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In This Issue . . .

Much recent criticism of the Federal Reserve System has focused on the secrecy that surrounds monetary policy decisions. Some observers have suggested that the Fed disclose the Federal Open Market Committee's policy decisions immediately, to prevent it from concealing useful information from the public and to make it more accountable for its actions.

In the first article of this *Review*, "Strategic Considerations in Monetary Policy with Private Information," Seonghwan Oh and Michelle R. Garfinkel illustrate why a central bank may not be able to make credible announcements about its policy decisions precisely even if it would be better off by doing so. The lack of credibility results from the public's knowledge that the central bank gains from "surprising" the public with its monetary policy actions. Oh and Garfinkel show, however, the central bank can make announcements that *imprecisely* reveal its private information. These imprecise or "noisy" announcements will be credible, only if constraints can be imposed on the central bank that limit its policy independence. Hence, the authors argue that, if limiting policy flexibility is costly, the advantages of avoiding secrecy in monetary policy—even partially—must be carefully weighed against the cost of doing so.

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In the second article in this *Review*, Peter Bofinger provides a detailed look at "The German Monetary Unification (Gmu): Converting Marks to D-Marks." The German monetary union represents the first step in uniting two countries with widely disparate economic systems and conditions. Bofinger describes these differences and shows how they influence the choice of the specific conversion rates used to determine the DM values of East German financial claims and income and salary payments previously valued in East German marks.

Bofinger also shows how the debate over the "appropriate" conversion rate was related to a variety of important concerns facing both East and West Germans. Among these were the resulting debt burdens that East German firms would face, the associated wealth transfers between East and West Germany, the impact on the level of West German government debt and the possible effect on the West German inflation rate. Bofinger concludes that the actual conversion rates chosen limit the wealth transfer from West to East Germany to a relatively small amount and make it unlikely that West German inflation will accelerate.

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Conventional wisdom holds that the introduction of new interest-bearing checkable deposits, especially in the early 1980s, had a substantial effect on M1 and its relationship to economic activity. Equally widely shared is the view that these accounts and the subsequent introduction of new money market deposit accounts had little or no effect on the broader monetary aggregates, such as M2. In the third article in this *Review*, "The Effects of Financial Innovations on Checkable Deposits, M1 and M2," John A. Tatom examines this financial innovations hypothesis.

As Tatom explains, the hypothesis implies that the growth of these new checkable deposits should have reduced the turnover of total checkable deposits and boosted the demand both for checkable deposits relative to currency holdings, and for M1. The growth in money market balances should not have affected the composition or demand for M1 and M2.

Tatom finds that these innovations did not have the statistically significant effects predicted by the financial innovations hypothesis. In particular, new interest-bearing checkable deposits had no effect on the turnover rate of total checkable deposits, the demand for total checkable deposits relative to currency, or the demand for M1. Also to the contrary, Tatom finds that M1 and M2 demand were both affected by the introduction of money market balances.

Tatom concludes that analysts of financial innovation effects generally have focused on the wrong innovation and the wrong monetary aggregate. His results indicate that the principal influence of financial innovations has been the substantial effect of money market balances on the demand for M2.

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Seonghwan Oh and
Michelle R. Garfinkel

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Strategic Considerations in Monetary Policy with Private Information: Can Secrecy Be Avoided?

THE FEDERAL RESERVE System has been criticized often for the secrecy that surrounds monetary policy. In particular, many observers have questioned the desirability of the Fed's practice of not disclosing the decisions of the Federal Open Market Committee (FOMC) immediately following its meeting. This criticism has been heightened recently by legislation introduced in the House of Representatives, proposing, among other things, that the Fed release the contents of the FOMC's directives *immediately* after each meeting rather than with a seven-week delay.[1]

The economic rationale behind this proposal is that the Fed's maintained secrecy limits the informational content of prices in financial markets and thereby detracts from the markets' ability to allocate resources efficiently. If, for example, the FOMC voted to maintain its current policy stance but subsequently added reserves to the banking system as a technical and temporary action, market participants might mistakenly interpret such an action as a fundamental change in policy. According to this view, without immediate disclosure of the FOMC's policy directive, confusion about the Fed's intentions can add to the variability of market interest rates.

Those who are skeptical of the value of this legislation argue that immediate disclosure of the FOMC's directive would complicate the implementation of monetary policy.[2] For example, the markets' response to announcements could generate large changes in interest rates that, according to this view, would be excessive and destabilizing.

[1]Lee Hamilton and Byron Dorgan, HR2735-the Federal Reserve Reform Act of 1989. See Hamilton (1989) for a brief discussion of the key changes in the structure of the Fed proposed by this legislation. As discussed by Goodfriend (1986), however, legislation proposed in this spirit is not new.

[2]See, for example, Mooney (1989), Rosenbaum (1989) and Uchitelle (1989). Also, see Goodfriend (1986) for an interesting and useful critique of the arguments made for maintained secrecy at the Fed.

In the context of a relatively simple game-theoretic model of monetary policy, in which the Central Bank would expect to be better off if it had no private information, this article shows why the Central Bank cannot reveal its private information credibly and precisely. The Central Bank might be able to reveal this information partially through imprecise or noisy announcements. From the Central Bank's perspective, however, such announcements are not costless, nor can they remove secrecy from policy perfectly. Hence, the analysis illustrates that, even if the Central Bank perceived monetary policy secrecy as undesirable, fully eliminating it might not be feasible.

STRATEGIC MONETARY POLICY: THE BASIC MODEL

To address issues of secrecy in monetary policy, it is helpful to study a model of monetary policy that specifies the objectives and constraints faced by a Central Bank. Given the particular specification, the model provides a framework for analyzing various strategies for the Central Bank and, in turn, for predicting which strategy is optimal for the Central Bank. The model, a slight variant of Canzoneri (1985), builds on a simple specification of the economy.[3] Output is given by

$$(1)\quad y_t = y^n + (p_t - w_t),$$

where y_t, p_t and w_t denote, respectively, the logarithms of output, prices and nominal wages in time t; y^n denotes the log of output that corresponds to the "natural" rate of unemployment. In this model, the natural level of output is the one that would prevail with a steady rate of inflation.

The public attempts to specify wages so as to minimize deviations of output from its natural level. Accordingly, it wants to set $w_t = p_t$. But, in this model, prices are not known at the time wages are set. Hence, wages are set to satisfy

$$(2)\quad w_t = p_t^e,$$

where p_t^e denotes the public's expectation, as described below, of the log of the price level conditional on information available to the public at the beginning of period t. By combining equations 1 and 2, output can be expressed as follows:

$$(3)\quad y_t = y^n + (\pi_t - \pi_t^e),$$

where $\pi_t = p_t - p_{t-1}$ is the actual rate of inflation in time t; $\pi_t^e = p_t^e - p_{t-1}$ denotes the public's expectation of inflation.

Equation 3 captures the notion that the long-run Phillips curve, which is the relationship (trade-off) between inflation and unemployment, is vertical. On average, unemployment and, consequently, output are independent of both expected and actual inflation. In any period, however, unanticipated inflation can create a wedge between output and its natural level. Specifically, the existence of contracts that fix nominal wages for a specific period means that actual output can depart from its natural level if people underestimate or overestimate the future rate of inflation.[4] The effect of unanticipated inflation on output is only temporary. In this model, it lasts only one period. The variance of output implied by equation 3 is simply the variance of the market's inflation forecast error.

The following simple variation of the quantity theory equation describes how prices are determined in each period given monetary policy:

$$(4)\quad p_t = m_t - y^n + v_t,$$

where v_t denotes an innovation to money demand and m_t denotes the log of the money supply in time t.

Taking the first-difference of equation 4 and rearranging shows how monetary policy affects inflation:

$$(5)\quad \pi_t = g_t - \delta_t,$$

where $g_t = m_t - m_{t-1}$ is the growth rate of money, the Central Bank's policy instrument, and $\delta_t = v_{t-1} - v_t$ denotes a random disturbance. This disturbance, which is bounded between

[3]The model is intended only to be an illustration, not a complete characterization of the economy. Canzoneri's (1985) model resembles that of Barro and Gordon (1983) except that it provides a role for the Central Bank to react to shocks. As will be evident below, this model does not imply that the first-best policy is a constant money growth rule. Rather, it is a contingent money growth rule. See Cukierman (1986) for a helpful review of this relatively new literature on central bank behavior.

[4]That unanticipated inflation can drive output above its natural level would also be implied by the Lucas-type (1973) supply curve. The important feature of this equation—that output, on average, will be independent of inflation—assumes that the public forms expectations rationally. The assumption that the elasticity of output with respect to unanticipated inflation is equal to one is used to simplify the notation and does not affect the qualitative results discussed below except where noted.

$-D$ and $+D$, is assumed to have a zero unconditional mean and a finite, constant variance, σ_δ^2. As revealed by equation 5, the Central Bank's control over inflation is imperfect; inflation depends not only on monetary policy but on the disturbance to money demand. Thus, equation 5 implies that the public's expectation for inflation in time t equals the difference between its expectation of money growth in time t, g_t^e, and its expectation of δ_t, δ_t^e.

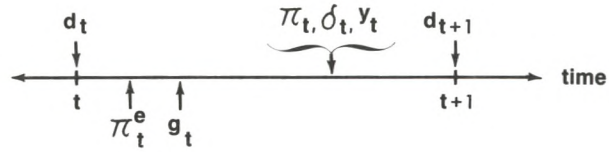
Secrecy arises in this model because, in contrast to the public, the Central Bank has a (nontrivial) forecast of the disturbance to money demand.[5] The Central Bank's "private" forecast, $d_t = E_t\{\delta_t\}$, satisfies

(6) $\delta_t = d_t + \varepsilon_t$,

where $E_\tau\{\bullet\}$ denotes the Central Bank's expectation, based on information available to it at the beginning of period τ, before wage contracts are signed. The Central Bank's forecast error, ε_t, has an expected value of zero, a finite variance, σ_ε^2, and no correlation with the Central Bank's forecast. The assumption that the forecast is independent of the forecast error implies $\sigma_\delta^2 = \sigma_d^2 + \sigma_\varepsilon^2$, where σ_d^2 is the variance of the private forecast.

Although this forecast is made just before wages are set, the markets' expectation of δ_t equals zero without any meaningful announcements by the Central Bank. When the Central Bank does not attempt to convey its private information, $\pi_t^e = g_t^e$. The public observes δ_t *after* policy is implemented when π_t is realized. The public, however, cannot infer from that observation what the Central Bank's forecast had been. Similarly, it cannot identify the Central Bank's forecast error. (See figure 1 which summarizes the sequence of events during any period t.) Nevertheless, people understand the Central Bank's objectives as described below and its constraints subject to the unknown disturbance δ_t; they incorporate that understanding into their expectations of money growth and, accordingly, their wage specification.

Figure 1
Sequence of Events in Period t.



Following Canzoneri (1985), the analysis assumes that the Central Bank has two goals: output and inflation stabilization. Its expected lifetime utility in period t = 1 is given by

(7a) $U_1 = \sum_{t=1}^{\infty} \beta^{t-1} E_1\{u_t\}$, $0 < \beta < 1$

where

(7b) $u_t = -(y_t - y^*)^2 - f(\pi_t - \pi^*)^2$, $f > 0$.

β is the Central Bank's discount factor.[6] The parameter f is the weight the Central Bank places on its objective of stabilizing inflation around its target level, π^*, relative to its objective of hitting its target for the log of output, y^*. These targets are given and fixed parameters.

The Central Bank's inflation target need not be zero. But its objective to stabilize inflation is consistent with the public's objective to forecasting future inflation correctly. In other words, by minimizing the variability of inflation, the Central Bank minimizes the variance of the public's inflation forecast error. The Central Bank's

[5]That the public does not have a forecast of δ_t implies $\delta_t^e = 0$, providing that the Central Bank does not communicate to the public its own forecast. Note that it is not crucial that the public has no forecast of the disturbance to money demand. Provided that the Central Bank's forecast is private, the following analysis is relevant. Furthermore, the private information could be in terms of a forecast about a supply shock or the Central Bank's preferences. The qualitative results to follow would not be affected. Also, it should be noted that the present model differs from Canzoneri's (1985) model in that the timing of the forecast here is such that, if the Central Bank released this information, it could be used by the public. The assumed sequence of events, shown in figure 1, is necessary for the analysis of imprecise announcements below.

[6]Note that equation 7 implies that the Central Bank is infinitely-lived. This assumption is only important for the discussion of reputational considerations below. This discussion would be qualitatively the same if, instead, the Central Bank lived only a finite number of periods, T, provided that T is not known with certainty. In this case, β would reflect the Central Bank's chances of survival as well as its time preference. See Grossman and Van Huyck (1988), for example.

objective to stabilize output, however, is consistent with the public's objective to forecast inflation correctly *only* if the Central Bank's target for output equals the natural level. But, in this case, the interesting issues revolving around monetary policy secrecy do not arise.

As in much of this literature, then, the present analysis assumes that $y^* > y^n$. That is to say, the Central Bank prefers output to exceed the public's target. Possible interpretations of this assumption could stem from either social welfare or self-interest considerations.[7] It is only important for the present analysis that the natural output level or the public's target for output be different than the Central Bank's (given) target. This assumption implies that the Central Bank does not have enough instruments to reach its two goals, giving rise to a credibility problem in policy as illustrated below.

Using equations 3, 5 and 7b and noting that the public's expectations for inflation, π_t^e, equals $g_t^e - \delta_t^e$, the Central Bank's utility in period t can be written as

$$(8)\quad u_t = -(g_t - g_t^e - \delta_t + \delta_t^e - \Delta^*)^2 - f(g_t - \delta_t - \pi^*)^2,$$

where $\Delta^* = y^* - y^n > 0$ and $\delta_t^e = 0$, without any announcements by the Central Bank about its private forecast. The Central Bank's problem is to choose g_t to maximize the expected value of its lifetime utility, after the markets set wage growth equal to expected inflation, π_t^e. The solution depends on how the Central Bank treats the markets' expectations.

The First-Best Solution

To see why the Central Bank might want to disclose its private information (that is, its forecast of the money demand disturbance), consider the benchmark case wherein the Central Bank recognizes the impact it can have on the markets' expectations and d_t is public information. Furthermore, assume that the Central Bank can make binding commitments to pursue an announced policy. In this case, it chooses g_t, subject to the restriction that expectations are consistent with its policy, to maximize its expected lifetime utility. Because of the stationary (time-independent) nature of the model, this maximization problem reduces to a sequence of one-period problems, in which the Central Bank chooses g_t to maximize its expected one-period utility, shown in equation 8, for each period t.

Given the constraint that $g_t = g_t^e$, creating surprise inflation in an effort to increase output above its natural level is precluded. Rather, the Central Bank commits itself to the following policy:

$$(9)\quad \hat{g}_t = \pi^* + d_t,$$

where $\hat{g}_t = g_t^e$ for all t. Note equation 9 implies that, on average, inflation would be equal to the Central Bank's target rate. Because the policy fully accommodates the part of the disturbance to money demand predicted by the Central Bank, $\pi_t^e = \pi^*$ and wage growth is set equal to π^*.[8]

The Central Bank's expected one-period utility in this regime can be found using equations 8

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[7]See Barro and Gordon (1983) and Canzoneri (1985) for a discussion of possible social-welfare interpretations of this assumption. These interpretations build on existing distortions in the economy. For example, the existence of large unions that keep real wages too high or the use of income taxes that influence labor decisions depress average output (or the natural level) below the "potential" level (or that level considered desirable from a social-welfare perspective). Although these distortions could be modeled explicitly here, the associated modifications would add unnecessary complexity to the model without providing much insight into the issues at hand. But see Cukierman (1986) for a useful critique of the social-welfare interpretation. Cukierman (1986) also provides an extensive discussion of a political interpretation. For example, although the Central Bank might be an independent institution, it might feel compelled, in order to preserve its existence or independence, to react to signals by the fiscal authority. The fiscal authority might be motivated to stimulate the economy to enhance its chances for re-election.

[8]In fact, the same outcome would be obtained if the Central Bank's forecast were not known by the public until after wages were set, so that δ_t^e still equaled zero. Because the Central Bank fully accommodates d_t, expected inflation, π_t^e, is independent of d_t in this regime. This is not to say that the Central Bank has no preferences about maintaining the privacy of its forecast. As will become obvious, the Central Bank wants to reveal its private forecast so that it can obtain this outcome. Whether the Central Bank *should* accommodate disturbances to the economy is a matter of controversy. In this model, its motive to react to d_t is compatible with the public's interests. The public prefers the Central Bank to react to its forecast, because such reactions minimize the variance of the public's forecast error. An argument against such a policy, for example, would be that it is destabilizing because the Central Bank's forecasts are inaccurate. As shown below, however, even if its private forecasts are fairly accurate (provided that $\sigma_\varepsilon^2 \neq 0$), the Central Bank might not find it desirable to react to its forecast. (Given σ_ε^2, however, the more accurate the forecast, the less likely the Central Bank would be willing to sacrifice flexibility in policy.) The alternative argument against flexibility in policy in this paper builds on the Central Bank's credibility problem.

and 9, with the assumptions that $g_t^e = g_t$ and $\delta_t^e = d_t$:

(10) $E_t\{\hat{u}\} = -(1+f)\sigma_\epsilon^2 - \Delta^{*2}$,

for all t, where, as defined previously, σ_ϵ^2 denotes the finite variance of the Central Bank's forecast error. It is equal to the variance of inflation and output in this regime. The contingent policy in equation 9 is referred to as the first-best solution since it yields the highest utility to the Central Bank among those policies that are consistent with the public's expectations.

As demonstrated by Kydland and Prescott (1977), however, the policy in equation 9 is not "dynamically consistent." That is, given the public's expectations, the Central Bank has an incentive to deviate from the first-best policy. Specifically, given $\pi_t^e = \pi^*$, the Central Bank would rather implement the following policy:

(11) $g_t^{CH} = \pi^* + d_t + \Delta^*/(1+f)$.

If the Central Bank could create surprise inflation with the policy shown in equation 11, it could augment output above the natural level to approach its target.[9] Such a "cheating" policy would increase the Central Bank's expected one-period utility by $\Delta^{*2}/(1+f)$.

The Myopic Solution

But, even if the Central Bank could break its commitment to follow the first-best policy, cheating would be *impossible* as long as people cannot be fooled. That is, rational people will always anticipate the Central Bank's incentive to cheat, if it cannot make binding commitments.

To consider another solution, one that is more likely to emerge as the equilibrium outcome when the Central Bank has private information, suppose the Central Bank ignores any impact that it could have on the public's expectations. This is not to say that the Central Bank actually fails to understand the impact of its actions on the public's actions that, in turn, influence its own welfare. Rather, given the Central Bank's incentive to cheat, it cannot control the public's expectations directly unless it could somehow be committed to follow an announced policy and to disclose its private information truthfully. Without being able to exploit the dependence of its actions on the public's actions, the Central Bank chooses g_t to maximize its expected one-period utility, shown in equation 8, *as if* it were not trying to influence g_t^e or δ_t^e.

Before the Central Bank sets g_t, the public specifies wage growth equal to its expectations of inflation. Because the public understands the Central Bank's maximization problem, it forms g_t^e by taking an (unconditional) expectation of the Central Bank's first-order condition given by

(12) $-2(g_t - g_t^e - \delta_t + \delta_t^e - \Delta^*) - 2f(g_t - \delta_t - \pi^*) = 0$,

for each t. Even though the Central Bank observes d_t before the public forms its expectations, without any announcements, $\delta_t^e = 0$. Since the public's expectation of g_t equals g_t^e and its expectation of δ_t equals δ_t^e, $g_t^e = \pi^* + \Delta^*/f$.

People recognize the Central Bank's incentive to engineer surprise inflation so as to augment output above its natural level. To protect themselves against a decline in their real wage, then, people specify higher rates of wage growth (equal to g_t^e) than in the first-best solution with commitments. Given that specification, the Central Bank's policy, $\bar{g}_t$, which is referred to here as the "myopic" solution for reasons that will become obvious later, is given by

(13) $\bar{g}_t = \pi^* + d_t + \Delta^*/f$,

for each t. With the myopic policy, the Central Bank fully accommodates its prediction of the money demand disturbance as in the first-best solution. Further, the policy shown in equation 13 validates the public's expectations, implying an average inflation rate equal to $\pi^* + \Delta^*/f$.

When the Central Bank acts as if it were ignoring the impact that it can have on the public's expectations, the best it can do is to follow the policy shown in equation 13. This policy, however, is myopic. Because it essentially ignores the potential benefit of reducing the public's expectations for inflation, it generates an "inflationary bias" for the economy. That is,

[9] The solution in equation 11 is found by substituting $g_t^e - \delta_t^e = \pi_t^*$ into the Central Bank's expected one-period utility function and maximizing that function with respect to g_t. (See the first-order condition below in equation 12.) The Central Bank would follow the same cheating strategy if it had not announced its private information before wages were set. It should be noted that, since such cheating strategies are not consistent with the public's expectations, they are implausible equilibrium strategies and are assumed not to be observed in equilibrium.

inflation, on average, exceeds the Central Bank's target level by Δ^*/f without the benefit of increasing average output above the natural level. It is important to note that the inflationary bias would emerge even if d_t were not private information, as long as the Central Bank did not try to influence the markets' expectations.[10]

The Central Bank's expected one-period utility in this regime can be found by using equations 8 and 13 with $g_t^e = \pi^* + \Delta^*/f$ and $\delta_t^e = 0$:

$$(14)\quad E_t\{\bar{u}\} = -(1+f)\sigma_\epsilon^2 - (1+(1/f))\Delta^{*2},$$

for all t. Because the variance of inflation and output are the same as in the first-best regime, σ_ϵ^2, the only difference between equations 10 and 14, Δ^{*2}/f, is the Central Bank's one-period disutility of the inflationary bias or, equivalently, the inefficiency of taking the market's expectations as given. Note that the larger Δ^* (which reflects the difference between the Central Bank's and the public's target for output) and the smaller f (the Central Bank's preference for inflation stability relative to output stability), the larger is the inflationary bias.

The inflationary bias is not easily avoided without the ability to make commitments. The problem stems from the Central Bank's incentive to create surprise inflation. This incentive to cheat, given expectations, ultimately stems from the insufficient number of instruments available to the Central Bank. In the present model, the Central Bank has two objectives with only one instrument. If it had two independent instruments, the Central Bank could achieve both of its goals simultaneously.[11] Alternatively, if the Central Bank "ignored" its goal of output stabilization or f became infinitely large, then the credibility problem would disappear and there would be no inflationary bias in equilibrium.[12] But, with an insufficient number of instruments, the Central Bank's incentive to surprise the public remains, making the first-best policy dynamically inconsistent and not credible, thereby calling into question the feasibility of the first-best solution.

REPUTATIONAL CONSIDERATIONS

If the Central Bank did not possess any private information, then a legislated rule could be imposed to force the Central Bank to follow the first-best policy. Even if it were not feasible to enforce such a rule, the Central Bank could recognize the importance of its "reputation" to eliminate or mitigate the inflationary bias.[13]

To see why its reputation could be important, suppose the Central Bank announces that it will always follow the first-best policy as shown in equation 9. Further, assume that the public always expects the Central Bank to adhere to that policy, provided that it never has cheated in the past by having deviated from the first-best policy. Through its policy actions, then, the Central Bank can maintain a reputation for not deliberately creating surprise inflation.

If, however, the Central Bank were to cheat, then people would expect the Central Bank to continue to cheat in the future. Once having lost its reputation by cheating, the Central Bank is "punished." Anticipating that the Central Bank will continue to cheat in the future because it has done so in the past, people will incorporate an inflationary bias into their wage specification. Given this specification for expectations,

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[10]In this regime, as in the first-best outcome, expected inflation is independent of d_t, since d_t is fully accommodated by the myopic policy. Nevertheless, because the presence of private information makes it difficult for the Central Bank to avoid the inflationary bias, as discussed below, it would like to be able to reveal its private forecast truthfully and precisely. See, however, Cukierman and Meltzer (1986) who show that the Central Bank might prefer to maintain the secrecy of its private information when it cannot control the growth of the money perfectly. In their analysis, maintained secrecy about its changing preferences permits the Central Bank to engineer inflation surprises when desired.

[11]Actual policy and expected policy are not independent instruments provided that the public is rational and forward-looking. If it were not, however, the Central Bank would optimally announce $g_t^A = g_t - \Delta^*$, where $g_t = \pi^* + d_t$, so that the Central Bank could systematically fool the public. If the public believed that announcement, the Central Bank's expected one-period utility could increase to $-(1+f)\sigma_\epsilon^2$.

[12]If the objective function in (7) were interpreted as a social-welfare function, then the analysis above suggests that appointing a "conservative" Central Banker (i.e., one whose concern about pursuing a goal of inflation stability exceeded that of society) would enhance social welfare. See Rogoff (1985) for a detailed discussion of this point. Indeed, this is the thrust of Representative Stephen L. Neal's recently proposed legislation to make price stability the ultimate objective of the Federal Reserve System (H.R. Res. 409). But also see Neumann (1990) who argues that strengthening the independence of the Central Bank could similarly help to avoid the credibility problem in monetary policy without explicitly imposing a goal of price stability on the Central Bank.

[13]See, for example, Barro and Gordon (1983).

the Central Bank can do no better than to follow the myopic policy shown in equation 13 once having cheated. During the "punishment," the outcome would return to the myopic solution that includes the inflationary bias, Δ^*/f.[14]

In some cases, the Central Bank's concern for its reputation can provide the same result as binding commitments when there is no private information. The critical condition is that the expected long-term gain from eliminating the inflationary bias must always exceed the expected short-term gain that could be realized by creating surprise inflation. The long-term gain is simply the present discounted disutility of the inflationary bias, $\frac{\beta}{1-\beta}\left(\frac{\Delta^{*2}}{f}\right)$. The short-term gain is the difference between the expected one-period utility if the Central Bank were to cheat and the expected one-period utility from adhering to the first-best policy, $\Delta^{*2}/(1+f)$ Note that as the Central Bank's discount factor, β, increases (that is, as it cares more about the future), the expected long-term gain from maintained reputation is more likely to exceed the short-term gain from cheating in the current period. Hence, as β increases, the Central Bank's concern for its reputation is more likely to support the first-best outcome.

Even if reputational considerations were not a perfect substitute for binding commitments to achieve the first-best outcome, they could still diminish the magnitude of the equilibrium inflationary bias. As long as the threat of punishment is sufficiently large, the Central Bank will be induced to adhere to the reputational policy that involves a smaller (if not zero) inflationary bias.[15] Hence, in the reputational equilibrium, cheating is never observed.

The presence of private information, however, greatly complicates this situation, influencing the possibilities for cheating. Specifically, because the public does not observe d_t (the Central Bank's private forecast) directly, it can never be certain that the Central Bank has actually implemented the reputational policy that depends on d_t. The public can easily verify that money growth equals the Central Bank's announced reputational policy. But the public cannot be sure that the Central Bank's announcement about d_t is truthful. Indeed, as shown below, the Central Bank has an incentive to misrepresent its private information.

WHY ARE PRECISE ANNOUNCEMENTS NOT FEASIBLE?

The existence of private information weakens the ability of reputational considerations to achieve the efficient outcome. This can be illustrated by showing that it is impossible to force the Central Bank to adhere to the first-best policy, because the Central Bank cannot make credible announcements that precisely reveal its private information.

Suppose that the Central Bank could be forced to adhere to a specified policy, but could not be forced to reveal its private information credibly and precisely.[16] For example, the following rule might be legislated:

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[14]Making this reputational mechanism effective, in the present model, requires that the Central Bank is infinitely-lived or has a finite but uncertain lifetime, which is consistent with the Central Bank's objective function shown in (7). If the Central Bank were to live a finite and certain number of periods, T, then it would always cheat in the last period, T. But, if the public expects such behavior, the period T outcome would just be the myopic solution. Along this line of reasoning, the solution unravels and the reputational mechanism cannot diminish the inflationary bias below Δ^*/f. Alternatively, if the Central Bank were finitely lived, but its preferences were private information (e.g., the value of the parameter f), the Central Bank could "build" credibility as an inflation-fighter by signaling with monetary policy actions. See, for example, Backus and Driffill (1985).

[15]Suppose, for example, that the Central Bank announces $g_t = k + \pi^* + d_t$, where k is the average inflation in excess of the optimal rate ($0 \leq k \leq \Delta^*/f$) and d_t is public information. (Note that when $k=0$, this policy is simply the first-best one and when $k=\Delta^*/f$ the policy is the myopic one.) Provided that $k<\Delta^*/f$, the temptation for the Central Bank to cheat, given by $(\Delta^2 + f^2k^2 - 2f\Delta^*k)/(1+f)$, will be positive but will decrease as k increases. The general condition for reputational considerations to work is that this temptation be less than the expected gain to maintained reputation given by

$$\frac{\beta}{1-\beta}\left(\frac{\Delta^{*2}}{f} - fk^2\right),$$

which is also positive as long as $k<\Delta^*/f$. This gain also decreases as k increases. Even if the expected present discounted gain from maintained cooperation is smaller than the Central Bank's temptation to cheat for $k=0$, the reputational equilibrium inflationary bias, k, can be less than Δ^*/f, if the temptation decreases faster than the expected present discounted gain as $k<\Delta^*/f$ increases.

[16]That there is no separate mechanism to force the Central Bank to reveal its private information might seem puzzling. For example, in the United States, Congress or the Administration could set up an agency to monitor the Central Bank's activities and take part in formulating monetary policy, whereby the private forecasts can be revealed to the public. Why such an arrangement is not adopted is beyond the scope of this analysis.

(15) $\hat{g}_t^L = \pi^* + d_t^A$,

for all t, where d_t^A denotes the Central Bank's announcement of its private forecast. If that announcement were believed by the public, the public would form the following expectations: $g_t^e = \pi^* + d_t^A$ and $\pi_t^e = \pi^*$. With these expectations, before setting its policy in period t, the Central Bank would announce optimally

(16) $d_t^A = d_t + \Delta^*/(1+f)$.

If the public were to believe the Central Bank's announcement, the Central Bank would be able to disguise its cheating policy (shown in equation 11) as the first-best policy by overstating the value of its forecast.[17] In this case, the Central Bank could drive output above its natural level by $\Delta^*/(1+f)$.

But, as in the case of simple cheating, the Central Bank's incentive to lie, which also fundamentally stems from its incentive to create surprise inflation, will be fully recognized; as a result, no one will believe the announcement. Given that the public cannot determine with certainty whether or not $d_t^A = d_t$, it can do no better than to protect itself from surprise inflation by setting wage growth equal to $\pi^* + \Delta^*/f$.[18]

Because the Central Bank's forecast is private information, a legislative approach depending on that information is not effective in achieving a better outcome than the myopic solution.[19] Similarly, the Central Bank's private information obscures the relevance of reputational considerations to improve upon the myopic outcome. Although people can see whether the Central Bank has implemented its announced policy—for example, the policy shown in equation 15—they cannot verify that its announcement truly reflects the value of its private forecast (that is, $d_t^A = d_t$), unless the forecast were always perfect (that is, $\varepsilon_t = 0$ for all t). Hence, the public cannot evaluate the Central Bank's reputation based on past policy actions.

A CONSTANT MONEY GROWTH RULE AND THE ROLE OF NOISY ANNOUNCEMENTS

Although the Central Bank cannot make credible announcements that precisely state its private information, it can make announcements that have some informational content. In a recent study, Stein (1989) applies the work of Crawford and Sobel (1982) to show that, through noisy announcements or "cheap talk," the Central Bank can reveal its private information partially. In his application, where the Central Bank's private information concerns its objective for the target exchange rate, Stein illustrates how the Central Bank can make announcements of a range in which its target falls. Because the announcement does not state the exact value of the Central Bank's target, it is a noisy announcement. These announcements are a costless form of communication in that no resources are used in making them. But the announcements are credible because the Central Bank would incur an implicit cost if it were to lie. This cost is sufficiently large to induce the Central Bank to reveal its private information truthfully, though not precisely.

An application of Crawford and Sobel's (1982) analysis to the present model, however, shows that noisy announcements might not be as "cheap" as Stein's (1989) analysis would suggest.

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[17] This can be seen by substituting equation 16 into equation 15. To verify that equation 16 is the optimal announcement, substitute equation 14 into the Central Bank's one-period utility function (8) and choose d_t^A to maximize the expected value of (8) subject to the public's expectations $g_t^e - \delta_t^e = \pi^*$. The Central Bank would lie in the same manner if it were not necessary to make its announcement until after the policy was implemented.

[18] To see this, note if the Central Bank were to act on its incentive to create surprise inflation given the public's expectations, it would set its policy optimally to satisfy the first-order condition in equation 12. Rearranging equation 12 and using $E_t(\delta_t) = d_t$, one can verify the following:

$$g_t = \frac{g_t^e - \delta_t^e}{1+f} + \frac{f\pi^* + \Delta^*}{1+f} + d_t.$$

Noting that $g_t - d_t$ equals the Central Bank's expectation for inflation given d_t, $E_t(\pi_t)$, and $g_t^e - \delta_t^e = \pi_t^e$, the expression above implies that

$$E_t(\pi_t) = \frac{\pi_t^e + f\pi^* + \Delta^*}{1+f}.$$

Since $E_t(\pi_t) > \pi_t^e$ for $\pi_t^e \leq \pi^* + \Delta^*/f$, the Central Bank always has an incentive to create surprise inflation unless the public incorporates the inflationary bias Δ^*/f into its wage specification.

[19] Garfinkel and Oh (1990a) have shown how a legislative approach that is independent of the Central Bank's private forecast can achieve a better outcome than the myopic solution studied above. With a multi-period (N periods) average targeting procedure, requiring $\sum_1^N g_t = N\pi^*$, the Central Bank can diminish the magnitude of the inflationary bias that emerges in equilibrium. This procedure is not efficient, however, in that it necessarily limits the Central Bank's flexibility to stabilize output and inflation. Nevertheless, it can permit more flexibility than a strict constant money growth rule.

In contrast to the present model, Stein's model implies that, if it were possible to force the Central Bank to reveal its exchange rate target truthfully and precisely, then the first-best outcome could be obtained. Accordingly, noisy announcements alone can easily achieve a better outcome than no announcements or complete secrecy.

The credibility problem in monetary policy in the present framework, however, is slightly more complicated. As indicated above, even if it were possible to make the Central Bank reveal its private forecast truthfully and precisely, imposing an additional restriction on policy either through a legislative rule or reputational considerations would be necessary to ensure that the Central Bank follow the first-best policy. That is, even if the public's expectations, g_t^e and π_t^e, included information about d_t, the Central Bank would have an incentive to surprise the public (according to equation 12) unless π_t^e also were to incorporate the inflationary bias, Δ^*/f.[20] But the Central Bank has no motivation to reveal d_t if it cannot reduce or eliminate the inflationary bias in doing so. Similarly, the Central Bank's incentive to create surprise inflation would not disappear if it were to make noisy announcements about its private forecast and could contaminate those announcements.

A Constant Money Growth Rule

Because of this incentive to surprise the market with inflation, limiting the degree of flexibility permitted in monetary policy is necessary to ensure that the announcements contain some information while allowing the Central Bank to avoid the inflationary bias. In other words, a rule for monetary policy must be imposed to "tie" the hands of the Central Bank. As indicated above, for this constraint to be effective, the rule must be independent of the private information.[21] For example, legislation could require

(17) $\tilde{g}_t^L = \pi^*$.

Although this constant money growth rule eliminates the inflationary bias, it precludes any (otherwise desirable) reactions to the part of money demand disturbances predicted by the Central Bank.[22] As such, this rule produces a higher variance of the public's forecast error for inflation and, hence, a higher variance of output than in both the first-best and myopic regimes.

The Central Bank's expected utility under this regime without any announcements is given by

(18) $E_t\{\tilde{u}\} = -(1+f)\sigma_d^2 - \Delta^{*2}$,

for all t. Expected utility in this regime will exceed that under the myopic regime only if $\Delta^{*2}/f > (1+f)\sigma_d^2$.

This condition underscores the Central Bank's trade-off between eliminating the inflationary bias and eliminating flexibility in monetary policy with the constant money growth rule. The larger is the inflationary bias that emerges in the myopic outcome (that is, the smaller f and/or the larger Δ^*), the more likely this condition will be satisfied. The Central Bank is less likely, however, to prefer a constant money growth rule over the myopic policy the larger the variance of the component of the money demand disturbance predicted by the Central Bank, σ_d^2, which captures the expected benefit of being able to react to d_t. Because the legislated rule in equation 17 does not permit the Central Bank to react to its forecast of the disturbance to money demand to stabilize inflation, the variance of inflation and output increase to σ_d^2. Nevertheless, if the possible benefits of maintained flexibility are not too large (that is, if σ_d^2 is small), the Central Bank might prefer to be constrained not to react to its private forecast to avoid the inflationary bias.

It is important to note that, even with this rule, the Central Bank still would not precisely reveal its forecast. In particular, given $g_t = \pi^*$, the Central Bank would want to overstate the value of its forecast according to

(19) $d_t^A = d_t + \Delta^*$.

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[20] See footnote 18.

[21] Whether it is possible to enforce a legislated rule is beyond the scope of this paper. Of course, reputational considerations might be able to support the same rule. To simplify the discussion, the analysis assumes that it is possible to enforce a legislated rule that does not depend on the Central Bank's private information.

[22] If there were another shock, say, in the supply equation, and the Central Bank's information about this shock were not private, then the legislated rule could provide flexibility to react to this shock. Moreover, not all flexibility needs to be removed from policy in this model. The constant money growth rule is not the only way to tie the hands of the monetary authority to make the announcements meaningful. The imposition of a multi-period average targeting rule that permits some flexibility would also work; however, with this constraint, the inflationary bias would not be eliminated totally. See Garfinkel and Oh (1990a).

Equation 19 illustrates again that the credibility problem of monetary policy is not easily resolved in the presence of private information. But if d_t were not private information, the Central Bank's expected one-period utility with a constant money growth rule would be

(20) $E_t\{\tilde{u}\} = -f\sigma_\delta^2 - \Delta^{*2}$.

Hence, the Central Bank would prefer to disclose d_t under a constant money growth rule even though it cannot do so precisely.

Noisy Announcements

By making noisy announcements about its forecast, the Central Bank could enhance its own welfare under the rule. Given that it must follow the rule in equation 17, the Central Bank cannot actively pursue its goal to stabilize inflation and output by reacting to d_t. Making noisy announcements, as an alternative policy tool, permits the Central Bank to pursue its goal of stabilizing output. Specifically, the Central Bank could partly influence expectations by announcing a range in which its forecast falls, thereby reducing the variance of the public's inflation forecast error and, in turn, reducing the variance of output.

To take a concrete example, suppose that the Central Bank announces that d_t lies either between $-D$ and a or between a and D.[23] For any announcement to contain some information about d_t, the Central Bank must perceive that lying is costly. The cost, however, cannot be directly imposed by the market upon observing δ_t because, as mentioned earlier, the market cannot infer the true value of d_t from that observation. Rather, the cost of lying about d_t is implicitly contained in how such a lie would affect the market's expectations about d_t.

Suppose the Central Bank were to announce that d_t fell in the higher range, [a,D]. Given that announcement and the money growth rule shown in equation 17, the market forms an expectation about future inflation. This expectation would equal the Central Bank's target rate of inflation, π^*, minus the expected value of d_t given that it lies somewhere between a and D. Call this conditional expectation d^h. On the other hand, if the Central Bank announced that d_t fell in the lower range, [$-D$,a], the market would expect a higher inflation rate equal to the difference between π^* and the expected value of d_t given that it falls somewhere between $-D$ and a. Call this conditional expectation d^L.

If d_t is greater than $-D$ but less than a, then the Central Bank's expected one-period utility by announcing $d_t \in [-D,a]$ must be greater than or equal to that by claiming $d_t \in [a,D]$ for the former announcement to be credible. That is,

(21) $-E_t\{(d^L - d_t - \varepsilon_t - \Delta^*)^2\} \geq -E_t\{(d^h - d_t - \varepsilon_t - \Delta^*)^2\}$.

The inequality in equation 21 would be reversed if d_t were greater than a and less than D. Finally, if $d_t = a$, then the Central Bank must be indifferent between announcing the higher and lower ranges.

This last condition can be used to determine the dividing point of the distribution of d_t, a, such that for all possible values of d_t, the Central Bank's announcement is credible. The determination of the dividing point from that condition ensures that the Central Bank will not act on its motive to lie about the range in which d_t falls. For example, when d_t is in the lower range, the Central Bank will not announce that d_t is in the upper range. If it did so, the public's inflationary expectations would fall by a sufficiently large amount that, in turn, drives output too far from the Central Bank's output target and, hence, renders lying undesirable.

By making noisy announcements about its private forecast while adhering to the constant money growth rule, the Central Bank can enhance its expected utility above what it would be when it simply follows the rule. This is not to say that the Central Bank will always choose to make noisy announcements. As illustrated with a more specific example in the appendix, the Central Bank would prefer to maintain full discretion and secrecy, the more it cares about inflation stability, the less the difference between its and the public's output goals, and the more accurate the private forecast.[24]

The basic intuition here is essentially the same as that used when discussing the merits of a

[23] See the appendix for a more detailed example. Also see Garfinkel and Oh (1990b).

[24] Again, see Garfinkel and Oh (1990b). Their analysis produces a somewhat surprising result: under the conditions that noisy announcements are more likely to be preferred by the Central Bank, the credibility problem is more severe so that, at the same time, these announcements cannot be particularly informative.

simple constant money growth rule over those of the myopic policy. The presence of private information forces the Central Bank to face a new trade-off between removing the inflationary bias and limiting flexibility in policy. But the money growth rule with noisy announcements is more likely to dominate the myopic policy than the rule by itself. Although both output and inflation will have a greater variance in the regime with noisy announcements than in the myopic regime, the variance of output will be smaller in this regime than when the Central Bank simply follows a constant money growth rule. The elimination of the inflationary bias possible with the constant money growth rule, combined with the slight reduction in the variance of output possible with noisy announcements, provide the main benefits that would make abandoning the myopic policy—that is, maintaining complete secrecy with full discretion—desirable from the Central Bank's perspective.

CONCLUDING REMARKS

This article has examined the possibility of fully or at least partially removing secrecy in monetary policy. In the context of a model in which the Central Bank has an incentive to create surprise inflation, the Central Bank would like to reveal its private information, whereby it could easily avoid an inflationary bias. The Central Bank's private information combined with its incentive to surprise individuals gives rise to a credibility problem in monetary policy that is nearly impossible to resolve. Neither reputational considerations nor binding commitments to force the Central Bank to adhere to the first-best policy are effective in improving upon the myopic solution if the public never directly observes the Central Bank's private information.

Although the Central Bank cannot make precise announcements, it can make announcements that partially reveal its private information. By announcing a range in which its forecast falls and adhering to the constant money growth rule, the Central Bank can avoid the inflationary bias and influence the market's expectations in a discrete way to lower output variability below that generated by a simple constant money growth rule alone. Nevertheless, some secrecy remains.

Moreover, the Central Bank might prefer to maintain complete secrecy. Unlike Stein's (1989) result that there is always room for improvement with noisy announcements, in the context of the more general model developed here, noisy announcements require constraints on flexibility that can be permitted in the conduct of monetary policy—for example, a legislated constant money growth rule. The constraints are costly if they preclude desirable reactions to disturbances in the economy.

More generally, the analysis suggests that legislation requiring the Fed to disclose the FOMC's decisions immediately after its meeting might be of little value. If the Central Bank has private information about the economy that influences its decisions and has an incentive to surprise the public, it will not release this information truthfully and precisely. The Central Bank's incentive to misrepresent its private information detracts from the value of any information it releases.

That noisy announcements can work in enhancing the efficiency of monetary policy only under restrictive conditions prompts a general but more fundamental conclusion. In the presence of private information, the Central Bank faces a trade-off between higher-than-desired average inflation and limited flexibility. Without eliminating the ultimate source of the credibility problem—namely, that the Central Bank has too few tools to achieve its ultimate goals—this consequence of the strategic considerations of monetary policy is not easily avoided.

REFERENCES

Backus, David, and John Driffill. "Inflation and Reputation," *American Economic Review* (June 1985), pp. 530-38.

Barro, Robert J., and David B. Gordon. "Rules, Discretion and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics* (July 1983), pp. 101-21.

Canzoneri, Matthew B. "Monetary Policy Games and the Role of Private Information," *American Economic Review* (December 1985), pp. 1056-70.

Crawford, Vincent P., and Joel Sobel. "Strategic Information Transmission," *Econometrica* (November 1982), pp. 1431-51.

Cukierman, Alex. "Central Bank Behavior and Credibility: Some Recent Theoretical Developments," this *Review* (May 1986), pp. 5-17.

Cukierman, Alex, and Allan H. Meltzer. "A Theory of Ambiguity, Credibility, and Inflation under Discretion and Asymmetric Information," *Econometrica* (September 1986), pp. 1099-128.

Garfinkel, Michelle R., and Seonghwan Oh. "Strategic Discipline in Monetary Policy with Private Information: Optimal Targeting Periods," UCLA Working Paper No. 584 (January 1990a).

_____. "When and How Much To Talk: Credibility and Flexibility in Monetary Policy With Private Information," Federal Reserve Bank of St. Louis Working Paper No. 90-004 (June 1990b).

Goodfriend, Marvin. "Monetary Mystique: Secrecy and Central Banking," *Journal of Monetary Economics* (January 1986), pp. 63-92.

Grossman, Herschel I., and John B. Van Huyck. "Sovereign Debt as a Contingent Claim: Excusable Default, Repudiation, and Reputation," *American Economic Review* (December 1988), pp. 1088-97.

Hamilton, Lee H. "Regulating the Federal Reserve Board," *Christian Science Monitor*, October 20, 1989.

Kydland, Finn E., and Edward C. Prescott. "Rules Rather than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy* (June 1977), pp. 473-91.

Lucas, Robert E., Jr. "Some International Evidence on Output-Inflation Tradeoffs," *American Economic Review* (June 1973), pp. 326-34.

Mooney, Richard E. "Don't Fiddle with the Fed," *New York Times*, October 3, 1989.

Neumann, Manfred J.M. "Precommittment to Rules in Monetary Policy: A Comment," in Michael T. Belongia, ed., *Monetary Policy on the 75th Anniversary of the Federal Reserve System*, Proceedings of the Fourteenth Annual Economic Policy Conference of the Federal Reserve Bank of St. Louis (Kluwer Academic Publishers, forthcoming).

Rogoff, Kenneth. "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics* (November 1985), pp. 1169-89.

Rosenbaum, David E. "Little Chance Seen for Bills on Fed Rein," *New York Times*, October 10, 1989.

Stein, Jeremy C. "Cheap Talk and the Fed: A Theory of Imprecise Policy Announcements," *American Economic Review* (March 1989), pp. 32-42.

Uchitelle, Louis. "Moves On in Congress to Lift Secrecy at the Federal Reserve," *New York Times*, August 24, 1989.

Appendix
Why Not Complete Secrecy?—An Example

This appendix illustrates with a simple example how noisy announcements work and under what conditions the Central Bank would prefer to use them rather than not reveal anything about its private forecast. For simplicity in what follows, suppose that δ_t has a uniform distribution bounded by $-D$ and D.[1] Consider the simplest example where there is only one dividing point, a_1, over that distribution.[2] Then, given an announcement by the Central Bank, say, that d_t falls in the lower range, $[-D,a_1]$, and (17) in the main text, the public will form expectations according to the following:

$$\text{(A1)}\quad \pi^e(-D,\, a_1) \;=\; \pi^* \;-\; \frac{-D+a_1}{2}\,.$$

With this influence on the public's expectations, it is important to ensure that the Central Bank will announce the correct range. For example, if $d_t \in [-D,a_1]$, the Central Bank should not announce $d_t \in [a_1,D]$. To guarantee that the Central Bank will not misrepresent the range in which d_t falls, it must always be indifferent between announcing the ranges, $[-D,a_1]$ and $[a_1,D]$ when $d_t = a_1$.

Formally, this condition, called the "arbitrage condition," is written as

$$\text{(A2)}\quad E_t\{\tilde{u}([-D,a_1],\, d_t)\} = E_t\{\tilde{u}([a_1,D],\, d_t)\},$$

or equivalently,

$$-E_t\{(\frac{-D+a_1}{2} \;-\; a_1 - \varepsilon_t - \Delta^*)^2\} \;=$$

$$-E_t\{(\frac{D+a_1}{2} \;-\; a_1 - \varepsilon_t - \Delta^*)^2\},$$

where $d_t = a_1$. For this condition to be satisfied, a_1 must equal $-2\Delta^*$.

The basic idea here is that, given that the Central Bank must follow the constant money growth rule, its incentive to lie depends on its

[1]Hence, the probability that $\delta_t = \bar{\delta}$, where $\bar{\delta}$ is any possible realization of δ_t, is the same for any value of $\bar{\delta}$: 1/2D. The distributions of d_t and ε_t are not specified here. They need only be independent random variables with zero means and finite variances that sum to the variance of δ_t. See Crawford and Sobel (1982) for a more general analysis of the noisy announcement equilibrium.

[2]See Garfinkel and Oh (1990b) for a derivation of a more general noisy announcement equilibrium of size n in this framework. (In this particular example, with $n=2$, $a_0 = -D$ and $a_2 = D$.)

forecast. The dividing point a_1, determined from the arbitrage condition, implies that if the Central Bank were to overstate the value of its forecast, when $d_t < a_1$, it would have to do so by an amount so large that it is too costly to lie.

Note that the dividing point is such that for $d_t < a_1$ the announcement is more precise—that is, informative. More generally, when there are n steps, the subintervals become longer as they move away from the lower bound. For example, consider when there are two dividing points, a_1 and a_2. In this case, the arbitrage condition requires $a_1 = -D/3 - 4\Delta^*$ and $a_2 = D/3 - 4\Delta^*$. The length of the first interval from $-D$ to a_1 equals $2D/3 - 4\Delta^*$; the length of the next interval equals $2D/3$; and, the length of the last interval equals $2D/3 + 4\Delta^*$. When the disturbance is smaller (closer to $-D$), the Central Bank's incentive to overstate the value of the forecast is smaller.

Although a constant money growth rule is not first-best in that it does not permit (otherwise desirable) reactions to the Central Bank's forecasts of money demand disturbances, it does eliminate the inflationary bias. When the Central Bank also makes noisy announcements, it can enhance its expected welfare above that with a simple constant money growth rule. With only one dividing point, its expected one-period utility is given by:

$$\text{(A3)}\quad \tilde{u} = -(6\,\Delta^{*2} + D^2(f + \tfrac{1}{4}))/3,$$

which is always greater than the Central Bank's utility when it simply follows a constant money growth rule, provided that $\Delta^* < D/2$.[3] Note that this condition will be satisfied by the requirement that $a_1 > -D$. More generally, noisy announcements with any number of dividing points (greater than or equal to 1) will always be better than a simple constant money growth rule provided that the first step is greater than $-D$.[4]

In addition, the Central Bank's utility under this regime can be greater than that under the myopic regime. In the present example, this condition is given by

$$\text{(A4)}\quad D^2(\alpha^2(1+4f) - 3(1-\alpha))/12 \;<\; \Delta^2(1-f)/f,$$

where $\alpha^2 = \sigma_d^2/\sigma_\delta^2$ with $0 < \alpha < 1$.[5] The parameter α captures the degree of accuracy of the Central Bank's forecast. As α approaches 1, the Central Bank's forecast is generally more accurate.

The condition in (A4) is weaker than that for a strict rule to dominate the myopic policy. Nevertheless, this condition is quite strong, reflecting the idea that, although the inflationary bias can be avoided, the resulting loss of flexibility in this regime can be costly. In fact, when the monetary authority's forecast is extremely accurate (that is, α approaches 1), a sufficient condition for the myopic policy to dominate the constant money growth rule with noisy announcements and one dividing point, a_1, is simply that $f > 1$. If the Central Bank cares more about inflation stability than about output stability (and its forecast is extremely accurate), then it will not prefer noisy announcements, with a_1, over the myopic policy. When α is close to 1, it can be shown that, given that $f > 1$, noisy announcements with any number of partitions will not be desired by the Central Bank.[6]

Nevertheless, noisy announcements might enhance the Central Bank's utility if $f < 1$. Even if a strict constant money growth rule without

[3]See Garfinkel and Oh (1990b), who show that, for a general noisy announcement equilibrium of size n, the Central Bank's expected one-period utility is given by $\tilde{u}_t = -(\Delta^{*2}(n^2+2) + D^2(f + 1/n^2))/3$. Under the specifications for the distribution of δ_t, the one-period expected utility for the Central Bank is $-(1+f)\,D^2/3 - \Delta^{*2}$ when it follows a simple constant money growth rule. This can be easily verified by either using the above expression for expected utility with $n = 1$ or by using equation 18 and noting that the variance of a random variable which has a uniform distribution bounded by x_1 and x_2 is given by $(x_2 - x_1)^2/12$.

[4]This no-nonsense condition is automatically satisfied by the requirement that the partition equilibrium of size n is feasible. See Garfinkel and Oh (1990b).

[5]In the myopic regime, the Central Bank's one-period expected utility is $-(1+f)(1-\alpha^2)D^2/3 - (1+(1/f))\Delta^{*2}$ since, by the definition of α, $1 - \alpha^2 = \sigma_\varepsilon^2/\sigma_\delta^2$.

[6]See Garfinkel and Oh (1990b). The intuition here, as discussed in the main text, follows simply from the trade-off between the benefits of reducing the inflationary bias and the benefits of maintained flexibility. Assuming that α is sufficiently close to 1, the larger is f, the smaller is the inflationary bias that emerges in the myopic regime and the smaller is the benefit of avoiding the inefficiency of that bias relative to the expected costs of not reacting to money demand disturbances. In the case that the elasticity of output with respect to unanticipated inflation were not equal to 1, the sufficient condition for the Central Bank to prefer the myopic policy is that f be greater than the square of that elasticity. The smaller that elasticity, the greater the likelihood of the Fed preferring the myopic policy. For example, if the elasticity were equal to 1/2, then $f > 1/4$ would imply that the myopic policy dominates the constant money growth rule with noisy announcements.

any announcements does not dominate the myopic policy, there can be room for improvement with noisy announcements and the strict rule. In the case of one dividing point, there can be room for improvement provided that $f < 1/2$ even when the private forecasts are extremely accurate (that is, α is close to one). More generally, the condition in equation A4 implies that noisy announcements are more likely to be preferred over no announcements with full flexibility in monetary policy, the less accurate the Central Bank's forecast (when there is a smaller desire for flexibility in monetary policy). Further, the larger the difference between the output goals of the Central Bank and the public and the smaller the Central Bank's relative preferences for inflation stability, the Central Bank is less likely to prefer complete secrecy over noisy announcements.

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The German Monetary Unification (Gmu): Converting Marks to D-Marks[1]

THE MONETARY and economic unification of the East and West German economy is a task without precedent in peacetime economic history. It not only merges two countries with strongly divergent income and productivity levels, but also unifies two economies with radically different economic structures—the German Democratic Republic's (GDR) centrally planned economy and the Federal Republic of Germany's (FRG) "social market economy." Although conventional wisdom calls for gradualism in the process of monetary and economic unification of capitalist economies and in the transition process from socialism to a market economy, in the German case, these tasks will be accomplished virtually overnight.[2]

The legal basis for the unification process is the treaty ratified by the East and West German parliaments on June 21, 1990, which took effect on July 1, 1990. The agreement outlines the principles for monetary union, the economic and social community of the two states and the fiscal reform of East Germany.

The arrangements for monetary union, which involved the replacement of the East German "Mark" (M) by the West German "Deutsche Mark" (DM), established the rates at which East German financial stocks and flows would be converted from their Mark values to D-Mark values. A 1M:1DM rate was applied to East German wages, salaries, rents, leases and pensions. Savings accounts of GDR citizens were converted at a 1M:1DM rate up to a limit of M 4,000 (approximately $2,425 at the current DM/$ exchange rate) for persons between 15 and 59 years of age. The corresponding limit

[1]At the present time, discussion and analysis of the Gmu has appeared primarily in German newspapers. I do not quote these articles explicitly in the paper. Publications of the Deutsche Institut fuer Wirtschaftsforschung, Berlin, of Norbert Kloten, Karl Otto Poehl, Helmut Schlesinger and Horst Siebert provided valuable insights and analysis. I have profited from many discussions with Norbert Kloten and members of the Research Department of the Federal Reserve Bank of St. Louis and of the Volkswirtschaftliche Abteilung der Landeszentralbank in Baden-Wuerttemberg.

[2]For the standard arguments, see Committee for the Study of Economic and Monetary Union (1989), ("Delors Committee"). In the debate on economic transformation of socialist countries see, for instance, Daviddi and Espa (1989). There seems to be, however, a growing awareness that partial reforms generate only limited success; see Roe and Roy (1989).

was M 6,000 for older persons and M 2,000 for younger persons. A 2M:1DM rate was used to convert all other financial assets and liabilities of GDR residents. Mark assets held by individuals who live outside the GDR were converted at a 3M:1DM rate.

The legal framework for the economic community between the two states and for the transformation of East Germany's economic order involves nearly a complete adoption of the FRG's economic laws and regulations by East Germany. These changes include the restoration of private property and competition in East Germany and the free movement of goods, services, labor and capital between East and West Germany. In addition, social welfare, pensions, unemployment and health insurance programs similar to those in West Germany were introduced into East Germany; any deficits in these new programs will be financed temporarily by the FRG. Pensions in East Germany were converted to DM values based on net East German incomes; an East German worker can receive a maximum pension of 70 percent of his or her net income after 45 years of employment. The agreement also guarantees that the DM value of East German pensions cannot fall below their former Mark equivalents.

Under the agreement, the East German government will abolish its old system of high tax levies on state enterprises and introduce, instead, a system of income and value added taxes consistent with those of West Germany. Future debt issues by the GDR government must be issued directly via the Deutsche Bundesbank or with its approval. The FRG will finance two thirds of the East German deficits from 1990 through 1994. For this purpose, a "German Unity" fund of DM 115 billion was launched; it will be financed by a combination of bond issues (DM 95 billion) and expenditure reductions in the FRG central government budget (DM 20 billion).

GOALS AND PROBLEMS OF THE GMU

The paper starts with a short analysis of the economic situation in East Germany after the fall of the Wall. It tries to identify both the goals of the East German people and those of the West German government which together have led to the present unification of both Germanys. A brief outline of the reforms necessary to transform the East German economy are discussed first. The rest of the paper focuses on monetary unification, certainly the most controversial issue in the debate over unification.

The East German Economy After the Wall Fell

The deep economic malaise of the East German economy provides a good example of the general failure of the centrally planned economic systems of Eastern Europe.[3] Prior to World War II, the part of Germany that now makes up the GDR was essentially as developed as those regions which now constitute the FRG. Data for 1936, for example, show that per capita income was 993 Reichsmark in the East and 996 Reichsmark in the West.

Today, of course, it is not as easy to assess the relative per capita incomes of the two Germanys. The GDR's administratively-set domestic prices and exchange rates do not accurately reflect its economic conditions; consequently, "official" data, when available, must be treated with skepticism. For example, the East German Statistical Office recently published the first official income estimate for East Germany; it reported that GDP was M 353 billion for 1989.[4] Most West German estimates of the GDR's 1989 GNP range from M 280 billion to M 300 billion.[5] If a 1M:1DM conversion rate is used with these estimates, the GDR's 1989 per capita income was somewhere between DM 15,000 and DM 21,000,[6] only about half of that estimated for

[3]See the detailed report of the Institute for International Finance (1990).

[4]Data for the GNP are not available.

[5]The lower figure is an estimate of the Kiel Institute for World Economics; the higher figure was estimated by the five leading economic research institutes of the Federal Republic in their report of April 12, 1990.

[6]At the present DM/Dollar exchange rate of about 1.65 DM per Dollar, this equals $9,000 to $13,000. For comparison, 1989 per capita income in the United States was $21,000.

Table 1

Basic Data for East and West Germany (1988)

	Unit	East Germany	West Germany
Area	thousands of sq. miles	41,768	96,094
Population	thousands	16,675	61,715
Employment	thousands	8,594	27,306
Agriculture[1]	% of total	11	5
Manufacturing[1]	% of total	47	40
Services[1]	% of total	25	36
Trade and transport[1]	% of total	18	19
GNP	Mark/D-Mark billion (1989)	280-350	2,260
GNP per capita	Mark/D-Mark (1989)	17,000-21,000	36,600
Gross monthly salary	Mark/D-Mark	1,250	3,192
Net monthly salary	Mark/D-Mark	1,050	2,153
Monthly social security retirement benefits	Mark/D-Mark	450	1,597
Labor productivity as a percent of West German labor productivity		49	100

[1]Data are for 1987.

SOURCES: Official statistics of the GDR compiled by the Deutsche Bundesbank and Deutsches Institut fuer Wirtschaftsforschung.

the FRG (DM 36,600) in 1989 (table 1). Thus, despite East Germany's good educational system, its per capita income and, by proxy, its labor productivity, is estimated to be, at best, only half that of West Germany.[7] Of course, these comparative productivity figures are likely to prove misleading if used to predict what might occur after unification takes place; for example, GDR products previously produced and sold under a central plan designed to achieve autarky may not be able to compete effectively with goods that can now be imported from the West.

The economic disparity between the FRG and the GDR is further demonstrated by the extremely high environmental pollution in East Germany, its obsolete infrastructure, outdated manufacturing plants and the generally poor quality of its housing stock. Another indication of the disparity between the two Germanys is shown by the relatively high proportion of total employment devoted to agriculture and manufacturing in the GDR (58 percent) compared to that in the FRG (45 percent); indeed, the GDR's current proportion of employment in agriculture and manufacturing is roughly identical to that which prevailed in the Federal Republic over 20 years ago.[8]

In the past, the large difference in living standards between the two German states could be maintained only by the GDR's actions to close its borders with the West and prohibit virtually all unauthorized movement of labor, capital, goods and services between East and West Germany. Since the border became permeable in autumn 1989, more than 2000 East German citizens have moved into West Germany daily;

[7]The 50 percent estimate for the GDR's relative labor productivity was made by the Deutsches Institut fuer Wirtschaftsforschung, Berlin, in 1987 for the year 1983. It is nearly identical to Collier's (1985) estimate of 54 percent and to cross-country comparisons (see Cornelsen and Kirner (1990)). However, the Kiel Institute for World Economics estimates that GDR labor productivity is only about 35 percent of West German levels.

[8]See Gerstenberger (1990).

as a result, between then and the first several months of 1990, the GDR's population decreased by about 500,000 persons.

This massive exodus was possible only because the West German constitution grants citizenship status to all East Germans. Among other things, this allowed East Germans who moved to West Germany to obtain immediate social benefits (unemployment benefits, retirement insurance and aid to the disadvantaged) that are tied to West German income levels. FRG unemployment payments, for example, are about 68 percent of West German net incomes; in comparison, net incomes in the GDR are only about one-third of that in the FRG.[9] The substantial difference between West German unemployment benefits and East German income levels explains, in part, the massive migration of East German workers. However, these specific incentives were eliminated on July 1, 1990, when the social community between both states was established. From that date, all social benefit payments to East Germans will be based on East German income levels, not on those in West Germany.

The migration of many skilled workers to the FRG caused the economic situation in the GDR to substantially deteriorate. Since November 1989, GDR industrial production and employment has decreased and most East German enterprises have been unable to fulfill their production plans. By the end of April 1990, industrial production was 4.5 percent below its level one year before, and the number of employed persons had fallen by 4.6 percent. Shortages of goods and services produced growing social unrest in East Germany.

The Disparate Goals of East Germans and West Germans

Given the circumstances described above, the goals of the GDR population are quite evident: They want to improve their relatively low standard of living as quickly as possible. Given the disappointing economic results associated with socialism, they were generally unwilling to experiment with a system part-way between socialism and capitalism. They chose, instead, immediate and complete integration with the Federal Republic of Germany even though they knew that it would require total restructuring of the East German economic and political systems.

The extreme political uncertainty in the GDR after the Wall fell, the obvious desire of the East German population to unify both countries and the massive outflow of East Germans into West Germany, which aggravated housing problems in the FRG, left little room for political maneuvering in West Germany and little time to find a solution that would satisfy both East and West Germans. Legally, of course, West Germany could not oppose rapid unification; the West German constitution (Article 23 of the "Basic Law") explicitly permits the East German states to join the Federal Republic without requiring the consent of either the West German Government or its Parliament. This excluded a variety of possible partial solutions and gradual approaches.[10]

Therefore, the main task facing West Germany was to design a unification strategy that would restore the confidence of East Germans in the future prospects of East Germany and, at the same time, be compatible with the chief interests of West Germans. Consequently, the debate in West Germany focused on the possible costs of the unification process. Among the costs mentioned were:

1. The possible increase in the West German inflation rate,
2. The prospects of either higher taxes or higher interest rates (due to increased FRG borrowing) resulting from increased FRG expenditures for East Germany, and
3. The wealth transfer from West Germans to East Germans associated with the replacement of Mark-denominated savings and currency in the GDR by DM-denominated monetary assets.

Once the actual conversion rates are chosen, it is possible, albeit tentatively, to assess the impact of monetary unification on matters that concern the East and West Germans. The ten-

[9]Pensioners moving to West Germany received an average pension of DM 1,121 (1988), more than twice the average East German pension in Marks.

[10]In fact, almost all West German economists as well as the Bundesbank preferred a more gradual approach involving either flexible or fixed exchange rates between the two currencies as an intermediate stage during the period of economic transformation in the GDR.

tative nature of the assessment is chiefly due to the absence of reliable data on the East German economy and to the simultaneity of the monetary and political integration with the transformation of the East German economy. The short-term focus of the analysis should not lead to the impression that the risks and problems associated with unification of the two Germanys are either substantial or pervasive. The strong overall consensus in both German states is that the long-term prospects of unification are positive and that East Germany has the potential to repeat the "economic miracle" achieved by West Germany from the 1950s to the present.[11]

REAL SECTOR REFORM

Although this paper focuses primarily on monetary unification, a brief discussion of the economic reforms necessary in the real sector of the GDR economy is needed. The Gmu itself will not improve the economic situation in East Germany substantially; it can provide, however, a sound monetary framework for an overall restructuring of the GDR's economic and legal system.

A cornerstone of real sector reform in the GDR will be the introduction of free-market pricing and production. Previously, most production and prices had been set by government agencies in accordance with their central plans. One consequence of this system—as in many other socialist countries—was that these prices had been held essentially unchanged for years despite changes in demand and cost conditions.[12] For example, the GDR's official index for consumer prices has shown virtually no movement over the entire post-World War II era.

Moving to a market-based economy will require a number of changes. First, the current pricing structure is distorted by large subsidies for some industries, especially food and energy (their subsidies totaled M 50 billion in 1988, about one-third of total private expenditures in the GDR) and heavy taxes on other industries, primarily consumer durable goods (the tax totaled M 43 billion in 1988). These distorting influences on prices will have to be reduced.

Second, the central planning approach to pricing and production must be replaced by the usual market mechanisms that determine these decisions in free-market economies. Not only must prices be set by market conditions rather than by government bureaucrats, but also the extensive system of state-owned enterprises must be privatized as well. In order for market prices and wages to successfully provide the signals for reallocating resources, the traditional "soft budget constraint" of state-owned enterprises has to be replaced by the "hard budget constraint" of profits, losses and, if necessary, strict bankruptcy laws.[13]

Third, the "Kombinate," which are conglomerates of GDR firms that produce similar products, have created an extremely high degree of horizontal concentration in the GDR economy; this has contributed to the GDR price inflexibility discussed previously. Consequently, price reform requires that these "Kombinate" be dismantled as soon as possible. However, even if this is not immediately forthcoming, the introduction of the freely convertible D-Mark will create a more competitive environment because it will significantly open up the GDR's economic relations with West Germany and the rest of the world.

Thus, while there are many open questions concerning specific details of how the divergent legal systems will be reconciled and how privatization will be achieved, there is wide acceptance that these are the central elements of real sector reform and that they will take place.[14]

DETERMINING THE EAST GERMAN-WEST GERMAN MONETARY CONVERSION RATE: PRINCIPLES AND PROBLEMS

As noted previously, the major controversy over unification focused on monetary unification—that is, how to determine the rates at which GDR financial stocks and flows denominated in Marks would be converted into their appropriate D-Mark values. The main reason for the intensive debate was that none

[11]See Institut der deutschen Wirtschaft (1990).

[12]See the survey conducted by Commander and Coricelli (1990).

[13]See Sokil and King (1989).

[14]See e.g. "Reform" (1990).

of the existing exchange rates between the Mark and the D-Mark seemed relevant for determining the D-Mark value of GDR financial stocks and flows after unification. In this respect, the Gmu is quite different from the formation of a monetary union between two or more market economies. For instance, the appropriate conversion rate was easily determined when Saarland, which had become independent from Germany after the World War II, was unified with the FRG in 1959. In this instance, Saarland's financial flows and stocks, which had been denominated in French Francs prior to unification, were simply converted to their DM values at the prevailing market exchange rate between the Franc and the D-Mark.

In the case of Gmu, however, all existing exchange rates were either highly distorted or essentially devoid of economic significance. The same criticism applies to the macroeconomic data that might otherwise have been used to calculate an "equilibrium exchange rate" on the basis of the traditional exchange rate models.[15]

The Flaws with Using Existing Exchange Rates for Conversion

After the fall of the Wall, the one market exchange rate between Mark and D-Mark was the DM price for Mark bank notes that had been illegally "exported" from the GDR to West Germany. However, this rate, which is shown in figure 1, is not representative of the underlying fundamental relative price of Marks in terms of DMs for several reasons. First, it was subject to speculative influences which made it very volatile.[16] Second, it reflected demands by East Germans for certain goods (e.g., consumer electronics and coffee) that were highly taxed in the GDR; table 2 shows that the Mark prices of these products in the GDR were about five times higher than their D-Mark prices in West Germany. Third, the arbitrage (flow) of subsidized East German products to the West has remained relatively weak due to transaction costs and trade restrictions.

Another possible candidate for the "true exchange rate" to use for conversion purposes might have been the so-called "Devisenrentabilitaet" (foreign exchange profitability) of GDR exports in terms of their DM equivalent. This rate is calculated by dividing the Mark value of the aggregate GDR exports by their DM revenue when they are sold to West Germany. In 1989, this ratio, which was used by the GDR government for all internal conversion calculations, was 4.4 Marks per DM. Again, however, this ratio does not indicate what the market exchange rate would be. First, the domestic prices of many GDR export products were artificially high due to taxes imposed by the GDR; consequently, the numerator of the ratio is heavily influenced by tax policy, not economic values. Second, export decisions were made by the GDR government primarily to obtain foreign exchange to finance its imports. It is evident that this non-market allocation process, which is typical of centrally planned economies,[17] is not representative of market-based trade; among other consequences, it can lead to exports with very low profitability.[18]

A third alternative is the official 1M:1DM exchange rate set in the past by the East German Government.[19] Like all such official exchange rates established in socialist countries, this was an arbitrary rate used primarily as an accounting unit which embodies no useful economic information relevant to determining the rate to use for Gmu conversion purposes.[20] All foreign exchange transactions were conducted at flexible (implicit) exchange rates which were the ratios of the internal Mark price to the world market DM price of each product.[21]

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[15]See Frenkel and Goldstein (1986), Williamson and Miller (1987).

[16]It varied from 16:1 (November 17, 1989) to 3:1 after the definitive conversion rate for non-GDR residents had become public.

[17]See Wolf (1985b, pp. 215).

[18]See Cornelsen and Kirner (1990).

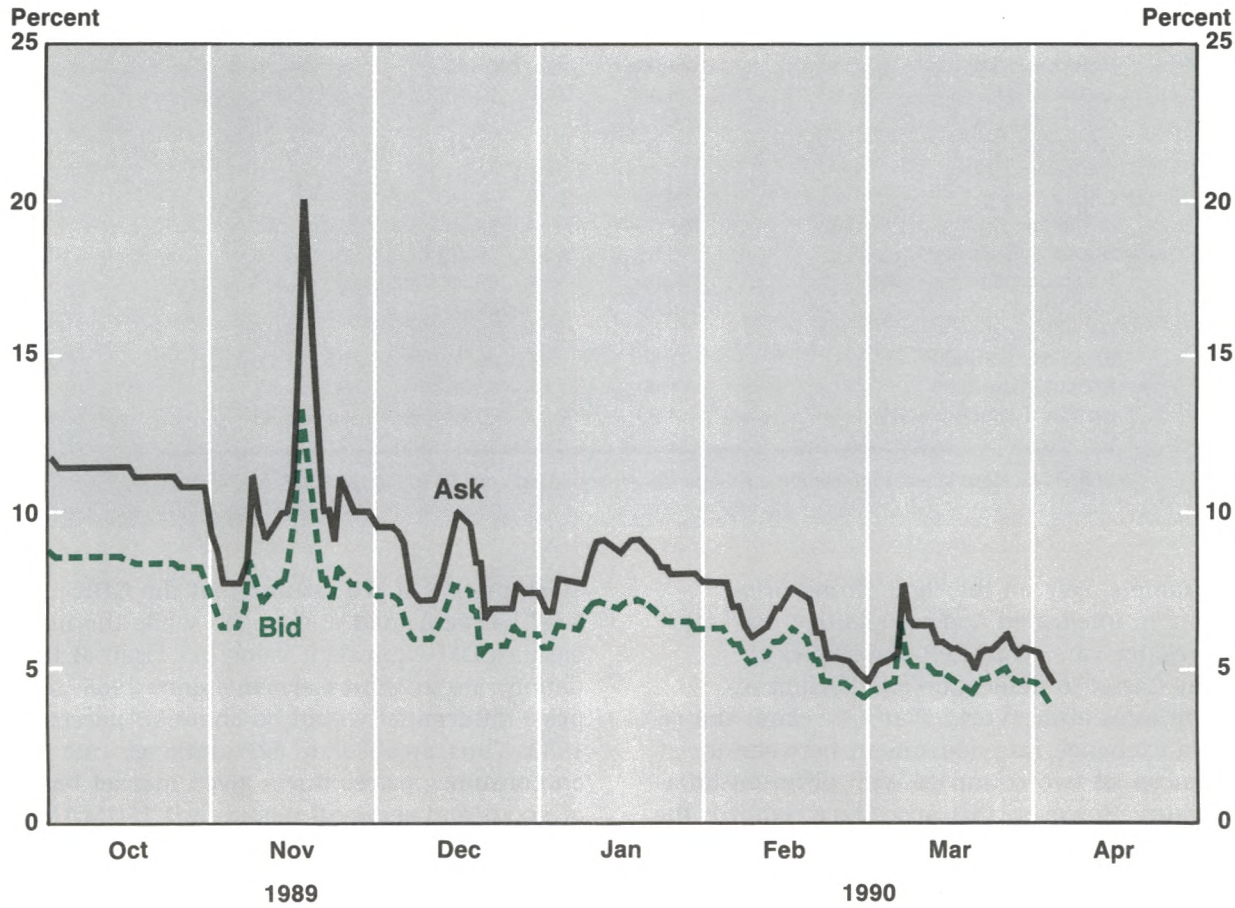
[19]Until 1989, this rate was also used for the "forced exchange" ("Zwangsumtausch") of DM 25 for West Germans who wanted to visit East Germany. From the beginning of 1990, West German travelers could exchange D-Marks at a 1:3 rate against Marks.

[20]The same criticism applies to the exchange rates agreed to by the East and West German governments in December 1989 when they established a fund to exchange bank notes for travel: Each East German citizen was entitled to purchase up to 100 DM at a 1DM:1M rate and an additional 50 DM at a 1DM:5M rate.

[21]See Wolf (1985b).

Figure 1
Exchange Rate for Mark Banknotes (M per DM)

Daily values for bid and ask prices
October 2, 1989-April 4, 1990



The Problems with Using Exchange Rate Models to Determine the Conversion Rate

The lack of reliable market exchange rates to use in setting the Gmu conversion rate might tempt one to consider using one or more traditional exchange rate models to calculate an appropriate "equilibrium exchange rate." Several approaches to exchange rate determination appear in the international economics literature; among the alternative approaches are purchasing power parity (PPP), structural exchange rate models and the so-called "underlying balance approach".[22]

A detailed discussion of these approaches is beyond the scope of this paper. However, they have limited usefulness in the Gmu context because they were developed primarily to explain exchange rate fundamentals in economies with open financial markets. All variants of PPP,

[22]See, for instance, Frenkel and Goldstein (1986).

Table 2

Consumer Prices of Selected Goods and Services in the GDR and the Federal Republic of Germany (1985)

Good/Service	Price in (M) GDR	Price in (DM) FRG	M price as a percent of the DM price
Potatoes (5 kg)	M4.05	DM5.32	76
Tomatoes (1 kg)	4.40	2.10	210
Rye Bread (1.5 kg)	0.93	4.54	21
Beef (1kg)	9.80	19.45	50
Chocolate (100 g)	3.85	0.89	433
Coffee (250 g)	25.00	5.25	476
Jeans (men's)	135.00	59.90	225
Brown Coal (50 kg)	3.51	19.40	18
Radio/Cassette Recorder	1,160.00	199.95	580
Color TV	5,650.00	1,199.00	471
Rent (1 bedroom)	75.00	390.00	19
Electricity (75 kwh)	7.50	29.30	26
Haircut (man)	1.90	11.25	17
Railway Ticket (50 km)	4.00	9.20	43

SOURCE: Materialien zum Bericht zur Lage der Nation, 1987, pp. 513, 516, 732-735.

for example, rely on the "law of one price" holding in integrated and competitive markets.[23] The *relative* version of PPP, developed by Gustav Cassel to determine equilibrium exchange rates after World War I,[24] relates the required exchange rate adjustment between the currencies of two countries with different inflation rates. However, this procedure requires the existence of an unbiased base period in the past, a condition which clearly is not met in the GDR setting.

The *absolute* version of PPP avoids the base period problem by defining an equilibrium exchange rate as the ratio of the price of a standard market basket of goods in one currency to the price of the same basket in another currency. Thus, the consumption basket of an average GDR household could provide one basis for absolute PPP calculations of an appropriate Mark/D-Mark exchange rate. In 1985, for example, the goods and services which made up this basket (excluding rents) had a DM equivalent value which was 10 percent higher than their Mark price.[25] If we assume that the GDR price level has remained unchanged while the market basket's DM equivalent value has risen at the inflation rate in West Germany since 1985, the price differential would be about 15 percent in 1989. Thus, an absolute PPP exchange rate based on consumer prices (for a given market basket of goods and services) would be 1.15DM:1M or a 1DM:0.9M conversion rate. However, due to high subsidies and the existence of a "monetary overhang" (explained later in the paper), indicative of an excess demand for goods in the GDR, the economic relevance of such calculations is severely limited.[26]

Because most structural exchange rate models (e.g., those based either on the monetary approach with fixed or flexible prices or on the portfolio balance approach) require either short-term or long-term PPP to hold, they are beset with the same conceptual drawbacks as the simple PPP calculations already discussed. In addition, they presume that people are able to engage in unlimited arbitrage between financial

[23]See Cassel (1918, p. 413): "As long as anything like free movement of merchandise and a somewhat comprehensive trade between the two countries takes place, the actual rate of exchange cannot deviate very much from this purchasing power parity."

[24]See Dornbusch (1987).

[25]Including rents the difference was 25 percent.

[26]An alternative PPP measure, the "Devisenrentabilitaet," yields an equilibrium exchange rate of 1DM:4.4M. However, the problems of this specific measure have already been discussed.

markets in the respective countries; this condition did not exist in the GDR prior to the Gmu.[27]

WHAT FINANCIAL STOCKS AND FLOWS WERE CONVERTED?

In order to clarify the issues associated with the Gmu, this section presents a brief discussion of the main items whose values were converted from Marks to DMs in the process of monetary unification. Throughout the paper, a distinction will be made between financial *stocks* and financial *flows*.

Conversion of the Stock of GDR Monetary and Financial Assets and Liabilities

The stock of financial assets in the GDR is represented by the consolidated balance sheet of its banking system presented in table 3. In contrast to how these accounts would be drawn up in the United States, the loans and liabilities of the central bank ("Staatsbank") must be added to the state-owned commercial banks on a consolidated basis. As is typical in most centrally planned economies, the GDR did not permit direct financial transactions between enterprises and households ("dichotomized money supply").[28] Therefore, this consolidated balance sheet presents a comprehensive picture of the stock of all financial assets and liabilities in East Germany.

The principal items on the asset side of the banking system were loans to state-owned enterprises, housing (chiefly state-owned), direct credits to the government, and claims on foreigners. Loans to households were negligible, making up less than 1 percent of all bank assets. In contrast, such loans represent about 23 percent of bank assets in the Federal Republic.

Savings of private households are the most important liability of the GDR's banking system. The consolidated balance sheet prior to the Gmu also shows a considerable amount of foreign liabilities. However, the bulk of these foreign liabilities (M 96 billion) was simply an accounting item ("Richtungskoeffizient") arising from the GDR's practice of valuing its foreign assets and liabilities at a 1DM:4.4M exchange rate rather than at its "official" 1DM:1M exchange rate. After Gmu, of course, the DM denominated foreign debt of the GDR will be valued at its face value. The revaluation of foreign assets and liabilities also reduced the amount of external claims (from M 45 billion to DM 36 billion) and the debt of the government (from M 61 billion to DM 12 billion).

After revaluation of foreign assets and liabilities and the overall 1DM:2M conversion of all domestic items, except for the limited 1DM:1M conversion of savings, the liabilities of the GDR banking system (DM 246 billion) exceeded its assets (DM 220 billion) by DM 26 billion. This difference was created by the asymmetric conversion of the left and the right side of the consolidated balance sheet produced by an effective 1DM:1.4M conversion rate of total savings. To equilibrate their balance sheets, East German banks were given interest-bearing government assets from an equalization fund established by the GDR for this purpose. Except for this fund, the post-Gmu balance sheet shows that the net bank debt of the actual GDR government sector is relatively small (DM 7 billion).

Conversion of Financial Flows

The 1DM:1M conversion rate for financial flows determined the D-Mark equivalent for Mark-denominated wage and rent contracts in existence prior to July 2, 1990. Although these contracts can (and undoubtedly, will) be renegotiated after this date, a legal transformation of existing contractual obligations from their previous Mark payments into DM payments ("rekurrenter Anschluss") was required.[29] For all new contracts and those old contracts for which payments could be adjusted immediately or on short notice, the conversion rate was irrelevant. GDR pensions were treated somewhat differ-

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[27]This also excludes the application of the "underlying balance approach to exchange rate assessment," which was developed by the International Monetary Fund. According to Williamson and Miller (1987, p. 10), who have elaborated this method, the "fundamental equilibrium exchange rate" is defined as the rate "which is expected to generate a current account surplus or deficit equal to the underlying capital flow over the cycle, given that the country is pursuing 'internal balance' as best as it can and not restricting trade for balance of payments reasons."

[28]See Wolf (1985a).

[29]Poole (1990) emphasizes, on purely economic grounds, that "any attempt to convert prices of goods and services from OM (Ostmark) to DM through central direction can only cause great difficulty."

Table 3

Consolidated Balance Sheet of the Banking System of the GDR as of May 31, 1990

Assets	M billion	Conversion rate	DM billion	Liabilities	M billion	Conversion rate	DM billion
1. Lending to domestic borrowers				**1. Deposits from domestic non-banks**			
Total	397.4	—	180.7	Total	249.9	—	156.6
Government	60.6	2:1[a]	12.3	Government	10.8	2:1	5.4
of which							
Lending in connection with the revaluation of external liabilities	31.2	—	—				
Claims on the government from the initial provision of notes and coins in 1948	4.9	—	—				
Enterprises	231.7	2:1	115.8	Enterprises	57.0	2.05:1[c]	27.8
Housing sector	102.6	2:1	51.3				
Individuals (excluding housebuilding loans)	2.5	2:1	1.3	Individuals	182.1	—	123.4
				Giro and savings balances of individuals			
				Residents	165.6	1.44:1[d]	115.2
				Non-residents	2.3	2.05:1[e]	1.1
				Life insurance	14.2	2:1	7.1
2. External claims	45.0	—	36.3	**2. External liabilities**	152.5	—	55.6
(a) CMEA countries	17.4	—	8.7	(a) CMEA countries	1.1	—	0.6
(b) Western industrial and developing countries	27.6	[b]	27.6	(b) Western industrial and developing countries	55.0	[b]	55.0
				(c) Provisions for external liabilities ("Richtungskoeffizienten")[1]	96.4	[f]	—
3. Participations	1.1	1:1	1.1	**3. Currency in circulation** (excluding the banks' cash holdings)	13.6	2:1	6.8
				4. Accumulated profits/ reserve funds/guarantee funds	23.4	1:1	23.4
4. Other assets	3.1	2:1	1.5	**5. Other liabilities**	7.2	2:1	3.6
Total	446.6	—	219.6	Total	446.6	—	246.0
Balancing item	—	—	26.4	Balancing item	—	—	—
Total	446.6	1.81:1	246.0	Total	446.6	1.81:1	246.0

[1]These are actually liabilities of the banking sector to the government, which might also be shown in liabilities item 1. In this table, they are shown in connection with the external liabilities of the GDR because the item may also be regarded as a kind of "value adjustment" for the external liabilities, which are otherwise put at too low a value in GDR Mark.

[a]Conversion of a balance of M 24.5 billion, which results after offsetting the lending from the revaluation of external liabilities (M 31.2 billion) and claims arising from the initial provision of notes and coins in 1948 (M 4.9 billion) against provisions for external liabilities ("Richtungskoeffizienten") to the same amount.

[b]External claims (assets item 2 (b)) and external liabilities (liabilities item 2(b)) are here still valued at the accounting rates of the end of 1989. The market rates of June 30, 1990 are to be used for the final conversion. The amounts shown will then presumably be somewhat lower (liabilities item 2(b) also includes foreign currency deposits from residents).

[c]Conversion rate for balances of non-residents arising on and after January 1, 1990 3:1, otherwise 2:1.

[d]Conversion rate of 1:1 for M 2,000 x 3.2 million = DM 6.4 billion; M 4,000 x 10.1 million = DM 40.4 billion and M 6,000 x 3.0 million = DM 18.0 billion yields a total of DM 64.8 billion; the remainder (M 100.8 billion) was converted at a rate of 2:1.

[e]Balances as at the end of 1989 amounting to M 2.1 billion were converted at 2:1, the remainder at 3:1.

[f]Partly offset against lending in connection with the revaluation of external liabilities (M 31.2 billion) and claims arising from the initial provision of notes and coins in 1948 (M 4.9 billion); the arithmetical remainder (M 60.1 billion) was used to reduce the balancing item.

ently. As already mentioned, the social union adjusted the GDR pension system to make it consistent with West German standards; among other things, this meant that the DM value of GDR pensions was not less than their previous Mark value.

Implications of the Conversion Rate for Price Stability in Germany

For West Germans, who traditionally have placed a very high social value on price stability, concern over the implications of the Gmu on the inflation rate played a predominant role in the choice of the conversion rate. The existence of an excess supply of money, which, by Walras' Law, reflects rationing on goods and labor markets,[30] is a widely acknowledged occurrence for centrally planned economies, including the GDR.[31] Many observers expected that a flat 1M:1DM conversion of the East German money stock would produce a rise in the price level and, hence, a transitory increase in the measured rate of inflation for the integrated German currency area after the Gmu.

The expected impact of monetary unification on the German inflation rate can be determined as follows: First, estimate a hypothetical GDR money stock that would be compatible with stable DM prices in the GDR; second, compare this hypothetical money stock with the actual DM money stock of the GDR after conversion. If the actual money stock exceeds the hypothetical one, the conversion could produce a temporary increase in inflation in both Germanys; otherwise, the conversion does not have inflationary implications.

To accomplish the first step requires calculating the East German money demand after the Gmu. To do this, of course, one has to estimate the velocity of money and potential nominal production of the GDR economy. The following estimates are based on the assumption that both relative and absolute DM prices in the GDR as well as the GDR's velocity of money will be identical to their West German counterparts after unification. GDR potential production can be estimated either by using its GNP, which is about 13 percent of West Germany's GNP, or some measure of potential output determined by relative labor productivity estimates. This latter method[32] uses the proportion of the East Germany population to West German population (about 26 percent) and the estimated average GDR labor productivity relative to that in West Germany (about 50 percent) to obtain a relative GDR potential production of about 13 percent, which is identical to the relative GNP differential noted above. Use of a lower estimate of the GDR productivity differential, for instance, the 30 percent estimate of the Kiel Institute for World Economics, reduces the GDR's potential production to only about 10 percent of that in the FRG.

This approach can be used to determine the "non-inflationary" conversion rates for different monetary aggregates; various estimates are shown in table 4. Applying the West German ratio between potential output to the stock of currency yields a conversion rate of about 1M:1DM for East German currency holdings. To calculate a non-inflationary M1 money measure for the GDR requires determining the "moneyness" of the various GDR deposit categories. If the "Spargiro" (M 69.0 billion) and deposits of enterprises are essentially demand deposits and the "Buchsparen" (M 90.7 billion) are essentially the same as traditional savings deposits included in M3, the pre-Gmu GDR M1 money stock was about one-third of that in West Germany. Thus, the non-inflationary conversion rate for the GDR's M1 money stock would lie in the 1DM:2.4M to 1DM:3.3M range. Using the M3 money stock, the non-inflationary conversion rate would lie within 1DM:1.5M and 1DM:2M.[33]

Comparing East and West German money stock measures is always problematical because there is a much wider spectrum of financial opportunities available to West German investors. Their savings in long-term time and savings deposits, bank savings bonds and other financial instruments issued by banks, which are called "monetary capital" and not included in M3, are larger than the M3 money stock. Adding these financial assets to the West German M3 money stock yields a liquidity stock measure (L).

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[30]See Commander and Coricelli (1990), p. 3.

[31]See Sokil and King (1989).

[32]It which was suggested by the President of the Kiel Institute for World Economics, Horst Siebert.

[33]In West Germany, the money stock M3 includes currency in circulation (excluding banks' cash balances), sight deposits, time deposits with a maturity of less than four years and savings deposits at statutory notice.

Table 4

Conversion Rates on the Basis of a Non-Inflationary Money Stock for the GDR (1989)

	Actual values		Non-inflationary values for the GDR		Conversion rates	
	GDR[1] (M billion)	FRG (DM billion)	A[2] (DM billion)	B[3] (DM billion)	A	B
Currency	17.0	146.9	19.1	14.7	1:0.9	1:1.2
M1[4]	146.6	450.6	59.9	45.1	1:2.4	1:3.3
M3[5]	252.0	1255.5	167.0	125.6	1:1.5	1:2.0
L[6]	252.0	2738.3	364.2	273.8	1:0.7	1:0.7

[1]Values for the GDR include deposits of enterprises and households with the banking system.

[2]Assuming that GDR potential output is 13.3 percent of FRG potential output.

[3]Assuming that GDR potential output is 10 percent of FRG potential output.

[4]Currency in circulation and domestic non-banks' sight deposits.

[5]M1 plus domestic non-banks' time deposits and funds borrowed for less than 4 years plus savings deposits at statutory notice.

[6]M3 plus saving deposits at agreed notice, long-term time deposits, bank savings bonds and other financial instruments held by private households and enterprises with banks.

SOURCE: Deutsche Bundesbank, Monatsberichte, Jahresbericht 1989 der Staatsbank der DDR.

In contrast, savings deposits and currency are the only financial stores of value available in East Germany.[34] Thus, for East Germany, L and M3 are identical. Using the L measure, the non-inflationary conversion rate would be about 1DM:1M. However, in order to make the converted East German L measure truly comparable to the West German L, about 50 percent of East German savings would have to be "frozen" for about four years.

As table 4 shows, an assessment of the inflationary impact associated with the Gmu depends on which monetary aggregate is regarded as the one linked most closely to inflation. Most econometric estimates for the Federal Republic show a very stable relationship between the money stock, M3, and inflation (and nominal GNP); this is the reason why the Bundesbank uses M3 as its main inflation indicator and as its central intermediate monetary policy target.[35] Taking M3 as the benchmark money stock for non-inflationary purposes suggests that the conversion rate for the GDR money stock should lie in a range between 1DM:1.5M to 1DM:2M. While the latter value was recommended by the Bundesbank, the political compromise reached between the two governments led to an average conversion rate of about 1DM:1.7M. While the estimated non-inflationary conversion rates shown in table 4 are subject to considerable uncertainty, the final conversion program chosen for the Gmu seems unlikely to produce any substantial inflationary impact on prices in the new DM currency area.

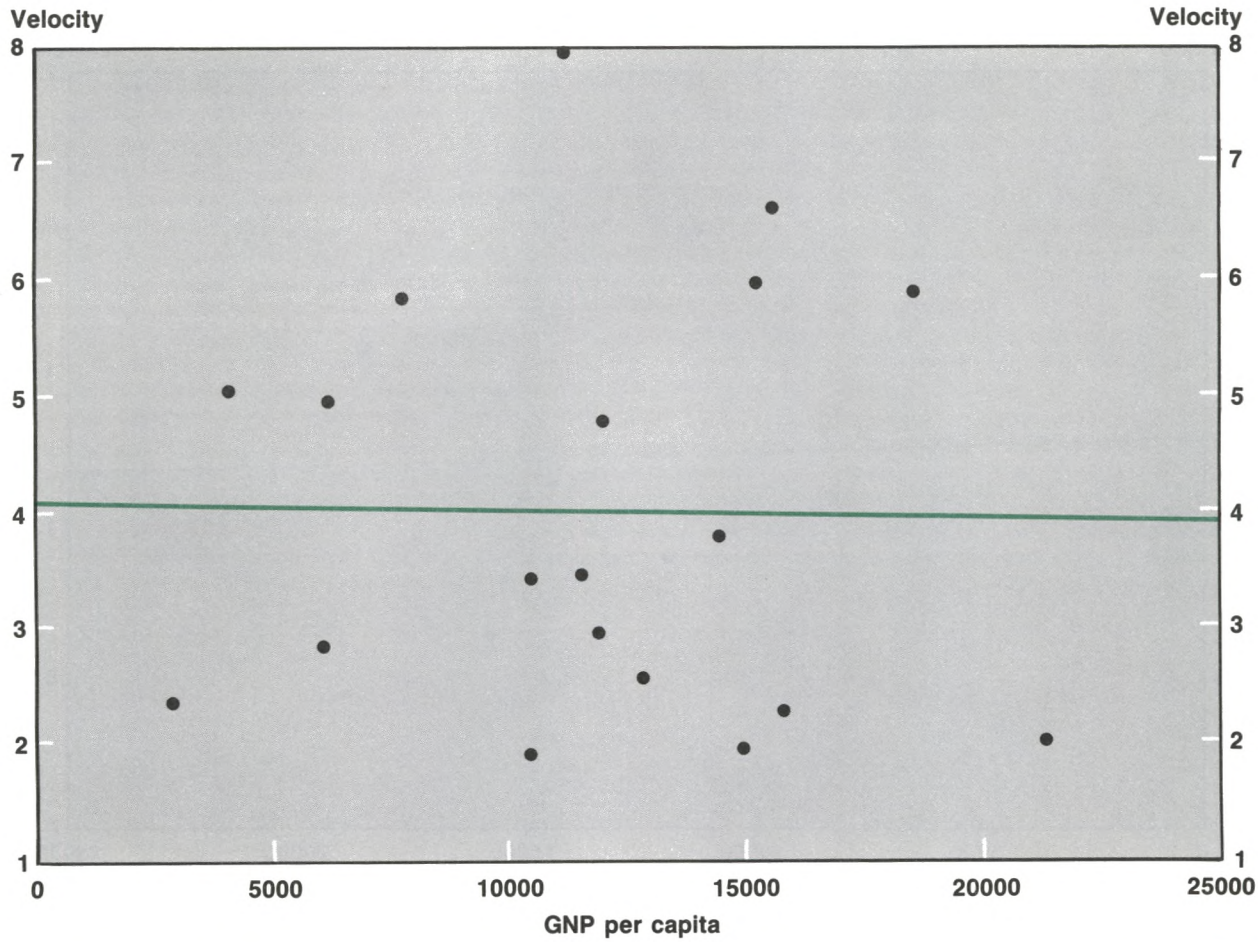
The Effect of the Velocity Assumption on the Non-Inflationary Conversion Estimates

The non-inflationary conversion calculations described above assumed that the velocity of the appropriate money stock in the GDR is identical to that in the FRG. Some observers in the Federal Republic have argued that countries with higher per capita income levels have different monetary velocities from those in less-developed countries. Figures 2 and 3 show the results of a cross-country analysis comparing

[34]This aspect was emphasized by the East German Central Bank ("Staatsbank") in an official statement of April 3, 1990.

[35]See Deutsche Bundesbank (1989a), Schlesinger and Jahnke (1987).

Figure 2
Velocity of M1 and GNP per Capita for OECD Countries

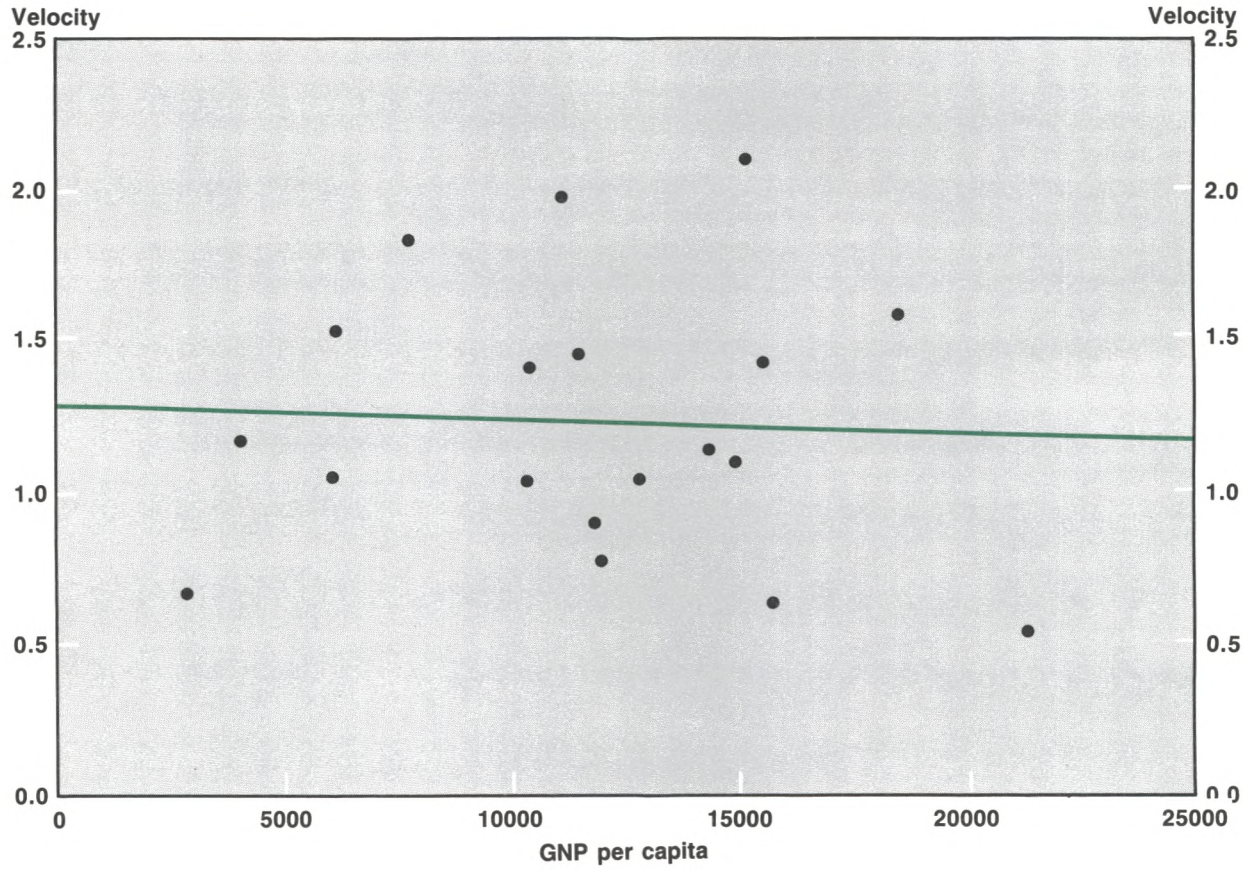


per capita nominal incomes and velocities for the M1 and M3 money stocks in OECD countries in 1987. The figures indicate that per capita income has no significant influence on the velocity of money. However, the marked intercountry differences in the velocity of money serves as yet another reminder that the noninflationary GDR money stock calculations are subject to considerable uncertainty.

Implications of the Gmu on the "Competitiveness" of East German Enterprises

The potential impacts of the Gmu on the unemployment rate in the GDR and its economic growth prospects were another important determinant of the conversion rate. While West Germans were concerned about the possible fiscal costs of unemployment payments to East Germans, the East Germans, as noted earlier, were primarily interested in the prospects for employment and for raising their standard of living as quickly as possible. These prospects depend fundamentally on how competitive the GDR firms will be after the central planning process is dismantled and the economy of the GDR is opened up to world markets. While it is evident that the conversion of enterprise debt has a direct impact on the financial structure and capital costs of firms in East Germany, the implications of the conversion rate for wages in the GDR are more difficult to evaluate.

Figure 3
Velocity of M3 and GNP per Capita for OECD Countries



The Impact of the Conversion of Enterprise Debt

The 1DM:2M conversion rate for financial stocks determines the debt burden and interest payments of enterprises after the unification process.[36] It has important consequences for the costs of capital and for the projected privatization of East German firms. The latter, an essential element of the process of economic transformation, requires that the firms to be privatized must have a positive net worth. For enterprises that will remain under state ownership, the ratio of their DM equity to their total DM assets after conversion will play a key role in determining whether they can survive with a "hard budget constraint," i.e. without subsidies from the government.

Because there is no data on the debt-equity ratios of East German enterprises, it is difficult to assess the implications of the 1DM:2M conversion rate on their financial situation and on their interest payments. To get a rough estimate of the sustainability of alternative debt burdens, however, the proportion of GDR potential output to FRG potential output can be used; as already mentioned, estimates vary between 10

[36]Again, the conversion rates which were put forward in the debate varied widely, ranging from a 100 percent debt relief which was recommended by the five leading German economic research institutes in their report of April 12, 1990, over the 1:2 rate, which was proposed by the Bundesbank, to a full 1:1 conversion.

and 13 percent. According to Bundesbank (1989) statistics, the net financial debt of West German enterprises (excluding housing and the financial sector) was DM 681.5 billion and the book value of their non-financial assets totaled DM 1096.5 billion in 1988. The FRG figures indicate that a 1DM:1M conversion for the debt of GDR enterprises would have produced a relatively large DM 175 billion net debt (see table 3), about 26 percent of the West German level.[37] If East German firms' nonfinancial assets are worth about 10 to 13 percent[38] of that for West German firms, the right side of their balance sheets would have exceeded the left side (DM 110-140 billion) by huge amounts, even if West German firms' balance sheets contain extensive hidden reserves. Without further debt reduction, privatization of virtually all East German firms would have been impossible. According to West German bankruptcy law, which requires bankruptcy proceedings if a firm has negative net worth, most East German firms would have had to be declared bankrupt.

Of course, an outright cancellation of all GDR enterprise debt would have avoided these problems. However, this "solution" was dismissed for two reasons: First, firms with permanent net debt levels are common in all industrialized countries; second, it would have led to a huge increase in the government debt as described later in this paper. The debt reduction[39] achieved by the 1DM:2M conversion rate places the average ratio of equity to assets for GDR enterprises in a range between 20 and 37 percent, which should allow the privatization of at least some firms. By comparison, the average equity to asset ratio is about 20 percent in West Germany and 50 percent in the United States.[40]

Because the results are quite sensitive to the estimate of the value of real assets in the GDR, it is difficult to assess whether the interest burden of East German firms will be similar to the West German enterprise sector or whether it will be significantly higher. In addition, it is not yet clear whether East German firms will have to pay market-determined interest rates on their debt after monetary unification.

WAGE CONVERSION

The second determinant of East German firms' post-conversion competitiveness are the DM wages they will have to pay. While neither the GDR nor the FRG government should determine wages after the transition to a market economy, their treaty established a wage conversion rate to define the financial obligations of existing contracts for the time immediately after July 2, 1990. However, the actual conversion rate chosen has implications for wage levels and competitiveness only if nominal DM wages in the GDR after conversion are inflexible downward and if initial DM wages are set "too high" compared with labor productivity.

These considerations would have called for a conversion rate that reduced average wages below the level indicated by the GDR's average productivity. The advantage of this low starting level for wages is that it would have allowed workers and firms in East Germany to renegotiate their contracts more easily after Gmu. This would have enabled them to establish a wage structure more closely matching sectoral productivity differentials than the prior GDR wage structure, in which wages were relatively uniform regardless of productivity differences.

To evaluate the competitiveness of East German firms after a 1DM:1M wage conversion, their labor productivity relative to that in comparable West German firms must be compared with their relative DM wages. These comparisons would require information on the productivity of individual firms or, at least, individual sectors in the GDR after July 2, 1990. Unfortunately, such sectoral data are not available at all; moreover, estimates of labor productivity in the GDR after the transition to a market economy are very difficult to determine ex ante. However, the experience following the West German currency reform in June 1948 shows that large productivity gains can be achieved rather quickly; these gains arise from better incentives associated with the market process and increased availability of inputs. In

[37]A high debt burden is regarded as a typical concomitant of the central planning mechanism, which gives enterprises automatic bank credits inducing large hoardings of inventories or camouflaging cost overruns, waste and sales in the black market (Grossman 1989, p. 31).

[38]On the basis of a Cobb-Douglas production function and assuming an identical elasticity of output with respect to capital as in West Germany, Alexander and Gagnon (1990) estimate the level of the East German capital stock to be 10.4 percent of the West German capital stock.

[39]A strategy of recapitalization is now also suggested for other Eastern European countries. See Hinds (1990, p. 44).

[40]See Bank for International Settlements (1989, p. 86).

the GDR, where such incentives are lacking, shortages of specific inputs are often reported to have led to significant decreases in output and productivity.[41]

On the other hand, the far-reaching restructuring of production processes will not be possible without some temporary output disruptions.[42] If these positive and negative effects roughly cancel each other in the first few months after conversion, the GDR's productivity should reach about 50 percent of that in West Germany, which is consistent with past estimates made by the Deutsches Institut fuer Wirtschaftsforschung.

Before the conversion took place, the average monthly salary of a worker was M 1250 in the GDR and DM 3192 in West Germany. With the 1DM:1M conversion of the initial nominal wages, monthly wage costs (including employers' contributions to social security) for East German firms would be about 37 percent of West German wages.[43] Thus, the average DM wage level in the GDR after the conversion is not so high relative to the average productivity differential between GDR and FRG workers that it would preclude future wage negotiations.

However, the initial wage differential cannot be held constant by the government after the Gmu. Therefore, the medium-term outlook for employment as well as for foreign and West German investment in the GDR will depend mainly on the rate of subsequent wage increases in the GDR. If these exceed the growth of productivity in the GDR, employment and investment in GDR firms will fall.

Implications of the Conversion Rate for GDR Real Incomes and Labor Migration

Because the unification process has been driven primarily by the desire of East Germans to improve their standard of living, the effects of monetary unification on the FRG-GDR real income differential were intensively discussed in both East and West Germany. However, since wages will be renegotiated after the Gmu, monetary unification will have only a short-term impact after July 2, 1990.

An estimate of the change in East German real incomes resulting from the Gmu can be calculated by assuming that nominal wages in the GDR will remain constant after conversion and after the various subsidies are abolished. The basis for comparing pre- and post-Gmu real incomes in the GDR is the consumption basket of an average GDR household that was discussed earlier.

The abolition of trade restrictions and product-specific taxes and subsidies will produce price structures and a price level in East Germany similar to that in West Germany. Thus, the Gmu will cause a "one-shot" consumer price increase of about 15 percent for the unchanged GDR consumer goods basket.[44] In addition, the increase in social security contributions, due to the introduction of the West German social security system into East Germany, will reduce the average net monthly income of an East German worker from M 1050 to DM 983 after unification. Together with the one-shot price adjustment in consumer goods, real incomes in the GDR will be reduced by about 21 percent.[45]

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[41]According to a survey of the Institut der deutschen Wirtschaft, about one third of all GDR employees had to suspend their work for two or more hours per day because of shortages and defective machines.

[42]In the past, all decisions on investment, production and sales were made by the central planning bureaucrats; managers of firms were mainly responsible for technical operations.

[43]The 1DM:2M conversion rate proposed by the Deutsche Bundesbank differs less from the 1DM:1M rate chosen than one might assume at first glance. In its calculations, the Bundesbank assumed that all subsidies would be removed before conversion, requiring an increase in Mark wages of about 25 to 30 percent to compensate for this effect. If these new Mark wages were then converted at a 1DM:2M rate, the effective conversion rate between initial East German Mark wages and DM wages after the Gmu would have been about 1DM:1.2M. Including the employer's contribution to social security, the initial labor costs in the GDR would have been about one third of the West German level if the 1DM:2M conversion rate had been used.

[44]This change from Mark prices to D-Mark prices has no effect on the overall German inflation rate which is measured on the basis of the DM equivalent of goods and services.

[45]These orders of magnitude show that conversion rates for GDR incomes considerably above 1DM:1M, for instance, 1DM:2M or 1DM:3M, would have strongly increased the movement of workers from East to West Germany. Assuming constant consumption patterns, a 1DM:2M (1DM:3M) rate would have reduced GDR real incomes by 57 percent (70 percent) compared to their pre-Gmu levels.

The above calculations overstate somewhat the negative welfare implications of unification. Households will adjust to the price changes by purchasing more of the goods with relatively cheaper DM prices and less of those whose prices rose more because they had been heavily subsidized in the past. The prospective adjustment of the previous Mark price structure to the DM price structure is indicated in table 2. As no detailed data on consumption patterns of East Germans are available, the quantitative relevance of this substitution effect is difficult to evaluate.[46] The same comment applies to the positive welfare effects attributed to prospective quality improvements in available consumer goods; after the Gmu, East Germans will be able to buy West German products which, on average, are of better quality than their East German counterparts.

On balance, the real income of East Germans and the real income differential between East and West Germany will remain essentially unchanged immediately after the Gmu, with real net incomes in the East about 50 percent lower than in the West. This result reflects the fact that monetary unification by itself can only create a framework for real sector reform. Significant improvements in East German living standards will only be generated by better allocation of their resources and increased investment. Thus, the incentive for East German workers, especially skilled workers, to move to the Federal Republic of Germany remains at least as strong as it was before the Gmu. However, the prospect of a rapid and wide-ranging restructuring of the GDR economy has already improved the motivation of East Germans to remain in the GDR and contribute to its economic recovery. The number of GDR citizens moving to the FRG, which reached a monthly peak of 133,000 in November 1989, fell to only 19,000 by May 1990.

The Gmu Wealth Transfer Between East and West Germany

The Gmu will result in a wealth transfer from West Germany to East Germany.[47] The mechanisms and the quantitative effects of this wealth transfer, however, remain uncertain.

To examine this issue, even if a definitive answer is not forthcoming, it is useful to start with an example of a hypothetical currency unification between two market economies, e.g., between France and West Germany. Suppose that the DM is to be replaced by the Franc and that the current market exchange rate (1DM = 3FF) will be used to convert all DM financial and real stocks and flows in their Franc equivalent. In this case, there is no transfer of real wealth; simply multiplying all D-Mark prices by three does not reallocate wealth within Germany nor between France and the Federal Republic.[48] Redistribution of wealth between creditors and debtors in both countries could occur only if that currency unification leads to unexpected changes in inflation and if some debtors or creditors had been expecting a parity adjustment. In this case, the net transfer between the two countries would then be determined by creditor/debtor relations between France and Germany and by the direction of the change in expectations.

In the Gmu case, there is no wealth transfer between GDR residents and West Germans due to unexpected exchange rate variations because there were virtually no financial linkages between individuals or enterprises in both countries prior to the Gmu. The asymmetric conversion of assets and liabilities, however, transfers GDR debt to the FRG (see shaded insert). Before the Gmu, the aggregate wealth of the East German economy consisted of its aggregate real assets and its aggregate net foreign claims (debts); domestic financial claims and liabilities simply cancel out in the aggregation process. Because monetary unification has no implications for the GDR's foreign claims and liabilities, it can increase the wealth of the GDR only if its domestic financial assets, which are mainly savings, are converted at a higher rate than its domestic liabilities.

In a closed economy, even this asymmetric conversion would have no aggregate effect on the economy's wealth; the gap between assets and liabilities in the consolidated banking system would have to be filled by government

[46] An analysis of the Deutsches Institut fuer Wirtschaftsforschung comes to the result that private households can compensate the price effect by reducing their consumption of foods by 10 percent.

[47] See, for instance, Poole (1990).

[48] It is assumed that a procedure for an equitable distribution of seignorage can be devised.

Mechanics of the Wealth Transfer Effected by Gmu

The total wealth (W_i) of each economic agent in the GDR is the sum of its real wealth (RW_i) plus its net monetary wealth (NM_i):

(1) $W_i = RW_i + NM_i$

Net monetary wealth is the sum of claims on other GDR residents (C_i^{GDR}) and on foreigners (C_i^F) minus liabilities against GDR residents (L_i^{GDR}) and foreigners (L_i^F):

(2) $NM_i = C_i^{GDR} + C_i^F - L_i - L_i^F$

Substituting (2) in (1) yields:

(3) $W_i = RW_i + (C_i^{GDR} - L_i^{GDR}) + (C_i^F - L_i^F)$

Total wealth of the GDR is the sum of individual total wealth:

(4) $RW = RRW + R(C^{GDR} - L^{GDR}) + R(C_i^F - L_i^F)$

Canceling all intra-GDR financial claims and liabilities ($RC_i^{GDR} = RL_i^{GDR}$) yields total wealth before Gmu:

(4a) $RW = RRW + R(C^F - L^F)$

The asymmetric conversion of intra-GDR financial liabilities and claims ($RC_i^{GDR} > RL_i^{GDR}$) requires the creation of an equalization item (E) which leads to:

(5) $RC_i^{GDR} = RL_i^{GDR} + E$

If this equalization item is regarded as a financial liability of West Germany, (5) can be substituted in (4):

(6) $RW = RRW + R(C^F - L^F) + E.$

Comparing 4a and 6 shows that the wealth transfer, which is directly associated with Gmu, depends on the amount of this equalization item.

bonds.[49] In the case of Gmu, the gap is closed by bonds which are issued by equalization funds established by East Germany. While these bonds are formally a debt of the East German government, they can actually be regarded as a financial obligation of West Germany. This conclusion is based on the wide-ranging financial support that West Germany agreed to provide to the East German public sector and the prospect of rapid political unification. The wealth transfer directly produced by Gmu is thus identical to the amount of bonds needed to equalize the consolidated balance sheet of the East German banking system after the Gmu.[50]

A second determinant of the wealth transfer between East and West Germany is the distribution of the GDR's real wealth after conversion. At the moment, most GDR firms are owned by the state. To the extent that these assets are transferred to a common German government, the net wealth transfer arising from the money stock conversion will be reduced. The same result would occur if these firms are sold at market prices and the proceeds are then used to repay part of the GDR government debt. This latter option is presently being discussed in the Federal Republic.

The Direct Impact of Gmu on German Government Debt

The consolidated balance sheet of the GDR's banking system in table 3 shows that the 1DM:2M conversion of the GDR enterprise sec-

[49]This was the case in the West German currency reform of 1948.

[50]Gmu would have indirect wealth effects if it contributes to non-competitive wages and if these wages are inflexible downward, which would require unemployment benefits from West Germany to East Germany.

tor's net debt and the limited 1DM:1M conversion of savings (including currency) implies a DM 26 billion (5.3 percent) increase in the German central government debt. The impact of this asymmetric conversion would have been even higher if it were not for the "Richtungskoeffizient" discussed previously.

Using an assumed 8 percent interest, this additional debt will increase the German government's interest payments by DM 2.1 billion, about 0.7 percent of its total expenditure. A uniform 1DM:1M conversion of enterprise debt, savings and currency would have produced a DM 76 billion increase in government debt. If this debt were borne mainly by West German tax payers, this would have been identical to a wealth transfer of DM 1230 from each West German—in the form of an interest-bearing and non-repayable IOU—and would have provided each East German with an additional DM 4560. This example illustrates why the 1DM:1M conversion rate for savings was controversial in West Germany after it had become evident that a 1DM:1M rate for enterprise debt was impracticable.

SUMMARY

The set of conversion rates chosen for the Gmu has important implications for the debt burden of East Germany's enterprise sector, for the wealth transfer between both German states and for the level of West German government debt. The 1DM:2M conversion rate for enterprise debt may cause some financial difficulties for many GDR firms, but it will also lay the groundwork for the privatization of the more profitable enterprises. This result is a necessary precondition for the GDR's transition to a market economy. The ceilings for the 1DM:1M conversion of savings limit the wealth transfer from West Germany to East Germany to a relatively small amount. The same applies to the required increase in German government debt and its interest payments.

A (transitory) rise in the inflation rate of the common German currency area is unlikely after the Gmu. The post-conversion money stock in the GDR seems to be roughly compatible with the GDR money demand at the new DM prices.

The medium- and long-term impacts of monetary unification on the competitiveness of GDR firms, on unemployment and relative living standards in East Germany, and on the wealth transfer from the West Germans to East Germans has been widely overestimated. The ultimate outcome of unification will be determined by the productivity of East German firms, the real income necessary to encourage East German workers to remain in the GDR and the actual wage and income levels that will be achieved in East Germany.

Monetary unification has only have a short-term impact on the initial wages and incomes in the GDR. Because the conversion rates are compatible with the more pessimistic estimates of the productivity differential between East and West Germany, they do not appear to have produced the problem of too-high initial GDR wage levels and possible downward-stickiness of wages in the face of some initial unemployment pressures. Whether the prospects provided by the economic and social community of the two states and the far-reaching financial assistance offered to East Germany by the West German government will suffice to keep skilled workers in the GDR remains open to question.

REFERENCES

Alexander, Lewis S., and Joseph E. Gagnon. "The Global Economic Implications of German Unification," International Finance Discussion Papers, No. 379 (Board of Governors of the Federal Reserve System, April 1990).

Bank for International Settlements. 59th Annual Report (Basle, Switzerland, 1989).

Cassel, Gustav. "Abnormal Deviations in International Exchanges," *Economic Journal* (December 1918), pp. 413-15.

Collier, Irwin L. "The Estimation of Gross Domestic Product and its Growth Rate for the German Democratic Republic," World Bank Staff Working Papers, No. 773, Washington, D.C., 1985.

Commander, Simon, and Fabrizio Coricelli. "Levels, Rates and Sources of Inflation in Socialist Economies: A Dynamic Framework," paper prepared for a seminar in Laxenburg, Austria, March 6-8, 1990.

Committee for the Study of Economic and Monetary Union. "Report on Economic and Monetary Union in the European Community," Luxembourg, 1989.

Cornelsen, Doris, and Wolfgang Kirner. "Zum Produktivitaetsvergleich Bundesrepublik-DDR," Deutsches Institut fuer Wirtschaftforschung-*Wochenbericht,* April 5, 1990, pp. 172-74.

Daviddi, Renzo, and Efisio Espa. "The Economics of Rouble Convertibility: New Scenarios for the Soviet Monetary Economy," Banca Nazionale del Lavoro *Quarterly Review* (December 1989), pp. 441-65.

Deutsche Bundesbank. "The Monetary Union with the German Democratic Republic," Monthly Report of the Deutsche Bundesbank (July 1990).

_____. "The Deutsche Bundesbank. Its Monetary Policy Instruments and Function," Deutsche Bundesbank Special Series No. 7 (Frankfurt, 1989a).

_____. "Enterprises' Profitability and Financing in 1988," Monthly Report of the Deutsche Bundesbank, (November 1989b).

Dornbusch, Rudiger. "Purchasing Power Parity," in John Eatwell, Murray Milgate, and Peter Newman, eds., *The New Palgrave: A Dictionary of Economics* (London, 1987), pp. 1075-88.

Frenkel, Jacob, and Morris Goldstein. "A Guide to Target Zones," IMF Staff Papers, Vol. 33 (December 1986), pp. 633-73.

Gerstenberger, Wolfgang. "Das zukuenftige Produktionspotential der DDR—ein Versuch zur Reduzierung der Unsicherheiten," ifo-schnelldienst (July 1990), pp. 13-22.

Grossman, Gregory. "Monetary and Financial Aspects of Gorbachev's Reform," in Christine Kessides et al., eds., *Financial Reform in Socialist Economies* (Washington, D.C.: World Bank, 1989), pp. 28-46.

Hinds, Manuel. "Issues in the Introduction of Market Forces in Eastern European Countries," paper presented at an Economic Institute of the World Bank Conference in Warsaw, Poland, March 12-13, 1990.

Institut der deutschen Wirtschaft. "Sozialverträgliche Ausgestaltung der Deutsch-Deutschen Währungsunion," Report for the State of Lower Saxony from March 12, 1990.

Institute of International Finance. "Building Free Market Economies in Central and Eastern Europe: Challenges and Realities" (Washington, D.C., 1990).

Poole, William. "The German Democratic Republic: Economic Goals, Constraints and Monetary Reform," Shadow Open Market Committee: Policy Statements and Position Papers, March 18-19, 1990.

"Reform der Wirtschaftsordnung in der DDR und die Aufgaben der Bundesrepublik, Stellungnahme einer deutsch-deutschen Arbeitsgruppe," Deutsches Institut fuer Wirtschaftforschung-*Wochenbericht,* February 8, 1990, pp. 65-71.

Roe, Alan, and Jayanta Roy. "Trade Reform and External Adjustment: The Experience of Hungary, Poland, Portugal, Turkey, and Yugoslavia," Economic Development Institute of The World Bank Seminar Report, No. 16, Washington, D.C., 1989.

Schlesinger, Helmut, and Wilfried Jahnke. "Geldmenge, Preise und Sozialprodukt," *Jahrbuecher fuer Nationaloekonomie und Statistik*, Vol. 205, pp. 410-26.

Sokil, Catherine, and Timothy King. "Financial Reform in Socialist Economies: Workshop Overview," in Christine Kessides et al., eds., *Financial Reform in Socialist Economies* (Washington, D.C.: World Bank, 1989).

Williamson, John, and Marcus H. Miller. "Targets and Indicators: A Blueprint for the International Coordination of Economic Policy," Policy Analyses in International Economics, Number 22, September 1987.

Wolf, Thomas A. "Economic Stabilization in Planned Economies," IMF Staff Papers, Vol. 32 (March 1985a), pp. 78-129.

_____. "Exchange Rate System and Adjustment in Planned Economies," IMF Staff Papers, Vol. 32 (June 1985b), pp. 211-47.

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The Effects of Financial Innovations on Checkable Deposits, M1 and M2

DURING THE EARLY 1980s, several new types of financial assets were authorized by Congress and included in the definitions of various monetary aggregates. The principal new accounts were NOW accounts, which were authorized nationwide in January 1981, and money-market deposit and super-NOW accounts, which became available in December 1982 and January 1983, respectively. Their growth and inclusion in monetary aggregates gave rise to increased uncertainty in explaining movements in the monetary aggregates and questions about the relationship of the monetary aggregates to various measures of economic performance.[1]

The widely accepted view is that these financial innovations have rendered M1 less useful, or even useless, as a monetary policy target.[2] The related view—that the broader aggregate M2 has been unaffected by these innovations and therefore remains a useful target—is almost as widely shared. While an apparent change in the linkage between M1 and economic performance in the 1980s has buttressed the impression that financial innovations distorted M1 and

[1]These uncertainties have been a continuing source of concern for the Federal Open Market Committee (FOMC). This concern has focused primarily on M1. See Hafer (1986) and Nuetzel (1987) for discussions of uncertainties associated with M1. In 1981, when the authority to offer interest-bearing checkable deposits was extended nationwide, the FOMC announced targets for the old M1-type measure that excluded such new deposits and for an M1-type measure that added these so-called other checkable deposits. See Tatom (1982) and Thornton (1982) for an analysis of the 1981 developments and their effects on monetary policy; the latter article discusses the evolution of the current M1 measure following the 1980 redefinitions discussed in Hafer (1980). In 1983, the FOMC refrained from targeting on M1 and indicated a greater reliance on M2. See Hafer (1985) for a discussion of the effects of 1983 innovations on policy deliberations.

[2]Some examples are: Hafer (1984), Barnett (1982), Spindt (1985), Morris (1982), Cox and Rosenblum (1989), Darby, Mascaro and Marlow (1989), Friedman (1988), Haraf (1986), Hetzel (1989), Hetzel and Mehra (1989), Judd and Trehan (1987), Judd, Motley and Trehan (1988), Keeley and Zimmerman (1986), Kopcke (1987), Porter and Offenbacher (1984), Mehra (1989), Roth (1987), Siegel (1986), Simpson (1984) and Wenninger (1986). In short, this view is widespread. Earlier studies disputing these claims include Cook and Rowe (1985), Gavin (1987), Hein (1982), Jordan (1984) and Tatom (1982, 1983a, 1983b). These studies follow an earlier theoretical and empirical tradition which suggested the ineffectiveness of deposit rate regulations. This literature includes such works as Barro and Santomero (1972), Bradley and Jansen (1986), Cox (1966), Frodin and Startz (1982), Kareken (1967), Benjamin Klein (1970, 1974), Michael Klein (1974), Saving (1971, 1977, and 1979), Santomero (1974), Startz (1979) and Tatom (1971).

impaired its usefulness, few quantitative studies have assessed the actual effects of financial innovations on the monetary aggregates.

This paper first describes the financial innovations hypothesis that M1, but not M2, has been significantly affected by the introduction and growth of these new assets. It then assesses the validity of this hypothesis by examining whether the turnover rate for checkable deposits, currency preferences, and M1 and M2 demand (velocity) have been affected as the hypothesis suggests.[3]

MONETARY AGGREGATES AND FINANCIAL INNOVATIONS

Table 1 shows the components of M1 and M2 in 1989. M1 consists of currency in the hands of the public, demand deposits, other checkable deposits and travelers checks. Other checkable deposits include accounts on which financial institutions can make explicit interest payments. During the 1970s, a few states authorized interest-paying negotiable order of withdrawal (NOW) accounts. In 1978, checkable accounts with automatic transfer from interest-paying savings accounts (ATS) were authorized by the Federal Reserve System.

As figure 1 shows, the share of other checkable deposits in total checkable deposits (demand and other checkable deposits) rose from about 10 percent in late 1980 to more than 25 percent by the end of 1981, the first year that nationwide NOW accounts were authorized. This share continued to rise, in part because of the introduction of super-NOW accounts (interest-bearing other checkable deposits with unregulated interest rates) in early 1983. By 1989, other checkable deposits had risen to $278.5 billion, nearly half of total checkable deposits and about 36 percent of M1.

M2 is the sum of M1, saving and small time deposits at all financial institutions, overnight (and continuing contract) repurchase agreements issued by all commercial banks, overnight Eurodollars issued to U.S. residents by foreign branches of U.S. banks and money market accounts (MM),

Table 1
M1 and M2 in 1989 (billions of dollars)

Components	Amount
Currency	$217.5
Demand deposits	280.4
Other checkable deposits	278.5
Travelers checks	7.3
M1	$783.7
Money market mutual funds component[1]	$276.3
Money market deposit account balances	475.0
Savings	410.0
Small time	1,105.5
Overnight Eurodollars[2] and repurchase agreements	79.1
M2	$3,129.5[3]

[1]General purpose and broker-dealer funds.

[2]Eurodollar deposits issued to U.S. residents by foreign branches of U.S. banks.

[3]Components do not add to total because of rounding.

which include both general purpose and broker-dealer money market mutual funds (MMMF) and money market deposit accounts (MMDA). Money market deposit accounts, which have unregulated interest rates, were authorized at the same time as super-NOW accounts and became available in December 1982. Within the first two quarters of 1983, they had grown to 17 percent of M2 (figure 2). Some of this growth apparently came at the expense of money market mutual fund accounts, since the total share of money market accounts, MMDA and MMMF, rose by less than 17 percentage points; the share of total money market balances, rose from 10 percent to about 24 percent of M2 at the time. Since there is little difference between MMDAs and MMMFs, which became available in 1978, they are grouped together here as money market accounts. The share of MM in M2, called s22 below, rose to nearly 25 percent of M2 by 1989 (see table 1 and figure 2).

[3]Numerous other financial innovations have occurred over the past several decades. This article focuses solely on the introduction of the principal new types of monetary assets that are included in the monetary aggregates. Moreover, the analysis is limited solely to the effects of these innovations on M1 and M2; it ignores the effects on broader aggregates or on differently weighted aggregates, like the divisia or turnover-weighted aggregates. These other measures are discussed by Barnett (1982) and Spindt (1985).

Figure 1
Share of Other Checkable Deposits in Total Checkable Deposits

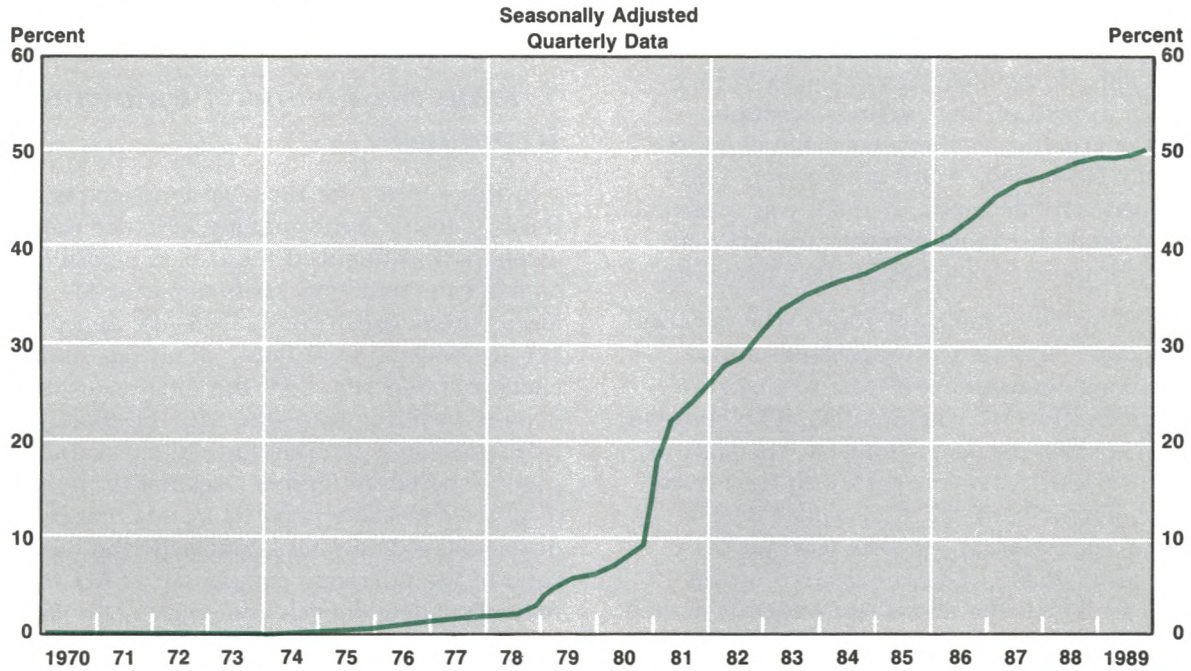
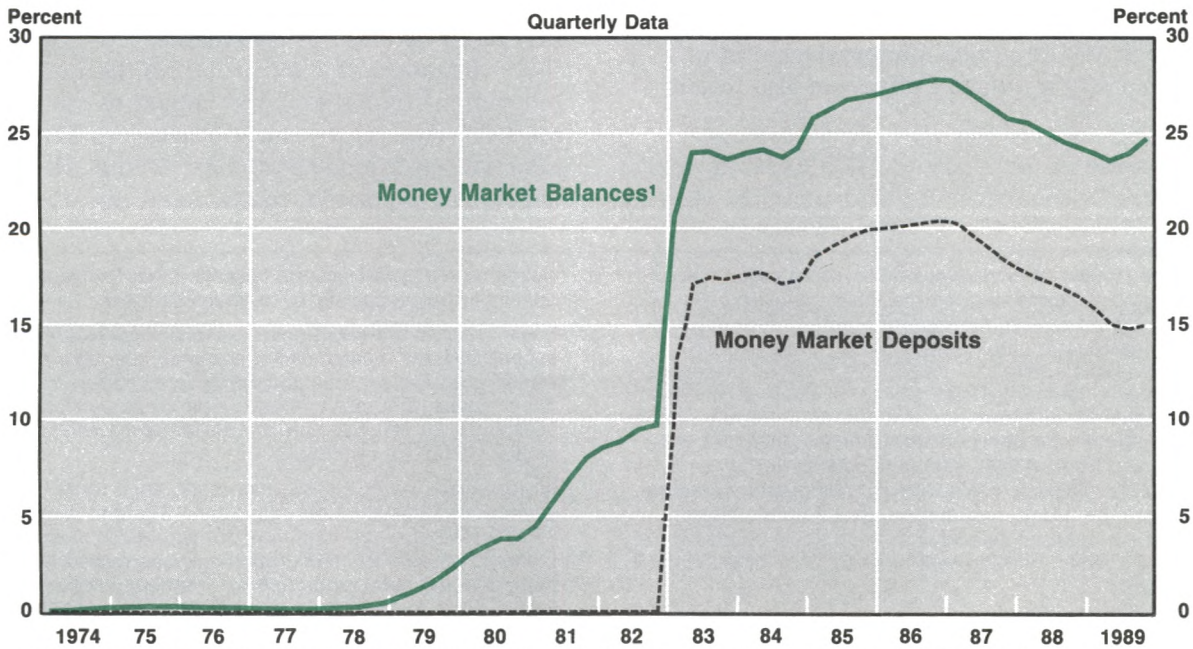


Figure 2
Share of Money Market Instruments in M2



¹Money market balances include both the money market deposit account and money market mutual fund components of M2, which are not seasonally adjusted.

THE FINANCIAL INNOVATIONS HYPOTHESIS

The financial innovations hypothesis described here focuses primarily on the effects of the growth of these new assets on M1. According to this hypothesis, the introduction of interest-bearing checking accounts made depositors more willing to hold savings balances in their checking instead of their savings accounts. Thus, the growth of other checkable deposits, especially nationwide NOW accounts in 1981 and super-NOW accounts in 1983, was expected to boost total checkable deposits and M1 and raise the interest elasticities of their demands.[4]

In addition, movements of funds from savings to checkable deposits were expected to take place among components of M2, so that the total demand for M2 was unaffected by shifts to other checkable deposits. Similarly, the shift of funds into MMDAs was expected to flow from other components of M2, especially MMMFs; thus, the expansion of MMDAs was not expected to boost M2.[5] One implication of this hypothesis is that the growth of MMDAs, or of MMMFs earlier, did not affect the demand for M1, its use or its composition.[6] If these assets provide transaction services that are substitutes for total checkable deposits, however, then shifts to these balances should reduce the demand for total checkable deposits relative to currency holdings, or raise the currency ratio. Such shifts would also reduce the overall demand for M1. Whether money market innovations had any significant effects is also tested below.

The surge in the share of MMs in M2 in early 1983 was associated with a sharp rise in M2 growth from a 9.1 percent rise in the four quarters of 1982 to a 16.6 percent annual rate in the first half of 1983. While this movement ran counter to the financial innovations hypothesis, many thought that it was transitory and carried little implication for future economic performance.[7]

Testing the Financial Innovations Hypothesis

In this article, the financial innovations hypothesis is tested by examining whether these new assets have influenced the use, composition or demand for total checkable deposits, M1 and M2 as predicted. If total checkable deposits and M1 are boosted by inflows of savings into other checkable deposits, then the total checkable deposit turnover rate—the ratio of debits on total checkable deposits to total checkable deposits—should be *inversely* related to the share of other checkable deposits in total checkable deposits (s1 = OCD/TCD). Similarly, the desired ratio of the currency component of M1 to the total checkable deposit component also should be inversely related to s1.[8]

When the effects of other checkable deposits on M1 and M2 are investigated, the innovations measures used are their ratios to M1 (s11 = OCD/M1) and to M2 (s12 = OCD/M2), respectively. If M1 is increased by an inflow of savings into other checkable deposits, then the demand for M1, given its other determinants, must be *positively* related to s11. According to the financial innovations hypothesis, the impact of money market balances, measured relative to M1 (s21 = MM/M1), on M1 demand is zero. Similarly, if the hypothesis is correct, the demand for M2 should

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[4]Rasche (1988a) cites several studies which argue that financial innovations lowered the interest elasticity of money demand. More recent proponents of a financial innovations effect argue for an increase in this elasticity. Rasche (1987, 1988a and 1988b) has provided evidence for a rise in the interest elasticity of M1 demand, but he does not link this to financial innovations. Friedman (1988), Moore, Porter and Small (1988), Carlson (1989), Mehra (1989) and Poole (1988) also have pointed to the rise in the interest elasticity of M1 demand, although for different reasons. The first four studies suggest that this effect arose from financial innovations, while Poole suggests that it is not a recent development; instead, only its recognition is recent.

[5]See Thornton (1983). In late 1982, the FOMC anticipated that maturing all-savers certificates and the impending introduction of MMDAs would temporarily boost M1 and, to a lesser extent, M2. The FOMC decided in October 1982 to set no short-run objective for M1, but to place greater weight on M2. There was no indication that M2 would rise relative to M1, especially by as much as it did.

[6]Some analysts, however, point to the similarities between super-NOW and money market accounts; the latter offer limited checking services and unregulated interest rates. They suggest that money market balances are close substitutes for M1. See Cox and Rosenblum (1989) and Motley (1988), for example.

[7]For example, the FOMC's initial target range for M2 announced in February 1983 called for M2 growth in the 7-to-10-percent range from the February-March average to the fourth quarter of 1983. This range was viewed as comparable to the 1982 range of 6 to 9 percent, allowing for a further boost to M2 due to new MMDAs. Hafer (1985) discusses these developments and their effects on the FOMC deliberations in detail.

[8]The appendix to this article presents a more formal discussion of the tests of the effects of financial innovations.

be unrelated both to other checkable deposits, measured by s12, and to money market balances, measured by s22.

Testing for a Shift in the Interest Rate Elasticity

The effect of other checkable deposits on the interest elasticity of each relationship also is examined. The financial innovations hypothesis indicates that the weighted average cost of holding total checkable deposits and M1 and the interest elasticity of various monetary linkages are functions of the relative size of other checkable deposit balances. The implication is that the relevant interest elasticity rose, on average, after the introduction of other checkable deposits. Under the financial innovations hypothesis, the rise in the interest elasticity is a function of s1, the relative size of other checkable deposits. Thus, if β_0 is the interest elasticity before the introduction of other checkable deposits (that is, when s1 is zero), then following this innovation the interest elasticity becomes $\beta^* = \beta_0 + \beta_1$ s1.

In the log-linear relationships estimated below, the interest elasticity following the advent of other checkable deposits is found from the β coefficients in the expression: β_0 lni + β_1(s1 lni); the interest elasticity is β_0 plus β_1 weighted (multiplied) by the average value of s1. In a first-difference equation, the appropriate expression is: β_0 Δlni + β_1 Δ(s1 lni). Whether the interest elasticity has increased as a result of this financial innovation is indicated by the sign and statistical significance of β_1.

In summary, in this study the financial innovations hypothesis is rejected if: (1) measures of other checkable deposit innovations have no significant effect on the M1-related variables and their interest elasticities, (2) these same measures have a significant effect on the size or interest elasticity of M2 demand, or (3) measures of money market innovations have any significant effect on the use, composition or demand for M1 or the demand for M2. These relationships are examined below.

FINANCIAL INNOVATIONS AND THE DEPOSIT TURNOVER RATE

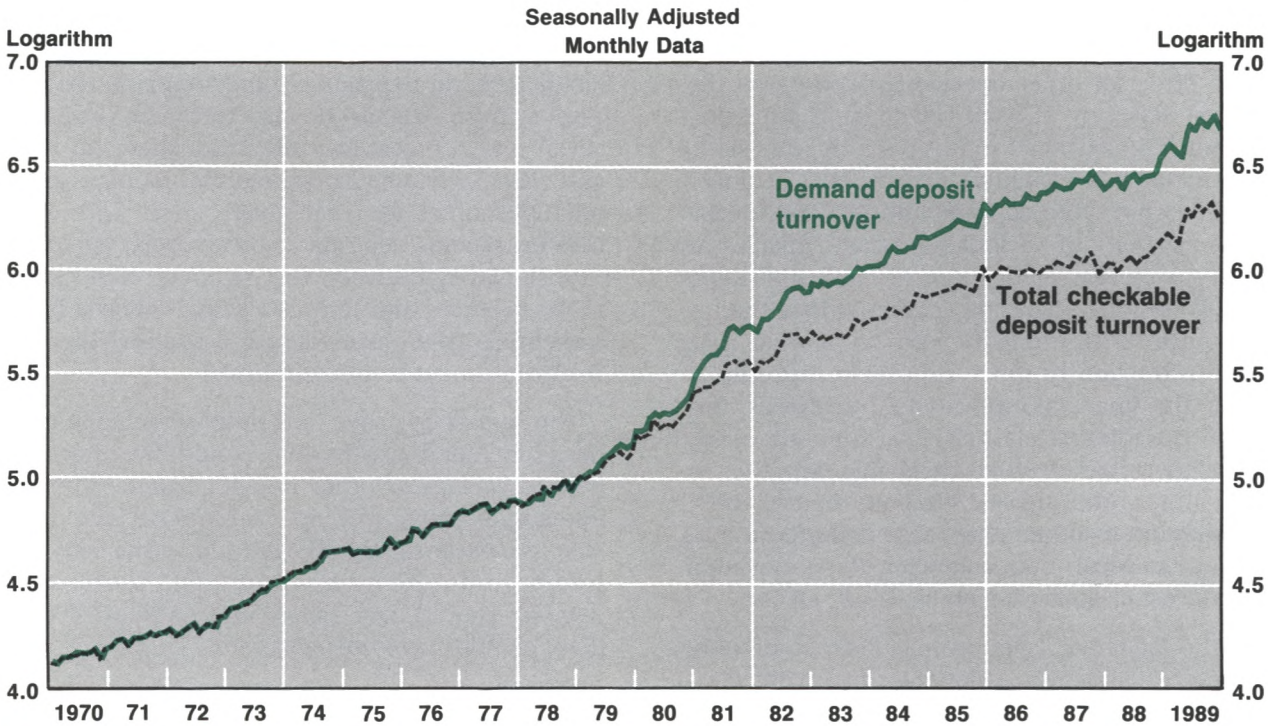
The turnover of other checkable deposits, their debits per dollar of deposits, is lower than the turnover of demand deposits. For example, in May 1989, the annual rate of debits per dollar of demand deposits at banks outside New York (where demand deposit turnover is nearly seven times larger) was 467.5; turnover on ATS and NOW accounts at commercial banks was only 18.2 times per year, much closer to the 3.6 rate on savings deposits at commercial banks.[9] The similarity between the turnover of ATS and NOW balances and that on saving deposits is sometimes taken as evidence to support the financial innovations hypothesis.

The hypothesis says that other checkable deposits include balances that would have been held in savings or other non-M1 balances before interest-bearing checking accounts became available. As these savings flowed into other checkable deposits, the turnover of total checkable deposits should have fallen, and its interest elasticity should have been altered.

Figure 3 shows the natural logarithms of the turnover rate for demand deposits and total checkable deposits (demand, ATS and NOW balances) since 1970. Turnover has a strong upward trend; for example, the turnover rate of demand deposits more than doubled from 1970 to early 1979. The two measures began to deviate in late 1978, when ATS accounts were introduced, reflecting the lower turnover rates for ATS and NOW balances. The upward surge of demand deposit turnover, especially in 1981, suggests that lower turnover deposits were switched from demand deposits to the new accounts. More important, however, the turnover rate for total checkable deposits *rose* in 1981, counter to the decline predicted by the financial innovations hypothesis. Overall, the turnover rate for total checkable deposits looks more like a continuation of the 1970-78 demand deposit turnover series than does the demand deposit turnover series itself.

[9]These data are available in the Federal Reserve statistical release, G.6, Debits and Deposit turnover at Commercial Banks. Debits on ATS and NOW accounts, like those on demand deposits, typically are third party payments; debits on savings, on the other hand, typically are in-bank withdrawals. Moreover, deposit turnover is substantially larger for business accounts than individuals; only the latter, however, can legally hold NOW and ATS accounts.

Figure 3
Demand Deposit and Total Checkable Deposit Turnover



Deposit turnover measures are velocity measures; as such, they are related to the same factors, like interest rates and income, that influence the demand for money. Higher interest rates, by increasing the cost of holding checkable deposits, should reduce the quantity of these deposits demanded and increase their turnover rates. As income rises, the demand for these deposits should rise; whether the turnover rate rises or falls, however, depends on whether debits rise more or less than the demand for checkable deposits. The continuous annualized growth rate of monthly total checkable deposit turnover, $\dot{CDT}$, was estimated as a function of the continuous annualized rates of increase of the three-month Treasury bill rate, $\dot{R}$, and real personal income, $\dot{y}$, for the period January 1979 to January 1989.

The financial innovations hypothesis indicates (1) that a rise in s1 should significantly reduce the turnover of total checkable deposits and (2) that a rise in money market balances, measured here by a rise in the ratio of money market balances to total checkable deposits, s2, should not affect it. This was tested by adding current and up to 12 lagged values of the annualized first-differences of s1 and s2, labeled Ds1 and Ds2, respectively, to the turnover equation; adding lagged effects beyond one month, however, was uniformly unnecessary.

The estimate for total checkable deposit turnover that contains the most statistically significant innovations term is:

$$(1)\quad \dot{CDT}_t = \underset{(5.22)}{13.00} - \underset{(-1.36)}{0.043}\dot{R}_t + \underset{(3.62)}{0.110}\dot{R}_{t-1} - \underset{(-2.45)}{1.013}\dot{y}_{t-1} + \underset{(0.76)}{0.227}Ds1_{t-1}$$

$$\hat{\rho}_1 = \underset{(2.80)}{0.255} \qquad \hat{\rho}_2 = \underset{(2.68)}{0.244} \qquad D.W. = 2.00$$

$$\bar{R}^2 = 0.15 \qquad S.E. = 29.255$$

(The numbers in parentheses in the equation estimates reported here are t-statistics.)

The results in equation 1 show that the share of other checkable deposits has not significantly depressed the turnover of checkable deposits; instead, the estimated effect is positive, but

statistically insignificant.[10] This result is counter to the financial innovations hypothesis.

If financial innovations increased the interest elasticity of total checkable deposits turnover, then the coefficients on the interest rate terms ($\dot{R}_t$, $\dot{R}_{t-1}$) in equation 1 should be related to s1. To test whether these coefficients have increased with the rise of the share of other checkable deposits in total checkable deposits, the annualized change in the product ($s1_i \ln R_i$) for the current and past month are added to equation 1. The sum of these coefficients is positive, 0.03, but it provides no significant explanatory power to the equation. The F-statistic for testing whether these coefficients are zero is $F_{2,112} = 0.04$, well below the critical value (5 percent) of 3.08. Thus, financial innovations, as defined here, have had no significant effect on the interest elasticity of total checkable deposit turnover. Again, this result is counter to the financial innovations hypothesis.

FINANCIAL INNOVATIONS AND THE CURRENCY-DEPOSIT RATIO

The currency ratio, the ratio of currency held by the public to its total checkable deposits, is a principal determinant of the money multiplier (the ratio of a monetary aggregate to the adjusted monetary base). Moreover, it is the principal channel through which financial innovations can affect the link between Federal Reserve actions and the monetary aggregates.[11] The desired ratio of currency to total checkable deposits is the outcome of a portfolio decision based on the relative costs and benefits of holding each means of payment. If total checkable deposits now include a larger component of savings balances than they did earlier, then the increase in the share of other checkable deposits in total checkable deposits should have lowered the currency ratio. In addition, if money market accounts are a substitute for checkable deposits included in M1, then the introduction and spread of money market holdings should have reduced total checkable deposits relative to currency holdings and raised the currency ratio.[12] According to the financial innovations hypothesis outlined above, however, this latter effect should be zero.

Figure 4 shows quarterly data on the ratio of the currency and the checkable deposit components of M1. This ratio does not decline in early 1981 or early 1983 when the largest boosts in savings held in other checkable deposits presumably would have occurred. Nor does the currency ratio rise in early 1983 when money market accounts surged.

A modified time series model is used to test the effects of these shifts on the currency ratio. The growth rate of the currency ratio can be described as a first-order autoregressive time

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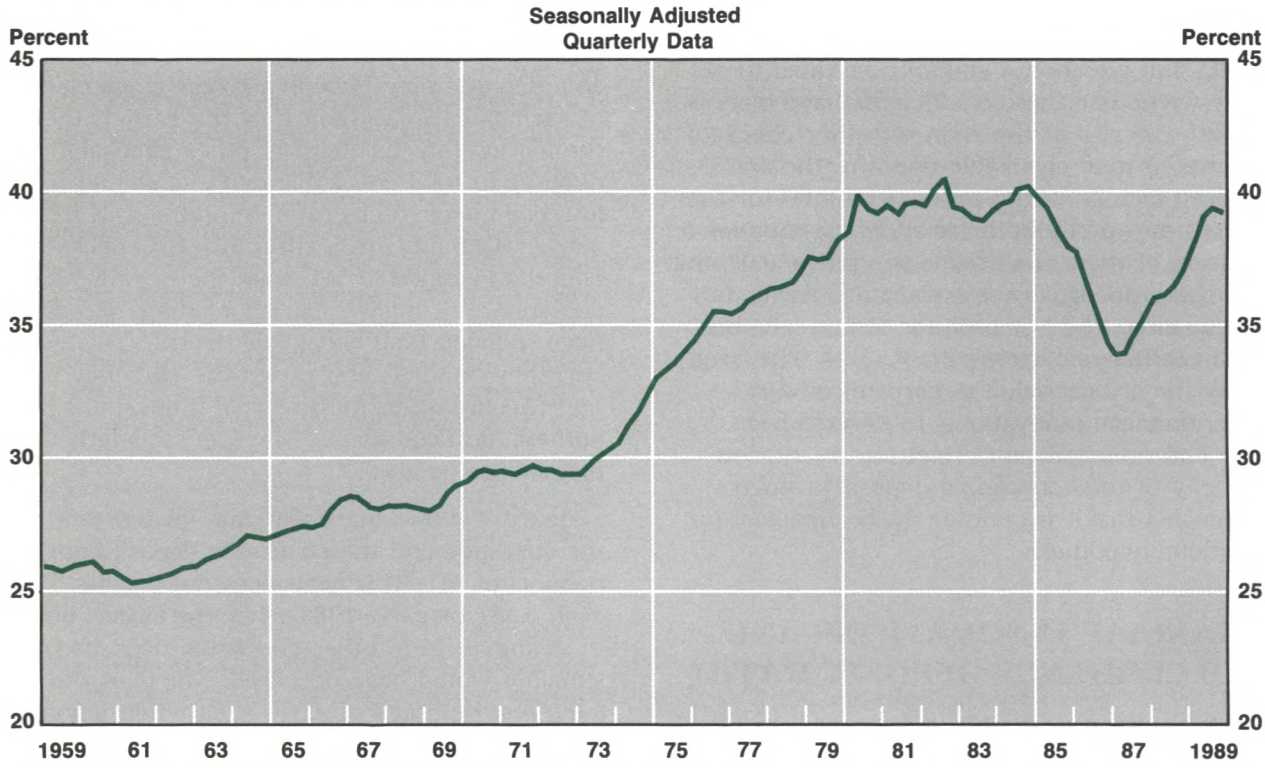
[10]Either the current or first-lagged value of Ds1 is strongly and positively statistically significant when added to an identical equation for demand deposit turnover growth. When both current and lagged Ds1 values are included, however, neither is statistically significant. The standard error of the estimate is lower when the current value is used instead of the lagged value. The coefficient on the current value is 1.025 (t = 3.49). The result in equation 1 is unaffected by regressing the growth rate of total debits on the same right-hand-side variables and on the growth rate of total checkable deposits; the coefficient on $Ds1_{t-1}$ is 0.282 (t = 0.95) in this case. Finally, when equation 11 in the appendix is estimated using the nonlinear least squares method, neither f nor gó is significantly different from zero. The estimates of f and gó are 0.005 (t = 0.01) and 0.021 (t = 0.37), respectively.

The turnover rate for deposits, excluding demand deposits in New York (and their debits) was also examined. Its growth rate is white noise and is independent of interest rates or real personal income. It is also not significantly correlated with the current or lagged values of the changes in the financial innovation shares. For example, the correlation coefficient for the growth rate of turnover of total checkable deposits, excluding New York demand deposits, and the first lagged change in s1 is 0.023. This insignificnat correlation rejects the implication of the financial innovations hypothesis that this correlation is significantly negative.

[11]The adjusted monetary base is described in Gilbert (1980 and 1987). A recent analysis of the behavior of the multiplier and its determinants can be found in Burger (1988).

[12]The effect of nationwide NOW accounts on the currency ratio is tested in Tatom (1982). A model of the demand for currency and demand deposits is used to test whether other checkable deposits lowered desired currency holdings relative to total checkable deposits. The tests reject the financial innovations hypothesis. Rasche and Johannes (1987) show that the 1981 shift to NOW accounts included a shift of savings to these accounts equal to about the 27.5 percent of such funds in the first four months of 1981. While this proportion also was suggested by the staff of the Federal Reserve Board, they suggested that it would have a continuing effect and applied it for all of 1981. Rasche and Johannes, on the other hand, argue that this shift significantly, but only temporarily, reduced the currency ratio and raised the money multiplier. They find no evidence that the shift to other checkable deposits or money market accounts had a permanent effect on the currency ratio or the multiplier. See Rasche and Johannes (1987, pp. 60-69).

Figure 4
Currency/Deposit Ratio[1]



[1]Ratio of Currency Component to Checkable Deposit Component of M1

series process; two other factors also have had a major impact on the currency ratio over the past 15 years and they are controlled for in the following estimates.[13] The first factor is energy prices, which rose sharply in 1973-74 and in 1979-81 and fell sharply in 1986. A rise in energy prices raises expenditures that use currency relatively more than it raises expenditures that rely more heavily on checkable deposits. Thus, the currency ratio rises when energy prices increase.[14] The second factor is the transitory effect of the credit control program in 1980, which temporarily boosted currency demand relative to checkable deposits in the second quarter of the year. Credit limitations increase the use of currency, especially in transactions that would otherwise be facilitated by retail credit.[15] Finally, the current and past quarter's three-month T-bill rates are included to examine the interest rate elasticity of the currency ratio; longer lags for the interest rate variables are not statistically significant.

The model of the currency ratio, k, estimated for the period III/1959 to IV/1989 is shown in the first column of table 2. The dependent variable, $\dot{k}_t$, is the annualized continuous rate of growth of the currency ratio. The annualized

[13]Rasche and Johannes (1987) argue for the superiority of a time series model over a structural approach like that used in Tatom (1982); the modifications here are made to include the sizable known effects of the two energy price shocks and to test whether the currency ratio's interest elasticity was affected.

[14]Tatom (1985) provides evidence that money demand is affected by energy price increases. The currency-ratio effect may arise, at least in part, through gasoline purchases that affect currency demand more than the demand for checkable deposits. A related argument is that a change in the mix of personal consumption expenditures toward nondurable purchases raises the currency ratio. See Dotsey (1988).

[15]The effect of the credit control program on the money stock is discussed in Tatom (1982) and Hein (1982). Also see Wallace (1980) for an analysis of the effects of credit controls on currency demand.

continuous rate of increase of the relative price of energy resources, $\dot{p}^e$, is measured by the ratio of the producer price index for fuel, power and related products to the implicit price deflator for business sector output. The credit-control variable, D80, equals one in the second quarter of 1980, negative one in the third quarter of 1980, and zero otherwise. These independent variables are generally strongly statistically significant in the estimates shown in table 2.[16]

When current and lagged (up to four) values of Ds1 or Ds2 were added to the model, only the estimate with the current-quarter change in s1 (Ds1), shows a statistically significant innovations effect; it is reported in the second column of table 2. Although, the negative coefficient on $Ds1_t$ is not statistically significant at a 5 percent level in a two-tail test, it is significantly negative using a one-tail test of the negative effect predicted by the hypothesis.[17] No other individual or group of current or lagged changes of the financial innovations variables are as significant.[18] These results suggest that growth in other checkable deposits has significantly lowered the currency ratio, which is consistent with the financial innovations hypothesis.[19]

This effect is weak, however, and is quite sensitive to the exclusion of only one observation—the second quarter of 1981. When this quarter is omitted, the coefficient on Ds1 falls in absolute value to −0.073, and its t-statistic falls to −0.89, which is far from statistical significance even with a one-tail test. Thus, the significant result for $Ds1_t$ in table 2 is spurious. The largest rise in the s1 measure occurs in I/1981 not in the second quarter; the omission of the I/1981 observation, however, does not affect the significance of $Ds1_t$. The decline in the significance of Ds1 when the II/1981 observation is omitted

Table 2

Tests for the Ratio of Currency to Total Checkable Deposits (k)

Dependent Variable: $400\Delta \ln k$
Period: III/1959 to IV/1989

Constant	0.496	0.750	0.419
	(1.70)	(2.32)	(1.37)
$\dot{k}_{t-1}$	0.503	0.477	0.503
	(7.28)	(6.81)	(7.20)
$\dot{R}_t$	0.013	0.011	0.014
	(1.95)	(1.75)	(2.02)
$\dot{R}_{t-1}$	0.025	0.028	0.023
	(3.83)	(4.16)	(3.28)
$\dot{p}^e_{t-1}$	0.058	0.059	0.053
	(3.13)	(3.21)	(2.81)
D80	11.292	10.783	11.398
	(4.73)	(4.53)	(4.75)
$Ds1_t$		−0.135	
		(−1.79)	
$D(s1_t, \ln R_t)$			−0.011
			(−0.39)
$D(s1_{t-1}, \ln R_{t-1})$			0.037
			(1.30)
$\bar{R}^2$	0.55	0.56	0.55
S.E.	3.052	3.023	3.054
D.W.	2.11	2.10	2.13
h	−1.01	−0.92	−1.20

[16]The F-statistic for a Chow test of the stability of the equation using the first and second half of the whole sample period is $F_{5,111} = 0.64$, well below the 5 percent critical value of 2.30. Thus, the stability of the currency ratio estimate cannot be rejected.

[17]In earlier versions of this article, this effect was insignificant even with a one-tail test. For example, before the February 1990 benchmark revisions, the estimate for the period III/1959 to III/1989 had a coefficient of −0.101(t = −1.24). The critical t-statistic value for a one-tail test is about 1.65. The significance of the rest of the results reported here was not so affected. The nonlinear least-squares estimate of equation 17 in the appendix (when g equals zero) yields essentially the same result as in the text; in particular, the point estimate of f is 0.1324 (t = 1.83). The g parameter is set equal to zero in this estimate because it is not significantly different from zero when freely estimated.

[18]For example, the coefficient on Ds2 is 0.013 when added to the equation in the first column, and its t-statistic is only 1.19.

[19]Although Rasche and Johannes find a significant transitory decline in the currency ratio in early 1981, this is not found in the error in either the first or second quarter of 1981 for the first equation in table 2. This difference may arise because they use monthly, seasonally unadjusted data, while seasonally adjusted quarterly data are used here. In the form estimated, their four-month long reduction corresponds to one observation here. The tests here cannot readily determine whether such a brief transitory effect of financial innovations took place.

does not occur from a decline in the variance of Ds1; the standard deviation of Ds1 rises from 0.076 to 0.082 when the II/1981 observation is omitted. The significant result in table 2 arises from a spurious decline in the currency ratio in II/1981, when s1 growth was relatively large.

The third column in table 2 examines whether the interest elasticity of the desired currency ratio increased in absolute value as a result of financial innovations. The results show a positive, but statistically insignificant, change in the interest elasticity. Neither interaction term is individually statistically significant, and the test statistic that they are jointly zero, $F_{2,114} = 0.91$, is not statistically significant. Therefore, the hypothesis that financial innovations raised the interest elasticity of the currency ratio is rejected.

FINANCIAL INNOVATIONS AND MONEY DEMAND

The evidence above on financial innovations influence on total checkable deposit turnover and the currency ratio rejects the financial innovation hypothesis. These results do not address the more familiar literature on M1 demand or the velocity problem; nor do they examine the implications of the financial innovation hypothesis for M2.

Figure 5 shows the income velocity of M1 and M2 measured by the ratio of nominal gross national product to M1 and M2, respectively. Movements in velocity inversely reflect movements in money demand. The velocity of M1 has a strong positive trend until 1981, while M2 velocity does not appear to have a noticeable trend either before or after 1981. These velocity patterns often are cited as evidence that the demand for M1, but not for M2, became less stable in the early 1980s, supporting the financial innovations hypothesis.[20]

The Demand for M1

Rasche provides a model of the demand for M1 and other monetary aggregates, which he argues has been stable for a long time.[21] He explains that the shift in M1 velocity behavior is a "shift in the drift" attributable to a change in the systematic components of velocity that are impounded in the mean of the growth rate specification or in the trend of the level of velocity.[22] Rasche also finds evidence that the interest elasticity of M1 demand rose after 1981. He argues, however, that the timing of financial innovations and their purported effect on M1 demand are inconsistent with the timing of the "shift in the drift" that he finds. Rasche's evidence also indicates that the demand for M2 is stable.

In Rasche's model, money demand, that is, nominal money per dollar of GNP, depends upon the interest rate (the three-month Treasury-bill rate), real income and unanticipated inflation. In quarterly estimates, real income, x, is measured by real GNP, and unanticipated inflation, $\dot{P}^u$, is measured by the residuals from an MA1 model of changes in the annualized continuous rate of increase of the implicit price deflator for GNP. The income and interest rate effects on money demand occur over three quarters.[23]

An unrestricted version of Rasche's M1 demand equation, estimated for the period II/1953 to IV/1989 is:

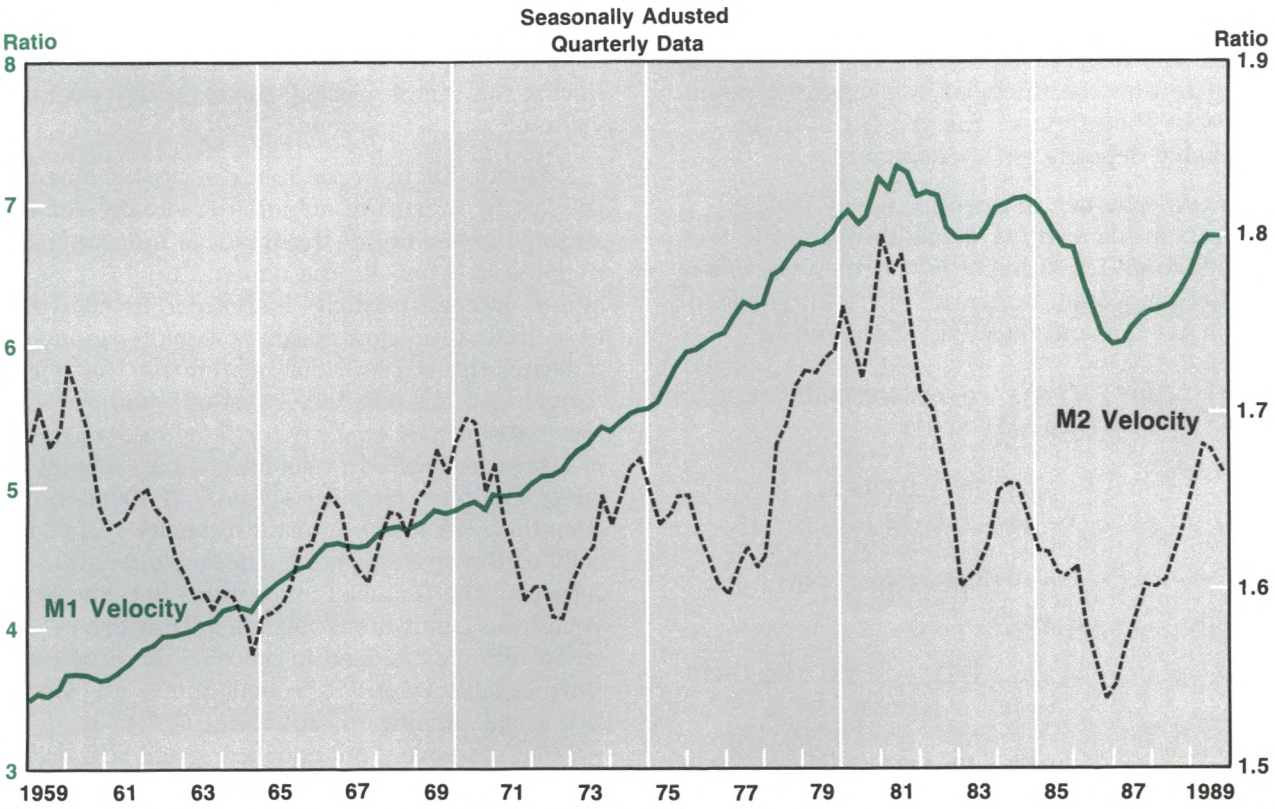
[20]Both Hetzel and Mehra (1989) and Judd, Motley and Trehan (1988) take this view; indeed, the central issue in the money demand literature, according to these papers, seems to be, first, whether the recent shifts and instability of M1 demand are permanent or will disappear after some transition to a deregulated environment, and second, if the breakdown in M1 demand is only transitory, whether its statistical properties will dominate those of M2 demand when M1 demand "settles down." Judd, Motley and Trehan are more optimistic about a return to normal than Hetzel and Mehra. More recently, Hetzel (1989) and Mehra (1989) provide arguments intended to reinforce their view. Carlson and Hein (1980), Hafer (1981) and Tatom (1983a) report evidence on the breakdown of the M2-GNP link after 1977, however. Tatom (1983b) and Darby, Poole, *et al.* (1987) provide a fuller treatment of the potential causes and consequences of the change in the behavior of M1 velocity.

[21]Rasche (1988a) extends his 1987 M1 analysis to M2, M3 and broader measures.

[22]This argument rules out shifts in M1 velocity due to changes in its response to economic factors that determine it or to changes in the error structure of the random elements that affect it. These two sources are typically the basis for claims of increased uncertainty or increased instability in a demand function. Rasche conjectures, however, that the shift in the drift arises from the decline in inflationary expectations or a rise in the instability of the economy, but he finds no direct evidence supporting these arguments.

[23]Several coefficient restrictions are tested in Rasche (1987) and used in Rasche (1988a, 1988b). These are not imposed here because they could bias the tests of the financial innovations hypothesis.

Figure 5
Income Velocities of M1 and M2



$$(2)\ \dot{M}1_t - \dot{GNP}_t = -1.989 - 0.036[400/3(\ln R_t - \ln R_{t-3})]$$
$$(-4.53)\ (-4.40)$$
$$- 0.517\ \dot{P}^u_t - 0.703\ \dot{x}_t$$
$$(-4.16)\quad (-11.97)$$
$$+ 0.407\ [400/2(\ln x_{t-1} - \ln x_{t-3})]$$
$$(4.17)$$
$$+ 2.336\ D82_t - 0.141\ D82_t DR13_t$$
$$(3.28)\qquad (-6.07)$$

$\bar{R}^2 = 0.68$ D.W. = 1.92

S.E. = 2.679 $\hat{\rho} = 0.227$
(2.74)

where GNP is nominal GNP, and $\dot{GNP}$ and $\dot{x}$ are the annualized continuous growth rates of nominal and real GNP, respectively, D82 equals one from I/1982 on and zero earlier, and $DR13_t$ is the variable in brackets in the second term on the right-hand-side of the equation.[24] The significant intercept shift (D82) changes the 2.0 percent trend rate of velocity increase until 1982 into a 0.35 percent trend rate of decline subsequently; the latter rate, however, is not significantly different from zero. The last term in equation 2 tests whether the magnitude of the interest elasticity of money demand rose; according to the estimate, it rose significantly in absolute value.

[24]Rasche (1988a) omits the first and second quarters of both 1980 and 1981 in arriving at his stability results. These quarters are included here; the adjusted R^2 and standard error actually improve when these quarters are included in estimating equation 2. For the M2 results, the adjusted R^2 reported below falls slightly when these quarters are included, but no other noticeable changes occur in any of the coefficients.

To test whether the rise in s11 has raised M1 demand, the variable 400 Δs11 is added to the equation. The financial innovations hypothesis predicts that its coefficient should be significantly positive. When this variable is added to equation 2, however, its coefficient is negative, but statistically insignificant, −0.063 (t = −0.58). This result refutes the financial innovations hypothesis about the effect of the growth of other checkable deposits on M1 demand.[25]

To test whether the rise in money market deposits influenced M1 demand, which the financial innovations hypothesis denies, the money market innovation measure, 400 Δs21, is added to the M1 demand equation; the result is:

$$(3)\ \dot{M}1_t - G\dot{N}P_t = -1.918 - 0.035[400/3(\ln R_t - \ln R_{t-3})] \quad (-4.45)\ (-4.35)$$

$$- 0.533\ \dot{P}^u_t - 0.699\ \dot{x}_t \quad (-4.34)\ \ (-12.10)$$

$$+ 0.392\ [400/2(\ln x_{t-1} - \ln x_{t-3})] \quad (4.08)$$

$$+ 2.432\ D82_t - 0.161\ D82_t DR13_t \quad (3.49)\ \ (-6.63)$$

$$- 0.034\ 400\Delta s21_t \quad (-2.36)$$

$$\bar{R}^2 = 0.70 \qquad D.W. = 1.91$$

$$S.E. = 2.636 \qquad \hat{\rho} = 0.22 \quad (2.67)$$

The money market innovations term is significantly negative; the introduction and growth of money market balances has statistically significantly reduced M1 demand. The coefficient on the innovations term is small, however; the rise in s21 to 1, about its level currently, has reduced the demand for M1 by 3.4 percent.

The proportion of MM that are transaction balances can be estimated from the coefficient on the innovations variable. The latter coefficient equals $-g/(1+gs21)$, where g is the share of transaction balances in MM, according to the derivation in the appendix to this article (eq. 20). Since the mean level of s21 is 21.85 percent during the sample period, the estimated average value of g is 3.4 percent.[26]

A skeptic might argue that the significance of the last two terms in equation 2 actually demonstrates the validity of the financial innovations hypothesis. After all, the demand for M1 rose and its interest elasticity increased, just as the hypothesis predicted. Rasche's timing argument indicates this is a spurious relationship, but more formal tests are possible. A test of whether the rise in the interest elasticity is related to the growth of other checkable deposits rejects this skeptical view. The term $(s1_t \ln R_t - s1_{t-3} \ln R_{t-3})$ 400/3 relates the shift in the interest elasticity systematically to the share of other checkable deposits following the financial innovations hypothesis. When this innovations-related shift in the interest elasticity is used in place of the post-1981 shift variable D82DR13 in equation 2, its t-statistic is still significant, but lower (−3.44 vs. −6.07); moreover, the equation's standard error rises (2.80 vs. 2.68). When both variables are included in equation 2, however, the t-statistic for the innovations-related shift variable falls to −1.43, while the t-statistic for D82DR13 remains strongly significant (t = 4.83).[27]

Similarly, the hypothesis that D82 is a proxy variable for the sharp rise in other checkable deposits in the early 1980s is tested by comparing the effect of Δs11 on equations 2 and 3 with and without D82. When this is done for equation 2, the t-statistic for 400 $\Delta s11_t$ is −0.10 when D82 is omitted and, as indicated above, −0.58 when D82 is included. When both are in-

[25]The absence of an effect of s11 on M1 demand implies that the growth of other checkable deposits is offset, dollar for dollar, by reductions in M1A (M1 less other checkable deposits). A similar test of whether no other checkable deposits should be added to M1A to obtain a stable demand is easily rejected. The proportion of other checkable deposits that must be added to M1A to obtain an aggregate whose demand is invariant to shifts in other checkable deposits is not significantly different from 100 percent. This rejects the usefulness of M1A, or at least the hypothesis that its demand is invariant to financial innovations.

[26]When equation 20 in the appendix is estimated with the same non-innovation variables as in equation 2, the estimate of f, 0.014, is not significantly different from zero (t = 0.15). The estimate for g, 0.037, however, is statistically significant (t = 2.40).

[27]These tests were also conducted using equation 3 instead of equation 2. When both measures are included in the equation, the shift in the interest elasticity in 1982 remains strongly significant (t = −5.36), while the s1-related interest elasticity shift is not (t = −1.00). The coefficient (−0.031) on the money market innovations term, 400 $\Delta s21_t$, remains significant in this case (t = −2.12).

cluded, however, the coefficient on D82 (2.425) is the same size as in equation 2 and it remains statistically significant (t = 3.32). The use of Δs11 and the s1-related shift in the interest elasticity, in place of the 1982 constant and interest rate shifts, also are easily rejected when tested jointly. Thus, the growth of the other checkable deposits does not account for the significance of the last two terms in equation 2. Similar results are obtained when these same substitutions are made in equation 3 and the significance of the money market innovations term remains unaffected by these changes.

The Demand for M2

The M2 money demand equation that uses the same set of variables for the same period as the M1 estimate is:

$$(4)\quad \dot{M2}_t - \dot{GNP}_t = 1.385 - 0.055\,DR13_t - 0.734\,\dot{P}^u_t \quad (3.63)\ (-7.82)\ (-7.41)$$

$$-0.761\dot{x}_t + 0.428[400/2(\ln x_{t-1} - \ln x_{t-3})] \quad (-15.95)\ (5.25)$$

$$-0.822\,D82_t - 0.072\,D82_t DR13_t \quad (-1.32)\ (-3.62)$$

$$\bar{R}^2 = 0.77 \qquad D.W. = 1.90 \qquad \hat{\rho} = 0.289 \quad (3.55)$$
$$S.E. = 2.177$$

Unlike the M1 estimate, the M2 estimate suggests that there was no significant shift in the M2 demand intercept after 1981. The interest elasticity of M2 demand rose significantly after 1981, however, like that for M1 demand.

The financial innovations hypothesis suggests that these innovations should have had no effect on the demand for M2. To test the hypothesis, the same procedure used for M1 was followed for M2.[28] The results indicate that the contemporaneous rise in the share of money market balances in M2 (s22) has a statistically significant effect on the demand for M2, but that no other financial innovation variable (lags of s22 or current and up to four lagged values of s12) has a significant effect. Moreover, when the contemporaneous share of money market balances is included in the equation, neither the intercept shift nor the interest elasticity shift is statistically significant. The estimate, without the insignificant variables, is:[29]

$$(5)\quad \dot{M2}_t - \dot{GNP}_t = 1.422 - 0.052\,DR13_t - 0.711\,\dot{P}^u_t \quad (3.55)\ (-7.73)\ (-8.29)$$

$$-0.802\dot{x}_t + 0.373[400/2(\ln x_{t-1} - \ln x_{t-3})] \quad (-18.48)\ (4.67)$$

$$+0.261\ 400\Delta s22_t \quad (6.04)$$

$$\bar{R}^2 = 0.81 \qquad D.W. = 1.79 \qquad \hat{\rho} = 0.44 \quad (5.75)$$
$$S.E. = 2.006$$

The result that the rise in the share of money market deposits significantly raised the demand for M2 runs counter to the financial innovations hypothesis.[30] According to the estimate, a 25 percent share of money market deposits in M2 (nearly its share at the end of 1989) raises M2 demand relative to GNP by about 6.5 percentage points.[31]

Figure 6 shows the growth rate of M2 measured over four-quarter periods since 1978 and an adjusted growth rate that removes the effect of shifts in money market funds from M2 using the estimated effect in equation 5.[32] The money-

[28] No attempt was made to adjust the T-bill rate for the average rate paid on the components of M2 in order to better measure the opportunity cost of M2. Rasche (1988a) notes that, in an estimate like equation 4, inferior overall results were found when such a measure is used instead of the T-bill rate.

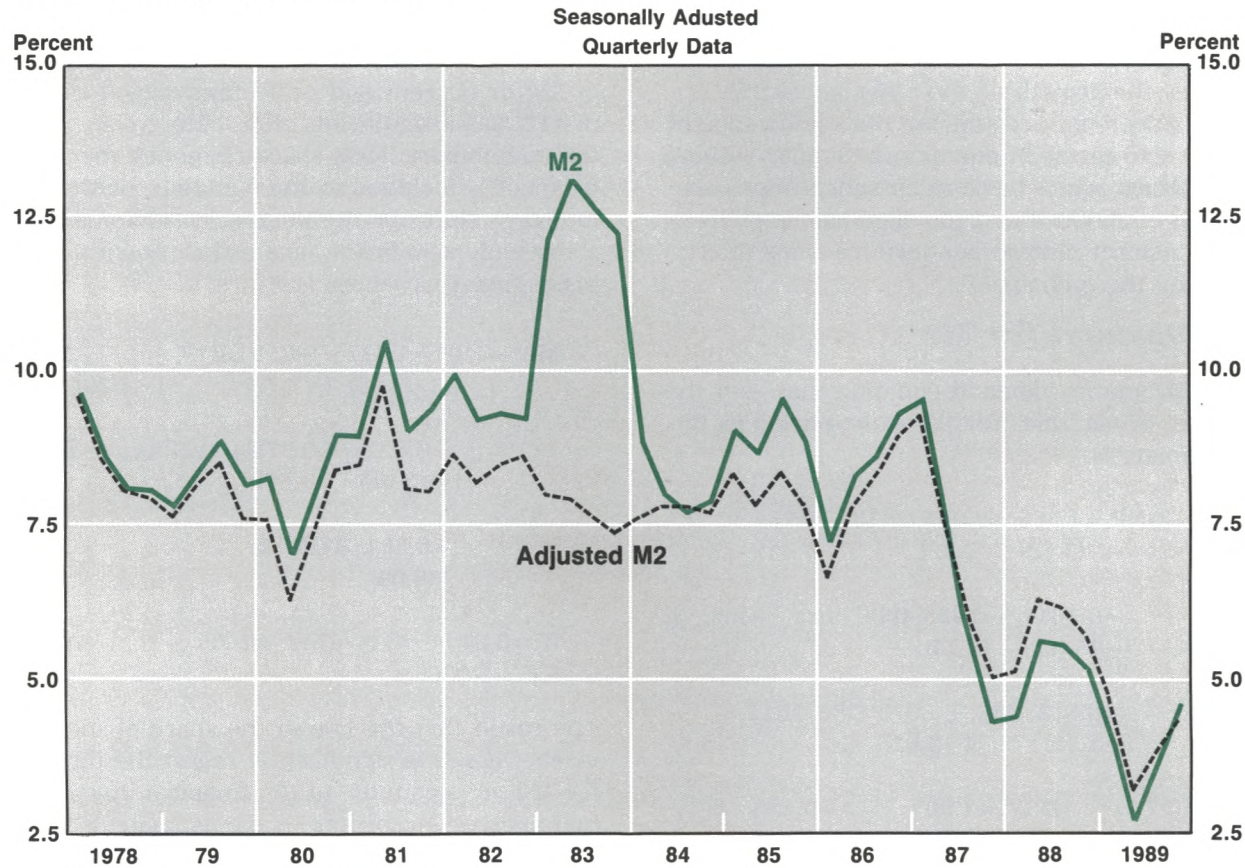
[29] When $D82_t$ and $D82_t DR13_t$ are added to the estimate they are not statistically significant; the coefficient on $D82_t$ is −0.894 (t = −1.39), and that for the shift in the interest elasticity is -0.033 (t = −1.60).

[30] These results do not depend on the inclusion of the four quarters that Rasche omits in his study. When these quarters are omitted, the standard error falls to only 1.926 percent and the other properties of the estimate are nearly identical. The same results also obtained when all four quarters of 1983, during which the largest shifts occurred, are omitted; in particular, the t-statistic for the s22 innovation term is 2.49.

[31] The theoretical value of the coefficient on 400 $\Delta s22_t$ is $g_1/(1\text{-}g_1\ s22)$, where g_1 is the proportion of MM balances that are not close substitutes for the rest of M2. This expression is derived in the appendix to this article. The sample estimate of g_1, given the sample mean value of s22 of 5.39 percent, is 25.7 percent. When equation 22 in the appendix is estimated using the nonlinear least squares method and with the same other variables as in either equations 4 or 5, the other checkable deposit innovation's coefficient is not significantly different from zero, but the money market innovation term is. Using this method, the trend shift and interest-elasticity shift again are insignificant when the money market innovation term is included. For the counterpart to equation 5 in the text, the nonlinear least squares estimate of g_1 is nearly the same, 24.2 percent, (t = 5.17).

[32] This adjustment subtracts 0.261 $s22_t$ from the logarithm of M2 to obtain a series that is independent of s22.

Figure 6
The Growth Rate of M2[1]



[1]Current rise from four quarters earlier.

market-induced shift in M2 demand had the greatest effect on the measured growth rate in 1983. In other periods, the growth rate of M2 has been affected only slightly. The adjusted growth rates ranged from 6.3 percent to 9.8 percent from 1980 until 1987. The sharp acceleration of M2 growth from 1980 to 1983 and subsequent slowing can be explained by the effect of financial innovations, in this case, by the growth of money market balances.

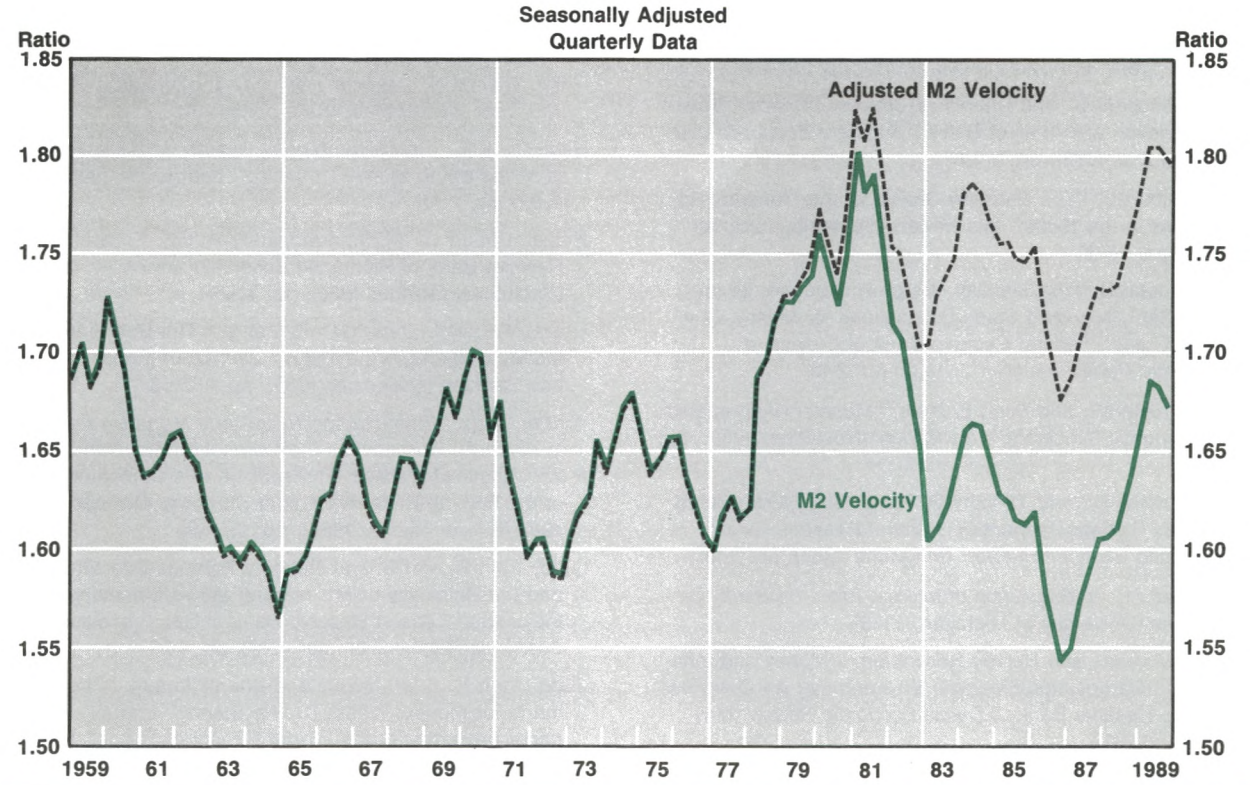
The effects on M2 velocity are shown in figure 7. Actual M2 velocity appears to vary about its mean in figure 7. When adjusted for shifts arising from money market accounts, however, M2 velocity has a positive trend, especially since the mid-1960s.

CONCLUSION

The financial innovations hypothesis that the introduction and acceptance of other checkable deposits, especially NOW and super-NOW accounts, have seriously, and perhaps permanently, distorted the measurement and effectiveness of M1, but not M2, is widely accepted today. The counterpart of this hypothesis—that the introduction and growth of money market assets like money market deposit accounts had no effects on M1 and M2—is as widely endorsed. A systematic investigation of this hypothesis, which focuses on the turnover rate of checkable deposits, the desired currency-deposit preferences of money holders, and the velocity or demand for M1 and M2, however, generally rejects its claims.

The financial innovations hypothesis implies that the turnover of total checkable deposits and the currency ratio will decline significantly as the share of other checkable deposits rises. The analysis here indicates that the turnover of total checkable deposits was not affected by these financial innovations. There was a signifi-

Figure 7
The Effect of Money Market Accounts on M2 Velocity



cant decline in the currency ratio associated with the rise in the share of other checkable deposits in total checkable deposits, but this significance is spurious in light of its sensitivity to the omission of only one observation and its refutation in the other tests presented here.

The introduction and growth of other checkable deposits has had no significant effect on the velocity of (demand for) M1. While there is evidence of a shift in M1 velocity and its interest elasticity after 1981, the tests here reject the financial innovations hypothesis that these shifts were related to the rise in the share of other checkable deposits in M1 in the early 1980s.

The introduction of money market deposit accounts and the earlier introduction of money market mutual funds have had a significant effect on the demand for monetary aggregates. The expansive growth of these new balances has had no effect on the composition of M1 or the use of checkable deposits. The demand for M1, however, was reduced slightly because of the growth of money market balances. More important, the growth of these balances was associated with a significant rise in the demand for M2. As a result, M2 velocity was depressed by the growth of money market balances. Ironically, this reduction has provided unwarranted support to the view that M2 velocity is stationary and M2 demand is stable. Movements in the share of money market accounts have accounted for much of the variation of M2 growth over the past 10 years or so.

Proponents of the view that financial innovations have distorted M1 apparently have been focusing on the wrong innovation. According to the evidence here, explicit interest-bearing accounts have not affected the use of checkable deposits, the composition of M1 or the demand for M1 (or M2 for that matter). Instead, the growth of money market balances *has* significantly affected the aggregates, raising M2 demand and depressing its velocity. Money market deposits also appear to provide substitute transaction services for M1, so that their growth has had a small depressing effect on the demand for M1.

REFERENCES

Barnett, William A. "The Optimal Level of Monetary Aggregation," *Journal of Money, Credit and Banking* (November 1982), pp. 687-710.

Barro, Robert J., and Anthony M. Santomero. "Household Money Holdings and the Demand Deposit Rate," *Journal of Money, Credit and Banking* (May 1972), pp. 397-413.

Bradley, Michael D., and Dennis W. Jansen. "Deposit Market Deregulation and Interest Rates," *Southern Economic Journal* (October 1986), pp. 478-89.

Burger, Albert E. "The Puzzling Growth of the Monetary Aggregates in the 1980s," this *Review* (September/October 1988), pp. 46-60.

Carlson, John B. "The Stability of Money Demand, Its Interest Sensitivity, and Some Implications for Money as a Policy Guide," Federal Reserve Bank of Cleveland *Economic Review* (Quarter 3, 1989) pp. 2-13.

Carlson, Keith M., and Scott E. Hein. "Monetary Aggregates as Economic Indicators," this *Review* (November 1980), pp. 12-21.

Cook, Timothy Q., and Timothy D. Rowe. "Are NOWs Being Used as Savings Accounts?" Federal Reserve Bank of Richmond *Economic Review* (May/June 1985), pp. 3-13.

Cox, Albert H., Jr. *Regulation of Interest Rates on Bank Deposits* (University of Michigan, 1966).

Cox, W. Michael, and Harvey Rosenblum. "Money and Inflation in a Deregulated Financial Environment: An Overview," Federal Reserve Bank of Dallas *Economic Review* (May 1989), pp. 1-19.

Darby, Michael R., Angelo R. Mascaro and Michael L. Marlow. "The Empirical Reliability of Monetary Aggregates as Indicators, 1983-87," *Ecomonic Inquiry* (October 1989), pp. 555-85.

Darby, Michael R., William Poole, David E. Lindsey, Milton Friedman, and Michael J. Bazdarich. "Recent Behavior of the Velocity of Money," *Contemporary Policy Issues* (January 1987), pp. 1-33.

Dotsey, Michael. "The Demand for Currency in the United States," *Journal of Money, Credit and Banking* (February 1988), pp. 22-40.

Friedman, Benjamin M. "Lessons on Monetary Policy from the 1980s," *Journal of Economic Perspectives* (Summer 1988), pp. 51-72.

Frodin, Joanna H., and Richard Startz. "The NOW Account Experiment and the Demand for Money," *Journal of Banking and Finance* (June 1982), pp. 179-93.

Gavin, William. "M1A—M.I.A.?" Federal Reserve Bank of Cleveland *Economic Commentary* (July 1, 1987).

Gilbert, R. Alton. "A Revision in the Monetary Base," this *Review* (August/September 1987), pp. 24-29.

_____ . "Revision of the St. Louis Federal Reserve's Adjusted Monetary Base," this *Review* (December 1980), pp. 3-10.

Hafer, R.W. "The FOMC in 1985: Reacting to Declining M1 Velocity," this *Review* (February 1986), pp. 5-21.

_____ . "The FOMC in 1983-84: Setting Policy in an Uncertain World," this *Review* (April 1985), pp. 15-37.

_____ . "The Money-GNP Link: Assessing Alternative Transaction Measures," this *Review* (March 1984), pp. 19-27.

_____ . "Much Ado About M2," this *Review* (October 1981), pp. 3-18.

_____ . "The New Monetary Aggregates," this *Review* (February 1980), pp. 25-32.

Haraf, William S. "Monetary Velocity and Monetary Rules," *The Cato Journal* (Fall 1986), pp. 641-62.

Hein, Scott E. "Short-Run Money Growth Volatility: Evidence of Misbehaving Money Demand?" this *Review* (June/July 1982), pp. 27-36.

Hetzel, Robert L. "M2 and Monetary Policy," Federal Reserve Bank of Richmond *Economic Review* (September/October 1989), pp. 14-29.

Hetzel, Robert L., and Yash P. Mehra. "The Behavior of Money Demand in the 1980s," Journal of Money Credit and Banking (November 1989), pp. 455-63.

Jordan, Jerry. "Financial Innovation and Monetary Policy," in *Financial Innovations: Their Impact on Monetary Policy and Financial Markets,* Proceedings of a Conference held at the Federal Reserve Bank of St. Louis, October 1 and 2, 1982 (Kluwer Nijhoff, 1984), pp. 135-50.

Judd, John P., and Bharat Trehan. "Portfolio Substitution and the Reliability of M1, M2 and M3 as Monetary Policy Indicators," Federal Reserve Bank of San Francisco *Economic Review* (Summer 1987), pp. 5-29.

Judd, John P., Brian Motley and Bharat Trehan. "The Demand for Money: Where Do We Stand?" unpublished paper presented at the Western Economics Association Meetings, Los Angeles, June 1988.

Kareken, John H. "Commercial Banks and the Supply of Money: A Market Determined Demand Deposit Rate," *Federal Reserve Bulletin* (October 1967), pp. 1699-712.

Keeley, Michael C., and Gary C. Zimmerman. "Deposit Rate Deregulation and the Demand for Transactions Media," Federal Reserve Bank of San Francisco *Economic Review* (Summer 1986), pp. 47-62.

Klein, Benjamin. "Competitive Interest Payments on Bank Deposits and the Long-Run Demand for Money," *American Economic Review* (December 1974), pp. 931-49.

_____ . "The Payment of Interest on Commercial Bank Deposits and the Price of Money: A Study of the Demand for Money," unpublished Ph.D. dissertation, University of Chicago, 1970.

Klein, Michael A. "Deposit Interest Prohibition, Transactions Costs, and Payments Patterns: A Theoretical Analysis," *Metroeconomica* (November/December 1974), pp. 144-52.

Kopcke, Richard W. "Financial Assets, Interest Rates and Money Growth," *New England Economic Review* (March/April 1987), pp. 17-30.

Mehra, Yash P. "Some Further Results on the Source of Shift in M1 Demand in the 1980s," Federal Reserve Bank of Richmond *Economic Review* (September/October 1989), pp. 3-13.

Moore, George R., Richard D. Porter and David H. Small. "Modeling the Disaggregated Demands for M2 and M1 in the 1980s: The U.S. Experience," in *Financial Sectors and Open Economies: Empirical Analysis and Policy Issues*, Pro-

ceedings of a May 1988 Conference of the Board of Governors of the Federal Reserve System, forthcoming.

Motley, Brian. "Should M2 be Redefined?" Federal Reserve Bank of San Francisco *Economic Review* (Winter 1988), pp. 33-51.

Morris, Frank E. "Do the Monetary Aggregates Have a Future as Targets of Federal Reserve Policy?" *New England Economic Review* (March/April 1982), pp. 5-14.

Nuetzel, Philip A. "The FOMC in 1986: Flexible Policy for Uncertain Times," this *Review* (February 1987), pp. 15-29.

Poole, William. "Monetary Policy Lessons of Recent Inflation and Disinflation," *Journal of Economic Perspectives* (Summer 1988), pp. 73-100.

Porter, Richard D., and Edward K. Offenbacher. "Financial Innovations and Measurement of Monetary Aggregates," in *Financial Innovations: Their Impact on Monetary Policy and Financial Markets*, Proceedings of a Conference held at the Federal Reserve Bank of St. Louis, October 1 and 2, 1982 (Kluwer Nijhoff, 1984), pp. 49-98.

Rasche, Robert H. "Demand Functions for U.S. Money and Credit Measures," Paper 8718, Department of Economics, Michigan State University (May 1988a) to be reprinted in *Financial Sectors and Open Economies: Empirical Analysis and Policy Issues* (Board of Governors of the Federal Reserve System, forthcoming).

_____ . "Monetary Policy and Financial Deregulation in the United States," *Kredit und Kapital* (Heft 3, 1988b), pp. 451-68.

_____ ."M1 Velocity and Money Demand Functions: Do Stable Relationships Exist?" in Karl Brunner and Allan H. Meltzer, eds., *Empirical Studies of Velocity, Real Exchange Rates, Unemployment and Productivity*, Carnegie-Rochester Series on Public Policy (North Holland, Autumn 1987), pp. 9-88.

Rasche, Robert H., and James M. Johannes. *Controlling the Growth of the Monetary Aggregates* (Kluwer, 1987).

Roth, Howard L. "Has Deregulation Ruined M1 as a Policy Guide?" Federal Reserve Bank of Kansas City *Economic Review* (June 1987), pp. 24-37.

Santomero, Anthony M. "A Model of the Demand for Money by Households," *Journal of Finance* (March 1974), pp. 89-102.

Saving, Thomas R. "Money Supply Theory with Competitively Determined Deposit Rates and Activity Charges," *Journal of Money, Credit, and Banking* (February 1979), pp. 22-31.

_____ . "A Theory of The Money Supply With Competitive Banking," *Journal of Monetary Economics* (July 1977), pp. 289-303.

_____ . "Transactions Costs and The Demand for Money," *American Economic Review* (June 1971), pp. 407-20.

Siegel, Diane F. "The Relationship of Money and Income: The Breakdowns in the 70s and 80s," Federal Reserve Bank of Chicago *Economic Perspectives* (July/August 1986), pp. 3-15.

Simpson, Thomas D. "Changes in the Financial System: Implications for Monetary Policy," *Brookings Papers on Economic Activity* (1: 1984), pp. 249-65.

Spindt, Paul A. "Money is What Money Does: Monetary Aggregation and the Equation of Exchange," *Journal of Political Economy* (February 1985), pp. 175-204.

Startz, Richard. "Implicit Interest on Demand Deposits," *Journal of Monetary Economics* (October 1979), pp. 515-34.

Tatom, John A. "Interest Rate Variability and Economic Performance: Further Evidence," *Journal of Political Economy* (October 1985), pp. 1008-18.

_____ . "Money Market Deposit Accounts, Super NOWs and Monetary Policy," this *Review* (March 1983a), pp. 5-16.

_____ . "Alternative Explanations of the 1982-83 Decline in Velocity," in *Monetary Targeting and Velocity*, Federal Reserve Bank of San Francisco, Conference Proceedings, December 4-6, 1983b, pp. 22-56.

_____ . "Recent Financial Innovations: Have They Distorted the Meaning of M1?" this *Review* (April 1982), pp. 23-35.

_____ . "Transactions Cost and the Supply of Real Average Demand Deposits," unpublished Ph.D. dissertation, Texas A&M University, 1971.

Thornton, Daniel L. "The FOMC in 1982: Deemphasizing M1," this *Review* (June/July 1983), pp. 26-35.

_____ . "The FOMC in 1981: Monetary Control in a Changing Financial Environment," this *Review* (April 1982), pp. 3-22.

Wallace, Neil. "Integrating Micro and Macroeconomics: An Application to Credit Controls," Federal Reserve Bank of Minneapolis *Quarterly Review* (Fall 1980), pp. 16-29.

Wenninger, John. "Responsiveness of Interest Rate Spreads and Deposit Flows to Changes in Market Rates," Federal Reserve Bank of New York *Quarterly Review* (Autumn 1986), pp. 1-10.

Appendix
A Formal Statement of the Hypotheses Tested

The financial innovations hypothesis, as presented and tested in this paper, states that the introduction and growth of other checkable deposits, OCD, distorted the measurement of both total checkable deposits and M1, but left the overall demand for M2 unaffected. Moreover, according to this hypothesis, the introduction and growth of money market balances (MM) had no effect on M2. Instead, the growth of these balances came at the expense of other non-M1 funds within M2, so that it had no effect on total checkable deposits, M1 demand, or the composition of M1.

The hypothesis suggests that some fraction, f, of other checkable deposits is not held as total checkable transaction balances and that money market deposit balances do not yield transaction services or are not held as part of total checkable transaction balances. Thus, the amount of total checkable deposits, TCD, that are "truly" transaction balances equals (1-fs1) TCD, where s1 is the share of other checkable deposits in total checkable deposits. If some proportion, g, of MM are also transaction balances, then the total MM component of transaction balances can be written as gs2, where s2 is the ratio of MM to TCD. Total transaction balances, TTB, can be defined as:

(1) $TTB = (1 - fs1 + gs2)\ TCD.$

In this framework, the financial innovations hypothesis is that $1 \geq f > 0$ and $g = 0$.

Prior to financial innovations, s1 and s2 were zero and TTB equaled TCD. The effective quantity of M1 was C+TCD, where C is the currency component of M1. The effective quantity of M1, designated M1*, when s1 and s2 are not zero, is C+TTB, or M1-fOCD+gMM. If s11 is defined to be the ratio (OCD/M1) and s21 is defined to be the ratio (MM/M1), then

(2) $M1^* = M1(1 - fs11 + gs21).$

Since M1 equals (1+k) TCD, where k is the ratio of currency to total checkable deposits, s11 equals s1/(1+k) and s21 equals s2/(1+k).

An effective quantity of M2, called M2*, can be defined similarly. Whether or not certain proportions of OCD and MM balances are appropriately considered part of TTB and M1*, they are definitionally part of M2. This is the central reason that the hypothesis claims that M2 is unaffected by these innovations. If, however, some fraction of these new deposits are not close substitutes for M2, then the effective quantity of M2, M2*, should exclude these fractions of the new deposits.

In particular, if some fractions, f_1 of other checkable deposits and g_1 of MM balances, are held for non-M2*-related reasons, then shifts in holdings of these funds will boost M2 relative to M2*, that is,

(3) $M2^* = M2(1 - f_1 s12 - g_1 s22),$

where s12 is the ratio of other checkable deposits to M2 and s22 is the share of money market balances in M2. According to the financial innovations hypothesis, the growth of other checkable deposits or MM involves substitutions within M2 and does not affect its total; therefore, M2 equals M2* and g_1 and f_1 equal zero.[1]

The hypothesis is tested below using the relationships in equations 1-3. In particular, two important economic variables, the turnover rate for total checkable deposits and the currency ratio, relate debits and currency holdings, respectively, to desired holdings of checkable transaction balances. Movements in other checkable deposits or money market deposits have predictable or systematic effects on the ratio of checkable transaction balances to observed total checkable deposits and, therefore on debits or currency holdings relative to total checkable deposits. Similarly, growth in these new assets affects the relationship of M1* and M2* to their observed counterparts and, therefore, systematically affect the relationship of the observed aggregates, M1 and M2, to the factors that influence the demands for M1* and M2*, respectively. The hypothesis also suggests that the interest elasticity of demand for transaction balances,

[1]Since M2 = (1+k+t) TCD, where t is the ratio of the non-M1 components of M2 to M2, the ratios s12 and s22 are simply $(1+k+t)^{-1}$ times s1 and s2, respectively.

M1 and M2 have been affected by financial innovations. The specific form of the hypotheses and tests are derived below.

THE TURNOVER RATE FOR TOTAL CHECKABLE DEPOSITS

The turnover rate for total checkable transaction deposits is the ratio of debits, D, on these deposits to their total, TTB. If v, the turnover rate of deposits held for transaction purposes is a function of a vector of variables, z_0, then

(4) $D = v(z_0)TTB.$

Substitution of equation 1 in equation 4 yields:

(5) $D = v(z_0)\ (1 - fs1 + gs2)\ TCD.$

The left-hand side of equation 5 includes any third-party debits on MM balances held for third-party payment, i.e., as checkable transaction balances, (gMM). For simplicity, assume that debits include only third-party payments and thus exclude cash-withdrawal debits on both TCD and MM balances. If debits on money market balances, D_m, are also a function of gMM and the vector z_0 above, or

(6) $D_m = v_m(z_0)\ gs2\ TCD,$

then the debits measured against total checkable deposits D_t, are

(7) $D_t = D - D_m = v(z_0)\ [1 - fs1 + gs2\delta]\ TCD,$

where $\delta = (1\text{-}v_m/v)$ and the turnover ratio for total checkable deposits is

(8) $d = D_t/TCD = v(z_0)[1 - fs1 + gs2\delta].$

A rise in s1 reduces the turnover ratio for total checkable deposits; if f is zero, however, then movements in s1 have no effect on v. If g and v_m are not zero, movements of funds into MM balances (relative to TCD) will affect the turnover of total checkable deposits. The sign of this effect depends on whether δ is positive, zero or negative, or whether transaction balances in MM have relatively low, the same or high turnover compared with the weighted average turnover of total transaction balances, v.

A log-linear specification of $v(z_0)$ is used, where z_0 includes the current and past interest rate (i_t, i_{t-1}) and real personal income, y_t, or

(9) $\ln v_t = \beta_0 + \beta_1 \ln i_t + \beta_2 \ln i_{t-1} + \beta_3 \ln y_t.$

The log-linear specification of equation 8 is

(10) $\ln d_t = \beta_0 + \beta_1 \ln i_t + \beta_2 \ln i_{t-1} + \beta_3 \ln y_t + \ln(1 - fs1 + g\delta s2),$

where v_m/v is assumed constant. When equation 10 is differenced, the result is:

(11) $\Delta\ln d_t = \beta_1 \Delta\ln i_t + \beta_2 \Delta\ln i_{t-1} + \beta_3 \Delta\ln y_t + \Delta\ln(1 - fs1 + g\delta s2).$

The last variable in equation 11 is unknown because f, g and δ are unknown. This problem is addressed indirectly in the paper.[2] If f, g and δ are constants, then

(12) $$\Delta\ln_t(1 - fs1 + g\delta s2) = -\frac{f}{1 - fs1 + g\delta s2}\, ds1 + \frac{g\delta}{1 - fs1 + g\delta s2}\, ds2.$$

The difference in the logarithm in the last term in equation 11 can be approximated using the total differential of the expression in parentheses and replacing ds1 and ds2 with $\Delta s1$ and $\Delta s2$.[3]
Thus, equation 11 can be written as:

(13) $\Delta\ln d_t = \beta_0 + \beta_1 \Delta\ln i_t + \beta_2 \Delta\ln i_{t-1} + \beta_3 \Delta\ln y_t + \beta_4 \Delta s1_t + \beta_5 \Delta s2_t,$

[2]All the estimates in this article contain a term like $\Delta\ln(1 - fs1 + g\delta s2)$ in equation 11. Estimating the constants like f and $(g\delta)$ directly by non-linear least-squares yields no differences from the result reported in the text for the financial innovations hypothesis. If f is correlated with movements in s1 or its counterpart measures below, the estimated coefficient on the share variables would be biased; if the correlation is positive, as proponents of the financial innovations might argue, this biases up the coefficient and biases the tests in favor of the financial innovation hypothesis. The same argument applies to g. The opposite bias would arise if f and the other checkable deposit share were negatively correlated, but this is counterintuitive. There is no *a priori* reason to expect f or g (or f_1 and g_1 below) to change, especially to change systematically with movements in the shares, however.

[3]The coefficients on $\Delta s1$ and $\Delta s2$ involve s1 and s2. These coefficients are estimated as constants and are evaluated at the sample period average values for f, $g\delta$, s1 and s2. Note that $g\delta$ is estimated from the s2 coefficient; consequently, the hypothesis that g equals zero cannot be tested. If δ equals zero (the turnover of transaction balances held in MM is the same as for the rest of such balances), then the coefficient on s2 will be zero; however, this does not imply that g is necessarily zero.

where β_0 is an intercept which should have a value of zero, unless a significant time trend has been omitted from equation 10. Under the financial innovations hypothesis, $\beta_4 < 0$ and $\beta_5 = 0$.

The Interest Elasticity of the Turnover Rate

The financial innovations hypothesis tested in the text implies that the interest elasticity of money demand rose as a result of financial innovations. Since turnover is a velocity measure, a test is conducted of whether the interest elasticity of the turnover rate of total checkable deposits rose in proportion to the growth of s1. In equations 9 and 10, this elasticity is constant and equals $(\beta_1 + \beta_2)$. If β_1 and β_2 are functions of s1, for example, $\beta_1 = \beta_1^{\circ} + \beta_1' \, s1_t$ and $\beta_2 = \beta_2^{\circ} + \beta_2' \, s1_{t-1}$, then the terms $(\beta_1 \, lni_t + \beta_2 \, lni_{t-1})$ in equations 9 and 10 must be replaced with $(\beta_1^{\circ} \, lni_t + \beta_1' \, s1_t + \beta_2^{\circ} \, lni_{t-1} + \beta_2' \, s1_{t-1} lni_{t-1})$. In equation 13, β_1° replaces β_1, β_2° replaces β_2, and the additional terms $\beta_1' \, \Delta(s1_t lni_t)$ and $\beta_2' \, \Delta(s1_{t-1} lni_{t-1})$ must be included. Whether the interest elasticity rose depends on whether β_1', β_2' and $(\beta_1' + \beta_2')$ are statistically significantly positive.

THE CURRENCY RATIO

The currency ratio is the ratio of currency to total checkable transaction balances. Currency demand relative to total checkable transaction balances is

(14) $C = k(z_1) \, TTB,$

where z_1 is a vector of the determinants of the desired ratio. With the advent of OCD and MM balances, currency holding competes with all other transaction-related balances, or TTB. Substitution of equation 1 in equation 14 yields

(15) $C = k(z_1) \, (1 - fs1 + gs2) \, TCD.$

When s1 rises, currency demand declines, given TCD, z_1, f and g, if $0 < f \leq 1$. Changes in s2 have no effect on the currency ratio under the hypothesis that $g = 0$.

The variables in z_1 that determine the desired currency ratio, and are controlled for in testing the financial innovations hypothesis, include the autoregressive component, a first lag of the currency ratio, the current (i_t) and past (i_{t-1}) interest rate, energy prices, p^e, and a credit control dummy variable, c. The first-difference of the log-linear form of equation 15, with the appropriate substitutions for z_1, is:

$$(16)\ \Delta \ln(C/TCD)_t = \delta_0 + \delta_1 \, \Delta lni_t + \delta_2 \, \Delta lni_{t-1} + \delta_3 \, \Delta lnp_t^e + \delta_4 \, D80 + \delta_5 \, \Delta \ln(C/TCD)_{t-1} + \Delta \ln(1 - fs1 + gs2)_t$$

where D80 equals Δc.

The last term on the right-hand-side can be approximated using the same argument used above for equations 11 and 12 since $d\ln(1 - fs1 + gs2)$ equals $[-f/(1 - fs1 + gs2)]ds1 + [g/(1 - fs1 + gs2)]ds2$. Thus, equation 16 can be written as:

$$(17)\ \Delta \ln (C/TCD)_t = \delta_0 + \delta_1 \, \Delta \ln i_t + \delta_2 \, \Delta lni_{t-1} + \delta_3 \, \Delta lnp_t^e + \delta_4 \, D80 + [-f/(1 - fs1 + gs2)] \, \Delta s1_t + [g/(1 - fs1 + gs2)] \, \Delta s2_t.$$

The financial innovations hypothesis, $0 < f \leq 1$, is tested by whether $\Delta s1_t$ has a significant negative coefficient. The hypothesis $g = 0$ is tested by whether $\Delta s2_t$ has a significant coefficient.

Whether the interest elasticity of the currency ratio is affected by the growth of s1 is also tested. The sum $(\delta_1 + \delta_2)$ in equation 16 or 17 is the interest elasticity of the currency ratio. If each of these components is a function of s1, then the interest components in $k(z_1)$ can be written as $(\delta_1^{\circ} + \delta_1' s1) \, lni_t + (\delta_2^{\circ} + \delta_2' \, s1) \, lni_{t-1}$, and $[\delta_1^{\circ} + \delta_2^{\circ} + \delta_1' \, s1_t + \delta_2' \, s1_{t-1}]$ is the interest elasticity of currency demand in this case. In the first-difference form given in equation 17, the interest rate components are replaced with $\delta_1^{\circ} \, \Delta lni_t + \delta_2^{\circ} \, \Delta lni_{t-1} + \delta_1' \, \Delta(s1_t \, lni_t) + \delta_2' \, \Delta(s1_{t-1} lni_{t-1})$. If financial innovations affect the interest elasticity, then δ_1' and/or δ_2' are significantly different from zero. Since δ_1 and δ_2 are negative, for the interest elasticity to become larger in absolute value requires that, $\delta_1', \delta_2' \leq 0$ and $(\delta_1' + \delta_2') < 0$.

MONEY DEMAND

Suppose "true" or effective M1 demand, M1*, is a function of a vector of variables z_3. Substituting equation 2 yields:

(18) $(1 - fs11 + gs21)M1 = D(z_2).$

In log-linear form, this equation can be rearranged as

(19) $\ln M1 = \ln[D(z_2)] - \ln(1 - fs11 + gs21)$.

When this is first-differenced and a similar substitution is made for the last term as was made in equation 13 and 17, the result is:

(20) $\Delta \ln M1 = \Delta \ln[D(z_2)] + \delta_6 \Delta s11_t + \delta_7 \Delta s21_t$,

where

$\delta_6 = f/(1 - fs11 + gs21)$, and

$\delta_7 = -g/(1 - fs11 + gs21)$.

If f is zero, then δ_6 equals 0. If $0 < f \leq 1$, however, then δ_6 is positive; that is, a rise in s11 should raise M1 demand, given the variables in z_2. If g equals 0, then δ_7 equals 0; if g is positive, then δ_7 is less than zero.

The variables included in z_2 are the interest rate, income and unanticipated inflation. The specification of $\ln[D(z_2)]$ also includes a shift in the interest rate elasticity of money demand and a shift in the level of M1 demand, where both shifts occur in 1982. Therefore, tests are conducted to determine if these two components of z_2 arise from financial innovations.

For M2 demand, the same set of tests are conducted. In particular, if "true" M2 demand, M2* in equation 3, is a function of variables z_3, $E(z_3)$, then substituting this in equation 3 yields

(21) $(1 - f_1 s12 - g_1 s22)\ M2 = E(z_3)$.

In the text, the z_3 vector includes the same set of other money demand variables as M1, that is, z_3 equals z_2. In differenced log-linear form and using the exact differential to derive the discrete $\Delta \ln(1 - f_1 s12 g_1 s22)$, equation 21 becomes

(22) $\Delta \ln M2_t = \Delta \ln E(z_3) + \delta_8 \Delta s22_t + \delta_9 \Delta s12_t$

where

$\delta_8 = [g_1/(1 - f_1 s12 - g_1 s22)]$ and

$\delta_9 = [f_1/(1 - f_1 s12 - g_1 s22)]$.

Under the financial innovations hypothesis, f_1, g_1, δ_8 and δ_9 are all zero. The coefficients δ_8 and δ_9 are positive if the proportions g_1 of MM or f_1 of OCD are positive; this result would indicate that these proportions are not a close substitute, given z_3, for the rest of M2.

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