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SCIENCE DIRECT
Journal of International Money and Finance
24 (2005) 693–718
Journal of International Money and Finance
www.elsevier.com/locate/econbase

The impact of macroeconomic surprises on spot and forward foreign exchange markets

Marc W. Simpson [a,*], Sanjay Ramchander [b,1], Mukesh Chaudhry [c]

[a] *Department of Economics and Finance, University of Texas, Pan American, 1201 West University Drive, Edinburg, TX 78539, USA*
[b] *Department of Finance and Real Estate, College of Business, Colorado State University, Fort Collins, CO 80523, USA*
[c] *Department of Finance and Legal Studies, Indiana University of Pennsylvania, 324 Eberly Complex, Indiana, PA 15701, USA*

Abstract

This paper evaluates the effects of surprises in 23 types of macroeconomic announcements on foreign exchange rates, and on the forward premium. Several findings emerge. First, as in the balance-of-payment framework, announcements that convey a decline in consumer demand increase foreign exchange rates. Second, the PPP hypothesis is rejected in favor of portfolio balance effects in determining exchange rates. Third, the behavior of forward premiums is consistent with covered interest rate parity. Fourth, exchange rates respond to announcements related to consumer demand, inflation, and interest rates, but not to the announcements directly related to the general strength of the economy. Finally, among the

* Corresponding author. Tel.: +1 956 381 2830.
E-mail addresses: mwsimpson@coba.panam.edu (M.W. Simpson), sanjay.ramchander@colostate.edu (S. Ramchander), chaudhry@grove.iup.edu (M. Chaudhry).
[1] Tel.: +1 970 491 6681.

doi:10.1016/j.jimonfin.2005.04.005

news releases considered, surprises in the Treasury budget, trade balance and capacity utilization have the strongest influence in the currency market.

JEL classification: F31; F41

Keywords: Foreign exchange; Forward premium; Macroeconomic news; Macroeconomic announcements; Error correction model; Panel data

1. Introduction

An empirical study of the effect of macroeconomic surprises on foreign exchange markets offers an excellent opportunity to test and clarify several fundamental theories in international finance. Such theories as purchasing power parity (PPP), covered interest rate parity (CIP), and the international Fisher effect (IFE) are all, internally-consistent, compelling models of exchange rate determination. In addition, Mundell–Fleming type models of adjustment in a large open economy posit balance of payment (BOP), and portfolio balance (PB) explanations for exchange rate movements. While there exists a broader tension and consistency among many of these theories, others appear to be at odds with one another. In the development of a unified theory of international exchange, it is necessary that these hypotheses, each of which contains merit in its own right, fit into a broader, cohesive whole. What is more, it is precisely when theories appear ambiguous or contradictory that one must look to empirical examination for clarification.

While the clarification of hypotheses in international financial theory may seem purely academic, it is perhaps a false dichotomy that separates theory from practical utility. Policy makers in governments, central banks, and the private sector can all gain from a deeper understanding of how forward and spot exchange rates react to unanticipated news. It could be of immense benefit to know, for example, whether an unexpected increase in the Consumer Price Index (CPI) tends to cause a devaluation in the currency, á la the PPP hypothesis, or if such an increase in CPI tends to raise domestic interest rates as per the Fisher effect, leading to a capital inflow and a currency appreciation as conjectured by the PB hypotheses.

The main goal of this paper is to shed light on the various theories of exchange rate determination. Specifically, we examine the reaction of spot and forward exchange rates, as well as the forward premium, of five currencies against the U.S. dollar, to the release of 23 types of periodic U.S. macroeconomic news. The announcement variables are chosen based on their information content and their expected association with exchange rate determination and variability. News about macroeconomic variables are defined as the difference between the actual values of the fundamentals and what market participants expected the fundamentals to be before they were announced. From a methodological standpoint, given the equilibrium nature of the relationship between spot and forward exchange rates, our

analysis is conducted within a vector error correction model (hereafter, VECM), and importantly, employs pooled estimation techniques.

This current study adds to the literature in five significant ways. First, the time frame under consideration is the largest of any study known to the authors. Our data set covers the time period from January 1, 1990 to September 7, 2000, over 10 years of daily observations. This is important for accurately measuring long-run effects. Second, the authors know of no other paper that examines the impact of so many types of macroeconomic announcements on foreign exchange markets. Third, we not only examine the response of the spot market to macroeconomic news, but we consider the forward market's reaction as well. The interaction between spot and forward exchange rates as they respond to macroeconomic announcements may be able to provide additional information on the forward premium—and hence, on international interest rate differentials—than would be possible otherwise. Fourth, by use of a VECM we are able to control for both the long-run and short-run time series dynamics of the spot and forward rates, thereby presenting a clearer picture of the impact of each announcement. Fifth, the pooling of exchange rates against the dollar allows us to develop an overall picture of how the currency market, in general, revises the foreign exchange value of the U.S. dollar, given a surprise in each of the macroeconomic variables.

We find that the daily change in spot foreign exchange rates is significantly influenced by surprises in 10 of the 23 types of announcements. The daily change in forward rates is also significantly impacted by 10 of the 23 types of announcements (spot and forward rates have nine of the significant surprises in common). The impact of six of the announcements is sufficiently different on the forward versus the spot rate so as to have a significant effect on the forward premium. The significance of these results is evaluated in light of several economic theories that are commonly used to explain exchange rate movements.

Section 2 of the paper discusses the academic literature related to the relationship between fundamental economic activities and currency markets. Section 3 describes the data used in the present analyses. Section 4 proposes the overall theoretical framework necessary in categorizing macroeconomic announcement variables, and provides an economic basis for evaluating our results. Section 5 details the econometric methodologies employed in the study. Section 6 presents a discussion of the results. Finally, Section 7 concludes the paper.

2. Previous work

The impact of macroeconomic news on various financial instruments has previously been the subject of extensive research, with most work concentrated in the U.S. stock and government bond markets. In the case of the stock market, the hypothesis that announcements have a significant impact on equity returns has been difficult to confirm (see Schwert, 1981; Cutler et al., 1989; Pearce and Roley, 1985; Hardouvelis, 1987 among others). In contrast, studies that have focused their attention on Treasury debt markets have found more encouraging results. This is because the theoretical ambiguities that are observed in the stock valuation model

are not present in the computation of bond values. The impact of macroeconomic announcements on government bond prices work solely through their influence on the discount rate. Several early researchers such as Berkman (1978), Grossman (1981), Urich and Wachtel (1981), and Roley (1983) among others show a significant impact of announcements in influencing bond market behavior.

Given the close economic relationships between exchange rates and economic fundamentals, increased attention has been paid, in recent years, to the impact of macroeconomic news on currency movements. Hardouvelis (1988), Aggarwal and Schirm (1992), Harris and Zabka (1995), and Kim (1998) all measure the impact of macroeconomic news on U.S. dollar exchange rates, sampled at daily frequencies.

Edison (1997) examines the response of foreign exchange rates and foreign and domestic interest rates to the surprise associated with six macroeconomic variables. While she finds that the dollar exchange rate reacts systematically to the release of U.S. macroeconomic data such as money supply, non-farm employment and trade balance, she does not detect a reaction to inflationary news. Further, while U.S. interest rates are sensitive to the macroeconomic news, little reaction was found in Japanese interest rates and none in German interest rates.

Hakkio and Pearce (1985), Ito and Roley (1987), Hogan et al. (1991), and Hogan and Melvin (1994) all report that the U.S. dollar exchange rate responds to money supply announcements and to announcements regarding the trade balance. They cannot document significant exchange rate reactions to other types of macroeconomic announcements. Furthermore, the results of Ito and Roley (1987) suggest that the Japanese yen–U.S. dollar exchange rate does not respond to Japanese macroeconomic announcements.

Almeida et al. (1998), on the other hand, argue that daily frequencies are too coarse to detect the impact of announcements. Therefore, they estimate the effects of 13 U.S. macroeconomic announcements and nine German macroeconomic announcements on the U.S. dollar–German mark exchange rate using high frequency intra-day observations over the period from January 1, 1992 to December 31, 1994. They indicate that the news emanating from the U.S. tends to be incorporated into the exchange rates faster than the corresponding German announcements. Furthermore, the announcements associated with capital flows seem to be more significant than announcements that provide information about trade balances. Interestingly, Tanner (1997), also using high frequency, intra-day data, for the period 1987–1991, comes to the opposite conclusion that the dollar exchange rate shows no significant response to news about the money supply, industrial production, the producer price index, or the unemployment rate. Tanner finds that the trade deficit is the dominant announcement affecting exchange rates.

Therefore, if one were to draw a consensus from the literature review, it follows that exchange rates are influenced by a wide variety of macroeconomic variables. Some of the macroeconomic factors that were found to have a significant impact include capital flows, trade balance, unemployment rate, and money supply announcements. Notably, most studies document inflationary surprises to have little or no impact on short-run exchange rate movements. This paper adds significantly to the literature by considering a comprehensive set of macroeconomic

news variables over an extensive time period, and examining their marginal influence on exchange rates. The investigation is conducted in a theory-consistent framework.

3. Data description

This study uses the consensus estimates of 23 types of periodic U.S. macroeconomic announcements provided by Money Market Services (MMS). The MMS estimates are used in conjunction with the actual value of the macroeconomic variables in order to compute the surprise element. Specifically, the value of the surprise is calculated as:

$$\text{Surprise}_i = (\text{Actual}_i - \text{Forecast}_i)/\sigma_i, \tag{1}$$

where σ_i is the standard deviation of the ith macroeconomic surprise. Thus, when regressing the dependent variables on surprises, the regression coefficient is the change in the dependent variable for a one standard deviation change in the surprise. Since the standard deviation, σ_i, is constant across all the observations for a given announcement i, this adjustment does not affect either the significance of the estimates or the fit of the regressions. The benefit of standardization is that it allows us to compare the size of regression coefficients associated with surprises across different announcements.

MMS surveys approximately 40 academics and practitioners, and reports the median value from these surveys as the forecast of the value of a forthcoming announcement. Such estimates have been used frequently in studies measuring the impact of economic announcements (see for example McQueen and Roley, 1993; Balduzzi et al., 2001; Ramchander et al., 2003), and have been found to be unbiased.

The impact of macroeconomic surprises on daily exchange rates is examined over the period from January 1, 1990 to September 7, 2000. The foreign exchange rates used in the study are for five currencies: the Canadian dollar, the German mark, the Japanese yen, the Swiss franc, and the British pound. Exchange rates are quoted in terms of foreign currency per U.S. dollar. The data on daily spot and one-month forward exchange rates are obtained from the *Federal Reserve Bank of Chicago* and *Bloomberg Systems*, respectively.[2] The natural logarithms of the exchange rates are used in the empirical analyses.

4. Theoretical considerations

The motivation for using macroeconomic announcements to explain exchange rate behavior is firmly rooted in the canons of international finance theory, all of which can be found in any textbook on international finance (e.g., Isard, 1995). The

[2] The choice of the time period was driven by the availability of consistent macroeconomic data. In economic terms, the euro has been in place since January 1999 when national exchange rates between euro area countries became irrevocably fixed. Only recently, beginning 2002, were the euro bank notes and coins introduced. *Bloomberg Systems* continued to report forward rates for the German mark throughout this period.

underlying proposition is that movements in asset prices should reflect new or unexpected information about fundamental asset values. In the context of this study, unexpected information about macroeconomic fundamentals is expected to help shape the beliefs about exchange rate determination held by market participants, and, these beliefs in turn would be registered on currency values.

For the sake of exposition, and to provide a framework within which to view the linkages between the macroeconomic announcements and the foreign exchange market, we have identified four broad areas of the domestic economy which should theoretically influence spot and forward exchange rates, and about which each announcement may provide valuable information. These four broad areas are: consumer demand, interest rates, inflation and economic growth. What follows is a discussion of the possible linkages between the announcements, these four broad macroeconomic topics, and the foreign exchange market.

Table 1 attempts to classify the type of information provided by the announcements. It is important to keep in mind that all of the macroeconomic variables, undoubtedly, share a close relationship with each other. For instance, macroeconomic announcements that reveal higher interest rate conditions may concomitantly portend greater inflationary pressures and robust economic growth. Therefore, the categorization of macroeconomic variables into discrete groups is by no means intended to deflect or mitigate the importance of these economic linkages. Rather, the exercise should help us interpret the model results in light of the theoretical considerations. Furthermore, it is worthwhile to point out that the focus of this study is to examine the impact of U.S. macroeconomic announcements and not those of the foreign countries.

4.1. Domestic consumer demand

A Mundell–Fleming type Large Open Economy Model (LOEM) of macroeconomic adjustment should relate net exports and net foreign investments to the exchange rate (see, for example, Mankiw, 1997, Appendix to chapter 11). In this framework, an autonomous increase in foreign demand for domestic goods that brings about an improvement in net exports leads to an appreciation of the domestic currency. By the same token, an increase in domestic consumption that lowers net exports leads to a depreciation of the domestic currency. If net exports improve, the exchange rate rises, and if net exports weaken, the exchange rate falls.

Seven of the 23 types of macroeconomic announcements considered in this study are hypothesized to reveal information on domestic consumer demand. They are Auto Sales, Business Inventories, Capacity Utilization, Personal Income, Personal Consumption Expenditures, Retail Sales, and Trade Balance.

The variable Auto Sales measures the monthly sales of all domestically produced vehicles. Auto and Truck Sales are considered to be an important indicator of consumer demand, accounting for roughly 25 percent of total Retail Sales. Furthermore, demand for such items tends to be interest rate sensitive, making the motor vehicle sector a leading indicator of business cycles. Therefore, it would be feasible to place Auto Sales in not only the consumer demand category, but also in the

Table 1
Hypothesized relationships between macroeconomic factors, macroeconomic announcements, and the spot foreign exchange rate

Variable	Domestic consumer demand	Economic growth	Domestic inflation	Domestic interest rates
Spot Rate	–	+	–	+
Consumer demand				
Auto Sales	+			
Business Inventories	–		–	
Capacity Utilization	+		+	+
Personal Consumption Expenditures	+			+
Personal Income	+			+
Retail Sales	+	+		
Trade Balance	–			
Inflation				
Consumer Price Index			+	+
Hourly Earnings			+	+
Non-farm Payroll		+	+	+
Producer Price Index			+	+
Unemployment Rate		–	–	–
Interest rates				
Consumer Credit				+
Treasury Budget				–
Economic growth				
Construction Spending		+		–
Durable Good Orders		+		+
Factory Orders		+		
Housing Starts		+		–
Industrial Production		+		
Leading Indicators		+		
New Home Sales		+		
Real GDP		+		
U.S. NAPM		+		

'economic growth' and 'interest rate' categories. However, because the variable is *explicitly* an indication of consumer demand, we postulate that this is where it is most likely to provide the most pertinent information.

By the time the Business Inventories report is released, the retail inventory section is the only new information it contains. Thus, the Business Inventories report is a coincidental indicator of consumer demand.

Capacity Utilization is a gauge of the productive capability of the economy. Thus, growth in Capacity Utilization could be spurred by increasing consumer demand. Furthermore, high levels of Capacity Utilization can signal inflationary pressure, and through a Fisher effect, rising interest rates.

Personal Income measures income from all sources. The largest component of total income is wages and salaries, a figure that can be estimated using Non-farm Payrolls and Hourly Earnings data from the Employment Report. Thus, the new information in this report is likely to be related to interest income and rents.

Personal Consumption Expenditures comprise three categories: durables, non-durables, and services. Most of the new information in this report is related to spending on services, as this report generally comes out two weeks after the Retail Sales report.

The Retail Sales report is a measure of the total receipts of retail stores. The changes in Retail Sales are widely followed as the timeliest indicator of broad consumer spending patterns. Trade Balance is the country's merchandise exports minus its imports. Thus, while other reports may give an indication of how domestic consumer demand is driving the supply of dollars in foreign exchange markets, the Trade Balance report explicitly considers the question. The currency market can be expected to react to this announcement as participants revise their estimates of the supply and demand for dollars.

4.2. Domestic inflation

The relative purchasing power parity hypothesis (PPP) postulates that the log change in the equilibrium exchange rate between two countries is equal to the difference in inflation rates between two countries; that is:

$$\Delta s_t = \pi_t^* - \pi_t, \tag{2}$$

where s_t is the log of the spot rate quoted in units of foreign currency per unit of domestic currency, π_t^* is the foreign rate of inflation, and π_t is the domestic rate of inflation.

The most widely cited inflation indicator, the Consumer Price Index (CPI), is a measure of the price level of a fixed market basket of goods and services purchased by consumers. In addition to providing information about inflation, CPI, through a Fisher effect, also provides information about interest rates.

Likewise, the Producer's Price Index (PPI) measures the price of inputs into the production process and hence inflation. Again, through a Fisher effect, increases in PPI could signal rising interest rates.

The three remaining inflationary indicators in our study come from the Employment Situation Report: the Unemployment Rate, Non-farm Payrolls, and Hourly Earnings. An increase in the non-farm payroll number, or a decrease in the unemployment rate, is considered an indication of a strengthening economy. At the same time, increased demand for labor, and/or a higher price for labor—as indicated by the Hourly Earnings figure—could also lead to inflationary expectations, and to rising interest rates.

Given that each inflationary announcement also gives rise to an increase in interest rates, it is an interesting empirical question as to whether the spot rate will depreciate as indicated by the PPP hypothesis, or rise as indicated by the PB framework. Shortly, we will present the results bearing on this issue and attempt there to reconcile our findings with both of the theories.

4.3. Domestic interest rates

Domestic interest rates are an important factor in foreign exchange markets for two reasons. First, the portfolio balance (PB) component of a Mundell–Fleming

type Large Open Economy Model (LOEM) postulates that in response to differences in interest rates and expected rates of return, investors shift their funds between foreign and domestic investments. Thus, a positive relationship is posited between domestic interest rates and the spot exchange rate.

Second, covered interest rate parity (CIP) postulates that the log difference between the forward rate and the spot rate is equal to the difference between foreign and domestic interest rates; i.e.:

$$f_t^k - s_t = i_t^{*k} - i_t^k, \tag{3}$$

where f_t^k is the log of the k-period forward rate at time t, s_t is the log of the spot rate at time t, and i_t^{*k} (i_t^k) is foreign (domestic) k-period interest rate at time t.

Under the CIP theory, the forward premium should adjust to reflect interest rate differentials between countries so as to preclude covered interest arbitrage. There are two implications of the CIP that are relevant here. First, those announcements that affect the spot rate, but do not cause a change in international interest rate differentials, should affect the forward rate in a similar manner. Second, those macroeconomic announcements that cause interest rate differentials to either widen or narrow are expected to change the forward premium.

Announcements on Consumer Credit and the Treasury Budget are hypothesized to influence domestic interest rates through the demand and supply interactions in the loanable funds market. Inflationary announcements are dealt with in a separate category.

Consumer Credit is broken down into three categories: auto, revolving (i.e., credit card), and other. Since this release follows releases of total consumer spending, the new information it provides relates to that portion of consumer spending that was driven by borrowing. Hence, the Consumer Credit report provides more information about the market for loanable funds, and less information about consumer demand.

The Treasury Budget is the difference between the government's tax receipts and its expenditures. An increase in the Treasury Budget indicates the government is moving more toward a surplus and further away from deficit spending, financed by the issue of Treasury securities. Thus, the Treasury Budget is an indicator of the demand for loanable funds, and an increase in the budget is indicative of lower interest rates.

4.4. Economic growth

Economic growth presents a bit of a conundrum in terms of the theoretical impact it should have on spot exchange rates. If economic growth is seen as increasing income and spurring domestic demand for foreign goods, it should weaken the domestic currency. If, however, economic growth is viewed as being more conducive for greater foreign portfolio and capital investments in the home country, it could be seen as strengthening the home currency.

Some of the variables that we have classified as primarily being concerned with economic growth are as follows.

The Construction Spending report is broken down between residential, non-residential, and public expenditures on new construction. As a component of

investment, construction spending could be seen as a leading indicator of economic growth, but a lagging indicator of residential and commercial mortgage interest rates.

The Durable Goods Orders release measures the dollar volume of orders, shipments, and unfilled orders of durable goods. Because investment in durable goods is an indication of the real capital investment in the economy, Durable Goods Orders are considered a leading indicator of manufacturing activity. Furthermore, long-lived durable goods are most likely to be financed by borrowing, and hence the Durable Goods Orders also provide information relevant to interest rates.

Factory Orders consist of the earlier announced durable goods report plus non-durable goods orders. Thus, much of the information in this release can be predicted before it is released.

Housing Starts and New Home Sales are indicators of conditions in the housing market and can signal economic growth and/or lower mortgage interest rates.

The index of Industrial Production is a fixed-weight measure of the physical output of the nation's factories, mines, and utilities. The new information in this release primarily concerns utility production.

The Leading Indicators report is, for the most part, a compendium of previously announced economic indicators: new orders, jobless claims, money supply, average workweek, building permits, and stock prices. Included among the leading indicators is the consumer sentiment index, and thus a possible link to consumer demand.

Gross Domestic Product (GDP) is the broadest measure of economic activity. Annualized quarterly percent changes in GDP reflect the growth rate of total economic output. Quarterly GDP reports are broken down into three announcements: advance, preliminary, and final.

The United States National Association of Purchasing Manager's Index (NAPM, or the Institute of Supply Manager's Index) is an indicator of the future level and health of the manufacturing sector and hence, future economic growth. The index is based on a survey of purchasing executives who buy the raw materials for manufacturing at more than 350 companies.

5. Methodological issues

The focal point of our analysis is the construction of a VECM of the forward and spot exchange rates. To construct a VECM, however, we must first provide evidence that the spot and forward rates are nonstationary and that they are cointegrated. Note that a special case of the latter proposition is identical to establishing that the forward premium is stationary.

5.1. Unit root tests

There is a great deal of literature suggesting that f_t (the log of the forward rate) and s_t (the log of the spot rate) have unit roots and are integrated of order one, $I(1)$ (e.g., Baillie and Bollerslev, 1989; Clarida and Taylor, 1997). To test for a unit root in each series, we employ the augmented Dickey–Fuller (ADF) (see Dickey and Fuller, 1981) and the Phillips Perron (PP) (see Phillips and Perron, 1988) tests. Both unit root tests

are conducted with and without a deterministic trend. The PP test was included, as it is well known that the ADF test loses power when a sufficiently large number of lagged differences are included in the right-hand side of the test equation. Furthermore, the PP test allows for weak dependence and heterogeneity in residuals. The critical values used for the unit root test statistics are those reported in MacKinnon (1991).

5.2. Cointegration test

Cointegration is based on the idea that while a set of variables are individually nonstationary, there exist a linear combination of the variables that might be stationary. Evidence of cointegration would suggest that there is a long-run statistical relationship between the variables. Furthermore, it implies that short-term movements of the variables will be affected by the lagged deviation from the long-run relationship between the variables.

Given the close nature of the relationship between spot and forward exchange rates, one can argue that the same underlying stochastic process drives both variables. In other words, spot and forward exchange rates cannot evolve independently and the levels of the variables are intricately linked together.

Previous tests of cointegration between f_t and s_t (or sometimes specifically, the stationarity of fp_t), most of which have been conducted using data sampled at a frequency of one month, have been found overwhelmingly in favor of cointegration between the two variables. Hai et al. (1997), Mark and Wu (1998), and Zivot (2000), among others find that fp_t is stationary, which suggests, therefore, that f_t and s_t are cointegrated with a cointegrating vector of $(1,-1)$.

Using our data set of daily observations over a period of more than 10 years, we test for cointegration between f_t and s_t for each foreign currency using the maximum likelihood tests suggested by Johansen and Juselius (1990) and Johansen (1991). The critical values for the test statistics are those reported in Osterwald-Lenum (1992).

5.3. Short-run dynamics and announcement effects

As Engle and Granger (1987) suggest, cointegration implies an error correction model that captures short-run dynamics between the variables. If there is evidence of cointegration between s_t and f_t, a vector error correction model (VECM) is constructed where the spot and forward rates are endogenous variables, and the surprises in the macroeconomic announcements enter the model exogenously.[3]

[3] The use of VECM has become standard in examining exchange rate dynamics (see, for example, Zivot, 2000). VECM is generally considered to be superior to alternate techniques such as OLS and IV estimation procedures. Johansen (1991), for instance, demonstrates that it is invalid to estimate variables that share a dynamic relationship with each other separately, thus, in effect, ruling out single-equation approaches such as OLS. In addition, Phillips (1991) posits that the use of single-equation techniques in cointegrated systems imparts second-order asymptotic bias and nuisance parameter dependencies. Unfortunately, even instrumental variable estimation does not do any better since the variance of the IV estimator is generally considerably higher than the variance of the OLS estimator.

Estimation of the VECM involves simultaneously estimating the following two regressions:

$$\Delta s_t = \alpha_s + \sum_{i=1}^{k} \beta_{i,ss} \Delta s_{t-i} + \sum_{i=1}^{k} \beta_{i,sf} \Delta f_{t-i} + \sum_{i=1}^{23} \gamma_{i,s} A_{i,t} + \delta_s z_{t-1} + \varepsilon_{t,s}, \tag{4}$$

$$\Delta f_t = \alpha_f + \sum_{i=1}^{k} \beta_{i,fs} \Delta s_{t-i} + \sum_{i=1}^{k} \beta_{i,ff} \Delta f_{t-i} + \sum_{i=1}^{23} \gamma_{i,f} A_{i,t} + \delta_f z_{t-1} + \varepsilon_{t,f}, \tag{5}$$

where, s_t and f_t are the logs of the spot and forward rates at time t, $A_{i,t}$ is a vector that contains the surprise in the ith announcement at time t, z_{t-1} is the residual from the estimated cointegrating vector in the previous period, and $\varepsilon_{t,s}$ and $\varepsilon_{t,f}$ are error terms.

Theoretically, the value of k should be sufficiently large so as to reduce the error terms to white noise. In practice, we have selected the value of k by the minimization of Akaike's Information Criterion (AIC) (see Akaike, 1973). Furthermore, the standard errors of the parameter estimates in Eqs. (4) and (5) are calculated using White's (1980) heteroskedasticity-consistent covariances.[4]

Prior to reporting the empirical results, some methodological notes and shortcomings are in order. First, the existence of the cointegration term in Eqs. (4) and (5) causes the time series behavior of s_t and f_t to differ from a conventional OLS or vector autoregression (VAR) representation. Specifically, the VAR or OLS approach ignores the long-run relationship between the integrated variables, s_t and f_t. Second, if s_t and f_t are cointegrated (1,−1), then z_{t-1} is equal to the forward premium, fp_{t-1}. For our purposes here, however, we have not restricted the cointegration of s_t and f_t to a (1,−1) vector, but rather, have estimated the relationship via ordinary least square regression (the resulting cointegrating vectors are extremely close to 1,−1). Third, the principal coefficients that are of interest in this study are the coefficients corresponding to the announcement vector, A_t. These coefficients would indicate the impact of each type of macroeconomic announcement on spot and forward exchange rates. The surprise vectors for each announcement, A_t, comprise the surprise value on the day of an announcement, and contain a zero on days when no announcement is made. Fourth, Eqs. (4) and (5) are estimated individually for each country's spot and forward foreign exchange rates versus the U.S. dollar, and collectively by using a panel data set comprising the f_t and s_t of the five countries. The panel estimation is conducted in a manner that does not weight the parameter estimates, but restricts the intercept terms in the two equations to a common value for all five sets of observations.[5] As a final note

[4] While it may be feasible to regress the dependent variable on each surprise in isolation, this approach would needlessly leave the regression open to omitted variable bias. However, to be sure, as in Balduzzi et al. (2001), we undertook a comparative investigation of both methodologies, and found no qualitative differences in the results. These results can be obtained from the authors upon request.

[5] Previously, panel data have been used in a VECM context to examine short-run real exchange rate dynamics (Coakley and Fuertes, 2000), and the pricing of Australian manufacturing firms (Bloch and Olive, 1999).

of caution, the reader should be aware that the present analysis is conducted with only U.S. macroeconomic surprises. Thus, the impact of surprises and the corresponding state of foreign economies are not explicitly considered.

We are not only interested in the impact of the surprises on s_t and f_t, but on fp_t as well. Therefore, we estimate the following m-order autoregression:

$$fp_t = \alpha_1 + \sum_{i=1}^{m} \beta_i fp_{t-i} + \sum_{j=1}^{23} \gamma_j A_{j,t} + \varepsilon_t, \tag{6}$$

where the value of m is sufficiently large to reduce ε_t to white noise, and is selected by the minimization of the AIC. Eq. (6) is estimated separately using the data from each of the five forward premia series, as well as by using a panel data set containing all of the forward premia observations. Again, White's heteroskedasticity-consistent covariances are used to compute the standard errors of the parameter estimates in Eq. (6).

6. Results and comments

6.1. Unit root and cointegration test results

Table 2 presents the results of the ADF and PP unit root tests. Consistent with the existing literature, the results confirm that both spot and forward exchange rates are nonstationary in their level representation. However, they achieve stationarity upon first-differencing. Therefore, there is strong evidence that exchange rates are integrated of order one, $I(1)$. Furthermore, our results indicate that all of the announcement variables are stationary in their levels, $I(0)$.

Table 3 reports the cointegration results. The findings suggest a maximum of one cointegrating vector between the forward and spot rates for each of the five currencies versus the U.S. dollar. In other words, consistent with previous research, forward and spot exchanges share a long-run equilibrium relationship with each other.

6.2. Short-run dynamics of exchange rates

Table 4 shows the results of the VECM as seen in Eqs. (4) and (5). Whereas, Panel A reveals the estimation results of the spot exchange rate equation, Panel B pertains to the estimation results of the forward exchange rate equation. Reported in both panels are the F-statistics from conducting Wald tests of the joint hypotheses that the coefficients on the lagged differences in the spot and in the forward rates are zero. The test statistics indicate that, in terms of the short-run dynamics, previous changes in spot rates and forward rates play a significant role in determining the current spot and forward rates.

Comparing the pooled estimation results in Panel A and Panel B, it is observed that in the equation for Δs_t (see Panel A), the coefficient on the cointegrating equation, z_{t-1}, is not shown to be significantly different from zero. However, in the corresponding equation for Δf_t (see Panel B), the coefficient on the cointegrating equation is significantly different from zero. This indicates that while the spot rate

Table 2
Unit root tests

	Intercept		Intercept and trend	
	ADF	PP	ADF	PP
Levels				
Spot British pound	−1.21	−2.24	−1.62	−2.62
Spot Canadian dollar	−0.33	−1.19	−1.81	−1.97
Spot German mark	−0.50	−0.58	−1.31	−1.44
Spot Japanese yen	−1.29	−1.57	−1.22	−1.72
Spot Swiss franc	−0.95	−1.24	−1.30	−1.59
Forward British pound	−1.95	−2.13	−2.33	−2.63
Forward Canadian dollar	−1.17	−1.11	−2.31	−2.37
Forward German mark	−0.27	−0.39	−1.30	−1.44
Forward Japanese yen	−1.51	−1.72	−1.57	−1.74
Forward Swiss franc	−1.37	−1.52	−1.80	−1.92
Surprises				
Auto Sales	−22.49***	−46.61***	−22.54***	−49.64***
Business Inventories	−23.73***	−52.89***	−23.72***	−52.88***
Capacity Utilization	−23.65***	−52.83***	−23.65***	−52.84***
Construction Spending	−23.47***	−52.57***	−23.47***	−52.56***
Consumer Credit	−23.64***	−52.82***	−23.74***	−52.89***
Consumer Price Index	−23.60***	−52.80***	−23.64***	−52.83***
Durable Goods Orders	−23.19***	−52.88***	−23.20***	−52.88***
Factory Orders	−23.66***	−53.37***	−23.69***	−53.38***
Hourly Earnings	−23.59***	−52.79***	−23.60***	−52.79***
Housing Starts	−23.61***	−52.60***	−23.62***	−52.59***
Industrial Production	−23.62***	−52.58***	−23.73***	−52.65***
Leading Indicators	−23.58***	−52.79***	−23.58***	−52.78***
New Home Sales	−23.59***	−52.71***	−23.63***	−52.74***
Non-farm Payroll	−23.62***	−52.82***	−23.66***	−52.84***
Personal Consumption Expenditures	−23.71***	−52.89***	−23.71***	−52.88***
Personal Income	−23.62***	−52.39***	−23.62***	−52.38***
Producer Price Index	−23.73***	−52.90***	−23.73***	−52.90***
Real GDP	−23.81***	−53.34***	−23.98***	−53.47***
Retail Sales	−23.63***	−52.83***	−23.66***	−52.84***
Trade Balance	−23.59***	−51.73***	−23.60***	−51.73***
Treasury Budget	−23.61***	−52.81***	−23.62***	−52.81***
Unemployment Rate	−23.74***	−52.91***	−23.74***	−52.90***
U.S. NAPM	−23.59***	−52.80***	−23.59***	−52.79***
First differences				
Δ British pound	−18.99***	−46.40***	−18.99***	−46.39***
Δ Canadian dollar	−21.51***	−47.97***	−21.51***	−47.96***
Δ German mark	−20.00***	−47.76***	−20.01***	−47.77***
Δ Japanese yen	−19.77***	−47.73***	−19.77***	−47.72***
Δ Swiss franc	−19.95***	−47.55***	−19.96***	−47.56***
Δ Forward British pound	−21.85***	−53.21***	−21.85***	−53.21***
Δ Forward Canadian dollar	−23.70***	−53.35***	−23.69***	−53.34***
Δ Forward German mark	−23.40***	−54.09***	−23.48***	−54.15***
Δ Forward Japanese yen	−23.63***	−52.31***	−23.63***	−52.30***
Δ Forward Swiss franc	−23.59***	−52.95***	−23.67***	−53.00***

*** Indicates statistical significance at the 0.01 level.

Table 3
Cointegration test results

	H_0: $r = 0$ Trace	H_1: $r \geq 1$ Eigenvalue	H_0: $r \leq 1$ Trace	H_1: $r \geq 2$ Eigenvalue
Canada	87.48***	0.0399	4.7E−6	2.2E−9
Germany	62.55***	0.0292	0.042	1.9E−5
Japan	81.27***	0.0365	1.220	0.0006
Switzerland	67.58***	0.0304	0.773	0.0004
UK	142.4***	0.0625	1.550	0.0007

*** Indicates statistical significance at the 0.01 level.

does not adjust to past errors in the cointegrating relationship between s_t and f_t, the forward rate is influenced by this relationship. In this sense, then, it is the forward rate that adjusts to maintain the cointegrating relationship.

The results of estimating the response of the forward premium via an m-order autoregression representation (see Eq. (6)) are reported in Table 5. Table 5 also reports the F-statistics from a Wald Coefficient test of the joint hypotheses that none of the coefficients on the lagged forward premia is different from zero. The test statistics indicate that the current forward premia exhibits a great deal of autocorrelation, as emphasized by Baillie and Bollerslev (2000).

6.3. The impact of macroeconomic news on spot rates, forward rates, and the forward premium

The impact of macroeconomic surprises on exchange rate movements is made by jointly examining Tables 4 and 5. Some summary observations follow. First, the pooled estimation of the VECM indicates that the surprise in 10 out of the 23 types of macroeconomic announcements significantly influence the daily change in the spot value of the dollar, and 10 of the surprises also influence the change in the forward value of the dollar. Second, for the most part, the significance and direction of the news impact are uniform across the various spot and forward currencies. A closer comparison across the different currencies reveals that the European currencies in general, and the German mark in specific, are more sensitive to U.S. macroeconomic announcements than the responses registered by the Canadian dollar and the Japanese yen. Third, six of the surprises have a sufficiently different impact on spot and forward rates so as to affect the forward premium. It is helpful when interpreting the results presented in this paper to bear in mind that a negative forward premium is equivalent to a forward discount.[6]

[6] In considering what impact the launch of the euro has on these analyses, we address this by asking a broader question: How robust are the results we report to the exclusion of any given exchange rate? To examine this issue we ran the pooled regressions, excluding each one of the five exchange rates in turn. There was very little qualitative difference in the results when any one exchange rate was excluded from the sample. The conclusion we draw from this is that the pooled regressions do a good job of examining how the market values the dollar, in general, given the various surprises.

Table 4
The effect of macroeconomic surprises on spot rates (Panel A) and forward rates (Panel B)

	Pooled	Canada	Germany	Japan	Switzerland	UK
(A) Spot rate vector error correction estimates						
$\sum\Delta$ Spot (*F*-stat)	24.90***	15.52***	16.07***	5.03***	7.88***	7.86***
$\sum\Delta$ Forward (*F*-Stat)	30.04***	22.00***	19.92***	5.68***	8.40***	8.08***
Constant	0.01 (0.12)	0.03 (0.46)	0.03 (0.19)	−0.02 (−0.10)	−0.07 (−0.33)	−0.03 (−0.23)
z_{t-1}	−10.23 (−0.33)	−42.95 (−0.97)	30.77 (0.49)	−12.66 (−0.17)	23.12 (0.34)	−86.01 (−1.03)
Consumer demand						
Auto Sales	−0.50 (−1.86*)	−0.23 (−0.88)	−0.70 (−1.12)	−0.03 (−0.05)	−0.88 (−1.23)	−0.59 (−1.07)
Business Inventories	0.81 (3.34***)	0.37 (1.45)	1.58 (2.45***)	0.10 (0.17)	1.53 (2.38**)	0.63 (1.35)
Capacity Utilization	−1.71 (−4.51***)	−0.23 (−0.78)	−2.25 (−2.88***)	−2.81 (−2.80***)	−1.87 (−1.89*)	−1.35 (−2.01**)
Personal Consumption	−0.16 (−0.56)	0.30 (0.87)	−0.42 (−0.57)	−0.23 (−0.31)	−0.17 (−0.23)	−0.42 (−0.74)
Personal Income	0.81 (2.25**)	0.01 (0.02)	1.35 (1.54)	0.01 (0.02)	1.73 (1.93**)	1.09 (1.17)
Retail Sales	0.79 (2.96***)	0.06 (0.24)	1.07 (1.68*)	0.45 (0.70)	1.03 (1.20)	1.44 (3.29***)
Trade Balance	1.10 (3.52***)	0.76 (2.23**)	1.14 (1.78*)	0.65 (0.60)	1.93 (3.19***)	0.97 (1.66*)
Inflation						
Consumer Price Index	0.58 (2.12**)	0.53 (1.36)	1.19 (1.71*)	−0.27 (−0.44)	1.05 (1.35)	0.54 (1.54)
Hourly Earnings	1.08 (3.02***)	0.09 (0.21)	1.32 (1.50)	0.92 (1.22)	1.53 (1.59)	1.58 (2.02**)
Non-farm Payroll	0.70 (1.97**)	0.17 (0.58)	0.68 (0.73)	1.06 (1.33)	0.90 (0.94)	0.73 (0.94)
Producer Price Index	−0.07 (−0.20)	−0.04 (−0.08)	−0.55 (−0.65)	1.02 (1.31)	−0.44 (−0.41)	−0.42 (−0.60)
Unemployment Rate	0.46 (1.14)	−0.11 (−0.35)	0.47 (0.43)	0.97 (1.23)	0.69 (0.59)	0.46 (0.53)
Interest rates						
Consumer Credit	0.41 (1.00)	−0.50 (−1.81*)	0.53 (0.53)	1.36 (1.21)	0.65 (0.54)	0.08 (0.10)
Treasury Budget	−2.42 (−3.35***)	−0.46 (−0.64)	−3.78 (−2.08**)	−2.14 (−1.25)	−3.62 (−2.08**)	−1.78 (−1.34)
Economic growth						
Construction Spending	−0.01 (−0.02)	0.04 (0.12)	0.22 (0.29)	1.15 (1.40)	−0.63 (−0.81)	−0.78 (−1.14)
Durable Good Orders	0.40 (1.00)	0.26 (0.80)	−0.15 (−0.17)	0.04 (0.04)	0.48 (0.50)	0.82 (0.98)
Factory Orders	0.27 (0.90)	−0.40 (−0.97)	0.55 (0.69)	0.89 (1.31)	0.58 (0.84)	−0.16 (−0.21)
Housing Starts	1.89 (0.45)	2.48 (0.66)	4.35 (0.47)	0.69 (0.06)	−0.27 (−0.03)	4.05 (0.42)
Industrial Production	−0.28 (−0.76)	0.14 (0.49)	−0.57 (−0.63)	−0.62 (−0.55)	−0.04 (−0.05)	−0.12 (−0.18)
Leading Indicators	0.24 (0.66)	−0.06 (−0.18)	0.19 (0.23)	−0.77 (−0.85)	0.69 (0.76)	0.98 (1.24)
New Home Sales	−0.15 (−0.55)	0.06 (0.18)	−0.07 (−0.14)	−1.28 (−1.57)	0.38 (0.51)	0.00 (−0.01)

Producer Price Index	−0.07 (−0.20)	−0.04 (−0.08)	−0.55 (−0.65)	1.02 (1.31)	−0.44 (−0.41)	−0.42 (−0.60)
Real GDP	−0.19 (−0.86)	−0.31 (−0.96)	−0.63 (−1.12)	0.46 (0.72)	−0.46 (−0.92)	−0.09 (−0.24)
U.S. NAPM	0.33 (1.12)	−0.29 (−0.64)	0.47 (0.63)	0.78 (1.20)	0.43 (0.52)	0.51 (0.88)
Adjusted R^2	0.13	0.16	0.13	0.12	0.14	0.15
N	7077	1384	1500	1271	1288	1500
(B) Forward rate vector error correction estimates						
$\sum\Delta$ Spot (F-stat)	1.90**	2.09**	1.75*	1.04	1.37	2.24***
$\sum\Delta$ Forward (F-stat)	1.12	2.19***	1.02	0.95	0.68	2.06**
Constant	−0.01 (−0.14)	0.07 (0.93)	0.04 (0.22)	−0.08 (−0.40)	−0.18 (−0.78)	0.03 (0.21)
z_{t-1}	69.15 (2.11**)	26.93 (0.57)	94.96 (1.44)	93.09 (1.17)	102.01 (1.44)	20.25 (0.23)
Consumer demand						
Auto Sales	−0.58 (−1.94**)	−0.08 (−0.27)	−0.75 (−1.02)	−0.27 (−0.34)	−1.13 (−1.45)	−0.74 (−1.19)
Business Inventories	0.46 (1.71*)	0.62 (2.40**)	1.11 (1.76*)	−0.66 (−0.90)	0.96 (1.53)	0.31 (0.51)
Capacity Utilization	−1.87 (−4.10***)	−0.26 (−0.67)	−2.41 (−2.44***)	−3.23 (−2.54***)	−1.85 (−1.68*)	−1.57 (−1.71*)
Personal Consumption	−0.44 (−1.56)	0.46 (1.32)	−0.86 (−1.20)	−0.77 (−1.10)	−0.67 (−0.96)	−0.61 (−1.06)
Personal Income	0.41 (1.09)	0.06 (0.19)	1.02 (1.16)	−0.32 (−0.42)	1.14 (1.19)	0.31 (0.32)
Retail Sales	0.66 (2.45***)	0.01 (0.04)	0.68 (1.04)	0.60 (0.87)	0.74 (0.84)	1.47 (3.29***)
Trade Balance	0.86 (2.21**)	1.08 (2.93***)	1.10 (1.61)	−0.21 (−0.14)	1.30 (1.96**)	1.07 (1.54)
Inflation						
Consumer Price Index	0.54 (1.72*)	0.91 (1.98**)	1.42 (2.10**)	−0.82 (−0.98)	0.88 (1.18)	0.42 (0.91)
Hourly Earnings	1.35 (3.44***)	0.59 (0.95)	1.71 (1.74*)	1.13 (1.35)	1.99 (1.94**)	1.38 (1.68*)
Non-farm Payroll	1.12 (2.96***)	0.55 (1.44)	1.39 (1.39)	1.47 (1.76*)	1.43 (1.44)	0.85 (0.99)
Producer Price Index	−0.17 (−0.44)	0.08 (0.16)	−0.71 (−0.70)	1.00 (1.35)	−0.33 (−0.31)	−0.92 (−1.11)
Unemployment Rate	0.51 (1.16)	−0.07 (−0.15)	0.64 (0.54)	0.96 (1.09)	0.90 (0.73)	0.34 (0.35)
Interest rates						
Consumer Credit	0.66 (1.37)	−0.35 (−1.02)	0.97 (0.84)	1.37 (1.09)	1.09 (0.72)	0.21 (0.23)
Treasury Budget	−3.03 (−3.85***)	−0.11 (−0.14)	−4.56 (−2.54***)	−3.12 (−1.70*)	−4.60 (−2.25**)	−2.43 (−1.67*)
Economic growth						
Construction Spending	−0.05 (−0.17)	−0.19 (−0.49)	0.12 (0.17)	1.03 (1.22)	−0.81 (−1.08)	−0.38 (−0.54)
Durable Good Orders	0.09 (0.21)	0.02 (0.07)	−0.32 (−0.30)	−0.13 (−0.12)	0.19 (0.16)	0.37 (0.43)
Factory Orders	0.24 (0.76)	−0.41 (−0.85)	0.44 (0.55)	0.73 (1.01)	0.61 (0.83)	−0.02 (−0.02)

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Table 4 (*continued*)

	Pooled	Canada	Germany	Japan	Switzerland	UK
Housing Starts	2.59 (0.55)	−5.71 (−1.04)	6.44 (0.67)	7.35 (0.48)	3.92 (0.40)	1.98 (0.21)
Industrial Production	0.14 (0.34)	0.14 (0.38)	0.03 (0.03)	−0.35 (−0.31)	0.36 (0.37)	0.48 (0.60)
Leading Indicators	0.30 (0.85)	−0.15 (−0.51)	0.23 (0.28)	−0.28 (−0.32)	0.63 (0.71)	0.91 (0.97)
New Home Sales	0.26 (1.03)	0.32 (1.05)	0.43 (0.80)	−0.90 (−1.27)	1.00 (1.57)	0.38 (0.61)
Real GDP	−0.27 (−0.95)	−0.46 (−1.17)	−0.68 (−0.92)	0.29 (0.36)	−0.49 (−0.73)	−0.09 (−0.23)
U.S. NAPM	0.53 (1.65*)	−0.47 (−1.14)	0.68 (0.79)	0.83 (1.22)	0.83 (0.96)	0.97 (1.46)
Adjusted R^2	0.02	0.02	0.02	−0.001	0.01	0.02
N	7399	1384	1500	1271	1288	1500

The parameters are estimated using a vector error correction model as specified in equations (4) and (5).
This table reports the section of results from the VECMs with the spot rate (A) and forward rate (B) as the dependent variables. The individual country results are reported for completeness. All coefficients have been multiplied by 1000. *t*-Statistics are in parentheses.
*, **, *** Indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5
The impact of macroeconomic surprises on the forward premium

	Pooled	Canada	Germany	Japan	Switzerland	UK
$\sum$ Lagged FP (*F*-stat)	158.87***	117.74***	76.10***	49.51***	66.96***	61.33***
Constant	−0.04 (−0.98)	−0.04 (−0.78)	−0.02 (−0.15)	−0.19 (−1.25)	−0.12 (−0.96)	0.12 (1.27)
Consumer demand						
Auto Sales	−0.11 (−0.68)	0.18 (1.17)	−0.09 (−0.21)	−0.62 (−1.37)	−0.05 (−0.13)	−0.11 (−0.34)
Business Inventories	−0.08 (−0.44)	0.43 (2.12**)	−0.29 (−0.93)	−0.38 (−0.76)	0.02 (0.06)	−0.20 (−0.46)
Capacity Utilization	0.01 (0.11)	−0.05 (−0.29)	0.17 (0.51)	−0.28 (−0.85)	0.08 (0.29)	0.30 (0.80)
Personal Consumption	−0.71 (−3.28***)	0.39 (1.81*)	−1.27 (−2.26**)	−1.17 (−2.67***)	−0.99 (−2.13**)	−0.57 (−1.17)
Personal Income	−0.41 (−1.97**)	0.17 (0.41)	−0.41 (−0.94)	−0.49 (−0.84)	−0.44 (−0.99)	−0.84 (−1.89*)
Retail Sales	−0.30 (−1.56)	0.05 (0.41)	−0.96 (−1.86*)	−0.34 (−0.74)	−0.33 (−0.56)	0.14 (0.38)
Trade Balance	−0.13 (−0.52)	0.33 (1.12)	−0.06 (−0.20)	−1.12 (−1.15)	−0.22 (−0.45)	0.43 (1.31)
Inflation						
Consumer Price Index	−0.07 (−0.32)	0.14 (1.03)	0.36 (0.82)	−0.42 (−0.70)	−0.39 (−0.76)	−0.12 (−0.33)
Hourly Earnings	0.14 (0.72)	0.62 (2.17**)	−0.03 (−0.07)	−0.07 (−0.14)	0.21 (0.38)	−0.25 (−0.67)
Non-farm Payroll	0.84 (4.16***)	0.87 (3.15***)	0.97 (2.60***)	0.66 (1.38)	1.26 (2.00**)	0.33 (0.83)
Producer Price Index	−0.09 (−0.43)	0.00 (0.01)	0.10 (0.25)	−0.16 (−0.39)	0.06 (0.11)	−0.56 (−1.02)
Unemployment Rate	0.25 (1.49)	0.29 (1.06)	0.14 (0.45)	0.17 (0.39)	0.76 (1.60)	−0.01 (−0.02)
Interest rates						
Consumer Credit	0.76 (2.82***)	0.39 (1.05)	1.03 (1.74*)	0.38 (0.65)	1.51 (1.81*)	0.40 (0.88)
Treasury Budget	−0.63 (−1.60)	0.09 (0.27)	−0.80 (−0.76)	−0.72 (−1.55)	−0.92 (−0.66)	−0.78 (−1.26)
Economic growth						
Construction Spending	−0.41 (−2.58***)	−0.24 (−0.83)	−0.54 (−1.55)	−0.38 (−1.35)	−0.81 (−1.71*)	−0.13 (−0.45)
Durable Good Orders	−0.30 (−2.52***)	−0.07 (−0.57)	−0.44 (−1.17)	−0.18 (−0.79)	−0.55 (−1.58)	−0.25 (−0.98)
Factory Orders	−0.03 (−0.10)	0.54 (1.08)	0.10 (0.13)	−0.44 (−0.87)	−0.06 (−0.09)	0.13 (0.27)
Housing Starts	3.29 (1.00)	−8.82 (−2.72***)	8.30 (1.37)	9.49 (1.12)	7.92 (0.95)	−1.40 (−0.25)
Industrial Production	0.85 (2.95***)	0.29 (0.84)	0.89 (1.35)	0.73 (1.87*)	1.32 (1.71*)	1.15 (1.36)
Leading Indicators	−0.33 (−1.48)	−0.15 (−0.88)	−0.31 (−0.41)	0.30 (0.79)	−0.81 (−1.35)	−0.62 (−1.35)
New Home Sales	−0.04 (−0.20)	0.13 (0.55)	0.21 (0.42)	−0.17 (−0.42)	−0.13 (−0.29)	−0.34 (−0.71)

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Table 5 (*continued*)

	Pooled	Canada	Germany	Japan	Switzerland	UK
Real GDP	−0.11 (−0.92)	−0.17 (−0.70)	−0.37 (−1.26)	−0.07 (−0.25)	−0.17 (−0.67)	0.17 (0.76)
U.S. NAPM	0.14 (0.88)	−0.21 (−1.33)	0.07 (0.17)	0.01 (0.02)	0.01 (0.02)	0.10 (0.29)
Adjusted R^2	0.54	0.51	0.48	0.35	0.42	0.40
N	3842	1384	1231	1271	1288	1297

The parameters are estimated using a m-order regression as found in equation (6).
This table reports the section of results from the m-order autoregression with the forward premium as the dependent variable. The individual country results are reported for completeness. All coefficients have been multiplied by 1000. t-Statistics are in parentheses.
*, **, *** Indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

For the sake of brevity and clarity, in the discussion that follows, we refer only to the pooled estimation results in Tables 4 and 5. The country results are provided in the table for comparative purposes.

6.3.1. Domestic consumer demand

Several of the announcements relate information relevant to the expected level of domestic consumer demand, and by extension to the expected change in net exports. In general, an increase in expected domestic consumer demand is associated with deterioration in net exports. Increased consumer demand increases consumption of domestic goods, leaving fewer goods to export, while at the same time increasing demand for imported goods.

Auto Sales, Business Inventories, Capacity Utilization, and the Trade Balance all appear to behave in a fashion consistent with the LOEM. A negative surprise in auto sales or in Capacity Utilization, or a positive surprise in business inventories or in the trade balance each cause an upward revision of the spot exchange rate. This is consistent with the idea that such surprises are indicative of an expected improvement in net exports. Similar results have been found by Irwin (1989) who documents a strong association between U.S. trade balance announcements and exchange rate movements for the period after mid-1984.

Furthermore, as postulated by the CIP hypothesis, in a situation where the difference between domestic and foreign interest rates are unaffected by the macroeconomic announcements, the forward rate moves in tandem with the spot rate. In other words, the above macroeconomic variables do not have a significant impact on the forward premium (see Table 5).

6.3.2. Domestic inflation

At first glance, our results do not appear to support the PPP hypothesis. Specifically, results indicate that a surprise increase in inflation, as seen by CPI, Hourly Earnings, and Non-farm Payroll announcements, actually serve to increase, rather than decrease, the spot and forward exchange rates.

When considering the results with regard to inflationary surprises, three points should be kept in mind. First, in a low inflationary environment, such as in the 1990s, higher than expected monetary growth or inflation may lead people to expect a monetary deceleration, and hence no PPP-type effects on the exchange rate.[7] Second, there is a great deal of academic research which seems to support the hypothesis that purchasing power parity is a long-run rather than a short-run phenomenon (see, for example, Frankel, 1986; Abuaf and Jorion, 1990; Flood and Taylor, 1995). Third, relative PPP is posited in terms of *relative* inflation levels, but our analysis considers only domestic macroeconomic announcements. Thus, an increase in domestic inflation will not lower exchange rates if foreign inflation is expected to increase at a greater pace.

[7] We thank the editor for this suggestion.

Our results suggest that the observed effects of inflationary announcements on exchange rates may be better explained in light of the Fisher and LOEM propositions. The explanation is twofold. At one level, consistent with a hypothesized Fisher effect, an increase in expected domestic inflation should raise nominal domestic interest rates. At the second level, the Portfolio Balance approach to capital flows in an LOEM postulates that, given imperfect substitutability between domestic and foreign assets, investors would rebalance their portfolio holdings. Specifically, in response to an increase in nominal interest rates, investors would shift out of foreign assets and into domestic assets. Such a shift would increase demand for the domestic currency. At the same time, this movement would reduce investment capital abroad, thereby raising foreign interest rates. It is evident that our results are in harmony with this conjecture. A surprise in CPI, Hourly Earnings, and Non-farm Payrolls all increase both spot and forward rates.

6.3.3. Domestic interest rates

In addition to the inflation related announcements, one other announcement that relates to domestic interest rates appears to have a significant impact on the spot and forward rates. As predicted, an increase in the Treasury Budget, which would indicate decreasing interest rates, lowers spot rates. According to the PB framework, this would lead to a capital outflow, a depreciation of the currencies, and a subsequent decline in foreign interest rates. Thus, there is no change in international interest rate differentials and the forward rate declines in tandem with the spot.

6.3.4. Economic growth

None of the announcements that were hypothesized to be primarily related to economic growth have a significant influence on exchange rates. However, indirect support for the relevance of economic growth can be made by examining news pertaining to consumer demand.

Specifically, Personal Income and Retail Sales could be related to either consumer demand or to economic growth. If their relation to consumer demand dominates, they would have negative relationships to the spot rate (via the trade effect relationship). If, however, their relationship to economic growth dominates, they would have positive relationships to spot rates (via the capital flow effect relationship). Consistent with the latter (capital flow) argument, both Personal Income and Retail Sales have significant, positive relationships with spot rates (see Panel A of Table 4).

6.3.5. Other news items that impact the forward premium

According to the CIP hypothesis, announcements that affect the forward premium must necessarily be acting through the market for loanable funds, as a change in the forward premium is a reflection of a change in domestic interest rates relative to foreign interest rates. Results in Table 5 seem to confirm this hypothesis.

First, positive surprises in Durable Goods Orders, Personal Consumption Expenditures, Personal Income, and Construction Spending all decrease the forward premium. Each of these announcements contains information related to the financing of purchases, and hence to the demand for loanable funds. An increase in the

demand for loans leads to a rising interest rate in the U.S. When an increase in domestic interest rates does not induce a foreign capital inflow, foreign interest rates are left unaffected, and the result is a decline in the differential between foreign and domestic interest rates. Since the forward premium, as per CIP, is a reflection of this interest rate differential, it also declines.

Second, results indicate that the forward premium increases in response to a surprise increase in Consumer Credit and Industrial Production. The economic justification behind this relationship is that a surprise increase in Consumer Credit reflects an increase in the supply of loanable funds, and hence a decline in domestic interest rates. Such a decline in domestic rates, ceteris paribus, widens the interest rate differential, and, correspondingly increases the forward premium.

Finally, we observe that of the three inflationary announcements, the surprise in Non-farm Payrolls appears to be the only one that causes an asymmetric increase in domestic and foreign interest rates. That is, to a given surprise in non-farm payroll numbers, not only do both spot and forward rates rise, but there is an increase in the forward premium as well.

6.3.6. Relative impact of announcements

The coefficients on the announcements reported in Tables 4 and 5 are standardized so that they may be interpreted as the effect on the dependent variables, given a one standard deviation increase in the surprise variable. This allows us to compare the relative impact of the announcements on exchange rates, and on the forward premium, across different announcement types.

Looking at the pooled results, among the significant macroeconomic variables, the Treasury Budget appears to have the largest relative impact on the spot and forward rates, where the coefficients are -2.42 and -3.03, respectively. This is followed by announcements on Capacity Utilization and the Trade Balance. The remaining announcements that have a significant impact on exchange rates have coefficients that range between $|0.46|$ and $|0.81|$.

In contrast to the previous results, no one announcement stands out as having a large relative influence on the forward premium. The significant coefficients reported in Table 5, for the pooled estimation, have values that range from $|0.41|$ to $|0.85|$.

7. Concluding remarks

The issue of the links between macroeconomic fundamentals and exchange rates is a perennial source of concern and investigation, more so with the advent of the flexible exchange rate system. The purpose of this paper is to test the probity of several related theories of exchange rate determination by analyzing the impact of macroeconomic surprises on the spot and forward exchange rates, and on the forward premium. The surprise component is constructed by using consensus estimates of 23 types of periodic macroeconomic announcements along with the actual value of the fundamentals. The empirical investigation is undertaken in a theory-consistent manner that controls for the long-run equilibrium relationship between the spot and forward exchange rates. The focal point of our analyses is the estimation of a pooled

vector error correction model that, exogenously, introduces a vector of macroeconomic surprises. The pooled estimation results demonstrate how market participants process new information about macroeconomic fundamentals in influencing the overall value of the U.S. dollar vis-à-vis foreign currencies.

Several important results are documented. First, as far as the linkages between forward and spot exchange rates are concerned, we find them to share a mutually reinforcing long-run equilibrium relationship with each other. An examination of the short-run dynamics indicates significant feedback relationships between the spot and forward currencies. Importantly, it is the forward rate that accommodates shocks in spot rates in order to maintain the cointegrating relationship.

Second, the study sheds light on several competing theories of exchange rate determination. Consistent with the Mundell–Fleming balance-of-payment framework, announcements that convey an unexpected decline in consumer demand increase both the spot and forward exchange rates. In support of this argument, for instance, we find that a surprise improvement in the trade balance, which is indicative of a decline in consumer demand, is positively related to the U.S. dollar exchange rate.

Contrary to the PPP hypothesis, inflation related news items such as CPI and Hourly Earnings are found to increase the value of domestic currency. A plausible explanation for the rejection of the PPP is that the countervailing short-term capital flow movements that take place within a portfolio balance context dominate the supply and demand adjustments in the currency market.

We also study the behavior of forward premiums in response to macroeconomic surprises and find them to be in accordance with the CIP hypothesis. Macroeconomic announcements such as an increase in Durable Goods Orders and Personal Consumption place an upward pressure on domestic interest rates that in turn results in the decline of the forward premium.

Finally, the study reports the relative importance of several types of macroeconomic surprises on spot and forward exchange rates. Spot and forward rates, themselves, register far more reactions to announcements that convey information about consumer demand, inflation, and interest rates, and almost no reaction to news about the overall strength of the economy, while the forward premium reacts to announcements in all four classifications. Among the individual announcement types, announcements conveying information on the Treasury Budget, Trade Balance and Capacity Utilization elicit the greatest attention in the exchange rate market.

Several extensions to this work are worth considering. For instance, it would be useful to account for the surprise component in foreign economies in order to gain greater insight into the issue of exchange rate determination. It will also be interesting to examine how sensitive our results are to the time period under investigation. These topics are left for future exploration.

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