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Economic News, Exchange Rates and Interest Rates

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The paper examines the post-October 1979 response of exchange rates and interest rates to the new information contained in the first announcement of fifteen US macroeconomic series. Markets respond primarily to monetary news, but also to news about the trade deficit, domestic inflation, and variables that reflect the state of the business cycle. For all fifteen macroeconomic variables, an increase (decrease) in interest rates is accompanied by an appreciation (depreciation) of the dollar, which is consistent with models that stress price rigidity and absence of purchasing power parity.

The effect of economic news on asset prices has received increasing attention in the economic literature because an outcome of the efficient markets/rational expectations hypothesis is that flexible asset prices change the moment new information about future fundamentals arrives in the market. In the exchange rate literature, the role of news has gained importance because structural models have failed to predict most of the variation in exchange rates during the 1970s (see Meese and Rogoff, 1983). Researchers were naturally led to investigate the types of news that make exchange rates so volatile, and to utilize news in order to test which model of exchange rate determination is consistent with the floating exchange rate experience. Notable studies are those of Dornbusch (1980), Frenkel (1981), Edwards (1982a,b, 1983), Copeland (1984), and Rose (1984).

In this paper, I also examine the effects of macroeconomic news on exchange rates, but I adopt a different, more direct strategy, one that complements previous work, avoids some of its shortcomings, and promises interesting conclusions. I examine the instantaneous response of exchange rates the moment a piece of economic news hits the market. If one can isolate the exact time during a business day when news arrives, it is straightforward to examine the response of exchange rates because financial data are continuously available. The advantages of the present methodology are many: first, it is possible to identify the exact types of economic news and how they affect exchange rates; second, the simultaneity bias, which plagues the previous literature on exchange rates and news, is not present here. The independent variables that represent news can be interpreted as causal

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variables because they are predetermined. There is a precise analogy to input and output variables of a controlled experiment. Third, it is possible to examine the simultaneous reaction of prices in other asset markets and, from the direction of the various reactions, gain a better understanding of how markets interpret the information they receive, and which exchange rate model they perceive as the correct one. Thus, in addition to exchange rates, I study the reaction of short- and long-term interest rates.

I examine the exchange rate and interest rate responses to news contained in the first announcements of a wide variety of US macroeconomic series: four monetary series (M1, bank reserves, and the Fed discount and surcharge rates), two inflation series (the consumer and producer price indices), the trade deficit, and eight other monthly macroeconomic series which provide information about the state of the business cycle and are closely watched by economic forecasters (the unemployment rate, the industrial production index, personal income, orders of durable goods, the index of leading indicators, retail sales, consumer credit, and housing starts). Some of the above macroeconomic series have been partly analyzed by previous authors.[1] But most of the empirical evidence presented here is new. In addition, the estimation of the market responses is done simultaneously for all fifteen independent variables. This provides a unified framework and avoids possible bias when two or more announcements occur within the same time interval.

The rest of the paper is organized as follows: Section I contains a discussion on the model underlying the estimation results, and an exposition of the different hypotheses. Section II presents the empirical evidence. Section III summarizes the main conclusions. An appendix contains a detailed description of the data.

I. Market Responses to Economic News

The equation which I estimate has the following form:

$$\langle 1 \rangle \qquad DP_t = a_0 + \sum_{i=1}^{15} a_i x_{it}^{u} + v_t ,$$

where DP_t represents the percentage change in a foreign currency price or the change in an interest rate in business day t; x_{it}^{u} is the unanticipated component of economic series x_i announced at t; and v_t is a random error term uncorrelated with information prior to the announcement at t. Each vector x_i^{u} contains zeros for the business days the series x_i is not announced. I estimate equation $\langle 1 \rangle$ separately for each bilateral currency and each interest rate using ordinary least squares. Although the daily changes of the different exchange rates and interest rates are correlated, the OLS estimates are as efficient as the estimates from a seemingly unrelated regressions procedure because the set of independent variables is identical in every equation. The OLS estimates are also unbiased. There is no *a priori* reason why the excluded information contained in the error term v_t, which is composed of other types of daily news that hit the market, may be correlated with the predetermined right-hand-side variables.

My discussion will focus on the interpretation of the estimated parameters a_i. Equation $\langle 1 \rangle$ is a reduced form equation and, therefore, the sign and size of the estimated a_is depend on many underlying factors, such as the policy rules of the monetary and fiscal authorities and the autocorrelation properties of the

macroeconomic series. Note also that the surprise about a variable, x^*, reflects, by definition, a surprise about both its demand and its supply side; and typically, it is the relative persistence of shocks to demand versus shocks to supply which determines the algebraic sign of the market reactions.[2]

My aim will be to identify the 'model' or economic story which market participants have in mind when they respond to the announcement of a macroeconomic variable. This may not be always possible, given the plethora of plausible scenarios. However, it is possible to discriminate between two sets of interesting hypotheses. The first set of hypotheses is consistent with models that assume price stickiness and absence of purchasing power parity and explain the reactions of exchange rates and interest rates as a result of a change in the expected future risk-free real rate of interest. An appreciation (depreciation) of the dollar concurs with an increase (decrease) in nominal interest rates. The second set of hypotheses is consistent with models that assume price flexibility and purchasing power parity and explains the reactions of exchange rates and interest rates as a result of a change in the expected future rate of inflation. An appreciation (depreciation) of the dollar concurs with a decrease (increase) in nominal interest rates.

II. Empirical Evidence

I will first make some general remarks on the empirical evidence of Tables 1, 2, and 3, and then analyze the market responses to each announced series separately. The independent variables in the regressions are the unanticipated components of the announced series and were constructed using survey forecasts. The unemployment rate (UN), consumer credit (CC), housing starts (HS), the trade deficit (TD), and the discount and surcharge rates (DISC, SUR) represent changes in levels; all other independent variables represent percentage changes. Table 1 presents the results for the federal funds rate, the three-month Treasury bill rate and the twenty-year Treasury bond rate. Table 2 presents the results for seven major currencies. The results for an additional ten currencies are reported in Hardouvelis (1985a).

My sample period runs from October 11, 1979 through August 16, 1984 and Table 3 presents tests of structural change by partitioning the sample into two subperiods with the break point occurring on October 15, 1982.[3] During the period October 1979 to October 1982 the Fed followed strict M1 targets and allowed wide fluctuations in interest rates. After October 1982, it began paying more attention to interest-rate smoothening and abandoned non-borrowed reserves as its intermediate target. We, therefore, have reason to suspect structural instability, especially with regard to monetary announcements, and more precisely, announcements about bank reserves which are more closely related to the Fed's intermediate targets. The hypothesis of parameter stability is consistently rejected in the case of bank reserves, RES. A joint test for all variables rejects the hypothesis only in the case of the three-month Treasury bill rate. Because there is apparent instability in the Treasury bill responses, in Table 1 I present the interest rate results for both the whole sample period and each subperiod separately. Notice also that interest rates (but not exchange rates) show considerable heteroskedasticity across the two subperiods. Thus the interest rate results for the entire sample come from a weighted least squares regression with weights equal to the standard error of estimate of each subperiod.

TABLE 1. Interest rate responses to economic news.

	October 1979 to August 1984			October 1979 to October 1982			October 1982 to August 1984		
	F-funds	*T*-bill	*T*-bond	*F*-funds	*T*-bill	*T*-bond	*F*-funds	*T*-bill	*T*-bond
C	0.001	0.004	0.004	−0.007	−0.005	0.002	0.004	0.005	0.004
	(0.014)	(0.004)	(0.003)	(0.030)	(0.012)	(0.006)	(0.016)	(0.004)	(0.004)
M1	0.197*	0.181*	0.101*	0.275*	0.221*	0.096*	0.069	0.155*	0.119*
	(0.072)	(0.023)	(0.015)	(0.101)	(0.039)	(0.019)	(0.105)	(0.029)	(0.025)
RES	−0.020	−0.031*	−0.011	−0.104	−0.114*	−0.024	0.041	−0.001	0.006
	(0.047)	(0.015)	(0.011)	(0.077)	(0.030)	(0.014)	(0.061)	(0.017)	(0.015)
DISC	0.113	0.244*	0.061	0.221	0.371*	0.103*	−0.259	0.087	−0.053
	(0.212)	(0.073)	(0.042)	(0.256)	(0.099)	(0.048)	(0.390)	(0.107)	(0.093)
SUR	0.411*	0.129*	0.023	0.390*	0.107	0.017	–	–	–
	(0.152)	(0.059)	(0.029)	(0.154)	(0.059)	(0.029)			
CPI	0.233	0.139	0.178*	−0.500	0.093	0.173	0.676	0.137	0.285*
	(0.359)	(0.115)	(0.075)	(0.545)	(0.211)	(0.102)	(0.521)	(0.143)	(0.124)
PPI	0.152	0.089	0.159*	0.200	0.255	0.262*	0.159	0.069	0.118*
	(0.187)	(0.055)	(0.042)	(0.431)	(0.167)	(0.080)	(0.209)	(0.167)	(0.050)
UN	−0.184	−0.272*	−0.156*	−0.221	−0.586*	−0.097	−0.170	−0.211*	−0.183*
	(0.306)	(0.091)	(0.068)	(0.601)	(0.233)	(0.112)	(0.355)	(0.098)	(0.085)
IP	0.168	0.028	0.017	0.201	0.039	0.054	0.151	0.023	−0.021
	(0.108)	(0.033)	(0.023)	(0.176)	(0.068)	(0.033)	(0.136)	(0.037)	(0.032)
PI	0.353	−0.009	−0.102*	0.364	−0.220	−0.177*	0.284	0.083	0.030
	(0.211)	(0.068)	(0.044)	(0.304)	(0.118)	(0.057)	(0.300)	(0.082)	(0.072)
DG	0.016	0.014	0.006	0.056	0.022	−0.003	0.019	0.013	0.013*
	(0.020)	(0.006)	(0.004)	(0.034)	(0.015)	(0.007)	(0.025)	(0.007)	(0.006)
LI	0.007	−0.000	0.002	−0.147	−0.097	0.003	0.015	0.002	0.001
	(0.039)	(0.011)	(0.009)	(0.153)	(0.059)	(0.029)	(0.040)	(0.011)	(0.010)
RS	−0.081	0.031*	0.026*	−0.139	0.058	0.020	−0.062	0.028*	0.028*
	(0.045)	(0.013)	(0.010)	(0.097)	(0.038)	(0.018)	(0.051)	(0.014)	(0.012)
CC	0.014	0.001	0.003	−0.094	−0.010	−0.015	0.021	−0.000	0.005
	(0.039)	(0.011)	(0.009)	(0.133)	(0.051)	(0.025)	(0.041)	(0.011)	(0.010)
HS	−0.697	0.037	0.006	−0.333	1.04*	0.108	−0.741	−0.006	0.001
	(0.385)	(0.110)	(0.090)	(1.22)	(0.471)	(0.227)	(0.407)	(0.112)	(0.010)
TD	0.008	−0.014	−0.006	−0.101	−0.092*	−0.020	0.043	−0.002	0.002
	(0.042)	(0.012)	(0.009)	(0.083)	(0.032)	(0.015)	(0.048)	(0.013)	(0.012)
$\bar{R}2$	0.015	0.076	0.056	0.026	0.112	0.058	−0.004	0.062	0.065
SEE	1.00	1.00	1.00	0.819	0.317	0.153	0.337	0.093	0.080
D-W	2.23	1.99	2.07	2.22	2.02	2.09	2.36	2.12	1.91
H1	4.11*	22.24*	13.07*	4.99*	20.72*	10.31*	0.44	9.79*	7.68*
H2	0.54	2.05	9.94*	0.53	1.26	6.74*	1.31	1.17	5.42*
H3	1.64	2.60*	2.47*	1.04	2.73*	1.85	1.04	1.71	1.96*
H4	2.19*	7.61*	5.81*	2.32*	7.30*	4.11*	0.86	3.18*	3.28*

Notes:

(a) Standard errors are inside the parentheses. Asterisk denotes statistical significance at the 95 per cent level. $\bar{R}2$ is the coefficient of determination adjusted for degrees of freedom. SEE is the regression standard error. D-W is the Durbin-Watson statistic.

(b) H1 is $F(4, n)$ and refers to M1, RES, DISC, and SUR; H2 is $F(2, n)$ and refers to CPI and PPI; H3 is $F(8, n)$ and refers to UN, IP, PI, DG, LI, RS, CC, and HS; H4 is $F(15, n)$ and refers to all the variables except the constant term, C; $n = 738, 446, 1199$ for the first subperiod, the second subperiod, and the entire sample period respectively.

(c) The independent variables are the unanticipated components of the weekly percentage change in M1, the weekly percentage change in non-borrowed reserves (RES); the monthly percentage change in the CPI, PPI, industrial production index (IP), personal income (PI), orders of durable goods (DG), index of leading indicators (LI), and retail sales (RS); the monthly level in the unemployment rate (UN), housing starts in millions of units (HS), and trade deficit in billions of dollars (TD); the monthly change in consumer installment credit in billions of dollars (CC); and the actual prospective changes in the Fed discount rate and surcharge rate (DISC, SUR).

(d) Interest rates are one business day changes in yields to maturity. A coefficient of, say, 0.199 denotes an increase of twenty basis points.

The explanatory power of the fifteen variables is low, varying from an $\bar{R}^2$ of 0.006 for the Canadian dollar to an $\bar{R}^2$ of 0.076 for the three-month Treasury bill. This is not surprising. The dependent variables are not levels but changes in the levels. Within a given business day a variety of news hits the market and our fifteen series represent a very small subset of such news. Furthermore, there are many days during which none of the variables that we examine is announced. Notice that the Durbin–Watson statistic is close to 2.0 for most markets indicating no apparent

TABLE 2. Exchange rate responses to economic news.

	October 1979 to August 1984						
	German mark	Japanese yen	Swiss franc	British pound	French franc	Canadian dollar	Italian lira
Constant	−0.038*	−0.005	−0.033	−0.039*	−0.064*	−0.009	−0.062*
	(0.019)	(0.020)	(0.022)	(0.018)	(0.020)	(0.008)	(0.017)
M1	−0.244*	−0.227*	−0.224*	−0.178*	−0.197*	−0.370	−0.203*
	(0.073)	(0.076)	(0.083)	(0.071)	(0.077)	(0.325)	(0.067)
RES	0.173*	0.179*	0.174*	0.132*	0.250*	0.054*	0.129*
	(0.054)	(0.056)	(0.061)	(0.053)	(0.057)	(0.024)	(0.050)
DISC	−0.379	−0.119	−0.340	−0.131	−0.404*	−0.028	−0.435*
	(0.196)	(0.203)	(0.223)	(0.191)	(0.205)	(0.087)	(0.180)
SUR	−0.279*	−0.006	−0.245	−0.080	−0.254*	−0.114*	−0.317*
	(0.122)	(0.126)	(0.138)	(0.119)	(0.128)	(0.054)	(0.112)
CPI	−0.013)	−0.766	0.314	0.210	−0.167	−0.005	0.050
	(0.383)	(0.398)	(0.435)	(0.374)	(0.402)	(0.170)	(0.353)
PPI	−0.044	0.038	−0.105	0.136	−0.045	0.021	0.041
	(0.259)	(0.269)	(0.295)	(0.253)	(0.272)	(0.115)	(0.239)
UN	0.528	−0.028	0.932*	0.794*	0.652	0.137	0.375
	(0.392)	(0.407)	(0.445)	(0.382)	(0.411)	(0.174)	(0.361)
IP	−0.108	0.113	−0.060	−0.108	−0.124	−0.031	−0.123
	(0.123)	(0.128)	(0.140)	(0.120)	(0.130)	(0.055)	(0.114)
PI	0.306	0.028	0.174	0.186	0.415	0.080	0.452*
	(0.220)	(0.229)	(0.251)	(0.215)	(0.232)	(0.098)	(0.203)
DG	−0.063*	−0.077*	−0.085*	−0.034	−0.062*	−0.011	−0.063*
	(0.025)	(0.026)	(0.028)	(0.024)	(0.026)	(0.011)	(0.023)
LI	0.017	0.047	0.057	0.043	0.034	−0.008	0.002
	(0.066)	(0.068)	(0.075)	(0.064)	(0.069)	(0.029)	(0.060)
RS	−0.185*	−0.089	−0.193*	−0.152*	−0.172*	−0.047	−0.139*
	(0.060)	(0.063)	(0.067)	(0.059)	(0.063)	(0.027)	(0.056)
CC	0.053	−0.064	0.037	0.021	0.075	−0.015	0.055
	(0.063)	(0.066)	(0.072)	(0.062)	(0.067)	(0.028)	(0.059)
HS	−0.811	−0.528	0.158	−0.305	−0.794	−0.042	−0.683
	(0.609)	(0.632)	(0.692)	(0.595)	(0.640)	(0.270)	(0.562)
TD	0.076	0.087	0.112	0.076	0.062	0.017	0.083
	(0.054)	(0.056)	(0.061)	(0.053)	(0.057)	(0.024)	(0.050)
$\bar{R}2$	0.039	0.023	0.032	0.016	0.041	0.006	0.039
SEE	0.650	0.675	0.739	0.635	0.683	0.288	0.600
D-W	1.99	1.97	1.99	1.95	2.04	2.29	2.09
H1: $F(4, n)$	9.59*	5.75*	6.50*	4.03*	10.42*	3.87*	9.56*
H2: $F(2, n)$	0.02	1.86	0.32	0.30	1.00	0.02	0.02
H3: $F(8, n)$	2.89*	1.77	2.86*	1.88	2.87*	0.76	2.97*
H4: $F(15, n)$	4.31*	2.92*	3.67*	2.31*	4.45*	1.52	4.31*

Notes: See notes (a), (b), and (c) of Table 1. The exchange rates represent one business day percentage changes in the prices of foreign currencies in US dollars. A coefficient of, say, −0.241 denotes appreciation of the dollar by 0.24 per cent.

misspecification. Also the F-statistics at the bottom of Tables 1 and 2 show that the four monetary variables carry most of the explanatory power and are jointly significant in all interest rate and all currency markets (hypothesis H1); the two inflation variables are jointly significant only in the twenty-year Treasury bond market (hypothesis H2); and the eight 'cyclical' variables are jointly significant in four of the currency markets and in the three-month Treasury bill market (hypothesis H3).

TABLE 3. Tests of structural change.

	October 1979 to October 1982 vs. October 1982 to August 1984						
	TD *t*-stat	M1 *t*-stat	RES *t*-stat	Monetary $F(3, n)$	Inflation $F(2, n)$	Cyclical $F(8, n)$	All $F(14, n)$
Federal funds	1.52	−1.40	1.50	1.90 (0.13)	1.21 (0.30)	0.38 (0.93)	1.00 (0.45)
Treasury bill	−2.62*	−1.33	3.36*	6.09* (0.01)	0.61 (0.54)	1.83 (0.07)	2.72* (0.01)
Treasury bond	1.17	0.76	1.49	1.60 (0.19)	1.42 (0.19)	1.51 (0.15)	1.44 (0.13)
W. German mark	0.20	−0.38	−2.21*	1.83 (0.14)	1.03 (0.36)	0.88 (0.53)	1.04 (0.41)
Japanese yen	0.18	0.82	−2.52*	2.60* (0.05)	0.20 (0.82)	1.41 (0.19)	1.38 (0.16)
Swiss franc	0.52	−0.51	−2.39*	2.42 (0.06)	0.60 (0.55)	1.10 (0.36)	1.25 (0.23)
British pound	0.58	−1.48	−2.80*	3.97* (0.01)	1.81 (0.16)	0.64 (0.75)	1.54 (0.09)
French franc	0.43	−1.90	−0.99	1.60 (0.19)	1.05 (0.35)	0.57 (0.80)	0.82 (0.64)
Canadian dollar	0.22	−0.02	−1.43	0.95 (0.42)	3.21* (0.04)	0.77 (0.63)	1.08 (0.37)
Italian lira	0.14	−0.98	−1.18	0.81 (0.49)	0.96 (0.38)	1.34 (0.22)	1.07 (0.38)

Notes:

(a) Marginal significance levels are in the parentheses. $n = 1185$.

(b) The test statistics were generated by including individual coefficient dummy variables which took the value of zero in the first subsample. 'Monetary' refers to M1, RES, and DISC (SUR does not appear in the second part of the sample). 'Inflation' refers to CPI and PPI. 'Cyclical' refers to UN, IP, PI, DG, LI, RS, CC, and HS. 'All' refers to Monetary, Inflation, Cyclical, and TD. The tests for the three interest rates correct for the heteroscedasticity across the subsamples; we performed weighted least squares with weights equal to the SEE of each subperiod.

II.A. Monetary Announcements

Let us begin by examining the market reactions to the announcement of M1, a topic that has been analyzed extensively in the past. Table 1 shows a positive reaction of all interest rates. A 1 per cent unanticipated weekly increase in M1 (which has an average sample size of approximately five billion dollars) increases the federal funds rate by twenty basis points, the three-month *T*-bill rate by eighteen basis points, and the twenty-year *T*-bond rate by ten basis points.[4] The exchange rate reactions confirm the evidence of previous authors that the dollar appreciates after an unanticipated increase in M1 and show that the result is robust and independent of the foreign currency examined. For example, after an unanticipated increase in M1 by 1 per cent, the dollar appreciates against the West German mark by 0.24 per cent.

Previous authors have emphasized that the exchange rate results show that markets expect the risk-free real rate of interest to change, and that the Fed has credibility in the market. A positive surprise about M1 signals a persistent increase in money demand, but (perhaps) only a temporary increase (because the Fed is expected to stick to its pre-announced M1 targets) in money supply. The

expectation of a future excess demand for money leads to an upward revision in the expected market clearing (in the face of price rigidity) real interest rate. This explanation cannot justify, however, the strong long-term interest rate response because a liquidity effect is short-lived. And there is no consensus in the literature about what exactly causes long-term interest rates to respond so strongly. In Hardouvelis (1985b), I attempt to rationalize this response as a simultaneous expected inflation effect. I develop a theoretical model in which both the liquidity and inflation effect are present simultaneously, but the liquidity effect dominates the reactions of short-term interest rates and exchange rates, while the inflation effect dominates the reactions of long-term interest rates. The two effects can coexist when market participants attach some positive probability weight on the possibility that the M1 targets will be abandoned. Thus the strong positive response of long-term interest rates could be interpreted as evidence that the Fed lacked *full* credibility in its fight against inflation.[5]

An unanticipated increase in free reserves by 1 per cent of non-borrowed reserves (this equals approximately 400 million dollars in the sample) decreases the three-month T-bill rate by eleven basis points during the first subperiod but has an insignificant effect on the twenty-year T-bond rate in both subperiods. In Hardouvelis (1987), I present a model of the reserves (and money) market which explains this reaction as an expected liquidity effect.[6] The exchange rate reactions to free reserves announcements represent entirely new evidence. The dollar shows a significant depreciation against all currencies. The depreciation of the dollar confirms that the accompanying decrease in interest rates represents a decrease in expected real interest rates. Both the interest rate and the exchange rate responses show the importance market participants attached to the Fed's inter-week behavior in the reserves market during the October 1979 to October 1982 period. However, unlike the money announcement responses, we cannot interpret the responses to reserves announcements as evidence of Fed credibility, because there is no one-to-one relationship between the Fed's inter-week reserves target and the M1 target.

Announcements of the Fed discount and surcharge rates have a positive effect on interest rates and a negative effect on exchange rates, implying that markets expect a change in the real rate of interest. A prospective increase in the discount or surcharge rate is interpreted by markets as a signal of a future tightening by the Fed, which increases the expected future real interest rate due to an expected liquidity effect.[7] Notice that the reactions to announced surcharge rate changes are slightly stronger for the case of the federal funds rate and the exchange rates, and slightly weaker for the other interest rates than the corresponding reactions to announced discount rate changes. Evidently, markets interpreted changes in the surcharge rate as only temporary attempts by the Fed to either tighten or loosen credit, which is quite reasonable given the nature of surcharge rates.[8]

II.B. Inflation Announcements

The short-term interest rate reactions to the CPI and PPI announcements were previously analyzed by Roley and Troll, and Urich and Wachtel.[9] They find a positive but insignificant response. Urich and Wachtel, after examining refined time intervals, are able to find a statistically significant delayed response to the PPI announcement during the afternoon of the day of the announcement (the announcement takes place in the morning). These authors have attributed the

response of short-term interest rates to revisions of inflationary expectations. But the response could also be due to changes in the risk-free real rate of interest as the Fed may be expected to counteract past increases in the rate of inflation. The twenty-year *T*-bond rate and the exchange rates of the present paper can provide evidence that allows us to discriminate between these two competing hypotheses. The expected inflation hypothesis predicts a depreciation of the dollar and an increase in long-term interest rates that is larger the more permanent the increase in inflation is expected to be. The expected liquidity hypothesis predicts an appreciation of the dollar and an increase in long-term interest rates that is much smaller than the observed increase in short-term interest rates because the liquidity effect disappears in the long-run.

Contrary to the short-term interest rate reactions, the reactions of the twenty-year *T*-bond rate are statistically significant. An unanticipated monthly increase in the PPI by 1 per cent increases the twenty-year *T*-bond rate by sixteen basis points (with a *t*-statistic of 3.8). An unanticipated monthly increase in the CPI by 1 per cent increases the twenty-year *T*-bond rate by eighteen basis points (with a *t*-statistic of 2.4). The exchange rate reactions are insignificantly different from zero, and the algebraic signs show a delayed appreciation (see Hardouvelis, 1985a). We conclude that neither hypothesis is able to explain all market reactions. The expected inflation hypothesis cannot explain the absence of a dollar depreciation, and the expected liquidity hypothesis cannot explain the strength of the reaction of long-term interest rates relative to short-term interest rates.[10]

II.C. Cyclical Announcements

Let us now consider variables that provide information about the state of the domestic macro-economy. Tables 1 and 2 show that significant responses are present only after the announcement of the unemployment rate (UN), personal income (PI), manufacturers' orders of durable goods (DG), and retail sales (RS). Evidently, the announcements of the industrial production index (IP), the index of leading indicators (LI), consumer installment credit (CC), and housing starts (HS) do not provide significant new information about future economic developments or provide mixed signals.

The market responses to cyclical news (as well as monetary news) are consistent with the textbook aggregate demand (IS-LM) —aggregate supply model in an open economy framework, in which prices are sluggish, asset markets adjust instantaneously (the interest parity condition holds), purchasing power parity does not hold in the short and intermediate run, and the foreign interest rate is allowed to change. Obstfeld (1985) has recently surveyed this model (which is an extension of the Mundell–Fleming model with perfect capital mobility) and used it to explain the post-1971 floating exchange rate experience. According to the model, a positive shift in the IS (LM) curve causes the real rate of interest to increase (decrease) and the dollar to appreciate (depreciate). A positive shift in aggregate supply causes the real rate of interest to decrease and the dollar to depreciate.

The market responses show that unanticipated changes in the unemployment rate, manufacturers' orders of durable goods, and retail sales were interpreted as evidence of a persistent change in aggregate demand originating in the real sector (a shift in the IS curve) rather than aggregate supply. This is reasonable because the presence of inventories drives a wedge between production and demand, and items

such as retail sales or orders of durable goods are more directly related to demand movements. An unanticipated increase in the level of the unemployment rate by one percentage point signals a future decrease in aggregate demand and causes the *T*-bill and *T*-bond rates to decrease by twenty-seven and sixteen basis points respectively, and the dollar to depreciate. Unanticipated increases in retail sales or durable goods signal a future increase in aggregate demand and cause an increase in interest rates and an appreciation of the dollar. Notice that the interest rate responses to retail sales and durable goods are significant in the second subperiod only. Finally, unanticipated changes in personal income were apparently interpreted as evidence of a persistent change in aggregate supply rather than aggregate demand. This is also reasonable, since income to the factors of production is more directly related to production rather than demand. An unanticipated increase in personal income causes a significant decrease in long-term interest rates and a depreciation of the dollar.

II.D. Trade Deficit Announcement

The announcement of the trade deficit has a statistically significant effect on the three-month *T*-bill rate during the first subperiod, but an insignificant effect on the other interest rates and the exchange rates. From October 1979 to October 1982, an unanticipated increase in the monthly trade deficit by 1 billion dollars decreases the three-month *T*-bill rate by nine basis points. In general, an unanticipated increase in the trade deficit decreases interest rates and depreciates the dollar. When markets learn that the trade deficit of last month was larger than they had anticipated, they apparently expect a further future increase in the trade deficit. This is consistent with the positive autocorrelation of the monthly trade deficit series shown in Hardouvelis (1985a). Markets probably attribute their surprise about the trade deficit mostly to unanticipated exogenous positively autocorrelated changes in the foreign demand for domestic products. A future contraction in the foreign demand for domestic products is expected to lead to a large deficit, temporarily lower real interest rates, and a depreciation of the dollar. This scenario is consistent with the model that we described earlier.

III. Conclusions

The post-October 1979 exchange rate and interest rate reactions to news about different macroeconomic variables are consistent with an extended version of the traditional Mundell–Fleming model, in which open interest parity holds instantaneously, purchasing power parity does not hold in the short or intermediate run, the foreign interest rate is allowed to change, and expectations play a crucial role, as in Obstfeld (1985). A basic characteristic of this model is that shifts of the textbook IS curve, the LM curve, or the aggregate supply curve affect the real rate of interest and, subsequently, the change in the real rate of interest affects the exchange rate through the interest rate parity condition. Our main empirical regularity is consistent with this characteristic. We discovered that an appreciation (depreciation) of the dollar is accompanied by an increase (decrease) in nominal interest rates. This is true for *all* fifteen macroeconomic series, although the responses to some of the series are not statistically significant. Evidently, during our sample period, exchange rate movements were primarily

driven by expectations of future changes in real interest rates rather than the expected rate of inflation. This empirical regularity is inconsistent with the simple monetarist model of exchange rate determination (see, for example, Frenkel, 1976), which assumes price flexibility and purchasing power parity.[11]

Monetary news carries most of the explanatory power in our regressions. The four monetary variables are jointly significant in all interest rate and exchange rate markets that we examine. The response to bank reserves announcements is particularly strong in the period until October 1982, when the Federal Reserve followed non-borrowed reserves as intermediate targets. The responses to monetary news are caused by expected developments in the money market, developments which are expected to affect the real rate of interest. Some non-monetary variables also show significant effects. These variables reflect news about the unemployment rate, manufacturers' orders of durable goods, retail sales and personal income. The first three signal future changes in aggregate demand, while personal income signals future changes in aggregate supply. Adverse news about the trade deficit decreases short-term interest rates but the adverse effect on the value of the dollar is insignificant. Finally, inflation news has a weak positive effect on short-term interest rates, a strong positive effect on long-term interest rates, and no effect on exchange rates.[12]

Appendix

The Data Set

All interest rates are annualized yields to maturity, expressed in percentages. They were provided by Data Resources Incorporated. *T*-bill and *T*-bond rates are collected at 3:30 p.m. Eastern Time, but the federal funds rate is a daily average. A regression coefficient of, say, 0.5 implies a change in interest rates of half a percentage point or 50 basis points. Exchange rates, defined as the prices of foreign currencies in terms of US dollars, are noon bid rates from the New York market as reported by the Board of Governors of the Federal Reserve System. In the regressions, the dependent variables are in the following form: $DP_{jt} = 100[\log(s_{jt}) - \log(s_{jt-1})]$, where s_{jt} denotes the spot price of foreign currency j in terms of US dollars during business day t. The factor 100 transforms the units of the dependent variables to percentages. Thus the magnitudes of the regression coefficients are comparable to those in the interest rate regressions. A coefficient of, say, 1.2 implies a change of 1.2 per cent or 120 basis points.

The survey data were provided by Money Market Services Incorporated of Belmont, California. They represent median forecasts of about forty market specialists. Douglas Pearce and V. Vance Roley (1985) among others have analyzed the unbiasedness, efficiency, and forecast performance of M1, the CPI, the PPI, the unemployment rate, and the industrial production index. I have performed a similar analysis (1985a) using the latest sample period and the additional eight survey variables (there are no survey data for changes in the discount and surcharge rates). The overall conclusion is that the survey forecasts, although not always unbiased or efficient, have a smaller root mean square error than forecasts which are based on autoregressive models. In the same paper, I also present the results on possible delayed responses to announcements, as well as the responses to the anticipated components of the series.

The data on M1 begin in October 1979 and end in February 1984, at the end of lagged reserve accounting. The data on reserves begin in late April 1980, when the first survey data on free reserves become available, and also end in February 1984. The data on discount and surcharge rate changes, unemployment, industrial production index, CPI, and PPI begin in

October 1979 and end in August 1984. The remaining series begin in February 1980, when the survey data become available, and end in August 1984.

The unanticipated component of M1 is defined as $100\{-1+[M1(t-2)-FDM]/M1(t-3)\}$, where $M1(t-2)$ is the announced during fiscal week t level of M1 of fiscal week $t-2$, $M1(t-3)$ was announced at $t-1$, and FDM is the survey forecast of the weekly change in M1 from $t-3$ to $t-2$. RES is defined as $100\{FR(t-1)-FRR\}/NBR(t-2)$, where $FR(t-1)$ is the announced at t level of free reserves of fiscal week $t-1$, FFR is the corresponding survey forecast, and $NBR(t-2)$ is the level of non-borrowed reserves of fiscal week $t-2$. DISC and SUR are the announced prospective changes in the discount and surcharge rates. PPI, CPI, IP, PI, RS, DG, and LI refer to the unanticipated monthly percentage change in the producer price index, consumer price index, industrial production index, personal income, retail sales, manufacturers' orders of durable goods, and the index of leading indicators. UN is the unanticipated monthly level in the unemployment rate. CC is the unanticipated monthly change in consumer installment credit ($ billions). HS is the unanticipated monthly level in housing starts (millions of units). TD is the unanticipated monthly level in the trade deficit ($ billions). All independent variables are seasonally adjusted except RES.

Notes

1. Cornell (1982), Engel and Frankel (1984), Frankel and Hardouvelis (1985), Hardouvelis (1984), Husted and Kitchen (1985), and Gavin and Karamouzis (1984) examined M1 announcements. Hardouvelis (1987) examined the reaction of the term structure of interest rates to the announcement of free reserves. Roley and Troll (1983) examined the reaction of the three-month T-bill rate to the announcement of the Fed discount and surcharge rate, the unemployment rate, the industrial production index (the latter two are also analyzed by Wachtel and Melzer, 1984), and the CPI and PPI announcements. Urich and Wachtel (1984) analyzed the reaction of short-term interest rates up to approximately one year to the CPI and PPI announcements. Batten and Thornton (1984) examined the exchange rate reactions to the announcement of the discount rate.
2. See, for example, the models of Nichols *et al.* (1983), or Hardouvelis (1985b).
3. Some of the series do not cover the whole sample. See the appendix for details.
4. Note that the federal funds rate does not respond to the M1 announcement after October 1982. Before October 1982, non-borrowed reserves were the instrument of monetary control. An announced unanticipated change in M1 provided information about the current week's demand for reserves (recall that until February 1984, required reserves of the week of the announcement were a function of deposits two weeks earlier, and that the announced level of M1 referred to two weeks earlier). This affected the market expectation of the demand for borrowed reserves and the market clearing federal funds rate. After October 1982 the Fed adopted borrowed reserves as its instrument for monetary control, and thus accommodated directly a change in the demand for reserves which made the federal funds rate less likely to respond in order to clear the reserves market.
5. Another hypothesis that can explain the data in combination with the expected liquidity hypothesis, which also presumes lack of full credibility, is the *inflation-risk* hypothesis. This hypothesis was first advanced by Cornell (1983) and predicts that long-term interest rates respond positively because inflation risk increases (decreases) after an unanticipated increase (decrease) in M1. (See Taylor, 1981, for empirical evidence on the positive relationship between inflation variability and the average rate of inflation.) It also predicts a slightly positive response for short-term interest rates, and no response for exchange rates, because the risk premium is already incorporated in domestic real interest rates and, therefore, no incipient capital movement could occur either into or out of the USA that would affect exchange rates.
6. The basic argument can be summarized as follows: Market participants have a fairly accurate estimate of total reserves of week $t-1$ before the announcement at t, because total reserves are a function of demand deposits of week $t-3$, which were announced at $t-1$ (our data on reserves and M1 end on February 1984, at the end of the lagged reserve accounting period). Thus the announcement at t of the monetary base of week $t-1$ with its components provides information about the *composition* of total reserves. An overestimate of non-borrowed reserves due to

unanticipated expansion of reserves by the New York desk implies an equal underestimate of borrowed reserves which, at the observed level of the federal funds rate and the discount rate, is due to an unanticipated increase in reserve pressure at the discount window. Thus, assuming that the surprise about excess reserves is zero (empirically the assumption does not make a difference), RES represents a proxy for an unanticipated increase (decrease) in non-borrowed (borrowed) reserves. After an announced positive RES, markets will expect real rates to go down in the future if they perceive that actions taken by the New York desk are more persistent than actions taken at the discount window. This is reasonable, particularly in the period between October 1979 and October 1982 when the Fed followed non-borrowed reserves targets.

7. Batten and Thornton (1984) argue that it is difficult to distinguish between an expected liquidity and an expected inflation effect using the exchange rate reactions, but eventually interpret the appreciation of the dollar after an (unanticipated) increase in the discount rate as evidence of an expected inflation effect. They consider the expected future Fed tightening as permanent, *i.e.*, as a permanent future decrease in the growth rate of the money supply that leads to a decrease in inflationary expectations. (See the Batten–Thornton Table 3, p. 285, which leads the authors to favor the expected inflation hypothesis.) Batten and Thornton treat the exchange rate reactions in isolation, without examining the simultaneous interest rate reactions. Their interpretation is rejected by the *positive* and significant response of, particularly long-term, interest rates.
8. I treat the actual announced changes in the discount and surcharge rates as unanticipated, but some of these changes may be widely anticipated due to, say, rumors or official pronouncements. My coefficient estimates may, therefore, be biased slightly towards zero. Batten and Thornton (1984) present a detailed study in which they separate discount rate changes into technical (mostly anticipated) and discretionary (mostly unanticipated). They claim that during our sample period discount rate changes were mostly discretionary rather than technical and, therefore, largely unanticipated. Smirlock and Yawitz (1985) also separate discount rate changes into anticipated and unanticipated components.
9. Contemporaneously with the initial draft of this article, Hakkio and Pearce (1985) have independently examined the exchange rate reactions to the announcement of M1, the CPI, the PPI, the industrial production index, and the unemployment rate, and have examined more refined time intervals. Their exchange rate results are similar to mine.
10. The inflation-risk hypothesis of note 5 is, however, consistent with *all* the market reactions. It predicts a strong positive reaction for long-term interest rates, a weak positive reaction for short-term interest rates, and no reaction for exchange rates, which are exactly the reactions we observe.
11. A similar conclusion was recently reached by Cornell and Shapiro (1985), who examined daily correlations between exchange rates and interest rates. However, as the authors recognize, their approach suffers from simultaneity bias because they regress one endogenous variable, the exchange rate, on another endogenous variable, the interest rate. (See Engel, 1986, for a detailed criticism.) In contrast, the present paper does not suffer from a similar simultaneity problem because I explicitly treat exchange rates and interest rates as endogenous variables.
12. As I mentioned in notes 5 and 10, the strong positive response of long-term interest rates to the surprise components of M1, the CPI, and the PPI could be the result of changes in inflation risk. This would imply that during our sample period, the Fed was not able to establish *full* credibility among market participants about its fight against inflation.

References

BATTEN, D.S., AND D.L. THORNTON, 'Discount Rate Changes and the Foreign Exchange Market,' *Journal of International Money and Finance*, December 1984, **3**: 279–302.

COPELAND, L.S., 'The Pound Sterling/US Dollar Exchange Rate and the News,' *Economics Letters*, 1984, **15**: 109–113.

CORNELL, B., 'Money Supply Announcements, Interest Rates, and Foreign Exchange,' *Journal of International Money and Finance*, August 1982, **1**: 201–208.

CORNELL, B., 'The Money Supply Announcements Puzzle: Review and Interpretation,' *American Economic Review*, September 1983, **73**: 644–657.

CORNELL, B., AND A.C. SHAPIRO, 'Interest Rates and Exchange Rates: Some New Empirical Results,' *Journal of International Money and Finance*, December 1985, **4**: 431–442.

DORNBUSCH, R., 'Exchange Rate Economics: Where do we Stand?,' *Brookings Papers on Economic Activity*, Spring 1980, **1**: 143–185.

EDWARDS, S., 'Exchange Rates and News: A Multi-Currency Approach,' *Journal of International Money and Finance*, December 1982, **1:** 211–224 (1982a).

EDWARDS, S., 'Exchange Rate Market Efficiency and New Information,' *Economics Letters*, 1982, **9:** 377–382 (1982b).

EDWARDS, S., 'Floating Exchange Rates, Expectations and New Information,' *Journal of Monetary Economics*, May 1983, **11:** 321–336.

ENGEL, C.M., 'On the Correlation of Exchange Rates and Interest Rates,' *Journal of International Money and Finance*, March 1986, **5:** 125–128.

ENGEL, C.M., AND J.A. FRANKEL, 'Why Money Announcements Move Interest Rates: An Answer from the Exchange Rate Market,' *Journal of Monetary Economics*, January 1984, **13:** 31–39.

FRANKEL, J.A., and G.A. HARDOUVELIS, 'Commodity Prices, Money Surprises, and Fed Credibility,' *Journal of Money, Credit and Banking*, November 1985 (part 1), **17:** 425–438.

FRENKEL, J.A., 'A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence,' *Scandinavian Journal of Economics*, May 1976, **78:** 200–224.

FRENKEL, J.A., 'Flexible Exchange Rates, Prices, and the Role of News: Lessons from the 1970s,' *Journal of Political Economy*, August 1981, **89:** 665–705.

GAVIN, W.T., AND N.V. KARAMOUZIS, 'Monetary Policy and Real Interest Rates: New Evidence from the Money Stock Announcements,' working paper, Federal Reserve Bank of Cleveland, December 1984.

HAKKIO, C.S., AND D.K. PEARCE, 'The Reaction of Exchange Rates to Economic News,' working paper, Federal Reserve Bank of Kansas City, January 1985.

HARDOUVELIS, G.A., 'Market Perceptions of Federal Reserve Policy and the Weekly Monetary Announcements,' *Journal of Monetary Economics*, September 1984, **14:** 225–240.

HARDOUVELIS, G.A., 'Economic News, Exchange Rates and Interest Rates,' working paper, Barnard College, Columbia University, February 1985, revised as First Boston Working Paper Series No. 86–12 (1985a).

HARDOUVELIS, G.A., 'Exchange Rates, Interest Rates, and Money Stock Announcements: A Theoretical Exposition,' *Journal of International Money and Finance*, December 1985: **4:** 443–454 (1985b).

HARDOUVELIS, G.A., 'Reserves Announcements and Interest Rates: Does Monetary Policy Matter?,' *Journal of Finance*, June 1987, **42:** 407–422

HUSTED, S., AND J. KITCHEN, 'Some Evidence on the International Transmission of Money Supply Announcement Effects,' *Journal of Money, Credit and Banking*, November 1985 (part 1), **17:** 456–466.

MEESE, R.A., AND K. ROGOFF, 'Empirical Exchange Rate Models of the Seventies: Do They Fit Our Sample?,' *Journal of International Economics*, February 1983, **14:** 3–24.

NICHOLS, D.A., D.H. SMALL, AND C.E. WEBSTER, 'Why Interest Rates Rise When an Unexpected Large Money Stock is Announced,' *American Economic Review*, June 1983, **73:** 383–388.

OBSTFELD, M., 'Floating Exchange Rates: Experience and Prospects,' *Brookings Papers on Economic Activity*, Fall 1985, **2:** 369–464.

PEARCE, D.K., AND V.V. ROLEY, 'Stock Prices and Economic News,' *Journal of Business*, January 1985, **58:** 49–67.

ROLEY, V.V., AND R. TROLL, 'The Impact of New Economic Information on the Volatility of Short-Term Interest Rates,' *Economic Review*, Federal Reserve Bank of Kansas City, February 1983, 3–15.

ROSE, A.K., 'Testing for News in Foreign Exchange Markets,' *Economics Letters*, 1984, **14:** 369–376.

SMIRLOCK, M., AND J. YAWITZ, 'Asset Returns, Discount Rate Changes, and Market Efficiency,' *Journal of Finance*, September 1985, **40:** 1141–1158.

TAYLOR, J.B., 'On the Relationship between the Variability of Inflation and the Average Inflation Rate,' *The Costs and Consequences of Inflation*, Amsterdam: North Holland, 1981, Carnegie–Rochester Conference Series on Public Policy, **15:** 57–85.

URICH, T., AND P. WACHTEL, 'The Effects of Inflation and Money Supply Announcements on Interest Rates,' *Journal of Finance*, September 1984, **39:** 1177–1188.

WACHTEL, P., AND M. MELZER, 'Interest Rates and Announcements of Information on Real Economic Activity,' working paper, NYU Business School, July 1984.