma_{t-1}} + \theta_1 u_{t-1}^2 \right\} \{\Gamma_t\} EXP\{\Xi \mathbf{Z}_{t-1}\} \qquad (3c')$$

Model for U.S. money markets holding period returns:

$$HIUS_t = \Psi X_{t-1} + \mathrm{B}FF_t + \Theta DV_t + \sum_{US,BD} \beta_n^{Pos} \left[F_{nt} - E_{t-1}(F_{nt})\right] D_n^{Pos} + \sum_{US,BD} \beta_n^{Neg} \left[F_{nt} - E_{t-1}(F_{nt})\right] D_n^{Neg} + \tilde{u}_t, \qquad (3a'')$$

$$h_t^2 = \left\{ h_0 + \rho_1 \frac{h_{t-1}^2}{\Gamma_{t-1}} + \theta_1 u_{t-1}^2 \right\} \{\Gamma_t\} EXP \left\{ \begin{array}{l} \chi_{iDM}^P UIDM_{t-1}^P + \chi_{iDM}^N UIDM_{t-1}^N \\ + \chi_{iUS}^p UFX_{t-1}^P + \chi_{iUS}^N UFX_{t-1}^N \end{array} \right\} EXP\{\Xi \mathbf{Z}_{t-1}\} \qquad \text{(3c'')}$$

<u>Model for German money markets holding period returns:</u>

$$\begin{aligned} HIDM_t = \Psi X_{t-1} + \mathrm{B} FF_t + \Theta DV_t + \sum_{US,BD} \beta_n^{Pos} \left[F_{nt} - E_{t-1}(F_{nt}) \right] D_n^{Pos} \\ + \sum_{US,BD} \beta_n^{Neg} \left[F_{nt} - E_{t-1}(F_{nt}) \right] D_n^{Neg} + \tilde{u}_t , \end{aligned} \qquad \text{(3a''')}$$

$$h_t^2 = \left\{ h_0 + \rho_1 \frac{h_{t-1}^2}{\Gamma_{t-1}} + \theta_1 u_{t-1}^2 \right\} \{\Gamma_t\} EXP \left\{ \begin{array}{l} \chi_{iDM}^P UIUS_{t-1}^P + \chi_{iDM}^N UIUS_{t-1}^N \\ + \chi_{iUS}^p UFX_{t-1}^P + \chi_{iUS}^N UFX_{t-1}^N \end{array} \right\} EXP\{\Xi \mathbf{Z}_{t-1}\} \qquad \text{(3c''')}$$

The three equation system of FX growth rate and the U.S. and German HPRs is estimated quasi-simultaneously. It is extremely difficult to achieve convergence in a fully simultaneous model of these three markets, given the large number of coefficients. We opt for a modified version: we estimate each market return model with the lagged residuals of the other two markets obtained from the last iteration. We continue this process until the N^{th} iteration residuals from all three markets are "arbitrarily close" to those of the N-1$^{\text{st}}$ iteration. This approach does not allow for seemingly unrelated regression gains, because the full VCV matrix of the coefficients cannot be obtained in this way. Since we don't conduct tests across markets we don't need the full VCV matrix. Furthermore, seemingly unrelated regression gains are unlikely to be material because the list of RHS variables is virtually the same for all three regressions. This procedure invariably converges in less than ten iterations.

APPENDIX 3

Univariate Analysis of FX Rate Volatility

Table A-1 shows the FX rate volatility associated with U.S. and German announcements. The table categorizes days according to the number of announcements listed in column 1. Columns 2 and 3 report the size of each category as the number of days and as a percent of total days. Column 4 reports the standard deviation of *gs* for each category. The sample includes 4,561 trading days, of which only 1,184 (25.5%) include no macro announcements. Many days include multiple announcements.

We take the "no announcement" day volatility (0.674 in row 2) as the "background" amount of information arrival. We test the hypothesis that FX rates should be more volatile on days with one or more influential macroeconomic announcements by comparing the return volatility of each category to the "no announcement" day volatility of 0.674. Column 5 reports the *p*-value for tests of equality between the realized return variances for each subset of trading days and the no-announcement variance. The table shows that FX rate volatility is higher for all U.S. or German announcement categories, and almost always significantly so. Most fundamentally, days with at least one U.S. or German macro announcement (row 3) have a return standard deviation of 0.721, which significantly exceeds the no-announcement days' standard deviation. The announcement days with only U.S. announcements (row 4) also have significantly higher volatility, but the return volatilities are indistinguishable between no-announcement days and the days with only German announcements (row 5). Rows 6 – 10 and 11 – 13 indicate that return volatility rises monotonically with both the number of U.S. and the number of German announcements in a day.

Table A-2 shows the return volatility associated with each specific announcement series. In order to facilitate comparison across announcements, in column 3 we express each return's standard deviation as a proportion of the "no-announcement" days' value from table A-1, 0.674. In column 4 we report the *p*-values of equality tests of each announcement's standard deviation to that of no-announcement days. As an example, the *BOT*'s "relative standard deviation" of 115.9% (in the first row) is the ratio of the return volatility for 226 *BOT* announcement days (0.781, not reported) and 0.674; the *p*-value of the equal-variance test is 0.30%. Nine of the nineteen distinct U.S. announcements exhibit DM/$ volatilities significantly above the "non announcements" value (p = 5.0%). The largest volatilities for U.S. announcements are associated with two real-sector announcements (*INDP-CapUt* at 123.9%, and *CONSTR* at 118.9%) and three nominal series (*M*1, *M*2, and *PPI* at 117.7%, 117.4%, and 117.1%, respectively). Half of the ten German announcements are associated with higher return volatilities, of which four are statistically significantly larger. The largest German effects occur for *BOT* (129.4%) and *WSAL* (121.7%).

Table A-1: DM/$ RETURN VOLATILITY BY ANNOUNCEMENT ACTIVITY[1]

Macroeconomic Announcements	**Number of Trading Days**	**% of days**	**Std. Dev. of *gs***	***P*-Value in %**
(1) **All sample days**	4,651	100	0.709	- -
(2) **No U.S or German announcements**	1,184	25.5	0.674	- -
(3) **One or more U.S. or German announcements**	3,467	74.5	0.721†	0.22
(4) **One or more U.S. announcements and no German announcement**	1,845	39.7	0.717†	0.91
(5) **One or more German announcements and no U.S. announcement**	732	15.7	0.679	41.57
Days with U.S. announcements:				
(6) **One announcement**	1,537	33.0	0.711†	2.47
(7) **Two announcements**	783	16.8	0.721†	1.97
(8) **Three announcements**	270	5.8	0.761†	0.73
(9) **Four announcements**	85	1.8	0.911†	0.03
(10) **Five or more announcements**	60	1.3	0.925†	0.13
Days with German Announcements:				
(11) **One announcement**	1,262	27.1	0.722†	0.79
(12) **Two announcements**	311	6.7	0.725*	5.94
(13) **Three or more announcements**	49	1.1	0.788*	8.40
Days with Either U.S. or German announcements:				
(14) **One announcement**	1,589	34.2	0.686	26.39
(15) **Two announcements**	1,098	23.6	0.735†	0.17
(16) **Three announcements**	468	10.1	0.720†	4.64
(17) **Four announcements**	194	4.2	0.765†	1.33
(18) **Five announcements**	71	1.5	0.856†	0.58
(19) **Six or more announcements**	47	1.0	1.080†	0.01

[1] We report the number of trading days characterized by the various levels of announcement activity and the associated standard deviation of *gs* across those days. The last column reports the *p*-value for an F-statistic under the hypothesis that the variance of gs_t on the indicated announcement days equals that of the "No U.S. or German announcements" sub-sample in row (2).

† Statistically significant at the 5% level.

* Statistically significant at the 10% level.

TABLE A-2: DM/$ RETURN VOLATILITY FOR EACH MACROECONOMIC ANNOUNCEMENT[1]

Macroeconomic Variables	Number of Announcements	Relative Std. Dev. of *gs* in %	*P*-Value in %
U.S. Announcements			
Balance of Trade: *BOT*	226	115.9†	0.30
Consumer Credit: *CCred*	223	103.1	28.70
Consumer Confidence: *CONF*	90	85.8†	1.76
Construction Spending: *CONSTR*	225	118.9†	0.07
Consumer Price Index and CORE CPI: *CPI* & *CCPI* [2]	227	108.6*	5.92
Non-farm Employment, Unemployment, and hourly wage in manufacturing: *EMPL*, *UNEM* and *HOURLY* [2]	227	116.6†	0.20
New Home Sales: *HOMESL*	223	107.1	10.11
Housing Starts: *HOMEST*	226	101.5	39.76
Industrial Production and Capacity Utilization: *INDP* & *CapUt* [2]	227	123.9†	0.00
Leading Indicators: *LeadI*	227	102.8	30.33
***M*1**	991	117.7†	0.00
***M*2** [3]	206	117.4†	0.21
Personal Consumption and Personal Income: *PCons* & *PInc* [2]	225	112.2†	1.54
Producer Price Index and Core PPI: *PPI* & *CPPI* [2]	227	117.1†	0.16
Real GDP: *RGDP* [4]	226	105.7	14.79
Retail Sales: *SALES*	227	97.4	29.53
Fed Bud Surplus: *SURP*	127	95.4	22.61
FOMC Meeting	154	92.7*	9.71
FOMC Meeting (last day dummy)	101	100.5	49.04
German Announcements			
Balance of Trade: *BOT*	223	129.4†	0.00
Current Account Balance: *CAB*	222	98.2	35.22
Consumer Price Index: *CPI*	226	99.6	45.65
Industrial Production: *INDP*	219	98.6	38.11
Money supply: *M*1	225	115.8†	0.32
Producer Price Index: *PPI*	226	100.1	50.40
Real GDP: *RGDP* [5]	68	92.9	18.29
Retail Sales: *RSAL*	224	97.6	31.19
Unemployment: *UNEM*	226	110.6†	2.86
Wholesale Sales: *WSAL*	178	121.7†	0.06

[1] For each set of announcement days we express the standard deviation of gs_t as a percentage of the standard deviation of all no-announcement days in the sample (= 0.674 from table 3.) *P*-values refer to the probability that the ratios in column 2 are equal to1.0.

[2] These series have separate announcement surprises but they are announced simultaneously.

[3] The monthly *M*2 variable is always announced simultaneously with the weekly *M*1 report.

[4] Even though the announcements are quarterly, U.S. *RGDP* has 226 announcements because the BLS makes three monthly announcements about each quarter's *GDP*.

[5] The German *GDP* is also announced quarterly.

† * Statistically significant at the 5% and 10% level, respectively.

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TABLE 1: U.S. AND GERMAN MACROECONOMIC ANNOUNCEMENTS:[1]

Announcement	**U.S. Begin Date**[2]	**Time-of-Day (New York time)**	**U.S. Mean Surprise [*p*-value]**[3]	**Germany Begin Date**
Balance of Trade: *BOT*	January 1980	2:30 p.m. through 11/29/83 Thereafter: morning	-0.032† [.018]	February 1980
Current Account Balance: *CAB*	- - -	- - -	- - -	January 1980
Capacity Utilization: *CapUt*	January 1980	Morning Anns. start 03/16/88	0.025 [.131]	- - -
Consumer Confidence: *CONF*	August 1991	Morning	0.567 [.285]	- - -
Consumer Credit: *CCred*[4]	March 1980	Afternoon	n.a.	- - -
Consumer Price Index: *CPI*	February 1980	Morning	-0.006 [.522]	February 1980
Core CPI: *CCPI*	January 1980	Morning	0.007 [.230]	- - -
Construction Spending: *CONSTR*	March 1980	Morning	0.045 [.406]	- - -
New Home Sales: *HOMESL*	March 1980	Morning	.371 [.317]	- - -
New Home Starts: *HOMEST*	March 1980	2:30 p.m. through 11/17/83 Thereafter: morning	- - -	- - -
Employment (Non-farm Payroll): *EMPL*	February 1980	Morning	0.003 [.627]	- - -
Unemployment: *UNEM*	February 1980	Morning	-0.052† [.000]	February 1980
Hourly Wage Rate Mfg: *HOURLY*	February 1980	Morning	0.015 [.204]	- - -
Fed Bud Surplus: *SURP*	March 1988	Mid-afternoon (~ 2 pm)	0.023 [.143]	- - -
Industrial Production: *INDP*	February 1980	Morning	0.005 [.807]	January 1980
Leading Indicators: *LeadI*	February 1980	Morning	0.005 [.832]	- - -
Money Supply: *M*1	January 1980	Afternoon	0.055 [.365]	January 1980
Money Supply: *M*2	June 1981	Afternoon	0.005 [.592]	- - -
Personal Consumption: *PCons*	February 1980	Morning	0.033† [.020]	- - -
Personal Income: *PInc*	February 1980	Morning	0.031* [.067]	- - -

Table 1 Continued:

Announcement	U.S. Begin Date[2]	Time-of-Day (New York time)	U.S. Mean Surprise [*p*-value][3]	Germany Begin Date
Producer Price Index: *PPI*	February 1980	Morning	-0.086† [.000]	February 1980
Core PPI: *CPPI*	January 1980	Morning	-0.025† [.031]	- - -
Real GDP: *RGDP*[5]	Septembe r 1980	Morning	0.008* [.073]	January 1980
Retail Sales: *SALES* (US), *RSAL* (Germany)	February 1980	2:30 p.m. through 11/10/83 Morning thereafter	-0.042 [.390]	March 1980
Wholesale Sales: *WSAL*	- - -	Morning	- - -	March 1980

"†" signifies a 5% and "*" a 10% confidence level.

[1] "- - -" cells indicate the absence of announcement data for that variable.

[2] For the U.S., the macroeconomic announcement data come from MMS International, which provides release dates and times as well as the actual release value (first release) and median market survey expectation. The German macroeconomic announcements were hand collected from official German government releases, which contain the announcement dates and actual release values (first release). We report the usual release times for the German announcements because the releases only contain the release date and corresponding data. Prior to 1994, the German data refer only to West Germany. Thereafter they are for unified Germany. The literature reports that between 1993 and 1998, the times of these announcements were not generally known in advance. However, the release times for the German announcements occur in the morning usually between 2:00 A.M. and 8:00 A.M EST NY, before the time of the DM/$ quotes that we use.

[3] This column reports the mean of the standardized announcement surprises of (the actual announced values less the median MMS forecasts, standardized to a StDev of 1) of the US announcements and the *p*-value of the hypothesis that the average surprise is zero. German surprises are the residuals from a 12^{th} order AR model (4^{th} order for the quarterly ones).

[4] MMS does not collect expectations information on *CCred*.

[5] Both governments announce their *Real GDP* measurement quarterly. Other announcements occur monthly, except the U.S. *M*1, which occurs weekly. The *p*-value reported for the U.S. is for all three sets of announcements: advance, preliminary, and final. The forecast mean of the advance announcement only is statistically different from zero. For *GNP* (before 1990), the forecast means are all indistinguishable from zero.

TABLE 2: DEFINITIONS AND SUMMARY STATISTICS FOR IMPORTANT VARIABLES

Variable Definitions:

gs_t	The percentage change in the DM/$ FX rate from market close at date = *t*-1 to close at date = *t*.
RVol	Trading volume on the CME's DM futures contract, detrended as discussed in section 2.2.
*EURO-US*1	The one-month yield on Eurodollar deposits, from Datastream.
*EURO-DM*1	The one-month yield on euro-DM deposits, from Datastream.
TPRE-US	U.S. term structure premium, computed as the difference between the 10-year U.S. T-Note and *EURO-US*1.
TPRE-DM	German (DM) term structure premium, computed as the difference between the DM 10-year and *EURO-DM*1.
JPRE-US	U.S. default premium (*JPRE*), defined as the difference between the Federal Reserve's H.15 series on BAA and AAA long-term corporate bond yields. We could find no analogous information for the German market.
DIVPRI-US	U.S. equity market's aggregate dividend yield, computed from CRSP. Computed as in Fama and French (1989) and Fama (1990). We use the 2nd lag to minimize simultaneity difficulties.
DIVPRI-DM	German equity market's aggregate dividend yield, computed from Datastream. Computed as in Fama and French (1989) and Fama (1990). We use the 2nd lag to minimize simultaneity difficulties.
ERM	Fama-French factor: return to the NYSE index, less the riskless rate
HML	Fama-French factor: return to high book-to-market stocks minus the return to low book-to-market stocks
SMB	Fama-French factor: the return to small vs. large cap stocks.
UMD	Fama-French (Carhart) factor: momentum.

Summary Statistics (4,652 observations)

	Mean	Median	Std. Dev.	Min.	Max.
Dependent Variables					
DM/$	1.943	1.780	n.a.	1.354	3.462
gs	0.002	0.000	0.709	-4.930	3.129
RVol	1.045	0.989	0.428	0.090	3.921
Conditioning Variables					
*Euro-US*1	0.022	0.019	0.010	0.008	0.066
*Euro-DM*1	0.017	0.015	0.007	0.008	0.042
TPRE-US	0.003	0.004	0.005	-0.020	0.014
TPRE-DM	0.003	0.004	0.004	-0.013	0.010
JPRE-US	0.003	0.003	0.001	0.001	0.008
DIVPRI-US	0.032	0.033	0.010	0.013	0.061
DIVPRI-DM	2.383	2.210	0.736	1.200	4.360
ERM	0.037	0.060	0.880	8.630	-17.160
SMB	-0.010	0.010	0.524	0.037	-11.300
HML	0.016	0.010	0.417	2.840	-2.540
UMD	0.027	0.024	0.012	0.061	0.010

TABLE 3: MACRO NEWS IN THE ASYMMETRIC GARCH MODEL FOR THE DM/$ RATE

Panel A: Joint Tests of Announcement Coefficients[a]

H0: All announcement coefficients = 0	**Rejected; *p*-value = 0.000**
H0: All U.S. announcement coefficients = 0	**Rejected; *p*-value = 0.000**
H0: All German announcement coefficients = 0	**Rejected; *p*-value = 0.007**
H0: All U.S announcement surprise coefficients = 0	**Rejected; *p*-value = 0.000**
H0: All German announcement surprise coefficients = 0	**Not rejected; *p*-value = 0.292**
H0: All U.S. announcement dummy coefficients = 0	**Rejected; *p*-value = 0.001**
H0: All German announcement dummy coefficients = 0	**Rejected; *p*-value = 0.000**
H0: Positive & negative surprise coefficients are equal	**Rejected; *p*-value = 0.008**

Contribution to Explanatory Power[a]

% of *gs - opcost* variance explained by the full model	**= 5.1%**
Contribution of All returns surprises to explanatory power:	**= 52.5%**
Contribution of U.S. returns surprises to explanatory power:	**= 44.5%**
Contribution of German returns surprises to explanatory power:	**= 9.5%**
Contribution of All announcements dummies to the conditional variance:	**= 13.5%**
Contribution of U.S. announcements dummies to the conditional variance:	**= 7.8%**
Contribution of German announcements dummies to the conditional variance:	**= 0.9%**
% of residuals' variance explained by the conditional variance, at a monthly level of aggregation	**= 75.7%**

Panel B: Macroeconomic Announcement Coefficients

U.S.						
1	**2**	**3**	**4**	**5**	**6**	**7**
	Negative Surprises		**Positive Surprises**		**Conditional Volatility**	
Variable[b]	**Estimate**	***P*-Value**	**Estimate**	***P*-Value**	**Estimate**	***P*-Value**
BOT	0.079	[.126]	$0.346^{\dagger}$	[.000]	1.136	[.267]
CapUt	0.013	[.898]	0.072	[.210]	Same as INDP	
CCred	n.a.	n.a.	n.a.	n.a.	1.059	[.567]
CONF	$0.178^{\dagger}$	[.023]	0.065	[.390]	0.849	[.302]
CONSTR	-0.031	[.607]	0.054	[.467]	1.210^{*}	[.064]
CPI	-0.047	[.499]	-0.087	[.265]	1.017	[.852]
CPI-Vlck	0.027	[.779]	-0.013	[.880]	n.r.	
CCPI	0.030	[.758]	-0.004	[.943]	Same as CPI	
EMPL	$0.297^{\dagger}$	[.001]	0.098^{*}	[.063]	0.821^{*}	[.073]
HOURLY	-0.125	[.086]	0.005	[.930]	Same as EMPL	
HOMESL	0.029	[.608]	0.008	[.853]	1.055	[.581]
HOMEST	-0.015	[.880]	-0.008	[.888]	1.023	[.815]
INDP	$0.206^{\dagger}$	[.021]	-0.005	[.948]	$1.422^{\dagger}$	[.000]
LeadI	-0.064	[.240]	0.110^{*}	[.054]	0.922	[.454]
M1	0.025	[.519]	0.055	[.197]	$1.202^{\dagger}$	[.006]
M1-Vlck	0.141^{*}	[.077]	$0.135^{\dagger}$	[.019]	n.r.	n.r.
M2	0.003	[.959]	-0.075	[.539]	0.921	[.510]
M2-Vlck	0.377	[.187]	$1.035^{\dagger}$	[.004]	n.r.	n.r.
PCons	-0.035	[.665]	-0.010	[.883]	1.194^{*}	[.078]
PInc	-0.007	[.914]	0.132	[.004]	Same as PCons	
PPI	-0.041	[.560]	0.119	[.349]	1.064	[.569]
PPI-Vlck	0.261^{*}	[.054]	$0.421^{\dagger}$	[.007]	n.r.	

U.S.						
Variable[b]	**Negative Surprises Estimate**	***P*-Value**	**Positive Surprises Estimate**	***P*-Value**	**Conditional Volatility Estimate**	***P*-Value**
CPPI	-0.010	[.882]	-0.186	[.138]	Same as PPI	
RGNP	0.030	[.693]	0.051	[.520]	1.033	[.720]
SALES	0.062	[.268]	0.057	[.297]	1.040	[.706]
SURP	-0.213	[.257]	0.077	[.226]	0.848	[.168]
UNEM	-0.155†	[.006]	0.121*	[.077]	Same as EMPL	
FOMCLD	n.a.	n.a.	n.a.	n.a.	0.852	[.492]
FOMC2D	n.a.	n.a.	n.a.	n.a.	1.123	[.672]

German						
Variable	**Negative Surprises Estimate**	***P*-Value**	**Positive Surprises Estimate**	***P*-Value**	**Conditional Volatility Estimate**	***P*-Value**
BOT	-0.008	[.939]	0.002	[.985]	1.447†	[.000]
CAB	-0.056	[.570]	-0.028	[.536]	0.924	[.428]
CPI	0.012	[.841]	0.070	[.178]	1.010	[.926]
INDP	-0.025	[.715]	-0.061	[.451]	0.807†	[.029]
M1	-0.056	[.404]	0.099	[.119]	1.109	[.250]
PPI	-0.168†	[.018]	0.088	[.115]	0.822†	[.040]
RGDP	-0.015	[.859]	0.052	[.726]	0.753*	[.098]
RSAL	-0.047	[.391]	0.088	[.269]	0.951	[.577]
UNEM	0.211*	[.091]	-0.001	[.988]	1.103	[.236]
WSAL	-0.112*	[.052]	0.014	[.860]	1.116	[.375]

Panel C: The Effects of Trading Volume, Money Market Surprises, and Risk Factors

Variable	**Negative Surprises Estimate**	***P*-Value**	**Positive Surprises Estimate**	***P*-Value**	**Conditional Volatility Estimate[c]**	***P*-Value**
ERVol	n.r.		n.r.		1.296†	[.000]
ERVol(-1)	n.r.		n.r.		0.869†	[.000]
$URVol^{N}(-1)$	n.r.		n.r.		1.051†	[.044]
$URVol^{P}(-1)$	n.r.		n.r.		0.904†	[.000]
$UIUS^{N}(-1)$	n.r.		n.r.		0.967†	[.038]
$UIUS^{P}(-1)$	n.r.		n.r.		0.987	[.316]
$UIDM^{N}(-1)$	n.r.		n.r.		0.993	[.654]
$UIDM^{P}(-1)$	n.r.		n.r.		1.039†	[.005]
ERM	0.105†	[.000]	0.000	[.998]	n.r.	n.r.
SMB	0.093†	[.027]	0.070*	[.091]	n.r.	n.r.
HML	0.032	[.534]	0.077	[.118]	n.r.	n.r.
UMD	-0.066	[.101]	0.077*	[.072]	n.r.	n.r.

"n.a." indicates the data are not available.
"n.r." indicates that the variable is not part of the specification.
† Statistically significant at the 5% level.
* Statistically significant at the 10% level.
[a] These *p*-values are computed using the coefficients of the full model, and deleting the U.S., German, and all the surprises from the fitted values of the returns. Because of correlations between the omitted variables, the constituent parts of the values reported here don't exactly add up.
[b] *XXX-Vlck* measures the effect of the announcement during the Volcker period of money supply control**.**
[c] These coefficients are calculated to be comparable to the results of the announcement dummy impacts on FX volatility. These regression coefficients are adjusted by taking into account of the mean and variance of each variable.

TABLE 4: COMPARISON OF REACTIONS TO SIGNIFICANT SURPRISES

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Dm/$ FX Rate						**Holding Period Returns –US$ Money Market**						**Holding Period Returns –DM Money Market**					
U.S	**Neg Surprises**		**Pos Surprises**		**Cond Vol**		**Neg Surprises**		**Pos Surprises**		**Cond Vol**		**Neg Surprises**		**Pos Surprises**		**Cond Vol**	
Announc	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**
BOT	0.079	[.126]	0.346†	[.000]	1.136	[.267]	-0.005†	[.001]	-0.004†	[.050]	1.030	[.737]	0.001	[.511]	-0.006	[.335]	0.998	[.976]
CONF	0.178†	[.023]	0.065	[.390]	0.849	[.302]	0.002	[.455]	-0.004†	[.041]	1.316	[.102]	-0.006	[.583]	-0.002	[.793]	0.752*	[.065]
CONSTR	-0.031	[.607]	0.054	[.467]	1.210*	[.064]	0.002	[.230]	0.002	[.205]	0.963	[.736]	0.003	[.376]	0.001	[.855]	0.732†	[.001]
EMPL	0.297†	[.001]	0.098*	[.063]	0.821*	[.073]	-0.008†	[.000]	-0.007†	[.000]	1.915†	[.000]	-0.008	[.129]	0.002	[.799]	1.008	[.935]
HOURLY	-0.125*	[.086]	0.005	[.930]	n.r.	n.r.	0.001	[.646]	0.001	[.463]	n.r.	n.r.	0.000	[.963]	-0.016	[.134]	n.r.	n.r.
INDP	0.206†	[.021]	-0.005	[.948]	1.422†	[.000]	-0.005*	[.059]	-0.003*	[.068]	1.152	[.196]	-0.001	[.850]	-0.008*	[.059]	0.717†	[.000]
LeadI	-0.064	[.240]	0.110*	[.054]	0.922	[.454]	0.001	[.638]	-0.002	[.559]	1.448†	[.001]	0.006	[.502]	-0.010†	[.027]	1.028	[.768]
M1	0.025	[.519]	0.055	[.197]	1.202†	[.006]	0.002†	[.002]	-0.001	[.233]	0.882	[.160]	0.008†	[.011]	-0.005	[.159]	1.356†	[.000]
M1-Vlck	0.141*	[.077]	0.135†	[.019]	n.r.	n.r.	-0.012†	[.020]	-0.012†	[.002]	n.r.	n.r.	0.014	[.150]	-0.011	[.188]	n.r.	n.r.
M2-Vlck	0.377	[.187]	1.035†	[.004]	n.r.	n.r.	-0.033	[.332]	-0.050*	[.077]	n.r.	n.r.	-0.092	[.219]	-0.043	[.513]	n.r.	n.r.
PCons	-0.035	[.665]	-0.010	[.883]	1.194*	[.078]	0.003*	[.082]	-0.005†	[.000]	1.075	[.438]	0.001	[.915]	-0.002	[.846]	1.225†	[.006]
PInc	-0.007	[.914]	0.132†	[.004]	n.r.	n.r.	-0.003*	[.078]	0.005†	[.020]	n.r.	n.r.	-0.008	[.371]	0.003	[.713]	n.r.	n.r.
PPI-Vlck	0.261*	[.054]	0.421†	[.007]	n.r.	n.r.	-0.003	[.713]	-0.010	[.238]	n.r.	n.r.	0.056†	[.000]	0.014	[.126]	n.r.	n.r.
UNEM	-0.155†	[.006]	0.121*	[.077]	n.r.	n.r.	0.006†	[.001]	0.004	[.138]	n.r.	n.r.	0.008	[.124]	0.001	[.917]	n.r.	n.r.
German	**Neg Surprises**		**Pos Surprises**		**Cond Vol**		**Neg Surprises**		**Pos Surprises**		**Cond Vol**		**Neg Surprises**		**Pos Surprises**		**Cond Vol**	
Announc	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**	**Coeff**	***P*-Val**
BOT	-0.008	[.939]	0.002	[.985]	1.447†	[.000]	-0.001	[.784]	-0.001	[.518]	1.017	[.874]	0.009†	[.002]	-0.005	[.255]	1.162*	[.069]
INDP	-0.025	[.715]	-0.061	[.451]	0.807†	[.029]	0.000	[.901]	0.002	[.214]	0.871	[.190]	-0.008	[.285]	0.001	[.847]	1.550†	[.000]
PPI	-0.168†	[.018]	0.088	[.115]	0.822†	[.040]	0.004*	[.056]	0.003	[.139]	1.179*	[.068]	0.004	[.585]	0.001	[.845]	1.011	[.883]
RGDP	-0.015	[.859]	0.052	[.726]	0.753*	[.098]	-0.008†	[.035]	0.010†	[.000]	0.802	[.327]	-0.002	[.849]	0.004	[.709]	0.687†	[.029]
UNEM	0.211*	[.091]	-0.001	[.988]	1.103	[.236]	0.000	[.944]	-0.001	[.557]	0.944	[.576]	0.023†	[.042]	0.005	[.158]	0.835*	[.065]
WSAL	-0.112*	[.052]	0.014	[.860]	1.116	[.375]	0.002	[.351]	-0.002	[.356]	0.989	[.926]	-0.011	[.118]	-0.007	[.403]	1.265†	[.009]

The table lists only the surprises that in some way significantly affect the DM/$ rate. The results for the DM/$ rate are identical with table 3 but are reproduced here for convenience. Recall that HPRs and yields are inversely related to one another.

TABLE 5: SENSITIVITY RESULTS FOR THE DM/$ RATE GARCH MODEL

Panel A: The Effects of Alternative Specifications

Fifteen US and six German announcements have at least one significant coefficient in at least one of our seven model specifications: the full model (reported in table 3) and six "alternative" specifications. The bolded words within each cell indicate the variable's significance in the full specification. The non-bolded words report the difference(s) in significance across the six specifications. Shaded cells indicate consistent significance across all seven specifications. Only the U.S. *CPPI* and the German *M*1 have no significant coefficient in the full model.

	Negative Surprise	Positive Surprise	Conditional Volatility
U.S.			
BOT	**Not significant** Significant when no *RVol*, *Aux*, *ARC*, or *AnnDums*	**Significant at 5%** No change	**Not significant** No change
CONF	**Significant at 5%** Not significant when no *AnnDums*	**Not significant** No change	**Not Significant** No change
CONSTR	**Not significant** No change	**Not significant** No change	**Significant at 10%** Not significant when no *RVol* or *ARC*
EMPL	**Significant at 5%** No change	**Significant at 10%** No change	**Significant at 10%** Not significant when no *RVol*, *Vlck*, *Aux*, or *ARC*
HOURLY	**Significant at 10%** Not significant when no *RVol*, *Aux*, *ARC*, or *AnnDums*	**Not significant** Significant when no *AnnDums*	Same as *EMPL*
INDP	**Significant at 5%** Not significant when no *ARC*	**Not significant** No change	**Significant at 10%** No change
LeadI	**Not significant** No change	**Significant at 10%** Not significant when no *AnnDums*	**Not significant** No change
M1	**Not significant** Significant when no *ARC*	**Not significant** Significant when no *Vlck*, or *AnnDums*	**Significant at 5%** No change
M1-Vlck	**Significant at 10%** Not significant when no *Aux*	**Significant at 5%** Not significant when no *AnnDums*	
M2-Vlck	**Not significant** Significant when no *ARC*	**Significant at 5%** No change	
PCons	**Not significant** No change	**Not significant** No change	**Significant at 10%** Not significant when no *RVol*, *Aux*, or *ARC*
PInc	**Not significant** Significant when no *ARC*	**Significant at 5%** No change	Same as *PCons*
PPI-Vlck	**Significant at 10%** Not significant when no *RVol* or no *AnnDums*	**Significant at 5%** No change	
CPPI	**Not significant** No change	**Not significant** Significant when no *RVol*	Same as *PPI*
UNEM	**Significant at 5%** No change	**Significant at 10%** Not significant when no *Vlck*, *Aux*, or *AnnDums*	Same as *EMPL*

	Negative Surprise	Positive Surprise	Conditional Volatility
German			
BOT	**Not significant** No change	**Not significant** No Change	**Significant at 10%** No Change
INDP	**Not significant** No change	**Not significant** No Change	**Significant at 5%** No Change
***M*1**	**Not significant** No change	**Not significant** No change	**Not significant** Significant when no *Aux*
PPI	**Significant at 5%** Not significant when no *ARC*	**Not significant** No Change	**Significant at 5%** Not significant when no *Aux*
UNEM	**Significant** Significant when no *RVol*, or *ARC*	**Not significant** No Change	**Not significant** No change
WSAL	**Significant at 10%** Not significant when no *RVol*, *Aux*, *ARC*, or *AnnDums*	**Not significant** No Change	**Not significant** Significant when no *Aux*

Panel B: The Causes of Significance Changes?

	No *RVol*	No *Vlck*	No *Opcst*	No *Aux*	No *ARC*	No *AnnDums*	Of Possible
U.S.	7	3	0	6	9	8	38
German	2	0	0	4	3	1	18

The cells report the number of inference changes for each specification listed in the first row. We define inference change to be a jump of significance from 5% or 10% to insignificance and vice versa. Changes between 5% and 10% significance count as "No Change." The last column shows the number of possible changes, the same for all the specifications.

Notes:

"No *RVol*" is when all *ERVol*, *URVol*, *UIDM*, and *UIUS* variables are eliminated from equation (3c).
"No *Vlck*" is when the Volcker dummies are eliminated from equation (3a).
"No *opcst*" is when all yield variables including *opcst* are eliminated from equation (3a).
"No *Aux*" is when all auxiliary variables are eliminated from equations (3a), (3c), and (3d).
"No *ARC*" is when we eliminate the distinction between positive and negative surprises in equation (3a).
"No *AnnDums*" is when all the announcement dummy variables are eliminated from equation (3c).