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WHY INTEREST RATES REACT TO MONEY ANNOUNCEMENTS
An Explanation from the Foreign Exchange Market*

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When the Fed announces a money supply greater than had been expected, interest rates rise. Why? One explanation is that the market raises its estimate of the future rates of money growth and inflation, and bids up nominal interest rates. We offer contrary evidence: on such days the dollar appreciates, not depreciates. An alternative explanation is that the market perceives the change in the money stock as a transitory fluctuation that the Fed will reverse in the future. The anticipated future tightening raises today's *real* interest rate, causes a capital inflow, and appreciates the dollar, the result in fact observed.

1. Introduction

One striking empirical regularity in recent years has been the tendency for interest rates to rise on Fridays when the Fed announces an increase in the money supply greater than had previously been expected.[1] One explanation of this phenomenon is that the market interprets such an announcement as an indication that the Fed has raised its target money growth rate, and the market accordingly expects higher inflation and so drives up nominal interest rates. We offer empirical evidence against this explanation: when the money supply announcement is greater than expected, the value of the dollar in terms of foreign exchange is observed to rise as well.[2] If the market were to raise its expected inflation rate, one would expect a *negative* effect on the demand for U.S. money, and thus on the value of the dollar,[3] not a positive effect.

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[1] This effect has been documented by Grossman (1981) and many others. See Engel and Frankel (1982) for further references.

[2] Subsequent to our paper, Cornell (1982) has written a similar paper that makes this point.

[3] The negative effect of expected inflation on the current value of the domestic currency is shown most simply in the flexible-price monetary model of Frenkel (1976).

If the explanation for the higher nominal interest rate is not an increase in the expected inflation rate, what is it? As a matter of definition, the only alternative possibility is that it is an increase in the *real* interest rate. The natural explanation for an increase in the real interest rate is that the market believes that the change in the money supply is not due to a change in the Fed's target but rather to a disturbance in money demand or the banking system, a disturbance that the Fed can be expected to reverse in the near future. A variety of models that allow variation in the real interest rate would lead one to expect that a future monetary contraction would have the effects observed: an increase in the real interest rate and – as a result of a capital inflow from abroad – an increase in the value of the dollar.[4]

In section 2 of this paper we put forth one specific example of a model that allows variation in the real interest rate and predicts the effect on the exchange rate that is in fact observed. The model is a generalization of Frankel's (1979) synthesis of the Frenkel (1976) and Dornbusch (1976) versions of the monetary approach to exchange rate determination. The reader who is willing to accept the intuitive argument is encouraged to skip directly to the empirical results in section 3.

2. A model of the exchange rate's dependence on monetary tightness

In this section we illustrate briefly how the exchange rate jumps in response to changes in the perceived future path of monetary policy, in a particular model where goods prices may be sticky. When announcements of unexpectedly large money supplies are interpreted as increases in the Fed's target money growth rate, the exchange rate – defined as the price of foreign currency – increases, i.e., the dollar depreciates. When such announcements are interpreted as transitory deviations bringing future contraction, the exchange rate falls, i.e., the dollar appreciates.

We begin with a Cagan-type money demand equation:

$$m_t - p_t = -\lambda i_t + a_t. \tag{1}$$

Here m and p are the logs of the money supply and price level, i is the very short-term interest rate and a_t represents the influence of real income and other exogenous shifts in money demand.

We allow prices to be sticky, to be prevented from jumping at a moment in time. Thus purchasing power parity may not hold in the short run. Prices adjust to excess demand over time, so PPP holds in long-run equilibrium: $\bar{s}_t = \bar{p}_t$; where $\bar{s}$ is the log of the equilibrium exchange rate, $\bar{p}$ is the log of the domestic equilibrium price level, and the log of the foreign equilibrium price

[4]Dornbusch (1976) is the most elegant such model.

level is exogenous and normalized at zero. $\bar{p}$ is in turn defined by the stable rational expectation solution to

$$\bar{m}_t - \bar{p}_t = -\lambda\left[\mathrm{E}_t\bar{p}_{t+1} - \bar{p}_t + i^*\right] + a_t, \tag{2}$$

where $\mathrm{E}_t\bar{p}_{t+1} - \bar{p}_t$ is the equilibrium inflation rate expected at time t and i^* is the foreign interest rate, also taken to be exogenous. This is a logical way to determine $\bar{p}$, because it is the way we would determine p in a flexible-price world. Solving for $\bar{p}$ through the method of recursive substitution:

$$\bar{p}_t = \frac{1}{1+\lambda}\sum_{\tau=0}^{\infty}\left(\frac{\lambda}{1+\lambda}\right)^{\tau}\mathrm{E}_t(m_{t+\tau} - a_{t+\tau}) + \lambda i^*. \tag{3}$$

We see that $\bar{p}_t$ is an indicator of how expansionary the entire future path of money supply is expected to be relative to money demand. In the special case in which goods prices are perfectly flexible, $p = \bar{p}$ and eq. (3) alone would give us the effect of monetary expectations on p, and therefore on s. Expectations of future expansion would cause p and therefore s to increase, and vice versa for expectations of future contraction.

Now we are going to see how changes in the observable $\bar{p}_t$ are reflected as changes in the observable s_t in the case where goods prices are sticky. We assume the price level adjusts gradually to an excess demand function, plus a term for the equilibrium inflation path. It can be shown [see, e.g., Frankel (1979), Engel and Frankel (1982)] that this assumption along with rational expectations implies

$$\mathrm{E}_t s_{t+1} - s_t = \theta(\bar{s}_t - s_t) + \mathrm{E}_t\bar{s}_{t+1} - \bar{s}_t, \tag{4}$$

i.e., exchange rate expectations take a regressive form. In the long-run equilibrium, when $\bar{s} - s = 0$, the spot rate s is of course expected to increase at the rate of the equilibrium spot rate $\bar{s}$, which will be the same as the rates of increase of the equilibrium price level (by purchasing power parity) and money supply (by money demand homogeneity). But in the short run, if the spot rate exceeds what the market considers its equilibrium path ($\bar{s} - s < 0$), then the currency is thought to be 'undervalued', and is rationally expected in the future to appreciate ($\mathrm{E}_t s_{t+1} - s_t < 0$) relative to the equilibrium path.

Our final assumption is uncovered interest parity:

$$i_t - i_t^* = \mathrm{E}_t s_{t+1} - s_t. \tag{5}$$

Return to the money demand function (1). An announcement of monetary growth at time t, as opposed to the event itself over the preceding period, does not change the money supply, or the price level or real money demand, so it

does not change the very short-term interest rate i_t. Thus, by (5) it does not change expected depreciation. So, taking the changes in (4):

$$0 = \theta\left((\bar{s}_t - \bar{s}_{t'}) - (s_t - s_{t'})\right) + (\mathrm{E}_t\bar{s}_{t+1} - \mathrm{E}_{t'}\bar{s}_{t+1}) - (\bar{s}_t - \bar{s}_{t'}), \qquad (4')$$

where we are using t' to denote the value of a variable the instant before the announcement.[5] We are interested in the change in the current spot rate induced by the announcement. Using (4') and long-run PPP we have

$$s_t - s_{t'} = \bar{p}_t - \bar{p}_{t'} + \frac{1}{\theta}\left[(\mathrm{E}_t\bar{p}_{t+1} - \bar{p}_t) - (\mathrm{E}_{t'}\bar{p}_{t+1} - \bar{p}_{t'})\right]. \qquad (6)$$

The expression in brackets is the revision in the market's expected equilibrium inflation rate. From (2), since m_t, i_t^* and a_t are tied down:

$$\bar{p}_t - \bar{p}_{t'} = \lambda\left[(\mathrm{E}_t\bar{p}_{t+1} - \bar{p}_t) - (\mathrm{E}_{t'}\bar{p}_{t+1} - \bar{p}_{t'})\right]. \qquad (2')$$

We combine (2') and (6):

$$s_t - s_{t'} = (1 + 1/\lambda\theta)(\bar{p}_t - \bar{p}_{t'}). \qquad (7)$$

Eq. (7) is the promised result that revisions in $\bar{p}$, which we have established as an indicator of the expected future path of monetary policy, cause jumps in the spot rate. The equation is a generalization of Dornbusch's celebrated overshooting result, that an unanticipated increase in the money supply causes an equilibrium increase in the exchange rate of the same percentage, and in addition causes the current exchange rate to overshoot its equilibrium by $1/\lambda\theta$. We could stop here. If the announcement of an unexpectedly high money supply induces the public to raise its expectation of future money supplies relative to money demand, a sudden increase in s_t will tell us so. On the other hand, if the announcement induces expectations of monetary contraction in the near future, a sudden fall in s_t will tell us so.

To make these two alternatives more concrete we now consider the two particular money supply processes described in section 1. Both involve a target path for the money supply with growth rate μ_t:

$$\bar{m}_t = \bar{m}_{t-1} + \mu_t. \qquad (8)$$

In both cases we also assume that a_t follows a random walk.

[5] Between $t-1$ and t' the money supply changes occur and the money demand errors occur. The announcement is made at t. The symbol t' is a device that designates the values of the variables that would hold at time t, if no money announcements had been made.

Under money supply process 'A', the Fed succeeds in hitting its money supply target weekly, but it keeps changing the target growth rate according to a random walk:

$$m_t = \bar{m}_t, \tag{9a}$$

$$\mu_t = \mu_{t-1} + v_t. \tag{10a}$$

If we use this money supply process in eq. (3), we find that the announcement of a money supply 1% greater than expected raises $\bar{p}_t$ by λ%:[6]

$$\bar{p}_t - \bar{p}_{t-} = \lambda(m_t - \mathrm{E}_{t-}m_t). \tag{11a}$$

Intuitively, under money supply process A, the announcement of m_t is interpreted as a one-for-one increase in the steady-state inflation rate, which reduces steady-state real money demand – or raises the equilibrium price level – by that amount times the semi-elasticity of money demand. From (7)

$$s_t - s_{t-} = \left(\frac{1+\lambda\theta}{\theta}\right)(m_t - \mathrm{E}_{t-}m_t). \tag{12a}$$

The announcement of an unexpectedly high money supply in this case causes an immediate depreciation of the dollar.

Under the alternative of money supply process 'B', the Fed sticks to its pre-set target growth rate μ, but the actual money supply deviates from the target due to unintended weekly fluctuations u_t,

$$m_t = \bar{m}_t + u_t, \tag{9b}$$

$$\mu_t = \mu. \tag{10b}$$

If we use this money supply process in eq. (3), we find that the announcement of a money supply 1% greater than expected reduces $\bar{p}_t$ by $\lambda/(1+\lambda)$%:

$$\bar{p}_t - \bar{p}_{t-} = -\frac{\lambda}{1+\lambda}(m_t - \mathrm{E}_{t-}m_t). \tag{11b}$$

Intuitively, under money supply process B, the announcement is interpreted as requiring a one-for-one contraction in the following period. This tightening in

[6]We have used the fact that $(m_t - \mathrm{E}_{t-}m_t) = (a_t - \mathrm{E}_{t-}a_t)$. Presumably the market has already used changes in the interest rate observed during the week to estimate money supply less money demand. Still, the market gains information when the true money supply is announced. When it does, the revisions in its estimates of money supply and money demand must be equal.

expectations of monetary policy is reflected in a sudden fall in $\bar{p}_t$. From (7)

$$s_t - s_{t^-} = -\frac{1+\lambda\theta}{\theta(1+\lambda)}(m_t - \mathrm{E}_{t^-}m_t). \tag{12b}$$

In this case, the dollar *appreciates* with the announcement of an unexpectedly high money supply – the opposite from case A.

With either money supply process A or B, the nominal rate of interest would increase with a higher-than-anticipated money supply announcement. [This is demonstrated formally in the Appendix to Engel and Frankel (1982).] However, with process A it would be the inflation premium that would rise, while in case B the real rate would jump. The two processes are only distinguishable by their differing implications for exchange-rate movements.

3. Empirical tests of announcement effects

The market of course reacts to the announced money supply *in excess of what was anticipated*. The market's anticipation is determined not only by past money supply figures, but by many other factors as well. Any attempt to measure expected money growth by, for example, an ARIMA model of the money supply time series is unlikely to be accurate. It turns out that there is a very convenient measure of the market's opinion of what the Fed is going to announce. Money Market Services, Inc., each week surveys sixty individuals who make predictions of what the announcement will be. It is these survey data that we use as our measure of expected money growth.

It would add to the credibility of the survey numbers if they were unbiased predictors of the actual money supply announcements. Grossman (1981) has recently shown that the Money Market Services forecasts are unbiased for the period September 1977–September 1979. Engel and Frankel (1982) perform some tests on an updated time sample, which show that potentially useful information, such as lagged forecast errors,[7] and the interest rate and exchange rate on the morning of the money announcement, does not improve the accuracy of the forecast. Thus, the survey members' guesses of soon-to-be-revealed money stock numbers seem to be unbiased and efficient with respect to some obvious potential sources of information.[8]

[7]The forecast error is the log of the actual announced money supply minus the log of the predicted money supply. Money Market Services supplied predicted changes in the money supply. These figures were added to the current revised figures for the previous week to get the predicted new money supply.

[8]In light of the finding that the survey data appear to be unbiased predictors of the actual money supply, one might be tempted to assume rationality of expectations, and to examine the actual money supply process directly. However, the announcement effect depends on interplay of money supply *and* demand. Simultaneous estimation of money supply and demand equations might be another way to answer the question.

Before we examine the effects of the monetary announcements on interest rate and exchange rate changes, we should pause to consider why we are treating the monetary forecast errors as the independent variable. If our observations of the financial variables are taken close enough in time, before and after the announcement, then we can hope that the changes are explained largely by the announcement effect. However, we will certainly not get a perfect fit; other factors will contribute to the changes. The question is whether the errors that do intervene in the relationship are independent of the monetary forecast errors. There is a reason to believe that they are: both the announced money supply figures and their forecasts as measured by Money Market Services are predetermined, by several days, at the time that the announcement is made. A claim of econometric exogeneity on the part of the monetary forecast error can be supported by a Granger causality test. A necessary condition for monetary forecast errors to be exogenous with respect to a particular variable is that, after taking account of the information in the lagged forecast errors, the variable in question does not help predict the forecast error. Table 1 shows that neither the interest rate nor the exchange rate Granger-causes the monetary forecast error.

Having confirmed the desirable properties of the monetary forecasts, we now proceed to the main results of the paper. Table 2 attempts to confirm the empirical regularity on which the paper is predicated: the positive dependence of interest rate change on monetary announcements. The interest rate is the one-month Eurodollar rate, and we look at the change from 10 a.m. on the day

Table 1

Causality Test. *Dependent variable*: MFE_t = logarithmic monetary forecast error at t. *Independent variables*: MIN_t = 1-month Eurodollar rate on morning of day t, MEX_t = log New York market bid exchange rate on morning of day t.[a]

	c	MFE_{-1}	MFE_{-2}	MFE_{-3}	MFE_{-4}	MIN_{-1}	MIN_{-2}	R^2	DW
	0.0073	−0.154	−0.024	−0.038	0.089	0.023	−0.041		
	(0.0033)	(0.108)	(0.115)	(0.116)	(0.112)	(0.059)	(0.083)		
(1)		MIN_{-3}	MIN_{-4}	MIN_{-5}	MIN_{-6}				
		−0.064	−0.002	0.086	−0.030	$F(6,86) = 1.50$		0.115	1.99
		(0.083)	(0.083)	(0.083)	(0.058)				
	c	MFE_{-1}	MFE_{-2}	MFE_{-3}	MFE_{-4}	MEX_{-1}	MEX_{-2}		
	0.0017	−0.069	0.065	0.0071	0.083	0.042	−0.084		
	(0.0038)	(0.107)	(0.109)	(0.109)	(0.106)	(0.037)	(0.053)		
(2)		MEX_{-3}	MEX_{-4}	MEX_{-5}	MEX_{-6}				
		0.140	−0.0060	−0.054	0.0019	$F(6,86) = 1.44$		0.121	2.02
		(0.053)	(0.055)	(0.054)	(0.058)				

[a]Sample period: October 1979–August 1981.

Table 2

Dependent variable: One-day change in Eurodollar rate.

Regression technique	*MFE*	*D.W.*	ρ	R^2
(1) OLS	0.236 (0.138)	1.099		0.007
(2) CORC	0.162 (0.110)		0.456 (0.091)	0.206

Table 3

Dependent variable: One-day change in log exchange rate.

Regression technique	*MFE*	*D.W*	R^2
OLS	−0.393 (0.145)	1.729	0.069

of the announcement (which is made at 4:15 p.m.) to 10 a.m. the following day. The sample period is restricted to October 1979 to August 1981. (The Fed changed its operating procedure on October 6, 1979. The purported aim of this policy change, of course, was to enable it to hit more nearly its money growth targets. Thus it seems appropriate to consider the post-October 1979 period alone.) The coefficient in the regressions is positive, and, when estimated by Cochrane–Orcutt, is significant at the 90% level. Somewhat stronger results were obtained by Grossman using Treasury bill rates that were recorded at 3:30 p.m. and 5:00 p.m. on announcement days.

Table 3 presents the regression of the change in (the log of) the dollar/mark exchange rate between 12:00 noon the day of the announcement and 12:00 noon the following day, against the monetary announcement forecast error. That is, table 3 tests eqs. (12a) and (12b) of section 2. The coefficient turns out to be negative and highly significant. So, on days when the money supply figures announced are greater than expected, the currency appreciates. This supports money supply process A over B. More generally, it indicates that the nominal interest rate rises because the real rate rises, not because of the expected inflation premium.

4. Conclusion

The announcement phenomenon is a valuable tool for cutting through the web of simultaneous causality that plagues much of empirical macroeconomics. The negative effect that the announcements have on the exchange rate indicates that the market believes that the Fed has been following a steady money growth policy, at least since October 1979. When the money supply grows

more rapidly than had been expected, the market assumes that the Fed will reverse the error in the future, not that it has raised its money growth target. The expectation of future tightening causes the interest rate to rise and the exchange rate to fall.

The results of this paper also shed light on a second issue. It is sometimes claimed that the real interest rate is constant, i.e., that fluctuations in the nominal interest rate mostly consist of fluctuations in the expected inflation rate. Within the framework of the model developed in section 2, the claim is that the speed of adjustment θ is close to infinite. Prices are perfectly flexible. Changes in the nominal money supply or expected inflation rate are reflected immediately in the price level and real money supply, and thus have no effect on the real interest rate. One way people have tested this view of the world is to run a regression of the exchange rate against money supplies, real income levels, interest rates and inflation rates. A significant negative coefficient on the interest rate indicates a rejection of the view that prices are perfectly flexible and that the real interest rate is constant [e.g., Frankel (1979)]. One difficulty with this approach is that there are serious simultaneity problems with considering the interest rate and expected inflation rate as independent variables.

The results in tables 2 and 3, when taken together, provide evidence against the flexible-price view in a context free from simultaneity problems. Given just the positive correlation of monetary announcements and interest rate changes, one could rationalize the flexible-price model by arguing that unanticipated money growth raises expected future money growth, as in money supply process A, and thus raises expected inflation. Given just the negative correlation of monetary announcements and exchange rate changes, one could rationalize the flexible-price model by arguing instead that unanticipated money growth generates the expectation of future contraction, as in money supply process B, thus reducing expected inflation. But the two results taken together can only be explained by granting a role to fluctuations in the real interest rate. Once again: the money growth announcement causes the real interest rate to rise, which explains *both* the rise in the nominal interest rate and the fall in the exchange rate.

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