R E V I E W

Vol. 76, No. 5 September/October 1994

THE FEDERAL RESERVE BANK of ST. LOUIS

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R E V I E W

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Federal Reserve Bank of St. Louis
Review
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information such as interest rates and position of the exchange rate within the band. The relationship between realignment expectations and macro-variables—such as output and prices—is weak and uncertain, however. Neely concludes that further work on the formation of expectations would make an important contribution to future research. Additionally, he finds that the role of the U.S. dollar in ERM realignments is often noted but has not yet been incorporated into the estimation techniques.

R. Alton Gilbert

During the three years ending in the fall of 1982, the Federal Reserve implemented the monetary policy decisions of the Federal Open Market Committee (FOMC) by targeting nonborrowed reserves. Policymakers described this change in the operating procedure as an attempt to improve monetary control. This three-year experience with nonborrowed reserves targeting has generated a great deal of analysis by economists.

R. Alton Gilbert investigates whether the record of policy actions during this period reflected a consistent attempt to hit short-run objectives for money growth, given the confidential information available then to policymakers: staff projections of total reserves over periods between FOMC meetings, and staff estimates of the level of total reserves that would be consistent with the objectives of the FOMC for money growth.

Joseph A. Ritter

Joseph A. Ritter is an economist at the Federal Reserve Bank of St. Louis. Heidi L. Beyer provided research assistance.

Job Creation and Destruction: The Dominance of Manufacturing

ESTIMATES OF GROSS JOB CREATION and destruction (gross flows) give a deeper perspective on the ebb and flow of labor markets in a market economy than do the headline-grabbing announcements of net employment growth. Gross flow data give insight into the uniformity of employment growth across different parts of the economy. The path of total employment may be the total of many industries with similar growth experiences or of many industries with extremely diverse experiences; overall employment growth may be the result of lots of job creation canceling lots of job destruction or only a little of each.

In addition, the mix between job creation and destruction can and does vary dramatically over the business and seasonal cycles in the economy. Considerable attention has been devoted recently to the behavior of gross flows in the labor market (Blanchard and Diamond, 1990; Davis and Haltiwanger, 1990, 1992; Ritter, 1993), and stylized facts from these descriptive analyses have begun to generate theoretical research (Mortensen and Pissarides, 1993). Little attention, however, has been devoted to the question of whether these facts characterize all parts of the economy or only particular segments. This paper addresses that question using the method for measuring gross flows developed in Ritter (1993). It examines gross job creation and job destruction in three broad sectors: goods production, trade, and service production excluding trade.

The main conclusion is that job creation and destruction behave much differently in the goods-producing sector than in the rest of the economy. Manufacturing and other goods-producing industries, which make up only a quarter of private nonfarm payrolls, contribute disproportionately to changes in overall job creation and destruction, particularly during recessions. Given systematic differences between goods- and service-producing sectors, it is misleading to draw sweeping conclusions (that is, "stylized facts") about the economy from aggregate gross flows (Blanchard and Diamond, 1990; Ritter, 1993) or from manufacturing gross flows (Davis and Haltiwanger, 1990, 1992). Anderson and Meyer (1994), studying labor turnover, also concluded that manufacturing was "atypical in a large number of dimensions."

In addition, the dynamics of job creation and destruction in manufacturing appear to have changed during the most recent recession. Combined with the declining share of goods production in overall employment, this suggests that the dynamics of job creation and destruction for the economy as a whole may be substantially different in the future.

CONSTRUCTING GROSS FLOW DATA

The raw data used to construct gross job creation and destruction are monthly employment levels in several hundred industries in the private nonfarm sector of the economy. The payroll or establishment survey, on which the employment data are based, currently covers more than 370,000 establishments, including all firms with more than 250 employees and a subset of smaller firms. These data are benchmarked annually using yet more comprehensive information. The survey excludes agricultural workers, unpaid family workers, domestic workers in private homes, and self-employed persons. To focus on job creation and destruction driven primarily by market forces, the data used for this paper also exclude government workers, though the survey includes them.[1]

The details of constructing job creation and destruction series (and caveats about them) are described in Ritter (1993), but the main idea is as follows. First, the breadth of coverage is defined by the set of industries for which continuous employment data are available since 1972. The 1972 start date was chosen because, for a large fraction of industries outside manufacturing, disaggregated employment data are not available for earlier years. Thus, the data cover a comprehensive cross-section of the nonfarm business sector. In January 1972, employment was 58.1 million for all private nonfarm payrolls, with 97.6 percent in the industries used in the job creation and destruction calculations. By March 1994, total employment was 93.4 million for all private nonfarm payrolls with 95.3 percent included in the present calculations. Second, a set of nonoverlapping industries is created using the finest level of detail available. These are three- and four-digit industries as well as the parts of two- and three-digit industries that are not more finely classified into three- and four-digit industries. The exact set of industries varies over time as the Bureau of Labor Statistics (BLS) refines the industrial classification scheme.

Third, for a month t when there is no change in the industrial classification (most months), gross job creation is defined as the sum of employment changes in industries in which employment is increasing:

$$JC_t = \sum_{i=1}^{N} \delta_{it}^{(+)} \Delta E_{it},$$

where $\delta_{it}^{(+)}$ is 1 if employment is increasing in industry i and 0 otherwise; E_{it} is employment in industry i; and N is the number of industries in the sector under consideration. Job destruction is defined as the sum of absolute values of employment changes in industries in which employment is decreasing:

$$JD_t = \sum_{i=1}^{N} (1-\delta_{it}^{(+)}) |\Delta E_{it}| = JC_t - \sum_{i=1}^{N} \Delta E_{it}.$$

Job creation and destruction *rates* used below divide creation and destruction levels by total employment in the sector's N industries:

$$JCR_t = \frac{JC_t}{\Sigma_{i=1}^{N} E_{it}}$$

$$JDR_t = \frac{JD_t}{\Sigma_{i=1}^{N} E_{it}}.$$

In several different years, the standard industrial classification (SIC) used by BLS to allocate employment among industries is revised. In general, the revision results in a finer breakdown of industries already included, but sometimes it adds coverage of entirely new industries. As previously mentioned, the job creation and destruction series are constructed so that the breadth of industrial coverage does not change from the first period to the last. A finer breakdown within a larger industry is exploited, however, by using an adjustment at the "birth" of a new (three- or four-digit) industry that accounts for the fact that the start of data on the industry does not indicate job creation, but reclassification. Since new three- and four-digit industries are generally created to subdivide growing industries, this procedure tends to limit the extent to which job creation and destruction net out within industries.[2]

This paper presents data on three sectors: (1) goods production, which includes manufacturing, construction and mining; (2) wholesale and

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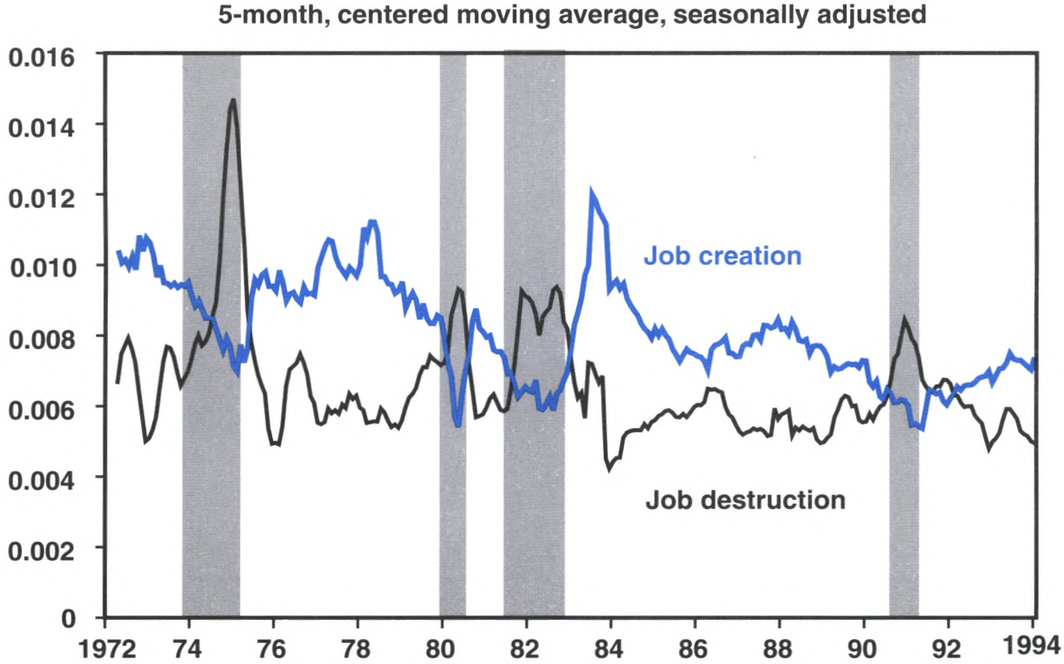
[1] Including government workers in subsequent calculations does not significantly change aggregate patterns of job creation and destruction.

[2] The exact procedure followed in months when a finer breakdown of an industry appears in the data is described in the appendix to Ritter (1993).

Figure 1
Job Creation and Destruction Rates for All Private Nonfarm Industries



retail trade; and (3) service production except trade. The third category includes services, transportation, utilities, communications, finance, insurance and real estate. Trade is usually counted as a service-producing industry, but is initially treated here as a separate category because its close tie to goods production (through purveyance of goods) could make its gross flow dynamics more similar to manufacturing than to services.

One problem with using industry data to measure gross flows is that the unit of measurement (an industry) is quite large. Substantial netting of job creation and destruction could take place within each industry. This point is discussed extensively in Ritter (1993), but the problem is magnified by the present attempt to disaggregate the gross flows. Although 573 industries are used in constructing gross flow measures for the private nonfarm economy, 338 are in goods production, but only 97 are in trade and 138 are in other service production. As a result, the average sizes of industries in 1993 were 69,239 workers in goods production, 264,679 in trade and 278,034 in service production.

GROSS FLOWS BY SECTOR

Job creation and destruction rates for the entire nonfarm sector are shown in Figure 1. The figure illustrates two features of gross flow data which have been noted in previous work: (1) There is always a great deal of both creation and destruction; at their lowest points the five-month moving averages of monthly creation and destruction rates were still 0.5 percent and 0.4 percent of private nonfarm employment per *month*. Because of intraindustry netting, these figures understate the extent of ongoing job creation and destruction.[3] (2) Net employment change during recessions is dominated by rises in job destruction, rather than falls in job creation. As noted in Ritter (1993), these features are shared by gross flow data produced from the Current Population Survey,

[3] Ritter (1993) compared job creation and destruction rates in manufacturing constructed from establishment-level data with those constructed from industry employment data. The former were more than three times higher on average.

Figure 2
Job Creation and Destruction Rates in Goods Production

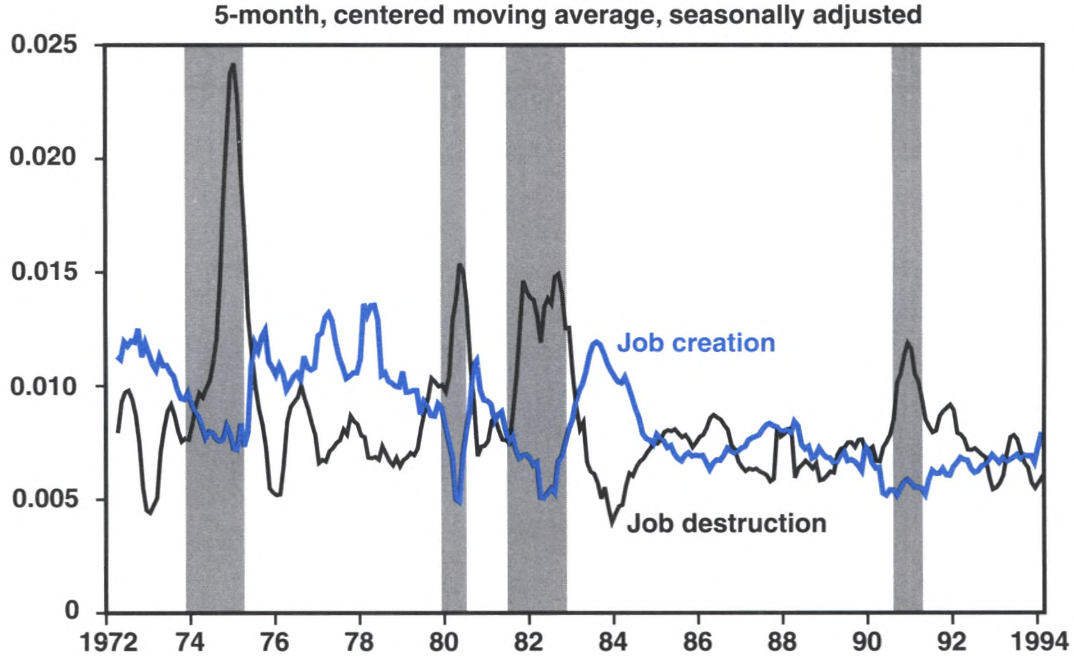


Figure 3
Job Creation and Destruction Rates in Trade

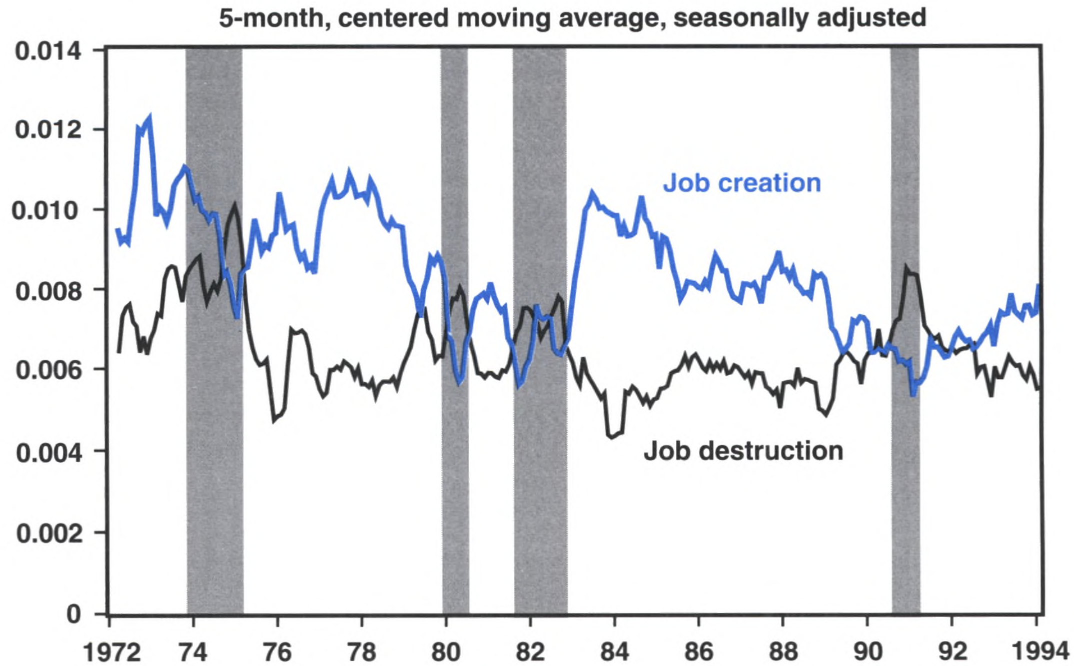
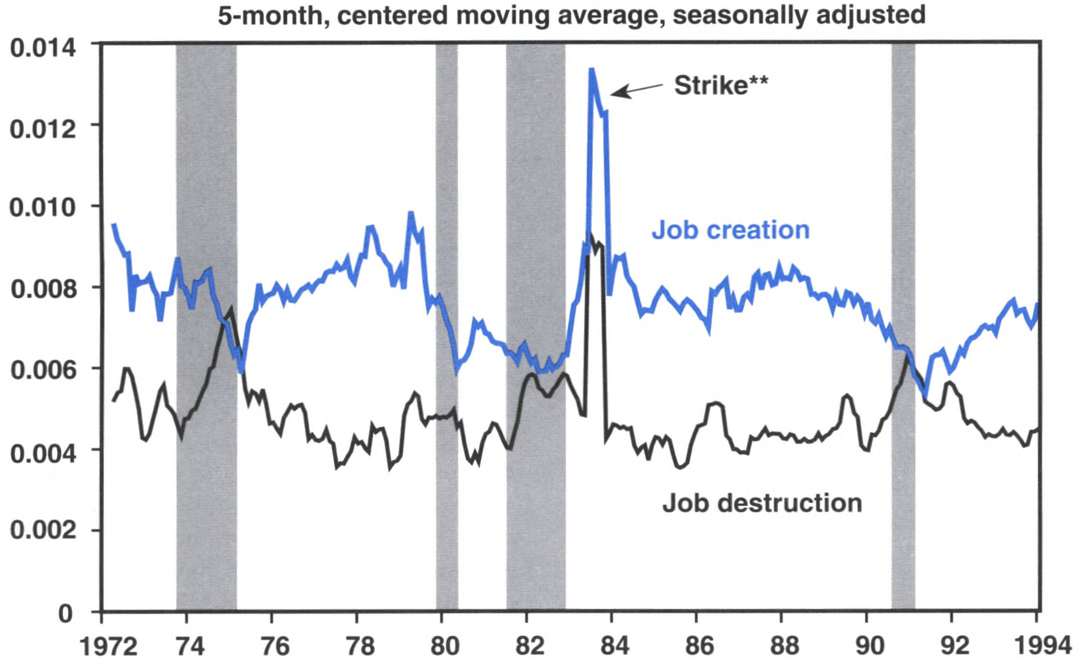


Figure 4
Job Creation and Destruction Rates in Service Production*



* Excluding trade

** Spikes in creation and destruction during 1983 are caused by a large strike in the telephone communications industry. See footnote 4.

which tracks individuals, and by gross flow data produced by Davis and Haltiwanger (1990, 1992) from the Census of Manufactures, which tracks employment at single establishments.

Figures 2, 3 and 4 show job creation and destruction rates for the goods-producing, trade and service-producing sectors.[4] Three points about these charts stand out. First, the gap between creation and destruction for the trade and service-producing sectors during the 1980s indicates the well-known fact that these sectors produced substantial net employment gains during the decade. In fact, in the service-producing sector, job creation exceeded job destruction during all but a few months since 1972. Trade experienced more frequent employment declines, but even during recessions these drops were not particularly large or prolonged. By contrast, following the recovery from the 1982 recession, job creation and destruction were closely balanced in the goods-producing sector until the onset of the 1990 recession.

Second, goods production shows a sharp asymmetry between creation and destruction during recessions; destruction is considerably more volatile. Neither trade nor service production shows evidence of this asymmetry, however.

Finally, despite trade's close link with goods production, gross flows in the trade sector do not exhibit patterns that closely resemble those in goods production.

Job creation and destruction rates for different sectors are compared directly in Figure 5, which

[4] The large spikes in destruction and creation during 1983 in Figure 4 reflect the beginning and end, respectively, of a large strike in the telephone communications industry (SIC 4813). A comparison of BLS data on new work stoppages (which starts in 1981) and the job destruction series shown in Figure 1 reveals that a few small spikes in job destruction during the 1980s correspond to relatively large strikes, but the telephone communications strike is the only one that has a noticeable impact on the series.

isolates a striking fact: Both creation and destruction rates are far more volatile in goods-producing industries than in trade or other service-producing industries. Goods production thus contributes disproportionately to fluctuation in aggregate gross flows, particularly job destruction.

Figure 5 does not tell the whole story about the relative importance of gross flows in goods production because this sector made up 25 percent of private nonfarm employment in 1993 (down from 39 percent in 1972). Figure 6 displays the contributions of goods-producing and service-producing (now including trade) industries to total job creation and destruction levels.

Figure 6 appears to show that goods production contributes a disproportionate share of overall job creation and destruction levels. This is probably misleading, however. The manufacturing sector is more finely divided, so there is probably less intraindustry netting of job creation and destruction in the goods-producing sector than in the service-producing sector. This would impart a substantial upward bias to the relative contribution of goods production to the *level* of overall job creation and destruction.

The relative contributions of goods- and service-producing industries to cyclical *changes* in overall job creation and destruction are shown more reliably in Figure 6. Goods production has typically accounted for more of the cyclical movements than the industries that make up the other 75 percent of employment. This is particularly evident in the lower panel of Figure 6, which shows much more dramatic cyclical swings in total job destruction than in service production alone.

Two pieces of evidence suggest that intraindustry netting does not substantially bias the contribution of goods-producing industries to *changes* in job creation and destruction. First, if four-digit industries are ignored in constructing the job creation and destruction series (thus increasing the average size of industries used in the calculation and the extent of intraindustry netting), both series shift down, but the amplitude of fluctuations is not significantly changed.[5] Second, in manufacturing, if job creation and destruction series created from industry employment data are compared to those created from establishment data by Davis and Haltiwanger, the size of fluctuations is again very similar, though the levels of the series differ dramatically (see Ritter, 1993).

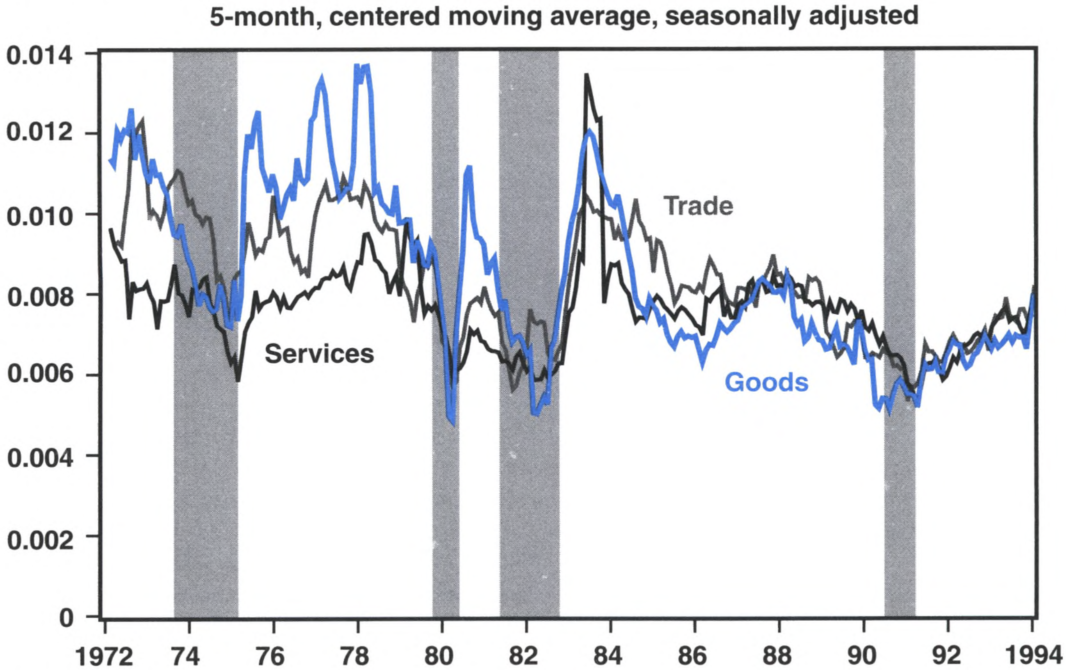
THE CHANGING ROLE OF MANUFACTURING

Figure 2 reveals that gross flows in the goods-producing sector were less volatile during the 1990 recession than during previous recessions. This warrants closer attention to manufacturing, which makes up more than three-quarters of goods-producing employment. Figure 7 shows that the phenomenon is even more pronounced in manufacturing. When the gross flow data for manufacturing are extended back to 1947 (which, unfortunately, cannot be done reliably for non-manufacturing industries), all previous recessions show much more dramatic swings in job creation and destruction than 1990. If manufacturing is split into durables and nondurables, both show patterns very similar to Figure 7. Gross flows for mining and construction (the remainder of the goods-producing sector) did not seem to follow the same pattern as manufacturing during the 1990 recession. The very low levels of job creation and destruction during the 1990 recession are, therefore, clearly due to developments in the manufacturing sector.

As measured by drops in either industrial production or manufacturing employment, the 1990 recession was mild. Manufacturing employment, however, declined almost continuously from the beginning of 1989 until late 1993. It appears that, rather than the usual sharp cyclical response, manufacturing firms have experienced a longer-term contraction over these five years. Though it is clear that something different happened during the 1990 recession, it is impossible to know whether the old pattern of sharp increases in job destruction will reassert itself in future downturns. If the fluctuations of gross flows in manufacturing remain subdued during future recessions, the movement of overall gross flows will be significantly damped. The declining share of employment found in manufacturing reinforces this effect by lowering the weight attached to the most volatile sector.

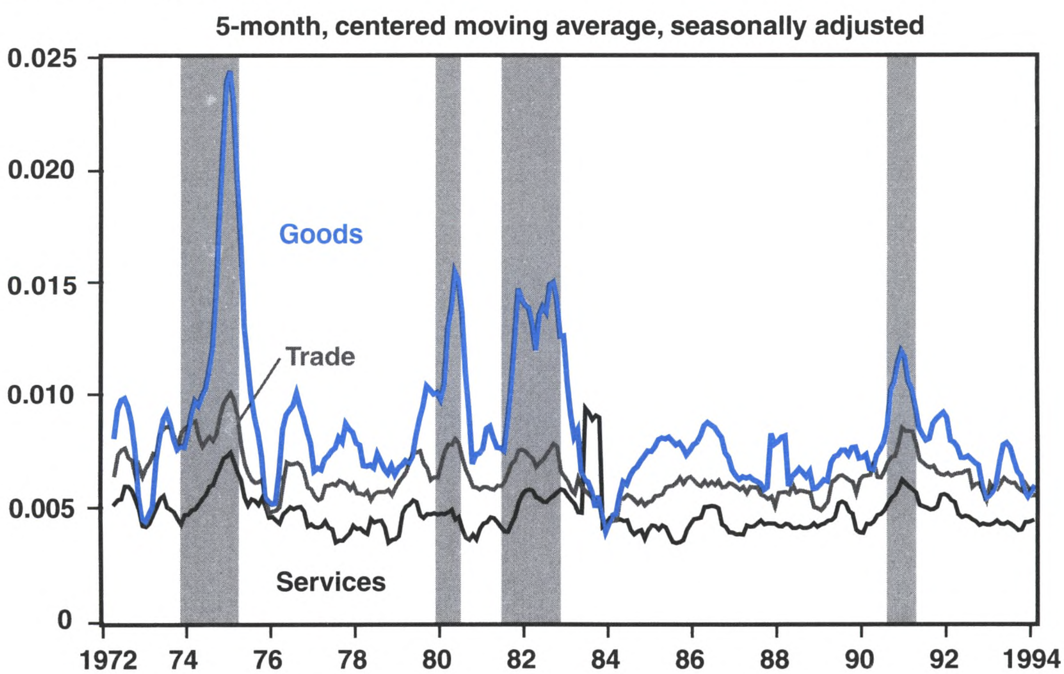
[5] Regressing job creation constructed without four-digit industries on job creation constructed with four-digit industries (or vice versa) produces a coefficient very close to 1.0 and an R^2 greater than 0.99. The same is true of the job destruction series.

Figure 5a
Job Creation Rates in Goods Production, Trade and Service Production*



* Excluding trade

Figure 5b
Job Destruction Rates in Goods Production, Trade and Service Production*



* Excluding trade

Figure 6a
Job Creation in Goods Production and Service Production

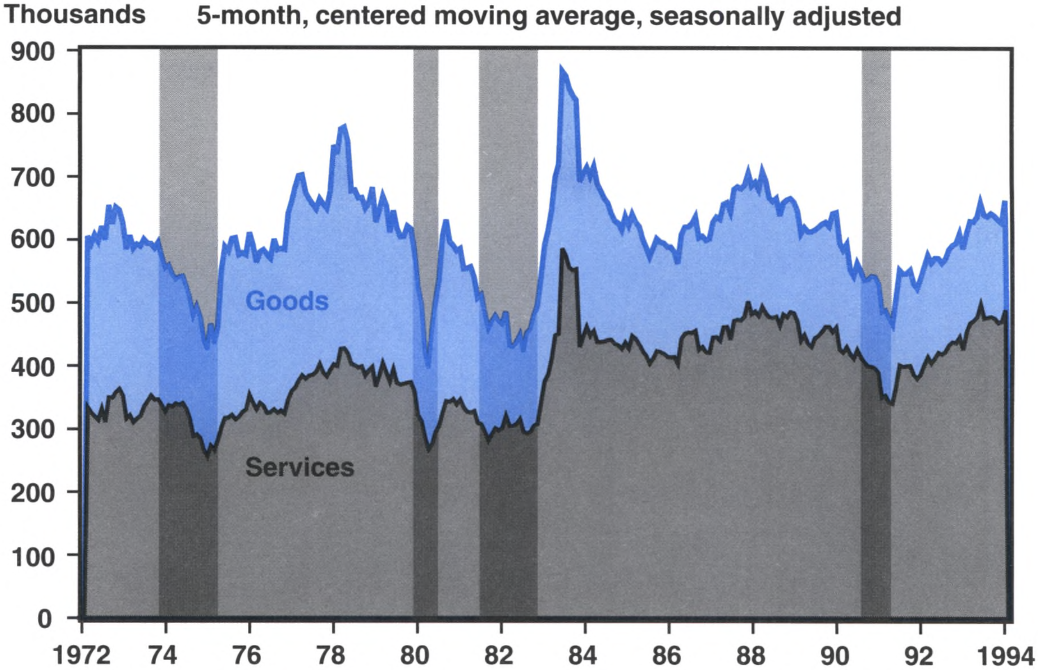


Figure 6b
Job Destruction in Goods Production and Service Production

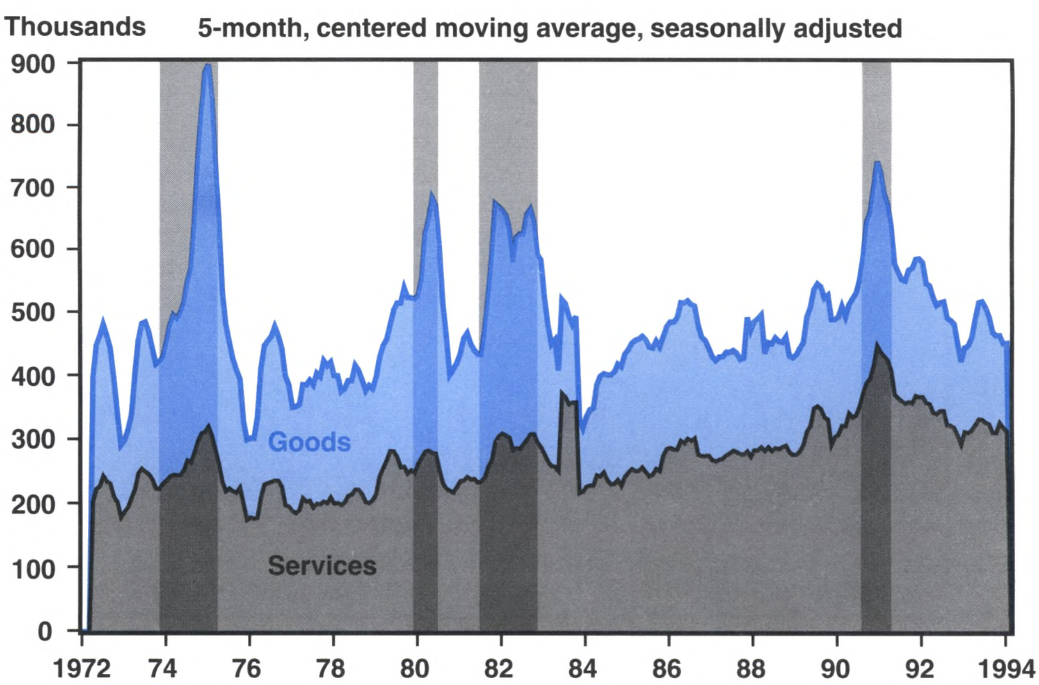
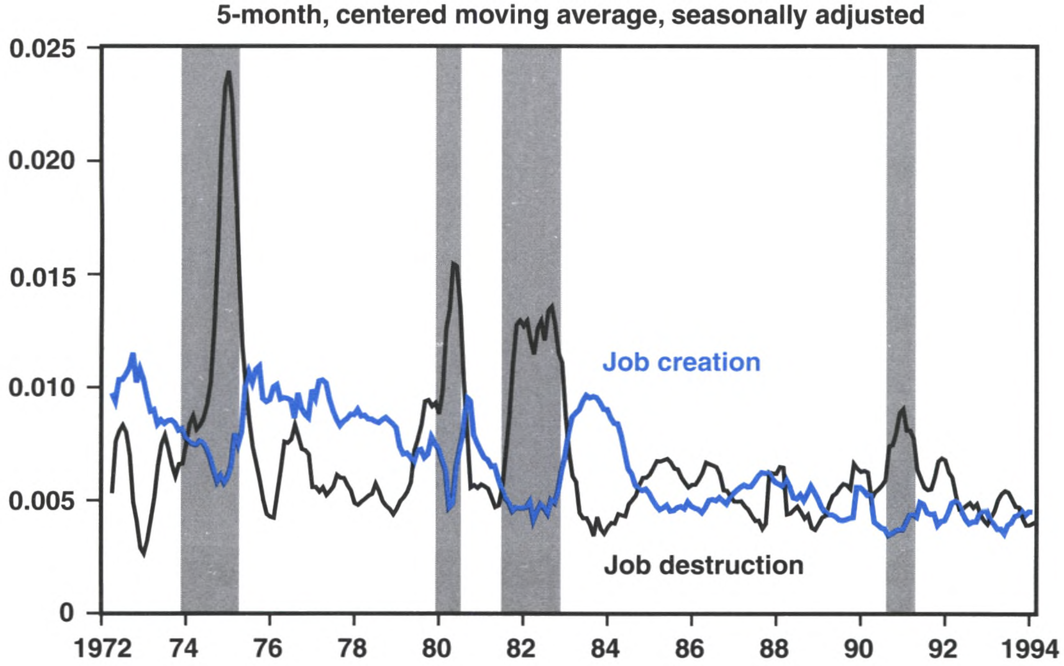


Figure 7
Job Creation and Destruction Rates in Manufacturing



CONCLUSIONS

Job creation and destruction behave much differently in the goods-producing sector than in the rest of the economy. Job creation and destruction have historically been much more volatile in manufacturing and other goods-producing industries, so that they have contributed disproportionately to fluctuations in overall job creation and destruction. Further, there does not appear to be a cyclical asymmetry between creation and destruction outside of manufacturing. The stylized fact, cited by several authors (Blanchard and Diamond, 1990; Davis and Haltiwanger, 1990, 1992; Ritter, 1993), that job destruction tends to dominate employment changes during recessions thus appears to be generated by manufacturing industries. In addition, job creation and destruction in manufacturing were noticeably damped during the most recent recession. Combined with the fact that goods production makes up a declining share of employment, this suggests that the dynamics of job creation and destruction may be substantially different in the future.

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Boom or Bust? The Economic Effects of the Baby Boom

BETWEEN 1947 AND 1962, the population of the United States grew at an average annual rate near 2 percent, a large increase from the average annual growth rate near 1 percent during the 20 years prior to World War II. Moreover, since 1962, the average population growth rate has fallen to its pre-war level. This large but temporary increase in the population growth rate, more familiarly called the baby boom, raises an interesting and important question: How do such large changes in the population growth rate affect a developed economy? Undoubtedly, the baby boom has already had a large effect on the U.S. economy, especially on the composition of goods and services produced by the marketplace and the government. But the economic effects of the baby boom are more basic than the optimal mix of convertibles and minivans, or the number of school buildings vis-a-vis nursing homes, because such large changes in the population growth rate affect aggregate consumption and saving. Specifically, a large influx of workers requires more capital to maintain the same level of labor productivity, which in turn affects individual living standards.

Questions about growth of per capita income and consumption per capita are not limited to the entrance of the baby boomers into the economy but extend to its aging as well. In a life-cycle framework, individuals retire and consume their savings. This implies that if a large fraction of the population is retired, society will save less, perhaps even "dissave," and lower aggregate saving leads to a slower rate of capital formation. This possibility has caused a great deal of concern about the impending retirement of the baby boom generation. Lower saving, however, need not impose a drag on the economy. Just as the entry of the baby boom increases the demand for capital, the baby boomers' retirement decreases the demand for capital since their retirement decreases the labor supply. Thus, the mere retirement of the baby boom generation need not imply slower growth since the economy requires less capital. So what is the likely impact of the baby boom on the rate of capital accumulation and, thus, on the growth of income per capita and consumption per capita?

To answer this question, I turn to three models of economic growth that incorporate different aspects of demographic changes. Although the models cannot possibly capture all aspects of economic behavior that may affect the answer to the question posed above, they can provide insights about the fundamental relationship between population growth and the growth of output per capita. The models presented here, and models of economic growth in general, depend on accumulation of capital as the engine of growth of output per worker and standards of living. At any given time, agents either consume or invest their resources, so their saving-consumption decisions are critical determinants of how fast labor productivity will grow.

All three models presented here predict that a temporary and unexpected increase of population growth rate raises aggregate saving, but such an increase in saving is not necessarily large enough to maintain pre-boom rates of growth per capita income and standards of living. Once a baby boom has completely entered an economy, capital intensity tends to rise and the economy gradually returns to its pre-boom status. The three models disagree about the speed and magnitude of such changes, but all show that after a period of slow growth, per capita consumption increases. Best of all, the models indicate such improvements in the standard of living occur as even aggregate saving drops. This suggests that in isolation, the retirement of the baby boom need not imply diminishing standards of living.

The paper proceeds as follows. The first section presents a brief description of the baby boom's effect on the U.S. population. Next, I present three growth models and their predictions about the response of the economy to the baby boom. The models focus on the relationship between the population growth rate and capital accumulation since all other economic factors depend on saving and the resultant path of capital. The third section examines the recent performance of the U.S. economy to check the consistency of the models' qualitative predictions with observed economic data. The final section draws some conclusions about the baby boom and the economy.

THE BABY BOOM

Figure 1, top panel, shows Bureau of Census estimates of the annual growth rate of U.S. resident population since 1930 and its middle projections of the annual growth rate from 1994 to 2050.[1] The figure underscores the demographic importance of the baby boom. The baby boom was well under way by 1947 and lasted some 15 years. During the baby boom, the population growth rate was nearly double the 1 percent average annual growth rate during the 20 years prior to 1947. Once the baby boom ended, the population growth rate returned to an average annual rate near 1 percent. The top panel also shows the annual growth rate of the working-age population, all individuals ages 18 to 65, again based on Bureau of Census' estimates and projections. The size of the working-age population reflects the impact of the baby boom with a lag of 18 years.

The top panel does not, however, adequately reflect one of the key economic issues associated with the passage of a baby boom: What happens when the baby boom retires? From a life-cycle viewpoint, the baby boomers' retirement will dramatically increase the number of dissavers vis-a-vis savers, as well as the number of consumers relative to workers. One way to measure the relative sizes of the two segments of the population is the dependency ratio, which I define as the ratio of the number of consumers to the size of the potential labor force. The bottom panel of Figure 1 shows the dependency ratio for the United States between 1930 and 2050 based on the estimates and projections from the Bureau of Census. The ratio rises at the start of the baby boom since children only consume, falls as they pass into adulthood, and finally, rises again as they retire.

THREE MODELS

In this section, I present three exogenous growth models to analyze the effects of a baby boom on the U.S. economy:[2] the neoclassical model of Ramsey (1928); the dependency-ratio model of Cutler, Poterba, Sheiner and Summers (1992); and the overlapping generations (OLG) model of Yoo (1994). Each model provides a framework to examine the relationship between changes in the population growth rate and the capital-labor ratio, which in turn determines per capita income and consumption per capita. I present each model with its simulation results and then highlight the differences and similarities among the three models.

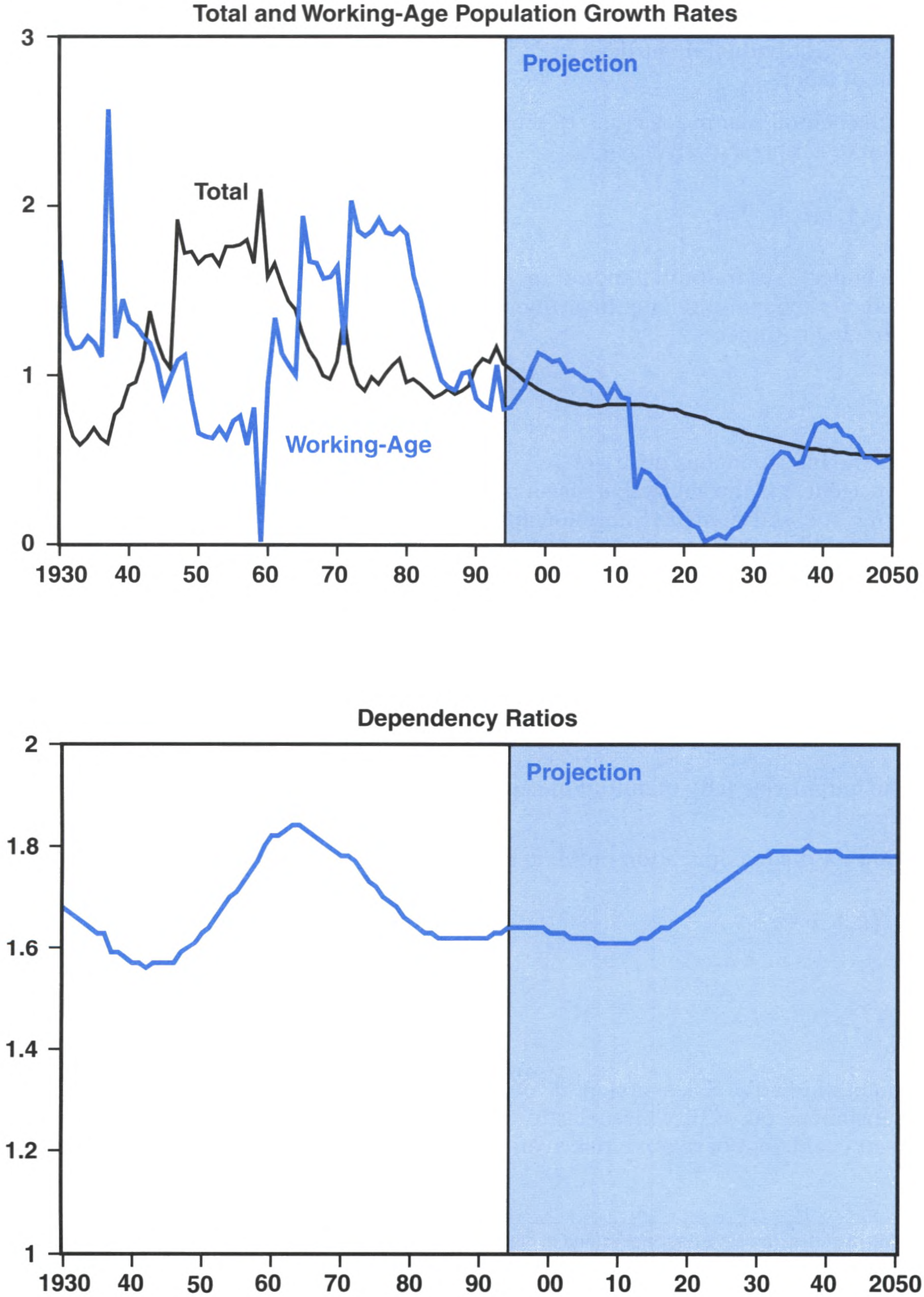
Neoclassical Growth Model

The simplest model that relates population growth rate to economic growth is the neoclassical growth model of Ramsey. The model has a benevolent social planner who, with perfect

[1] The Census Bureau regularly publishes three projections—lowest, middle and highest. They represent different assumptions about fertility, net immigration and life expectancy. See Current Population Reports, P25-1104, pp. xxxv-xxxix.

[2] Also see Auerbach, Kotlikoff, Hagemann and Nicoletti (1989) and Auerbach, Cai and Kotlikoff (1991).

Figure 1
U.S. Population Characteristics



foresight, maximizes the discounted utility function of a representative agent subject to the economy's resource constraints.[3] The solution to the social planner's problem is equivalent, under appropriate assumptions, to the competitive equilibrium in which individuals and firms maximize their utility and profits. The model also assumes each individual inelastically provides one unit of labor.

Formally, the central planner maximizes the utility function of a representative agent:

$$(1)\ \max U(c_t)=\int_0^{\infty} u(c_t)e^{-\delta t}\,dt,$$

subject to the budget constraint that output in each period equals consumption, net investment and capital for new entrants: [4]

$$(2)\ y_t=c_t+\dot{k}_t+n_t\,k_t,$$

where $U(c_t)$ is the instantaneous utility of a representative agent, δ is the subjective discount rate with $0 < \delta < 1$, c_t and y_t are consumption and output per unit of labor, k_t is the capital-labor ratio, and n_t is the population growth rate. I assume that the net production function of the economy is Cobb-Douglas to simplify the simulation:

$$(3)\ y_t=f(k_t)=k_t^{\alpha},$$

where α is the output elasticity of output of capital, and $0 < \alpha < 1$.

The solution for the maximization problem is

$$(4)\ \frac{\dot{c}_t}{c_t}=\frac{1}{\rho}[f'(k_t)-\delta-n_t],$$

where

$$\rho\equiv-\frac{u''(c_t)}{u'(c_t)}c_t$$

is the coefficient of relative risk aversion. I assume that instantaneous utility is isoelastic with a constant coefficient of relative risk aversion, so that

$$u(c_t)=\frac{c_t^{1-\rho}}{1-\rho}.$$

This assumption also applies to all three models in this paper. In the steady state, the equilibrium capital-labor ratio yields the modified golden rule, which states that the marginal product of capital in steady state equals the sum of the subjective discount rate and the population growth rate.

$$(5)\ f'(k^*)=\delta+n^*,$$

where stars denote steady-state values of each variable. The corresponding optimum per capita consumption equals

$$(6)\ c^*=f(k^*)-n^*k^*.$$

To determine the dynamics of the economy near the steady state, I linearize equations 2 and 4 using a Taylor's series expansion. Solving the resulting system of second-order differential equations and ruling out the divergent path, the following equations describe the path of the economy near the steady state: [5]

$$(7)\ k_t=k^*+(k_0-k^*)e^{\lambda t},$$

where

$$\lambda\equiv\delta-\frac{1}{2}\sqrt{\delta^2+4\beta}$$

$$\beta\equiv-\frac{f''(k^*)c^*}{\rho}$$

and k_0 is the initial capital-labor ratio.

To simulate the economic effects of the baby boom, I assume that the U.S. economy starts at the steady state for slow population growth and introduces the baby boom. The economy then moves toward the new steady state associated with the faster population growth rate. Once the population growth returns to its pre-boom rate, the economy reverses direction and moves to the pre-boom steady state. Table 1 shows the

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[3] The assumption of perfect foresight does not extend to the timing of the beginning or end of the baby boom. Rather, I assume that both the start and end of the baby boom are unanticipated shocks to the population growth rate. This assumption about the timing and the duration of the baby boom applies to all three models. This assumption affects the dynamics of the economy's response to the baby boom. If the timing of the baby boom were anticipated, the economy would react earlier to the beginning and the end of the baby boom.

[4] Multiplying the budget constraint by the size of the labor force gives the accounting identity $Y = C + I + G$, with G equal to zero.

[5] See Blanchard and Fischer (1989, chapter two) for more details.

Table 1
Simulation Parameter Values

Parameters	Description	Value
T	Lifespan (OLG model only)	60
T'	Working life (OLG model only)	45
n	Initial population growth rate	0.01
ϵ	Size of baby boom	0.01
τ	Duration of baby boom	15
δ	Subjective discount rate	0.01
ρ	Coefficient of relative risk aversion	2
α	Capital's share of output	0.33

parameters required to simulate this and the two other models.[6] Rather than using the actual population growth rates, which would unnecessarily complicate the simulations, the simulations use a stylized baby boom. As the top panel of Figure 1 indicates, the baby boom lasted approximately 15 years with an average growth rate of nearly 2 percent per annum, whereas the growth rate before and after the baby boom averaged nearly 1 percent per annum. I therefore assume that the pre- and post-baby boom population growth rate is 1 percent, the population growth rate during the baby boom is 2 percent, and the baby boom lasts for 15 years. Since the Ramsey model assumes all individuals in the economy provide one unit of labor inelastically, I also ignore childhood, pushing the start of the baby boom by 18 years to 1965.

Figure 2a shows three variables—the capital-labor ratio, the saving rate and per capita consumption—normalized by their respective paths in an economy without the baby boom. The first figure shows that an increase in the labor force depresses capital intensity; the higher population growth rate depresses the modified golden rule capital-labor ratio, which causes capital intensity to drop for 15 years until the entry of the baby boomers stops and the capital-labor ratio is some 10 percent below the pre-baby boom level. Thereafter, capital intensity converges to the pre-boom level but does so very slowly. Figure 2a also shows saving measured as fraction of output, again normalized by the no-baby boom economy. The Ramsey model shows a concentrated spike in saving, almost 20 percent higher than the no-baby boom saving rate. Once the population growth rate returns to pre-baby boom level, saving falls and eventually returns to its previous level. The last graph in 2a shows the path of consumption per capita normalized by the path of consumption in the economy without a baby boom, and it shows an initial drop in per capita consumption of 10 percent, but once the population growth rate returns to 1 percent, per capita consumption gradually returns to its original level.

The Dependency-Ratio Growth Model

One obvious problem with the Ramsey model is its inability to address the problem of the baby boomers' retirement because the model assumes that agents are homogeneous and that they are infinitely lived. Once an individual enters an economy, he or she is no different than any other individual at that time, and then has an infinitely long life. A recent paper by Cutler, Poterba, Sheiner and Summers introduces agent heterogeneity by incorporating a dependency ratio into the Ramsey model. This captures the effects of the retirement of the baby boom on the economy, albeit in a rather ad hoc manner. Cutler and others solve the model from a social planner's point of view with all individuals alive in each period weighted equally in the social welfare function. Unlike the Ramsey model, the command and decentralized solutions are not equal. The dependency-ratio model, therefore, gives a path for the economy that does not correspond to a market equilibrium.[7]

The command optimization problem is

$$(8)\quad \max U = \int_0^\infty u(c_t)N_t e^{-\delta t}dt \,,$$

subject to resource constraint similar to equation 2,

$$(9)\quad y_t = \gamma_t c_t + \dot{k}_t + n_t k_t \,,$$

where c_t is per capita consumption, y_t, k_t, δ and n_t are as previously defined, N_t is the population size, and γ_t is the dependency ratio at time t and equals

$$\gamma_t \equiv \frac{CON_t}{LF_t} \,,$$

where LF_t is the labor force and CON_t is the number of consumers.

[6] See Auerbach and Kotlikoff (1987, chapter four) for a discussion about the selection of the preference and production parameters.

[7] The simulations presented in Cutler and others differ from the one presented here because they incorporate an age-dependent labor productivity profile into their simulations.

Figure 2a
Simulation Results: Ramsey Model

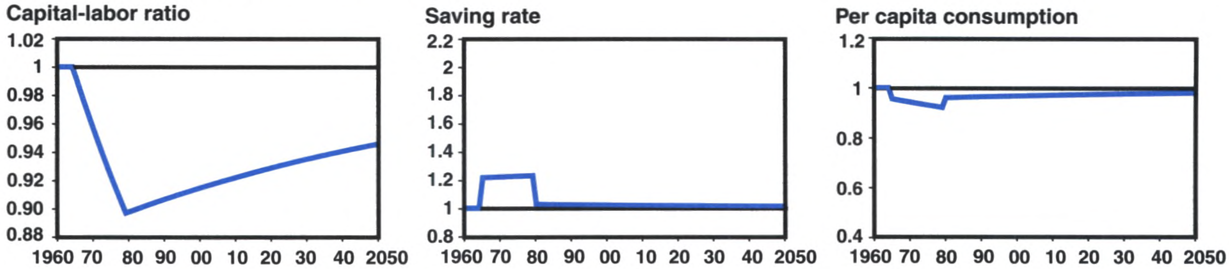


Figure 2b
Simulation Results: Dependency Ratio Model

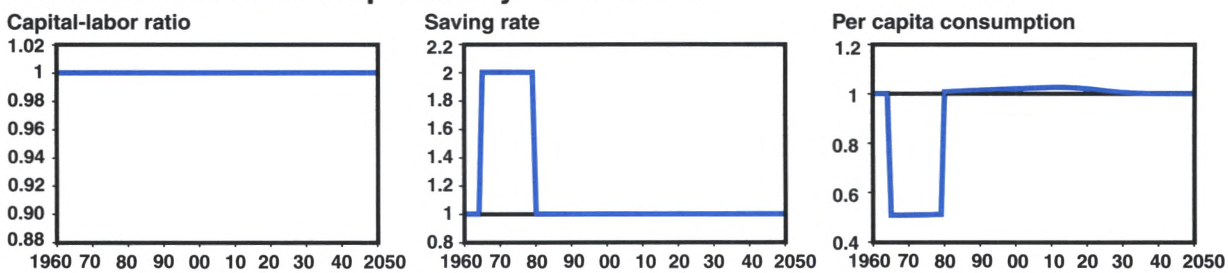
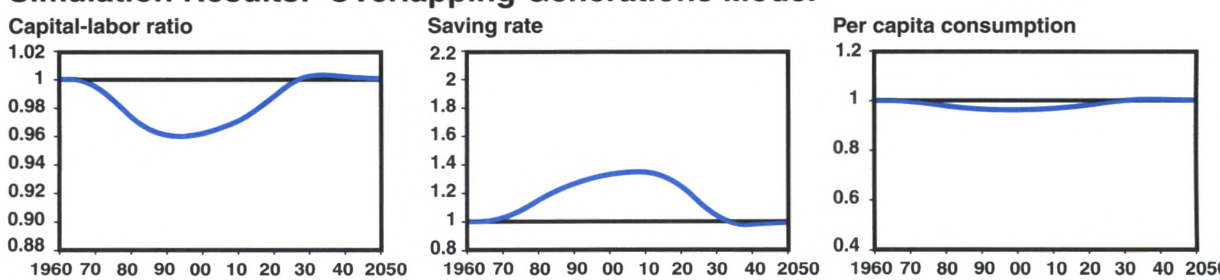


Figure 2c
Simulation Results: Overlapping Generations Model



The solution from the first-order conditions of the planner's problem is

$$(10)\quad \frac{\dot{c}_t}{c_t} = \frac{1}{\rho}[f'(k_t) - \delta].$$

In the steady state, equation 11 implicitly defines the optimum capital-labor ratio:

$$(11)\quad f'(k^*) = \delta .$$

The model has the interesting property that the steady-state capital-labor ratio is independent of all parameters except the subjective discount rate and the parameters of the production function. Thus, unlike the Ramsey model (or the overlapping-generations model), the capital-labor ratio does not adjust to changes in the population growth rate. Rather, consumption must respond to any unexpected changes in the population growth rate or to the dependency ratio, and furthermore, the response to such changes is instantaneous.

Although the dependency-ratio model of Cutler and others incorporate some agent heterogeneity into the problem, they do not consider the saving decisions of individuals, especially saving for retirement and, furthermore, Cutler and others solve the model from a social planner's viewpoint. These two facts produce a simple solution, but the solution requires substantial redistributions as the baby boom enters and exits the economy. Cutler and others use the existence of the Social Security system to justify their modeling choice and the resultant redistribution. But the redistributions required by the social optimum are not the redistribution scheme embodied by Social Security. In the model, a large unexpected increase in the population growth rate requires a large cut in consumption to finance a large increase in investment to maintain the constancy of the capital-labor ratio. Moreover, the end of the baby boomers' entry into the economy diminishes the rate of capital formation, causing a sharp increase in consumption. The transfers involved are opposite those provided by Social Security; the dependency-ratio model's solution transfers resources to the new entrants, whereas Social Security transfers wealth from the young to the elderly.

Figure 2b shows the results of the simulation from the dependency-ratio model. As before, I have normalized the results by the no-baby boom economy. As shown by the first graph and equation 11, the baby boom has no effect on the capital-labor ratio. The second graph in 2b shows saving as fraction of output, again normalized by the no-baby boom economy. Any changes in the growth of the labor force must be offset by changes in saving because the model requires a constant capital-labor ratio. Therefore, a doubling of the population growth rate requires a doubling of the saving rate to provide enough capital for the faster rate of population growth. Once the population growth rate reverts to the initial rate, saving returns to the baseline. Since output is either saved or consumed, per capita consumption reflects the path of saving. Figure 2b also shows the path of consumption per capita normalized by the path of consumption in the economy without a baby boom. Since the dependency-ratio model shows doubling of saving, consumption falls by 50 percent and indeed the third graph of 2b reflects such a drop. Once the boom is over, the increase in the number of workers supporting retirees implies less has to be saved and more can be consumed, although this does not last forever.

An Overlapping-Generations Growth Model

The model used by Yoo confronts some of the problems of the Ramsey and the dependency-ratio models by using the overlapping-generations framework. An individual with a finite lifetime and an explicit retirement period maximizes his or her utility subject to a lifetime budget constraint. I then aggregate each individual's decisions with the decisions of an optimizing firm to obtain a general equilibrium solution for the path of an economy confronted with an unanticipated baby boom. Unlike the other two models, the model uses discrete time periods, although this quantization is materially insignificant.

The individual born in period t faces the problem

$$(12)\quad \max \sum_{s=1}^{T} (1+\delta)^{1-s} u(c_{t+s-1,s}),$$

subject to the lifetime budget constraint that his or her discounted expenditures be no greater than the person's available lifetime resources:

$$(13)\quad \sum_{s=1}^{T'} \frac{w_{t+s-1}}{(1+r_t)^{s-1}} \geq \sum_{s=1}^{T} \frac{c_{t+s-1,s}}{(1+r_t)^{s-1}},$$

where $c_{t,s}$ is the consumption in period t of an agent s years old, T is the lifetime of an individual, T' represents the number of periods working and w_t and r_t are the real wage and the real returns to capital in period t.

The explicit solution comes from recursively solving the associated Euler equations, and it produces, under the assumption of static expectations, the following two equations, which describe the optimal saving-consumption decisions of an individual: [8]

$$(14)\quad c_{t+s-1,s} = \theta_s \left[\sum_{i=s}^{T'} \frac{w_{t+i-1}}{(1+r_t)^{i-s}} + (1+r_t)a_{t+s-2,s-1} \right],$$

(15)

$$a_{t+s-1,s} = \begin{cases} (1+r_t)a_{t+s-2,s-1} + w_{t+s-1} - c_{t+s-1,s} & if\ s \leq T' \\ (1+r_t)a_{t+s-2,s-1} - c_{t+s-1,s} & if\ s > T', \end{cases}$$

where

$$\theta_s = \left[1 + \sum_{i=s+1}^{T} \left(\frac{1+r_t}{1+\delta} \right)^{\frac{i-s}{\rho}} \right]^{-1}$$

and $a_{t,s}$ is the asset level of an agent s years old in period t which he or she holds as physical capital.

The sum of all individual savings equals the capital stock, and the number of working-age

[8] Static expectations imply that agents assume that future factor prices equal today's prices.

individuals equals the labor force of the economy:

$$(16)\quad L_t = \sum_{s=1}^{T'} \varphi_t(s)$$

$$(17)\quad K_t = \sum_{s=1}^{T} a_{t,s}\varphi_t(s),$$

where $\varphi_t(s)$, the age distribution, is the number of individuals age s in period t. I also assume markets are competitive and firms minimize costs so that factor prices equal their marginal product:

$$(18)\quad r_t = f'(k_t)$$

$$(19)\quad w_t = f(k_t) - f'(k_t)\, k_t .$$

Given a set of parameters, modeling the effects of a baby boom requires specifying the path of $\varphi_t(s)$ to reflect changes in the population growth rate. Once I have specified the parameters and $\varphi_t(s)$, calculating the effects of the baby boom becomes a series of iterations. First, equations 14 and 15 determine individual behavior, then given their saving-consumption decisions, equations 16 through 19 determine output and factor prices which become the basis for the next iteration, which again begins with 14 and 15.

Figure 2c shows the impact of the baby boom, simulated by the OLG model. An increase in the labor force depresses capital intensity, and the model shows declining capital relative to labor for a long period of time, nearly 30 years, in which the minimum is approximately 4 percent lower than the no-baby boom baseline.[9] Figure 2c also shows saving gradually increasing until all baby boomers are dead, reaching a peak near 2010 approximately one-third higher than the no-baby boom economy. The third figure shows the path of consumption per capita, and it indicates that consumption falls gradually, 5 percent below baseline. Consumption then rises for the following four decades until it reaches its initial level.

Comparing the Simulation Results

Comparing the nine graphs in Figure 2 indicates several similarities as well as several points of divergence. The figures indicate that the magnitude and the timing of the economic effects of the baby boom are the major points of divergence among the three models. Although the Ramsey and OLG models both show declining capital-labor ratios, the drop is much larger in the Ramsey model, 10 percent versus 4 percent. Furthermore, the Ramsey model predicts the trough will occur more than 10 years earlier than the OLG model, despite the fact that the Ramsey model requires substantially more time to return to the pre-baby boom steady state. The paths of saving also indicate responses of different magnitudes and timing, although the signs of the responses are the same. Both infinite horizon models show declining saving at the end of the baby boom, whereas the OLG model continues to increase until the first of the baby boomers are near retirement. Peak savings in the Ramsey and OLG models are similar in magnitude, and the much higher saving of the dependency-ratio model is attributable to the constancy of the marginal product of capital. The behavior of consumption per capita is very similar to that of saving, both in timing and magnitude; the two infinite-horizon models indicate that per capita consumption in the United States should have already rebounded from the depressed state induced by the entry of the baby boomers, with the dependency-ratio model suggesting a significantly bigger response to the baby boom. The OLG model, in contrast, suggests that we should be now near the trough of the fall in consumption.

The most striking point of agreement among the three models is the response of the consumption and saving relationship to the passage of the baby boom. All three models predict that an unexpected baby boom causes a temporary increase in saving and an associated temporary drop in per capita consumption. Most importantly, the return to the pre-baby boom saving rate that occurs in all three models coincides with an increase in consumption. This counterintuitive result arises because the demand for capital diminishes as the population growth rate slows. Moreover, the overlapping-generations model shows that even with the baby boomers dissaving in retirement, consumption per capita continues to increase. These results suggest that current concerns about an economic decline following the retirement of the baby boomers may be unfounded.

U.S. EXPERIENCE THUS FAR

Figure 3 shows a series of comparisons between observed data and simulation results.

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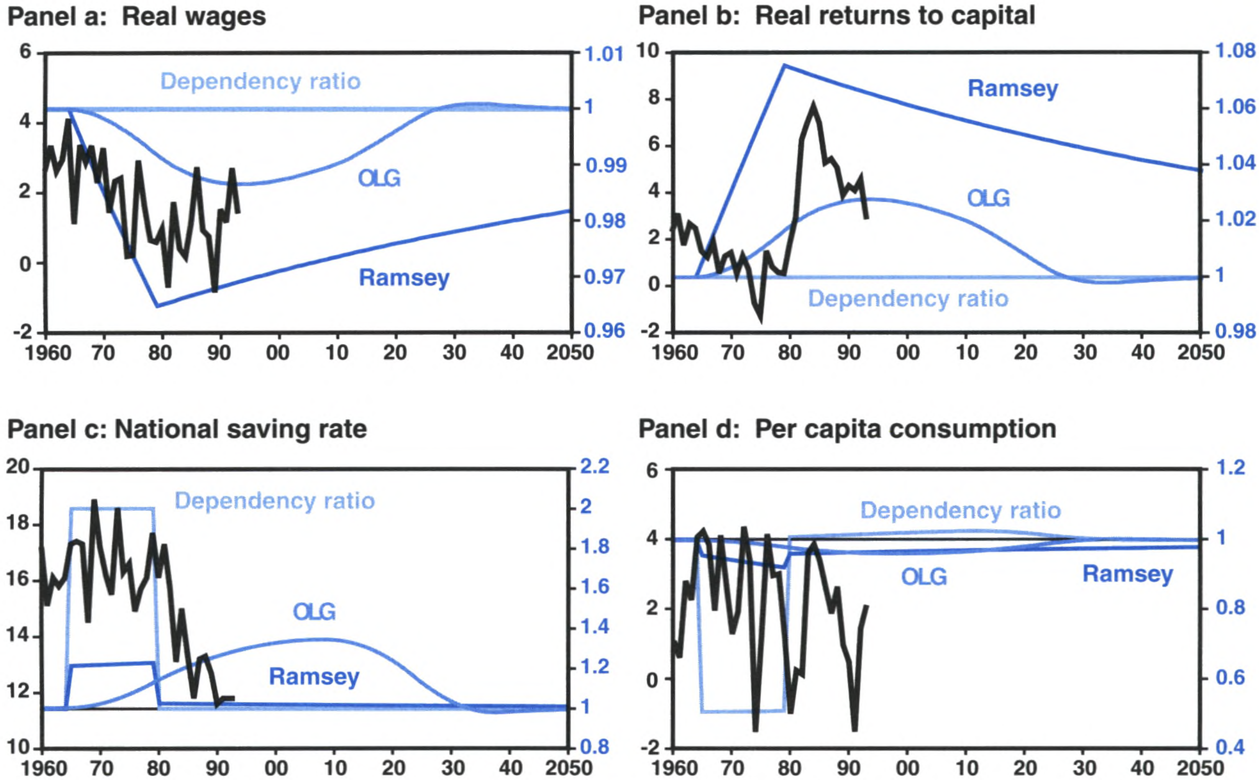
[9] The relative smoothness of the OLG model is partially attributable to the static expectations assumption.

Figure 3
Observed Data vs. Simulation Results



Scale: observed data; left, simulation; right

It is important to note that the actual data is not normalized; therefore, the magnitudes of the actual data and the simulation results are not directly comparable. Panels a and b show real wages and real returns to capital rather than capital-labor ratios. Since the two factor prices are monotonic transforms of the capital-labor ratio, they should provide a reasonable alternative to directly comparing observed and simulated capital-labor ratios. Panel a shows the annual growth of real wages, as measured by hourly compensation, compared to the wages from the three models, which I have also normalized by the no-baby boom wages. Growth of real wages has been on a downward trend that is consistent with the predictions of the Ramsey and OLG models. Panel b shows the real returns to capital, measured by long government yields less CPI inflation, compared to returns to capital from the three models, also normalized by the no-baby boom baseline. Although the rise of real long government bond yield during the 1980s is consistent with the OLG model, its relationship to the simulated returns to capital is ambiguous.

Panels c and d provide direct comparisons between observed and simulated paths of saving and consumption. Once again, I have normalized the simulated results by the baseline economy with no-baby boom. As shown in panel c, the observed saving rate, measured by the national saving rate, has fallen recently, as predicted by the Ramsey and the dependency-ratio models, but the drop does not correspond to a reversion to pre-baby boom rates. The observed behavior of the real annual growth of consumption per capita is more consistent with the paths from the three models' predictions. The growth of consumption has gradually slowed since the start of the baby boom as predicted by all three models, especially the OLG model, since the Ramsey and dependency-ratio models indicate that consumption should have already returned to near pre-baby boom levels.

PROGNOSIS

As the models show, demographic factors can play an important role in macroeconomic performance, mostly at low frequencies. Given the simple and stylized simulations reported in this paper, the correspondence between simulation and observed low-frequency movements in several important macroeconomic variables is noteworthy. Slow wage growth and diminished consumption growth are consistent with the predictions of the models, especially the OLG model. The evidence from saving rates and the real returns to capital is less clear.

What does the baby boom imply for future growth and welfare? The models suggest a faster rate of consumption growth, along with declining real returns to capital and higher wages that accompany higher labor productivity. Moreover, these benefits occur throughout the remainder of the baby boom generation's lifetime, including retirement. Thus, even as they dissave, according to the OLG model, consumption per capita will continue to increase.

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Realignments of Target Zone Exchange Rate Systems: What Do We Know?

Chief Witch: Yes, that's right.

MacBeth: I understand you can foretell the future.

— From a BBC Radio Program, June 1968

During the French revolution such people were known as *agioteurs* (speculators) — and they were guillotined.

— Michel Sapin, French Minister of Finance, speaking of currency traders[1]

SINCE MARCH 1979, most of the nations of the European Union have participated in a "target zone" system of exchange rate management known as the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS). Although the target zones of the ERM have weathered many adjustments since their inception, speculative currency attacks in September 1992 and August 1993 led to the de facto suspension of the system. The United Kingdom and Italy suspended their participation in the ERM on September 17, 1992. After August 1993, the bands were broadened sufficiently to functionally alter the character of the system. These recent crises have focused attention on the stability of not only the ERM, but of target zone systems generally.

A target zone is a hybrid exchange rate regime, a compromise between floating and completely fixed exchange rates. In a target zone system, monetary authorities pledge to keep the exchange rate with a particular foreign currency, or basket of currencies, within given margins around a central parity. At times, the authorities may also choose to realign the central parity. Advocates argue that target zones blend the advantages of fixed exchange rates and flexible exchange rate systems.[2] Krugman and Miller (1992) point out that the original justification for constraining EMS exchange rates within target zones was to reduce exchange rate volatility, which contributes to uncertainty and risk in international trade and investment.[3] More recently, a desire to "borrow"

[1] Macleod (1992).

[2] See Corbae, Ingram and Mondino (1990) for a theoretical development of one justification for target zones.

[3] Engel and Hakkio (1993) and Neely (1993) study the volatility of exchange rates under target zones from different perspectives.

the low inflation reputation of a foreign central bank (for example, the Bundesbank) has been frequently cited as an advantage of target zones. Compared to completely fixed rates, target zones allow central banks greater scope for monetary independence.[4] Paradoxically, the exercise of independence may contribute to expectations of realignment, which produce a "speculative attack," in which speculators refuse to hold one of the currencies at any exchange rate in the target zone. A successful speculative attack necessitates a realignment of the central parity, thus thwarting the goal of stability of the exchange rate.[5]

Researchers would like to understand the circumstances associated with speculative attacks and the realignments of central parities within a target zone for several reasons. If financial market participants could forecast realignments, they could profit from the large changes in asset prices. For example, it is estimated that investor George Soros made $1 billion speculating against the pound and the lira as a result of the crisis of 1992. Monetary authorities have a different rationale for analyzing realignments: They wish to be able to manage the economy more effectively. Ideally, they would like to maintain stable exchange rates and low inflation while also retaining sufficient monetary flexibility to conduct countercyclical stabilization policy. Although there is no consensus on the microeconomic benefits of exchange rate stability versus the macroeconomic benefits of domestic stabilization policy, realignments produce uncertainty about the value of internationally held assets/investments which policymakers would like to avoid.

Economists have had little success in forecasting exchange rates at short horizons. Yet, there is evidence (Mizrach, 1993c) that we can forecast target zone realignments over a short interval using information from interest rates, inflation, and the position of the exchange rate in the target zone. This article surveys the recent research on forecasting realignments and estimating the credibility of target zones. To facilitate understanding of the functioning of exchange rate target zones, the next section of this article presents a simple monetary model of exchange rate determination. Section three discusses the functioning of target zone systems. The empirical literature on realignments and credibility of target zones is surveyed in section four. The final section summarizes the conclusions of the literature and suggests future research.

EXCHANGE RATE DETERMINATION

Target zones are created to stabilize exchange rates. It is necessary to understand exchange rates and the market forces that determine them to understand the forces behind realignments of target zones. To give the reader an idea of what an exchange rate within a target zone looks like, the top panel of Figure 1 depicts the log of the deutsche mark per franc exchange rate from March 1979 to July 1993. As the relative price of money, the exchange rate is determined by market "fundamentals," that is, output, price levels, money supplies and interest rates. In the short run, a relation called uncovered interest parity (UIP) is thought to control exchange rates. In the long run, theory suggests that the relative prices of goods determine exchange rates through a relation called purchasing power parity (PPP).

Uncovered Interest Parity

Markets for financial instruments have low transactions costs and very good information, so small changes in expected asset returns cause large movements of capital. Expected asset returns drive exchange rate movements because investors must exchange currencies to purchase foreign financial instruments or repatriate earnings from international investments. For example, if French interest rates exceed those of Germany, a German investor might choose to exchange deutsche marks for francs at the current exchange rate, buy French financial assets (such as government bonds) that pay a higher interest rate, and then repurchase deutsche marks with the francs when the bond matures.

Of course, if French bonds pay a higher interest rate, why would any investor choose to buy German bonds? The answer is that there are two forms of returns from international investments, the return on the investment itself and

[4] In this context, independence means freedom to use monetary policy for internal, rather than external, goals. The limits of this type of monetary independence in a target zone are explored by Kool (1993). Pollard (1993) examines the benefits of freeing central banks from political pressures.

[5] The theoretical literature on speculative attacks on fixed exchange rate systems is well-developed. Salant and Henderson (1978), Flood and Garber (1984) and Obstfeld (1984 and 1986) have made important contributions.

the return on the exchange rate. Generally speaking, the expected return for international assets should be the same for all assets.[6] A simple example illustrates the manner in which the asset returns and expected exchange rate movements interact.

The expected gross return in deutsche marks for a German investor who invests DM 1000 in German bonds during period t, for τ years, compounded annually, is simply

(1) *Expected gross return for investing in German Bonds* $= 1000 \cdot (1 + i_t^{Ge})^{\tau}$,

where i_t^{Ge} is the annual rate of interest on a German bond.[7] If the same investor exchanged deutsche marks for francs, bought and held French bonds, then exchanged the earnings in francs for deutsche marks, the expected gross return would be:

(2) *Expected gross return for investing in French Bonds*

$$= \frac{1000}{e_t} \cdot (1 + i_t^{Fr})^{\tau} \cdot E_t(e_{t+\tau})$$

$$= 1000 \cdot (1 + i_t^{Fr})^{\tau} \cdot (E_t[\frac{e_{t+\tau}}{e_t}]).$$

Define the log of the expected return on the exchange rate (deutsche marks per franc) from period "t" to period "$t+\tau$" by [8]

$$(3)\quad E_t[\Delta s_{t+\tau}] \equiv \ln(E_t[\frac{e_{t+\tau}}{e_t}])$$

$$= \ln(E_t[e_{t+\tau}]) - \ln(e_t).$$

For expected returns to be equalized, a higher French interest rate must be offset by an expected depreciation in the exchange rate (fewer deutsche marks per franc in the future). If nominal interest rates are not too large, equating the right sides of equations 1 and 2 and using definition 3 gives us an approximation to the expectation of the exchange rate change next period:

$$(4)\quad \frac{E_t[\Delta s_{t+\tau}]}{\tau} \approx i_t^{Ge} - i_t^{Fr},$$

where τ is the number of years per period. If the periods are months, for instance, $\tau = 1/12$. Economists call this relationship UIP.[9] Nations with consistently high inflation rates tend to have higher nominal interest rates (to compensate investors for loss of purchasing power) and depreciating currencies.

Empirical studies have failed to find much support for the UIP hypothesis among flexible exchange rate systems (Froot and Thaler, 1990). This may be due to unrealistic assumptions. UIP assumes that investors are risk-neutral when, in fact, there seem to be time-varying risk premia in the data. Also, there are frequently capital controls in the real world that prevent investors from adjusting their portfolios in response to changes in interest rates or expected exchange rates. Despite the fact that it has a poor record of empirical support among flexible exchange rate systems, UIP is a useful way of thinking about target zone exchange rates. In contrast to previous studies on flexible rate systems, Mizrach (1993a) finds support for UIP in the well-integrated capital markets of the EU.

Purchasing Power Parity

One can buy goods and services as well as financial assets with money. A higher price level in France means that one can buy fewer goods with a given quantity of francs; each franc is less valuable. PPP says the exchange rate will adjust downwards to reflect higher prices. That is, if France maintains a 10 percent higher infla-

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[6] This is, of course, a simplification. A more accurate statement would be that the after-tax, risk-adjusted return for different assets must be the same. Koedijk and Kool (1993) compare the profitability of investment strategies in different ERM currencies.

[7] If it were not necessary to consider intervals other than a year, τ could be set equal to 1 for simplicity.

[8] We will take advantage of the fact that for $-.2 < x < .2$, a reasonable approximation is $ln(1+x) \approx x$. An immediate application of this is $ln(1 + i_t^{Ge}) \approx i_t^{Ge}$. This means that for small percentage changes, the log difference of a variable is approximately the percentage change in the variable. Define $s_t = ln(e_t)$. Using the approximations and the definitions, $[(e_{t+1}/e_t) - 1] \approx ln(e_{t+1}/e_t) = ln(e_{t+1}) - ln(e_t)$ $= s_{t+1} - s_t = \Delta s_{t+1}$.

[9] If we were to repeat this example from the point of view of a French investor, we would find an analogous UIP condition which, together with equations 1 and 2, would imply that $E_t[1/\Delta s_{t+\tau}] = 1/E_t[\Delta s_{t+\tau}]$. Since, in general, $E_t[1/\Delta s_{t+\tau}] \neq 1/E_t[\Delta s_{t+\tau}]$, UIP cannot hold simultaneously in discrete time for two currencies. This is known as Siegel's paradox. Siegel's paradox was shown to be irrelevant in empirical work by McCulloch (1975).

tion rate than Germany, its exchange rate will depreciate 10 percent per year in the long run.

A variable useful for measuring changes in relative purchasing power is called the "real exchange rate." The real exchange rate in period $t\,(rx_t)$ is defined to be:

$$(5)\quad rx_t = \frac{e_t \cdot P_t^{Fr}}{P_t^{Ge}},$$

where P_t^{Fr} and P_t^{Ge} denote the price levels in France and Germany in period t, and e_t denotes the nominal exchange rate in that period. An increase in the real exchange rate means that the franc becomes more valuable, imports will be cheaper to French consumers but the price of French exports to Germany rises. French goods will become less competitive on the world market. If PPP holds, the real exchange rate will tend to be mean-reverting; it will tend to return to some constant level.[10] Empirically, evidence supporting PPP is limited, but PPP remains useful for thinking about long-run tendencies in exchange rates.[11]

Both UIP and PPP suggest that a nation which has a consistently more expansionary monetary policy will have a currency that will tend to depreciate. The depreciation will occur through the inflation premium built into the nominal interest rate according to UIP, and through rising prices of domestic goods which require that the home currency lose value relative to foreign currencies to keep the real exchange rate constant according to PPP.

TARGET ZONE EXCHANGE RATE SYSTEMS

A target zone is a hybrid exchange rate regime, a compromise between managed floating and completely fixed exchange rates. In a managed float, monetary authorities may or may not, at their discretion, intervene to control the rate of exchange. If monetary authorities fix the exchange rate, they willingly buy or sell their own currency in unlimited quantities at the fixed rate. A target zone exchange rate system has elements of each. Monetary authorities pledge to intervene in the market to keep the domestic exchange rate with a particular foreign currency, or basket of currencies, within narrow margins around a central parity. Realignments occur when central banks are unwilling (or find it too costly) to conduct the interventions necessary to preserve the target zone.

The ERM

The most important target zone, the ERM, has operated since March 1979 to prevent what was perceived to be the excessive volatility in exchange rates that had prevailed in the 1970s.[12] The target zones for each currency were initially established at ±2.25 percent around the bilateral central parities for most of the currencies, ±6 percent for the more volatile currencies such as the Italian lira, Spanish peseta, British pound and Portuguese escudo.

It is common to divide the period of the ERM into three sub-periods. The first period extends from the inception of the ERM in March 1979 until the end of 1983. The target zones were characterized by lack of credibility and frequent devaluations during this period. The second period lasted from 1984 to the end of 1991 and coincided with increasing confidence in the ERM and greater convergence in the economic fundamentals of the member nations. Figure 1 illustrates four devaluations of the French franc relative to the deutsche mark in the first period and only two in the second period.[13] It was widely thought in 1989 and 1990 that the target zones had become permanent and would never be realigned but would simply lead into monetary union, a system of permanently fixed exchange rates with one monetary authority. This would effectively mean one currency. Events would prevent this smooth transition.

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[10] Roughly speaking, a random variable, such as the real exchange rate, that can be forecasted accurately far into the future is said to be mean-reverting. A mean reverting process is one that will tend to return its usual value in the long run.

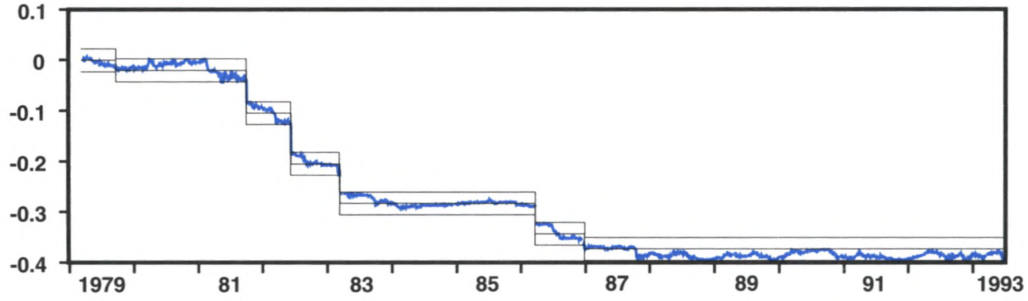
[11] Barriers to trade, transportation costs, differing baskets of goods across countries, imperfect competition, nontraded goods and differentiated goods may all contribute to weakening the effects of PPP. For an investigation of PPP within the EMS, see Edison and Fisher (1991). Coughlin and Koedijk (1990) review the literature on the determination of the real exchange rate in the long run. Dueker (1993) investigates PPP with the more recent econometric technique of fractional integration.

[12] For more information on the history and practices of the EMS, see Fratianni (1988), Ungerer, Hauvonen, Lopez-Claros and Mayer (1990), Zurlinden (1993), Edison and Fisher (1991), Bean (1992) and Higgins (1993).

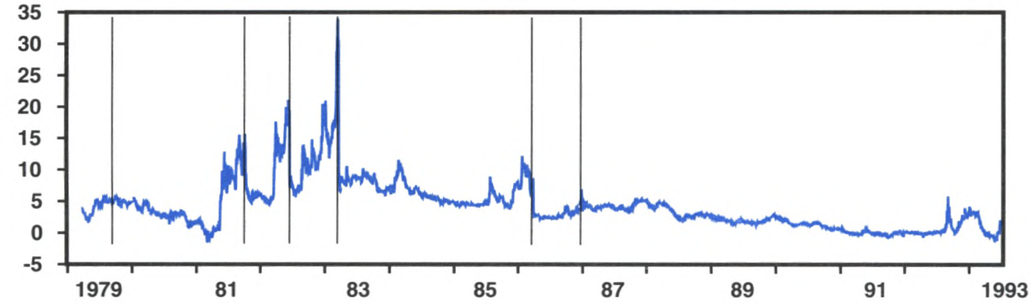
[13] The data in Figure 1 ends shortly before the widening of the target zones to ±15 percent for all rates except the guilder/deutsche mark in August 1993, which was a de facto realignment and the practical suspension of the system. See Zurlinden (1993) for a full description of the evolution of the bilateral central parities in the ERM.

Figure 1
Deutsche Mark Per Franc Exchange Rate
(March 1979 through July 1993)

In levels of normalized exchange rates



French-German 3-Month Interest Rate Differentials
(March 1979 through July 1993)



The third period for the system was the time leading to the crises and suspension of the system. German unification and the recession in Europe are widely accepted as the underlying causes of the crises of September 1992 and August 1993.[14] Reunification opened up major investment opportunities in the undeveloped East, increasing the demand for deutsche marks and required the German government to spend a great of money to subsidize the East and bring it up to western standards. The government also agreed to convert East German ostmarks to West German deutsche marks on a very generous 1:1 basis.[15] This one-time expansion of the money supply raised fears of inflation. High German interest rates put upward pressure on the deutsche mark. At the same time, a recession was ravaging Europe, striking Britain and Italy particularly hard. Pressure mounted on the Bank of England and the Bank of Italy to lower interest rates to fight their recessions, while the Bundesbank resisted lowering money market interest rates due to fear of inflation. Furthermore, the Danish rejection of the Maastricht treaty in June 1992 put the European Monetary Union (EMU) in jeopardy. This was the catalyst for the speculative attack of September 1992, which drove the British pound and the Italian lira from the ERM.[16] The pressure mounted over the next year as speculation against the remaining weaker currencies continued. Finally, in August 1993, the ERM was effectively suspended as bilateral bands were widened from ±2.25 percent to ±15 percent for all the rates except the Dutch guilder/deutsche mark rate.

[14] Higgins (1993) and Zurlinden (1993) examine the events leading to the collapse of the ERM in more detail.

[15] The exchange of deutsche marks for ostmarks was not unlimited on a 1:1 basis. Bofinger (1990) provides a more detailed account of these events.

[16] See Zurlinden (1993) for a detailed description of the experiences of the British pound in the ERM.

THE CREDIBILITY OF TARGET ZONES: FORECASTING REALIGNMENTS

Realignments have been a common feature of target zone systems. This section surveys the research on realignments of target zones conducted in the last several years. This literature has focused on a number of related issues such as the credibility of a particular target zone, the probability of a realignment and the expected size of a realignment. Economists have had little success in forecasting financial variables such as exchange rates.[17] Target zone exchange rates may be different, however. Central banks manage exchange rates to promote full employment or low inflation or some other economic goal; they do not conduct monetary policy for profit. Knowledge of economic variables may be used to forecast their policies. Expectations that the monetary authorities will prefer to realign rather than defend the target zone will lead investors to demand an interest rate premium to hold the weak currency. Therefore, clear expectations of a devaluation will be accompanied by a high interest rate differential between the currencies.[18]

The Simplest Test of Target Zone Credibility

This test is constructed to evaluate a weak currency that is expected to stay the same or depreciate. Recall that we developed a forecast for expected future exchange rate changes based on interest rate differentials, UIP:

$$(6)\quad \frac{E_t[\Delta s_{t+\tau}]}{\tau} = i_t^{Ge} - i_t^{Fr}.$$

The intuition behind equation 6 is that investors must be compensated by a higher interest rate for holding assets denominated in a currency that is expected to lose value (depreciate).

In a target zone, the most that the exchange rate could depreciate without a realignment is the distance from the exchange rate to the lower bound. Denote this distance in percentage terms (it must be a nonpositive number):

$$(7)\quad d_t = \frac{\underline{e}}{e_t} - 1 \approx \underline{s} - s_t,$$

where $\underline{e}$ is the lower bound of the target zone, $\underline{s} = ln(\underline{e})$ and $s_t = ln(e_t)$. If the target zone is perfectly credible (no probability of a realignment), the expected depreciation in the exchange rate can be no greater than the distance from the exchange rate to the bottom of the band. That is, for all period lengths we must have

$$(8)\quad E_t[\Delta s_{t+1}] \geq d_t.$$

In a perfectly credible target zone, at a forecast horizon of length $(1/\tau)$, we must have

$$(9)\quad \tau \cdot (i_t^{Ge} - i_t^{Fr}) \geq d_t.$$

As τ goes to zero, that is, as the forecast horizon becomes arbitrarily short, equation 9 must hold; the right side is less than or equal to zero and the left side is going to zero. If equation 9 fails to hold, we can conclude the target zone is not perfectly credible; devaluation is considered possible.

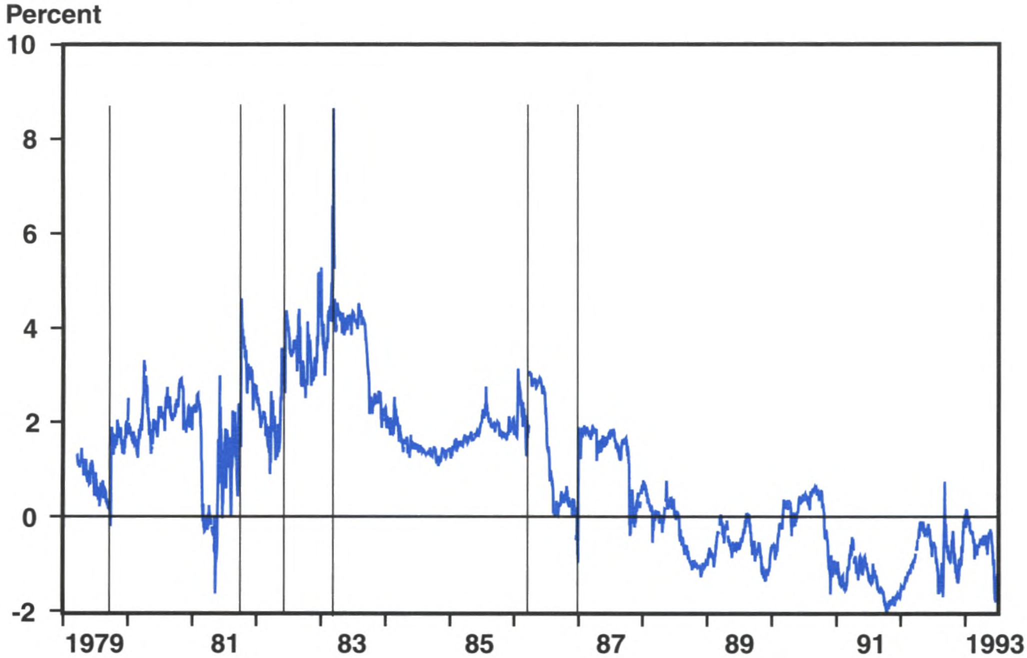
The converse is not true, however. There could be significant realignment expectations with equation 9 still holding. For example, suppose that the deutsche mark per franc rate is currently at central parity so $d_t = -2.25$ percent, $i_t^{Fr} = 4$ percent and $i_t^{Ge} = 2$ percent. Further, investors know it to be equally likely that either there will be no realignment and the exchange rate will be exactly the same a year ($\tau = 1$) from now or that there will be a realignment and the exchange rate will be exactly 3 percent lower. That means that in this case, equations 8 and 9 would hold but the target zone is not perfectly credible since there is a 50 percent chance of a devaluation (realignment downward).

Formal tests of target zone credibility or realignment probabilities are usually based on the information content of interest rate differentials. The greater the risk of devaluation, the higher the difference in interest rates. An example of the relation between exchange rates and

[17] There is a good reason for this. If someone could predict the future movement of an asset price (for example, an unusual increase in a stock price) based on public information, that person would borrow money to buy as much stock as possible immediately, driving the price up right away. This is a simple version of the “efficient markets hypothesis.” If price changes could be easily anticipated, they would already have happened.

[18] There are other methods for determining the credibility of target zones, such as those in Koedijk and Kool (1993), but this article will focus on those methods using interest rate differentials.

Figure 2
Deutsche Mark/Franc Within the Band Minus Adjusted Interest Differentials



interest rate differentials is shown in Figure 1. The top panel shows the time series of the exchange rate with the devaluations and the bottom panel shows the corresponding series of the French three-month interest rates minus German three-month interest rates.[19] The interest rate differential was always greater than 0; the expectation was always that the French franc would depreciate. The bottom half of Figure 1 shows that interest rate differentials tend to widen before realignments (vertical lines).

Figure 2 displays the time series of the deutsche mark per franc exchange rate within the target zone minus the adjusted three-month interest rate differential. This series is equivalent to the guaranteed excess return from investing in French securities over German securities conditional on the band remaining intact. In the notation used above, it is

$$(10)\quad d_t - \tau \cdot (i_t^{Ge} - i_t^{Fr}).$$

This variable indicates a lack of credibility at the three-month horizon for the target zone when it is greater than zero. This is the "simplest test" of target zone credibility. Thus, Figure 2 shows the target zone lacked credibility most of the time in the early 1980s, gradually falling below zero later in the decade as French inflation fell.

In "The Simplest Test of Target Zone Credibility," Lars Svensson (1991) uses equation 9 to examine if interest rates were high enough to conclude that there must be some devaluation expectation for the Swedish target zone from 1987 to 1990. The data are monthly. During the period of Svensson's study, Sweden had a unilateral target zone with a trade weighted "basket" (or weighted average) of the currencies of its 15 largest trading partners. Hence, the relevant exchange rate is now measured in basket units per krona and the respective interest rates are in basket units and krona. The width of the band was 1.5 percent during this period. Svensson plots the return available on domestic securities (for 12-month maturities) against the maximal return (in Swedish krona) on the weighted basket of foreign securities,

[19] The periods of realignments are marked in the bottom panel by vertical lines.

assuming the target zone would remain intact. He found the Swedish target zone lacked credibility with the ECU for securities with a 12-month horizon from the third quarter of 1989 until the end of the sample in 1990.

The hypothesis of UIP is used to investigate credibility in the same way as the "simplest test." Recall that UIP expressed the expected movement in (basket units per Swedish krona) exchange rates as:

$$(11)\quad E_t[\Delta s_{t+\tau}] = \tau \cdot (i_t^{Basket} - i_t^{Sw}).$$

This expression is also called the expected rate of devaluation. By using the interest rates for securities of different maturities, Svensson is able to construct a series of forecasts for the future value of the exchange rate. For example, the forecast for the exchange rate in two years was constructed using the 24-month Euro-currency interest rates for the basket of currencies and the Swedish krona in equation 11 to get the expected change in the weighted exchange rate over that period. If the forecasted exchange rate fell outside the target zone for a particular maturity at some point, the target zone was said to lack credibility at that forecast horizon.

Svensson used maturities of 12, 24 and 60 months over the sample period to conclude that while the market generally found the Swedish target zone to be credible in the short run, there was strong evidence that the market also always believed that devaluation within a longer horizon (24 to 60 months) was a distinct possibility. Expected exchange rates always fell outside the target zone for those maturities for the sample period.

Mean Reversion Within the Target Zone

A major problem with using UIP to estimate the credibility of target zones is that it predicts movements in the exchange rate, not the central parity. The movement of the exchange rate within the band, especially at short horizons, could account for much or all of the interest rate differential. At longer horizons, the interest yield for securities gets larger (as more interest accrues over time) but the exchange rate within the band is still bounded. For example, if the target zone is 2.25 percent wide (as were the ERM target zones before August 1993) and the exchange rate is at central parity, the simplest test tells us that the interest rate differential on 12-month securities would have to exceed 2.25 percentage points (the width of the band) before we could reject the idea that the target zone is perfectly credible. But, the same test tells us the annualized interest differential for three-month securities would have to exceed 9 percentage points before we could reach the same conclusion.[20]

To more accurately estimate the credibility of the target zone, at short horizons, it is necessary to estimate the movement of the exchange rate *within* the band. Investigating this matter, Rose and Svensson (1991) find that daily deutsche mark per franc rates within the band tend to be mean-reverting, that is, they tend to come back to central parity if they are away from it. The mean reversion is due to the fact that monetary authorities will usually defend the target zone by intervening to move the exchange rate back to the center of the target zone if it approaches the edges.

To explain how movements of the exchange rate within the band are forecasted, define the log of the position of the exchange rate within the band as

$$(12)\quad x_t = s_t - c_t,$$

where c_t is the log of the central parity of the band at time t. Note that x_t may be positive or negative. Of course, one may rewrite the exchange rate as the sum of the central parity and the position within the band as

$$(13)\quad s_t = x_t + c_t,$$

and by taking differences (percentage changes) of this equation over time we get

$$(14)\quad \Delta s_t = \Delta x_t + \Delta c_t.$$

Using the UIP condition stated earlier and rearranging terms, we may express the expected change in central parities (the expected realignment) as

$$(15)\quad E_t[\Delta c_{t+\tau}] = \tau \cdot (i_t^{Basket} - i_t^{Sw}) - E_t[\Delta x_{t+\tau}].$$

Equation 15 illustrates that to more accurately predict changes in the central parity (realignments), it

[20] (12/3)*.0225 = .09

is necessary to predict the way exchange rates might move within the band.

Rose and Svensson (1991) make the additional assumption that the future movements of the exchange rate within the band might be predicted from present position and other ERM exchange rates with the deutsche mark. They use an ordinary least-squares regression to predict the changes in the exchange rate within the band for the next month ($E_t[\Delta x_{t+\tau}]$). They find that future changes in the exchange rate are dominated by current position within the band. If the exchange rate is near the edges, it will tend to come back to the middle. Other variables, including other ERM exchange rates, lagged changes and higher-order terms were found to be statistically or economically insignificant.

In order to predict the rate of expected realignment ($E_t[\Delta c_{t+\tau}]$) they substitute the forecast for the change in the exchange rate within the band ($\hat{E}_t[\Delta x_{t+\tau}]$) into equation 15 to predict realignments. They report some success, but suggest that since the expected rate of realignment consistently "overpredicts" realignments, private agents may not anticipate realignments very well. Since their model is based on market expectations—high interest rate differentials—misprediction by private agents may degrade its performance.

Expectations

The question of why private agents may fail to anticipate realignments is puzzling to economists. Kaminsky (1993) attributes this lack of success in predicting exchange rate movements in general to the fact that agents must "learn" about the nature of the economy and the behavior of the monetary authorities. While they are learning, they may make systematic mistakes about the credibility of the authorities or the nature of shocks hitting the economy. The question of how private agents develop their expectations and beliefs about the economy is an important one. If central banks knew how to influence expectations of devaluation, they could prevent speculative attacks and stabilize the exchange rate.

The UIP relation tells us something about expectations; interest rate differentials forecast expected movement, but the story is not as simple as that presented in section two. Investors care not only about expected profit, but also about minimizing risk associated with the profit. For instance, German investors buying domestic bonds are sure of their nominal return, but if they buy French bonds, they must also take the risk that exchange rates will not move as predicted. If the exchange rate depreciates more than expected, they lose money. Because of this risk, investors require a "risk premium" in the form of an especially high interest rate to hold certain currencies. This risk premium may also change over time as economic conditions change and investors perceive more or less risk in the exchange rate. This time-varying risk premium makes it difficult to accurately estimate expectations from interest rate differentials.

An obvious way to investigate agents' expectations about the exchange rate is to ask them. Frankel and Phillips (1991) use this method to investigate the hypothesis of increasing EMS credibility after 1987 (until 1991). With the survey data method from the *Currency Forecasters' Digest* (*CFD*) as well as the UIP method, Frankel and Phillips examine whether forecasts of future exchange rates fall within the target zone for monthly EMS exchange rates. They consider the main advantage of survey data to be immunity from error due to exchange rate risk premia. The closer the forecast is to the central parity, the more credible the target zone.[21] Prior to 1990, estimates of the expected annual rates of devaluation were about 2-5 percent for most currencies. These estimates tended to overpredict actual devaluations. Their study concludes that between 1987 and 1991, the EMS experienced a significant gain in credibility using one- and five-year horizons. That is, one- and five-year forecasts of the exchange rate move much closer to current central parity after 1987.

UIP and survey data approaches are useful to inform us as to the expectations of market participants with respect to the exchange rate, but they do not tell us how these expectations are formed. Using Swedish data from 1982 to 1991, Lindberg, Svensson and Söderlind (1991) consider this problem of explaining time-varying market devaluation expectations in terms of underlying factors. They first use a variant of the "simplest test" to compute devaluation expectations over time for one-, three-, six- and

[21] Their methods are very similar to Svensson's "simplest test" discussed above.

12-month forecast horizons. Generally, they were unable to find much incidence of a lack of credibility at short forecast horizons.[22]

Lindberg, Svensson and Söderlind (1991) attribute the failure to find a lack of credibility at shorter horizons to ignoring expected changes within the band. As discussed in the context of mean reversion, changes within the band may be large relative to interest rate differentials at short horizons. To get more precise estimates of devaluation expectations, Lindberg, Svensson and Söderlind (1991) required a specification for future values of the exchange rate. Theory suggested starting with a simple log linear specification:

$$(18)\quad x_t = \beta_0 + \beta_1 \cdot x_{t-1}.$$

Although they considered a variety of explanatory variables and methods to estimate equation 18 and its variants, a simple OLS regression with a Newey-West correction for conditional heteroskedasticity to the errors worked best for estimating changes within the band. The gains to precision were described as "substantial" for short horizons.

With the new devaluation expectations series, Lindberg, Svensson and Söderlind examine the circumstances around four specific periods of high realignment expectations. The first period, October 1982, was the only time that the target zone was actually realigned. The market seemed to have weakly anticipated it two to three months before it occurred. The high realignment expectations in the spring of 1985 were ascribed to the election of a new government and uncertainty about the width of the band.[23] The third period of high realignment expectations was also associated with political events, the political crisis and weak economy of the first three quarters of 1990. Finally, high realignment expectations in the late fall of 1990 were also imputed to fears that the government would change the target zone before the general election of September 1991.

In a more formal investigation of how expectations are formed by political events and macrovariables, Lindberg, Svensson and Söderlind regressed devaluation expectations on variables such as changes in the real exchange rate, parliamentary elections, changes in foreign exchange reserves, unemployment, money growth, government borrowing and the current account. Only changes in the real exchange rate, parliamentary elections and the current account proved to be significant explanatory variables. The coefficients on these significant explanatory variables were unstable over subperiods, however, perhaps indicating the shifting focus of market participants as they develop their expectations.

Rose and Svensson (1993) extended the efforts to learn about the causes and behavior of realignment expectations during the EMS. They regressed realignment expectations on measures of relative money, output, the real exchange rate, inflation, the trade balance, reserves and exchange rate volatility within the band. They found no robust link between realignment expectations and the macroeconomic variables. Use of a vector autoregressive system had no more success. They conclude that there is "no apparent relationship between macroeconomic variables and credibility" (p. 16).

After examining the behavior of macroeconomic variables and political events before the currency crises of 1992 and 1993, Rose and Svensson find it difficult to convincingly explain the cause and suddenness of the crises. Although it is easy to claim ex post that the macroeconomic fundamentals dictated a revaluation of the deutsche mark, "it remains a mystery that the deepest financial markets in the world yielded so remarkably few indications of an imminent crisis" (p. 26). Furthermore, the weak link between realignment expectations and macroeconomic variables is troubling.

Truncated Data

An often ignored problem in working with data from target zone exchange rate systems is that the data are "truncated." This is a problem for statistical research on this data; much commonly used statistical theory assumes the distribution of the random variable to be unbounded. Chen and Giovannini (1992) suggest transforming the exchange rate into the following unbounded random variable:

$$(19)\quad z_t = \ln[\frac{L + x_t}{L - x_t}],$$

[22] There was a lack of credibility at all horizons before the only actual devaluation (October 1982) and around the time of an election (September 1985). In addition, the target zone frequently lacked credibility at the 12-month forecast horizon.

[23] The width of the target zone was not public information at this time.

where $L = ln(\bar{e}/c_t)$, $\bar{e}$ is the upper edge and c_t is the central parity of the target zone.

Working with the transformed random variable z_t, Chen and Giovannini investigate target zone credibility in the usual ways using monthly data from the ERM and the Bretton Woods system.[24] With a linear prediction of the exchange rate within the target zone, they estimate band credibility from the UIP relationship. Their confidence intervals for the expected changes within the band are actually constrained by the band (by construction) whereas the confidence intervals for the untransformed variables frequently fall outside the target zone. This property rules out nonsensical values for expected changes within the band and means a better estimation of the process. As in other studies, they are able to frequently reject perfect credibility for ERM zones during the 1980s.

The Probability and Size of Realignments

The simplest test of target zone credibility only predicts the expected rate of devaluation ($E_{t-1}[\Delta s_t]$) over a period of time. It does not predict the probability of realignment over that period, nor does it predict the size of a realignment conditional on one occurring. The simplest test is unable to differentiate between an almost certain small realignment and a low probability of a large realignment.

Recently, Mizrach (1993b and 1993c) has used a hybrid Markov-Probit model to estimate the probability of realignment and the expected size, conditional on an occurrence. The probability of realignment estimated by a probit model uses the log of the position of the exchange rate within the band, and the domestic yield curve as independent variables. The log of the exchange rate within the band is again modeled as a linear autoregression; lagged values of x_t predict future values. The expected size of an exchange rate movement, conditional upon a realignment, is allowed to depend on the real exchange rate. Nonlinear least-squares were used to estimate the model on daily data from the ERM, the FF/DM and IL/DM exchange rates.

Mizrach found strong evidence of mean reversion within the band; the parameter estimates suggest that any deviation from central parity would be expected to be cut in half in a week or two. The model forecasts systematically larger realignments than actually occurred for both the franc and the lira. The probit parameters all were significant and had the appropriate sign. Restrictions of constant realignment risk and no mean reversion were strongly rejected.

It was found that, typically, probabilities were at usual levels up until a month before a realignment and then began climbing upwards. The short nature of the warning time provided by the model leads Mizrach to conclude that realignments "surprised" market participants and policymakers. Mizrach concludes that his model supports the hypotheses of mean reversion within the band and produces credible estimates of time-varying realignment risk.

The Role of the Dollar

The empirical work discussed above does not use a potentially important indicator of realignments, weakness in the U.S. dollar. As noted by Edison and Kole (1994) and others, realignments tend to be associated with weakness in the U.S. dollar. The role of the dollar and the deutsche mark as international stores of value is the explanation for this. When the dollar is weak, investors substitute into deutsche mark-denominated assets. This increases the value of the deutsche mark not only with respect to the dollar but also to other ERM currencies. This added pressure in times of crisis has frequently contributed to realignments.

CONCLUSIONS

This article has surveyed recent work on forecasting realignments and estimating the credibility of target zones. The literature has found that realignments are predictable to some extent within short intervals from readily available information such as interest rates and the position of the exchange rate within the band.

Most of the research surveyed here has taken the formation of expectations for granted and has used interest rate differentials which develop from those expectations as starting points for forecasting realignments. The relationship between realignment expectations and macrovariables is weak and uncertain. It is not clear how expecta-

[24] While generally described as an adjustable-peg fixed-rate system, the Bretton Woods system is more accurately described as a narrow target zone system. The target zones were ± 1 percent around dollar parities.

tions are formed. Further, realignments are said to "surprise" policymakers and market participants; realignment expectations rise only a short time before realignments. To some extent, this is to be expected. Although there are false alarms in which realignment expectations rise and then fall back again, once realignments are seen as likely, speculative pressure builds up that often results in a self-fulfilling speculative attack. Further research on the formation of expectations would be an important contribution.

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A Case Study in Monetary Control: 1980-82

FOR SEVERAL YEARS PRIOR to October 1979, the Federal Reserve implemented monetary policy decisions of the Federal Open Market Committee (FOMC) by targeting the federal funds rate. Staff of the Open Market Desk bought or sold government securities with the objective of keeping the federal funds rate within a range specified by the FOMC at its latest meeting.

The effects of monetary policy on the economy under a procedure of targeting the federal funds rate depend on the willingness of policymakers to move the funds rate target fast enough and far enough when the pace of economic activity changes. In the 1970s, the tendency of the Fed to limit changes in the federal funds rate as the growth of total spending accelerated produced rapid money growth, resulting in accelerating inflation in the late 1970s.

In response to the accelerating inflation, the Fed in October 1979 adopted a procedure of targeting nonborrowed reserves (NBR). The FOMC stated that it adopted the NBR operating procedure to promote better short-run control of the monetary aggregates, to better control inflation.[1] Under the NBR operating procedure, the objective of the staff of the Open Market Desk was to keep the average level of NBR between FOMC meetings at levels consistent with the short-run objectives of the FOMC for growth of the monetary aggregates.

The Fed stopped targeting NBR in the fall of 1982; the operating procedure used since then is similar to targeting the federal funds rate.[2]

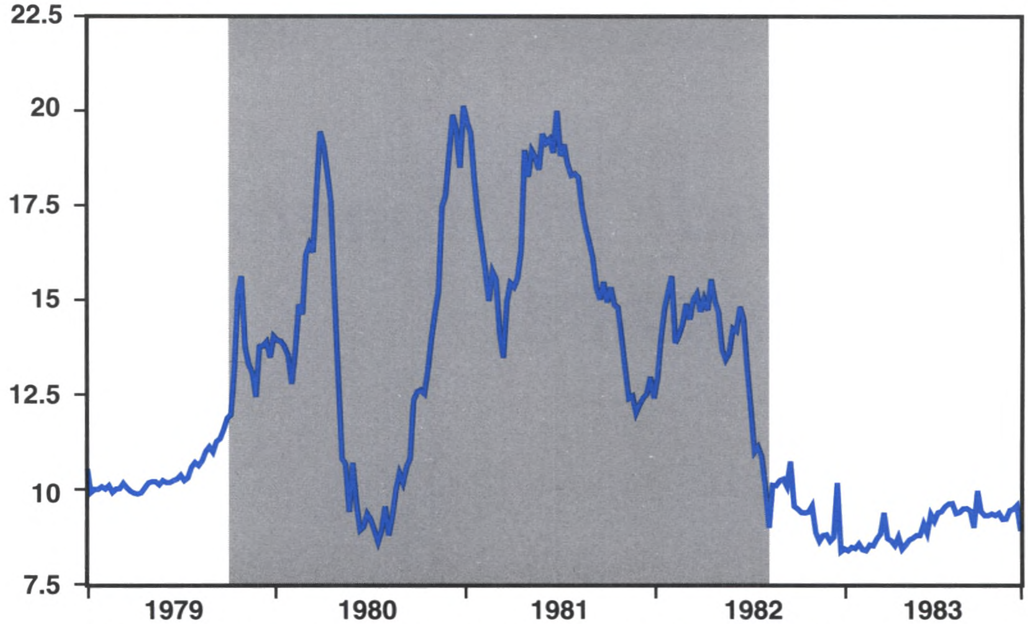
The NBR operating procedure generated a great deal of interest and controversy among economists. There is a large literature on the conduct of monetary policy under that procedure and, in recent years, economists have continued to analyze the conduct of monetary policy during the three years ending in the fall of 1982.[3] Critics of the NBR procedure contend that it caused a high degree of interest rate volatility, as illustrated in Figure 1. Some critics argue that the Fed actually did not change its operating procedure

[1] For a description of the decisions by the FOMC at its meeting in October 1979, see Board of Governors (1979, p. 974).

[2] For a general description of the mechanics of various operating procedures, see Gilbert (1985). Thornton (1988) provides evidence that targeting borrowed reserves has been essentially the same as targeting the federal funds rate.

[3] The following are selected references to the literature on the NBR operating procedure: Goodfriend (1983); Hetzel (1982, 1986); Hoehn (1983); Lindsey (1982, 1983); Lindsey and others (1984); McCallum (1985); Poole (1982); and Spindt and Tarhan (1987). For recent additions, see Avery and Kwast (1993), Goodfriend and Small (1993) and Pearce (1993).

Figure 1
Weekly Federal Funds Rate: January 3, 1979, to December 28, 1983



Note: Shaded area encompasses the period of nonborrowed reserves targeting (10/3/79 through 9/29/82).

in any fundamental way in October 1979.[4] Others blame large errors in hitting money targets on improper design of the operating procedure, especially in combination with lagged reserve accounting in effect at the time.[5]

Whatever the flaws in the NBR targeting procedure as a method of monetary control, the Federal Reserve did achieve its objective of sharply reducing the rate of inflation during the period in which it used that procedure (Figure 2). That success in reducing the rate of inflation, however, came at the price of a very sharp recession (Figure 3).

This article extends the literature on NBR targeting in two ways. First, it presents information relevant for interpreting policy actions that was confidential until several years after the end of the period of NBR targeting: Federal Reserve staff projections of total reserves (TR) over periods between FOMC meetings, and staff estimates of the levels of TR over the same periods that would have been consistent with FOMC objectives for growth of the monetary aggregates (the TR paths).[6] In addition, this article extends the literature by answering a question not answered by the other studies: Did the pattern of policy actions under the NBR operating procedure reflect a consistent use of the procedure for hitting short-run targets for growth of the monetary aggregates, given the information available to policymakers on staff projections of TR and estimates of the TR paths?

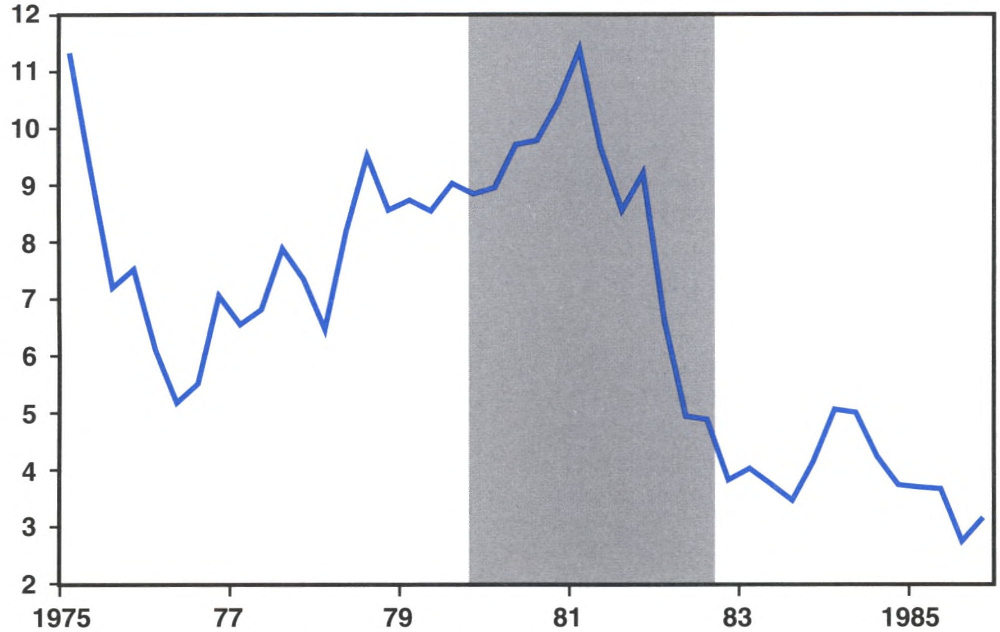
This article may have implications for the choice of operating procedure in the future. If the Federal Reserve chose once again to target a

[4] See Poole (1982).

[5] See McCallum (1985). Gilbert and Trebing (1982) provide a description of lagged and contemporaneous reserve accounting.

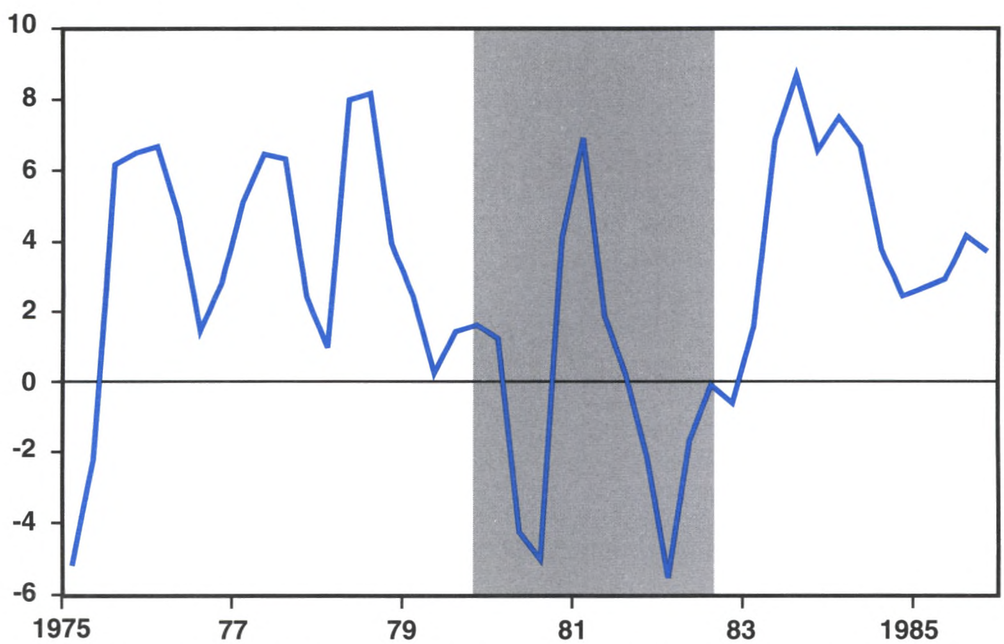
[6] The weekly reports of the Manager of the Open Market Account, which included the projections and estimates of TR, became public information five years after the dates of the reports. Cook (1989a, 1989b) presents some, but not all, of the information on the NBR operating procedure presented in this article. In particular, Cook presents information on the *gap* between projections of TR and the TR path, but he does not present the levels of those projections and estimates. Feinman (1988) made extensive use of the data from the weekly reports of the Manager of the Open Market Account in an unpublished dissertation.

Figure 2
Rate of Growth in the GDP Deflator



Note: Rates of growth in the GDP deflator are two-quarter growth rates; the shaded area encompasses the period of nonborrowed reserves targeting (1979:Q4 through 1982:Q3).

Figure 3
Rate of Real GDP Growth



Note: Rates of real GDP growth are two-quarter growth rates; the shaded area encompasses the period of nonborrowed reserves targeting (1979:Q4 through 1982:Q3).

narrow monetary aggregate, the Federal Reserve might consider a change in operating procedure, perhaps to an NBR operating procedure. Several prominent monetary economists have expressed dissatisfaction with the lack of success of the FOMC in hitting its targets for money growth under NBR targeting.[7] It is not possible to evaluate NBR targeting as a method of monetary control from the experience of 1979-82, however, without knowing whether policy actions were consistent with use of the procedure for monetary targeting.

TARGETING NONBORROWED RESERVES

This section describes the nature of the NBR operating procedure. Most members of the FOMC at the special meeting on October 6, 1979, agreed that the degree of monetary control under the procedure of targeting the federal funds rate had become unsatisfactory. They decided to adopt instead a procedure that linked the supply of NBR to their objectives for money growth, while permitting larger fluctuations in the federal funds rate than under the previous procedure of federal funds rate targeting.[8]

Changes in the Nature of FOMC Decisions

Under the federal funds rate targeting procedure, the FOMC stated its objectives for growth of each monetary aggregate between meetings as a range of growth rates from a month before the meeting to a month after the meeting. Beginning with its meeting on October 6, 1979, the FOMC began specifying its objectives for growth of the monetary aggregates as specific growth rates over periods between meetings. Under the federal funds rate targeting procedure, in contrast, the FOMC stated its objectives for money growth as ranges of growth rates of the monetary aggregates.

Although the FOMC continued to specify ranges for the federal funds rate under the NBR operating procedure, the ranges were widened substantially. For most periods, the range was 400 basis points, compared with ranges of 50 to 100 basis points under the federal funds rate operating procedure. The role that the wider ranges for the funds rate played in the operating procedure is unclear. On several occasions, the FOMC widened the range on the federal funds rate when the rate threatened to move outside the range. On other occasions, the federal funds rate was allowed to move outside its range for short periods of time.[9]

At each meeting, the FOMC also made an assumption about the average level of borrowed reserves over the period until the next meeting. The staff used this "borrowings assumption" in deriving the target level for NBR.

Staff Projections of TR and Estimates of the TR Path

After each FOMC meeting, the staff would estimate the average level of TR that would be consistent with the FOMC's objectives for growth of monetary aggregates until the next meeting. This was called the "TR path." The target for the average level of NBR between FOMC meetings, called the "NBR path," was simply the TR path minus the borrowings assumption of the FOMC. The objective of the Open Market Desk was to keep the average level of NBR between FOMC meetings equal to the NBR path.[10]

Staff estimates of the TR path were based on FOMC objectives for M1 and M2 and estimates of the following: (1) currency in the hands of the public; (2) average reserve requirements on deposit liabilities in M1 and M2; (3) required reserves on bank liabilities not included in M1 or M2; and (4) excess reserves. The staff generally revised their estimate of the TR path each week, based on new information about the factors that affected the relationship between reserves and the monetary aggregates.

Each time the staff estimated the TR path, they also projected the average level of TR over the same period. Projections of TR were based on estimates of the actual levels of the monetary aggregates between FOMC meetings and the four estimates specified above that were made in estimating the TR path. Each change in the gap between the staff projection of TR and their estimate of the TR path during an intermeeting period, therefore, reflected a change in the staff projections of the monetary aggregates. Appendix 1 illustrates the process of projecting TR and esti-

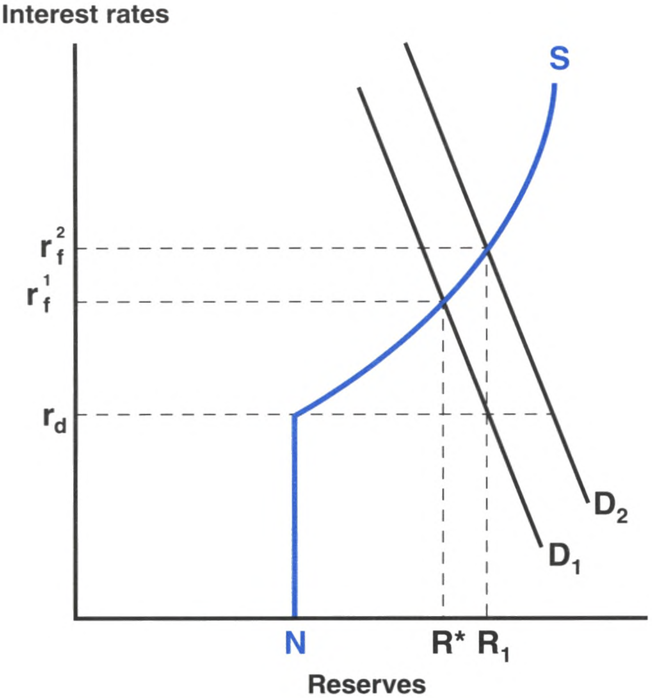
[7] See Friedman (1984), McCallum (1985), Pierce (1984) and Poole (1982).

[8] See Board of Governors (1979, p. 974).

[9] See Gilbert and Trebing (1981) and Thornton (1982, 1983).

[10] The staff of the Open Market Desk converted the NBR path for each intermeeting period into weekly and daily objectives for NBR. See Levin and Meek (1981), Meek (1982) and Stevens (1981).

Figure 4
Supply and Demand for Reserves



mating the TR path for the first intermeeting period in Table 1.[11]

Since projections of TR and estimates of the TR path reflected information about the same four variables specified above, projections of TR often were revised in the same direction as the estimates of the TR path. In the three weeks ending February 27, 1980, for instance, the projections of TR and the TR path were both reduced, but by different amounts (Table 1). Changes in projections of TR and TR paths over the 37 periods in Table 1 had the same signs in all but eight of the periods. These comparisons indicate that changes in projections of TR over intermeeting periods tended to reflect the same factors that caused the staff to revise its estimates of the TR path: changes in factors that affect the relationship between reserves and the monetary aggregates.

Graphical Representation of NBR Targeting

Implementation of monetary policy under this operating procedure is illustrated in Figure 4, using the concepts of supply and demand for reserves and equilibrium in the market for reserves described in Appendix 2.[12] Levels of TR and NBR on the horizontal axis refer to average levels for the weeks between FOMC meetings. On the vertical axis, r_d is the level of the discount rate and r_f is the level of the federal funds rate. The TR path is illustrated as R^*. The NBR path is N, based on a borrowings assumption of R^* minus N. The objective of the Open Market Desk was to keep the average level of NBR over intermeeting periods close to the NBR path.

TR would be at the path level R^* if the demand

[11] Although the Federal Reserve began using the NBR operating procedure in October 1979, the reports of the Manager of the Open Market Account did not include projections of TR and TR paths on a consistent basis until February 1980. Cook (1989b) discusses some of the difficulties in deriving consistent information from the weekly Reports of Open Market Operations on the conduct of monetary policy in the first few weeks under the NBR operating procedure.

[12] Lindsey (1982, 1983) describes how the procedure of targeting NBR worked in practice by examining the timing of money growth relative to FOMC objectives, borrowed reserves, the federal funds rate and the discount rate. Meek (1982) describes in detail the operations of the Open Market Desk under NBR targeting.

Figure 5
Tightening of Monetary Policy

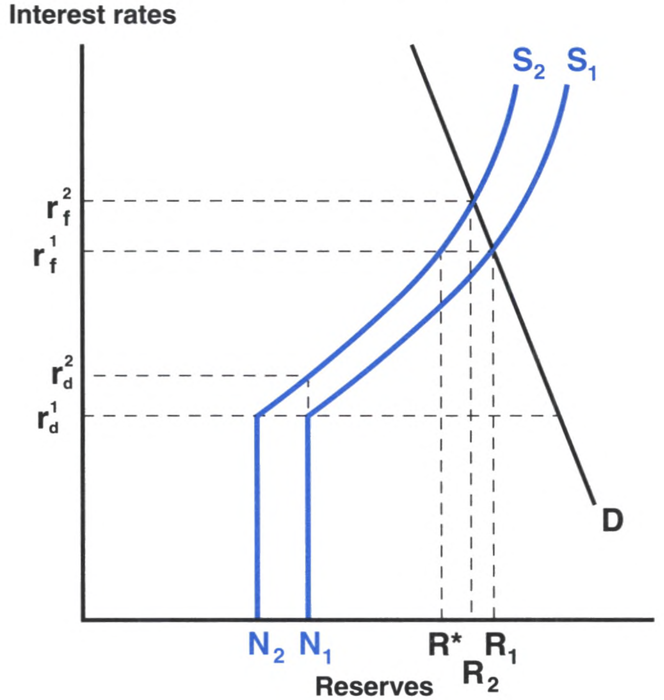
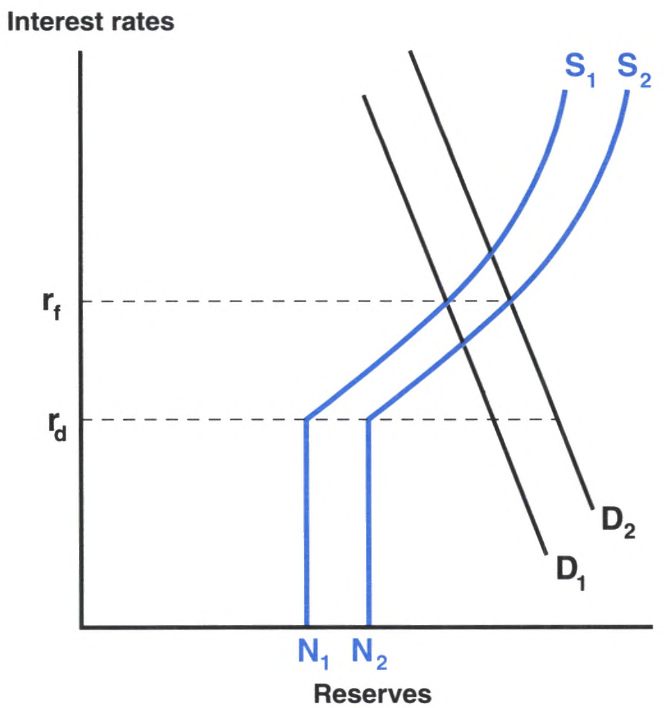


Figure 6
Federal Funds Rate Targeting



curve for reserves was D_1. From that initial position, consider the effects of an increase in the demand for reserves, illustrated by a shift in the demand curve to D_2, which reflected an increase in the demand for money.[13] TR would rise to R_1, which is above the TR path. Since the staff of the Open Market Desk would keep NBR at the level N, the rise in TR to R_1 would involve an increase in borrowed reserves. The federal funds rate would rise from r^1_f to r^2_f, inducing the higher level of borrowings. Without any additional policy actions, the money stock would tend to exceed the FOMC's objectives because TR would be above the path level.

During some intermeeting periods, the Federal Reserve took no policy actions in response to changes in the demand for reserves. In the case illustrated in Figure 4, FOMC members considered the rise in the federal funds rate from r^1_f to r^2_f an adequate response to the shift in demand for reserves, even if growth of the monetary aggregates exceeded objectives established at the last FOMC meeting.

Experience eventually convinced some Federal Reserve officials that rapid policy responses were necessary to close the gap between actual money growth and FOMC objectives once money growth started to deviate substantially from FOMC objectives.[14] During some periods between FOMC meetings, the Federal Reserve adjusted the level of the NBR path or the discount rate to reduce the deviations of the money stock from desired levels. The Federal Reserve took such policy actions when the deviations appeared to reflect more than transitory movements in the money demand schedule, perhaps due to changes in aggregate spending.[15]

In the situation illustrated in Figure 5, the staff projects TR to be R_1, which is above the TR path (R^*). The policy action illustrated in Figure 5 is a reduction in the NBR path from N_1 to N_2, which involves an increase in the borrowings assumption from R^* minus N_1 to R^* minus N_2. Due to the inelastic demand for reserves over intermeeting periods, the average level of TR would decline to R_2, still above the TR path, but the reduction in NBR would produce a sharp increase in the federal funds rate. The Fed could have the same effect on the funds rate and TR by keeping NBR at N_1 and raising the discount rate to r^2_d. In taking policy actions that reduced but did not eliminate the gap between projections of TR and path levels, Fed officials emphasized the assumption that sharp increases in interest rates would, over time, reduce the quantity of money demanded. This article does not model the assumed feedback mechanism based on money demand as a function of lagged interest rates.[16]

One of the issues policymakers confronted in determining whether to adjust the NBR path or the discount rate when TR was projected to deviate from path levels involved their confidence in the projections of TR and estimates of the TR path. Studies conducted during the period of NBR targeting indicated large errors in these projections and estimates.[17] These errors would tend to be smaller later in intermeeting periods, when actual observations were available for part of the periods. Observations in Table 1 are consistent with the view that the projections and estimates of TR were subject to large errors, and that the errors affected the timing of policy actions. Table 1 indicates that often there were large revisions to the projections of TR and to TR paths over intermeeting periods. Also, on those occasions when policymakers took actions between FOMC meetings, they generally acted at least two weeks after an FOMC meeting, when they might assume that the projections and estimates were more accurate.

Graphical Representation of Targeting the Federal Funds Rate

One way to highlight the nature of NBR targeting is to contrast the open market operations for a given situation under NBR targeting and under the procedure of targeting the federal funds rate. Suppose the demand for reserves increases, reflecting an increase in the demand for money. Under the NBR targeting procedure, the staff of the Open Market Desk would continue to target the same average level of NBR over the intermediate period (as in Figure 4). If the policymakers

[13] If the shift in demand for reserves resulted from an increase in average reserve requirements on deposit liabilities or excess reserves, the TR path would shift to the right. The rise in the demand for reserves would not affect the federal funds rate.

[14] See Axilrod (1981, pp. A23 - A24).

[15] See Lindsey (1983, p. 5).

[16] For references to this feedback mechanism from changes in interest rates to changes in the quantity of money demanded, see Axilrod (1981, p. A23) and Lindsey (1983).

[17] See Levin and Meek (1981) and Pierce (1981).

wished to limit the deviation of money growth from FOMC objectives, they would reduce the target level of NBR (as in Figure 5). Under the federal funds rate targeting procedure, in contrast, the Fed would respond to an increase in the demand for reserves by increasing the level of NBR enough to keep the federal funds rate unchanged, as illustrated in Figure 6. This contrast provides a standard for judging whether Fed actions in the three years ending in the fall of 1982 were consistent with use of the NBR operating procedure for targeting the monetary aggregates.

INTERPRETING FEDERAL RESERVE ACTIONS

The framework of supply and demand for reserves is used to interpret monetary policy actions under the NBR operating procedure, as recorded in Table 1.[18]

Policy Actions in Selected Intermeeting Periods

This section illustrates use of the NBR operating procedure for implementing monetary policy during the first two intermeeting periods covered in Table 1. These periods illustrate very different patterns in use of the procedure. During the first period, after the FOMC meeting on February 4-5, 1980, the Fed reduced the NBR path and raised the discount rate when projections of TR began to rise relative to the TR path. This period illustrates aggressive use of the procedure for monetary targeting. During the second period, after the FOMC meeting on March 18, estimates of TR declined sharply relative to the TR path, but the Fed made no adjustments in the NBR path or discount rate in response.

The period from the FOMC meeting on February 4-5, 1980, until the next FOMC meeting was divided into two periods of three weeks each for purposes of projecting the average level of TR and estimating the TR path.[19] As of February 7, the staff projected an average level of TR for the three weeks ending February 27 that was only $38 million below the initial estimate of the TR path. By February 15, however, the projections and estimates of TR had changed substantially, with TR projected to be $313 million above the path level. As of February 15, the Fed reduced the target for NBR by $67 million relative to the new estimate of the TR path. The reduction in the NBR path was a restrictive policy action. The staff of the Open Market Desk responded to a reduction in the NBR path by adjusting its plans for open market operations to hit a lower average of NBR over the intermeeting period. The Fed also raised the discount rate from 12 percent to 13 percent, effective February 16, another restrictive policy action.

Even though the Fed took these restrictive policy actions over the three weeks ending February 27, the average level of TR was $272 million above the final estimate of the TR path. These observations raise an issue about how to interpret monetary policy actions under the NBR operating procedure. One view of the conduct of monetary policy during the three weeks ending February 27 would be that policy actions were inconsistent with hitting FOMC targets for monetary aggregates because TR was above the TR path. Interpretation of these actions, however, must account for the way that the Fed operated under lagged reserve requirements, which were in effect during the period of NBR targeting. Required reserves for each week were determined by deposit liabilities two weeks earlier. The Fed operated under the constraint of supplying each week enough reserves to meet required reserves, either through open market operations or through the discount window. For the three weeks ending February 27, required reserves were based on deposits over the three weeks ending February 13. By the time the Fed took policy actions on February 15, therefore, required reserves for the three weeks ending February 27 were predetermined.

This article evaluates whether policy actions

[18] Information on the conduct of monetary policy in Cook (1989a, 1989b) is similar to that in columns six through nine of Table 1. One difference involves the dating of the difference between projections of TR and the TR path (column six) and policy actions (columns seven and eight). The dates in Table 1 are those in the weekly Report of Open Market Operations from the Federal Reserve Bank of New York. Cook dates the gap between the projections of TR and the TR path and dates policy actions as of weeks ending on Wednesdays, thus reflecting the changes that occurred during each seven-day period. For this reason, the dates in Table 1 and in Cook (1989a, 1989b) do not match.

[19] When periods between FOMC meetings were longer than five weeks, the staff divided the intermeeting periods into two subperiods for purposes of setting TR paths and projecting the average levels of TR. The staff divided these intermeeting periods into subperiods to avoid setting weekly objectives for NBR just after an FOMC meeting based on estimates of variables for six or seven weeks into the future. The staff considered their estimates that far into the future to be so unreliable that revisions in their estimates over intermeeting periods could generate unnecessary noise in weekly objectives for NBR.

Table 1

Policy Actions Under the Nonborrowed Reserves Operating Procedure (amounts in millions of dollars)

FOMC meeting	Period for setting total reserves path	Dates of projections and estimates	Projected total reserves	Total reserves path	Difference	Changes in the NBR path between FOMC meetings to limit the size of deviations of TR from path	Discount rate	Change in the federal funds rate, in basis points	
1980								1980	
February 4-5	3 weeks ending February 27	February 7	$ 43,182	$ 43,220	$ - 38		Through 2/15: 12%	February 13	84
		15	43,083	42,770	313	As of 2/15: $ -67	As of 2/16: 13	20	123
		22	43,311	42,770	541			27	-25
		27	43,042	42,770	272				
	Change		-140	-450					
	3 weeks ending March 19	February 29	42,915	42,289	626	As of 2/29: $ -300[1]	As of 3/14: imposed 3% surcharge	March 5	155
		March 7	42,933	42,289	644			12	28
		14	43,013	42,289	724			19	-21
		19	43,005	42,289	716				
	Change		90	0					
March 18	5 weeks ending April 23	March 21	44,597	44,571	26		No change	March 26	154
		28	44,633	44,571	62			April 2	161
		April 4	44,458	44,771	-313			9	-35
		14	44,476	44,771	-295			16	-69
		18	44,339	44,771	-432			23	-79
		23	44,336	44,771	-435				
	Change		-261	200					
April 22	4 weeks ending May 21	April 25	44,543	45,131	-588		As of 5/7: eliminated 3% surcharge	April 30	-244
		May 2	44,379	45,181	-802	As of 5/2: $ 100		May 7	-216
		9	44,410	45,231	-821			14	-211
		16	44,377	45,231	-854			21	-14
		21	44,352	45,231	-879				
	Change		-191	100					
May 20	4 weeks ending June 18	May 23	43,821	43,821	0		As of 5/28: 12%	May 28	-125
		30	43,714	43,714	0		As of 6/13: 11%	June 4	128
		June 6	43,548	43,554	-6			11	-106
		13	43,592	43,592	0			18	-69
		18	43,535	43,592	-57				
	Change		-286	-229					
	3 weeks ending July 9	June 20	43,299	43,299	0		No change	June 25	9
		27	43,354	43,354	0			July 2	33
		July 7	43,377	43,377	0			9	-15
		9	43,509	43,377	132				
	Change		210	78					
July 9	5 weeks ending August 13	July 11	41,602	41,602	0		As of 7/28: 10%	July 16	-28
		23	41,558	41,558	0			23	-30
		28	41,538	41,505	33			30	30
		August 1	41,512	41,455	57			August 6	62
		8	41,639	41,480	159			13	-75
		13	41,645	41,480	165				
	Change		43	-122					

Table 1(continued)

FOMC meeting	Period for setting total reserves path	Dates of projections and estimates		Projected total reserves	Total reserves path	Difference	Changes in the NBR path between FOMC meetings to limit the size of deviations of TR from path	Discount rate	Change in the federal funds rate, in basis points	
1980									1980	
August 12	5 weeks ending September 17	August	15	$ 39,944	$ 39,816	$ 128		No change	August 20	50
			19	40,239	40,111	128			27	68
			22	40,393	40,111	282			Sept. 3	44
			29	40,623	40,261	362			10	-25
		September	5	40,596	40,311	285	As of 9/5: $ -150		17	42
			12	40,691	40,311	380				
			17	40,686	40,311	375				
	Change			742	495					
Sept. 16	5 weeks ending October 22	September	19	41,581	41,199	382		As of 9/26: 11%	Sept. 24	21
			26	41,694	41,199	495			1	153
		October	3	41,522	41,199	323	As of 10/3: $ -200		8	21
			10	41,741	41,299	442			15	5
			17	41,737	41,299	438			22	9
			22	41,697	41,299	398				
	Change			116	100					
Oct. 21	4 weeks ending November 19	October	24	42,004	41,795	209		As of 11/17: basic rate 12%; 2% surcharge	October 29	62
			31	41,996	41,795	201			Nov. 5	82
		November	7	41,639	41,420	219	As of 11/7: $ -100		12	66
			14	41,745	41,445	300	As of 11/14: $ -50		19	57
			19	41,753	41,445	308				
	Change			-251	-350					
Nov. 18	5 weeks ending December 24	November	21	39,988	39,691	297		As of 12/5: basic rate 13%; 3% surcharge	Nov. 26	221
			25	40,224	39,821	403			Dec. 3	29
		December	1	40,382	40,041	341	As of 12/1: $ -170		10	110
			5	40,392	40,131	261			17	101
			12	40,381	40,171	210			24	-39
			23	40,395	40,171	224				
			24	40,514	40,171	343				
	Change			526	480					
December 18-19	4 weeks ending January 14	December	23	40,948	40,948	0		No change	Dec. 31	-99
			29	40,991	41,048	-57			January 7	161
		January	5	40,971	41,148	-177			14	-42
			9	41,168	41,338	-170				
	Change		14	41,199	41,338	-139			January 21	-29
				251	390				28	-123
	3 weeks ending February 4	January	16						February 4	-93
			23	41,740	42,041	-301		No change		
			30	41,509	41,841	-332				
		February	2	41,427	41,841	-414				
			4	41,520	41,934	-414				
	Change			41,371	41,934	-563				
				-369	-107					

Table 1(continued)

FOMC meeting	Period for setting total reserves path	Dates of projections and estimates	Projected total reserves	Total reserves path	Difference	Changes in the NBR path between FOMC meetings to limit the size of deviations of TR from path	Discount rate	Change in the federal funds rate, in basis points	
1981								1981	
February 2-3	4 weeks ending	February 6	$ 39,627	$ 39,796	$ -169		No change	February 11	-68
	March 4	17	39,671	39,998	-327			18	-70
		25	39,622	39,973	-351	As of 2/25: $ -166		25	-85
		27	39,489	39,973	-484			March 4	77
		March 4	39,583	39,973	-390				
	Change		-44	177					
	4 weeks ending	March 6	39,819	40,300	-481		No change	March 11	-20
	April 1	13	39,663	40,135	-472			18	-140
		20	39,661	40,010	-349			25	-65
		27	39,608	40,010	-402			April 1	145
		April 1	39,714	40,010	-296				
	Change		-105	-290					
March 31	4 weeks ending	April 3	40,006	40,006	0		No change	April 8	50
	April 29	10	40,132	40,165	-33			15	-10
		20	40,229	40,132	97			22	22
		24	40,122	40,132	-10			29	73
		29	40,027	40,132	-105				
	Change		21	126					
	3 weeks ending	May 1	40,959	40,407	552	As of 5/1: $ -250[2]	As of 5/5: basic rate	May 6	263
	May 20	8	40,736	40,362	374	As of 5/8: $ -234	14%; 4% surcharge	13	-70
		15	40,683	40,294	389			20	68
		20	40,679	40,294	385				
	Change		-280	-113					
May 18	4 weeks ending	May 22	40,011	40,011	0		No change	May 27	-18
	June 17	29	40,104	40,098	6			June 3	-31
		June 5	40,141	40,204	-63			10	93
		12	40,078	40,138	-60			17	-23
		17	40,069	40,138	-69				
	Change		58	127					
	3 weeks ending	June 19	40,464	40,643	-179		No change	June 24	10
	July 8	30	40,674	40,808	-134			July 1	-36
		July 6	40,743	40,907	-164			8	109
		8	40,879	40,907	-28				
	Change		415	264					

Table 1(continued)

FOMC meeting 1981	Period for setting total reserves path	Dates of projections and estimates		Projected total reserves	Total reserves path	Difference	Changes in the NBR path between FOMC meetings to limit the size of deviations of TR from path	Discount rate	Change in the federal funds rate, in basis points 1981		
July 6-7	3 weeks ending July 29	July	10	$ 41,359	$ 41,359	$ 0		No change	July	15	-117
			17	41,136	41,104	32				22	29
			24	41,126	41,134	-8				29	-51
			29	41,273	41,134	139					
	Change			-86	-225						
	3 weeks ending August 19	July	31	40,627	40,782	-155		No change			
		Aug.	6	40,815	40,954	-139			Aug.	5	-29
			14	40,824	40,982	-158				12	4
			19	40,830	40,982	-152				19	-10
	Change			203	200						
August 18	4 weeks ending September 16	Aug.	21	40,510	40,668	-158		No change			
			28	40,483	40,683	-200			Aug.	26	-78
		Sept.	4	40,515	40,833	-318			Sept.	2	-52
			15	40,535	40,833	-298				9	-39
			16	40,589	40,833	-244				16	-41
	Change			79	165						
	3 weeks ending October 7	Sept.	18	40,715	41,162	-447		As of 9/22: 3% surcharge	Sept.	23	-76
			25	40,721	41,140	-419				30	-33
		Oct.	2	40,847	41,226	-379			Oct.	7	46
			7	40,821	41,226	-405					
	Change			106	64						
October 5-6	3 weeks ending October 28	Oct.	9	40,997	40,997	0		As of 10/12: 2% surcharge	Oct.	14	-53
			20	40,812	40,883	-71				21	39
			23	40,799	40,868	-69				28	-45
			28	40,751	40,868	-117					
	Change			-246	-129						
	3 weeks ending November 18	Oct.	30	40,673	40,817	-144					
		Nov.	6	40,661	40,855	-194	As of 11/6: $56	As of 11/2: basic rate 13%			
			13	40,600	40,754	-154			Nov.	4	-8
			17	40,617	40,771	-154		As of 11/17: surcharge eliminated		11	-78
			18	40,662	40,771	-109				18	-84
	Change			-11	-46						
November 17	5 weeks ending December 23	Nov.	20	41,209	41,209	0		As of 12/4: 12%			
			30	41,277	41,252	25			Nov.	25	-75
		Dec.	4	41,305	41,252	53			Dec.	2	6
			14	41,620	41,525	95				9	-44
			18	41,488	41,389	99				16	22
			23	41,488	41,389	99				23	17
			23	41,533	41,389	144					
	Change			324	180						

Table 1(continued)

FOMC meeting	Period for setting total reserves path	Dates of projections and estimates		Projected total reserves	Total reserves path	Difference	Changes in the NBR path between FOMC meetings to limit the size of deviations of TR from path	Discount rate	Change in the federal funds rate, in basis points		
1982									1982		
December 21-22, 1981	6 weeks ending February 3	Dec.	28	$ 42,684	$ 42,684	$ 0		No change	Dec.	30	11
		Jan.	4	42,779	42,573	206			Jan.	6	44
			8	42,860	42,536	324				13	-56
			15	43,020	42,534	486	As of 1/15: $ -187			20	54
			22	42,976	42,459	517				27	102
			29	42,965	42,351	614			Feb.	3	79
		Feb.	3	43,013	42,351	662					
	Change			329	-333						
February 1-2	4 weeks ending March 3	Feb.	5	41,270	41,270	0		No change	Feb.	10	42
			16	41,214	41,309	-95				17	42
			19	41,077	41,158	-81				24	-175
			26	41,065	41,181	-116			March	3	21
		March	3	41,141	41,181	-40					
	Change			-129	-89						
	4 weeks ending March 31	March	5	39,102	39,376	-274			March	10	28
			12	39,094	39,239	-145				17	54
			19	38,988	39,159	-171				24	-41
			26	39,002	39,159	-157				31	51
			31	39,035	39,159	-124					
	Change			-67	-217						
March 29-30	4 weeks ending April 28	April	2	39,536	39,536	0		No change	April	7	16
			9	39,537	39,449	88				14	-47
			16	39,582	39,414	168				21	33
			23	39,498	39,334	164				28	-29
			28	39,474	39,334	140					
	Change			-62	-202						
	3 weeks ending May 19	April	30	39,679	39,702	-23			May	5	81
		May	7	39,658	39,702	-44				12	-56
			14	39,786	39,821	-35				19	-30
			19	39,810	39,821	-11					
	Change			131	119						
May 18	6 weeks ending June 30	May	21	39,401	39,401	0		No change	May	26	-97
			28	39,409	39,385	24			June	2	-27
		June	4	39,368	39,355	13				9	17
			11	39,478	39,428	50				16	64
			18	39,487	39,373	114				23	-7
			28	39,472	39,373	99				30	64
			30	39,507	39,373	134					
	Change			106	-28						

Table 1(continued)

FOMC meeting 1982	Period for setting total reserves path	Dates of projections and estimates		Projected total reserves	Total reserves path	Difference	Changes in the NBR path between FOMC meetings to limit the size of deviations of TR from path	Discount rate	Change in the federal funds rate, in basis points 1982		
June 30– July 1	4 weeks ending July 28	July	2	$ 39,978	$ 39,978	$ 0		As of 7/20: 11.50%	July	7	-34
			9	39,994	40,078	-84				14	-129
			16	40,017	40,114	-97	As of 7/16: $ 85			21	-104
			23	40,002	40,085	-83				28	-112
			28	39,976	40,085	-109					
	Change			-2	107						
	4 weeks ending Aug. 25	July	30	40,203	40,411	-208	As of 7/30: $100	As of 8/2: 11%	Aug.	4	13
		Aug.	6	40,156	40,411	-255		As of 8/16: 10.50%		11	-25
			13	40,139	40,391	-252				18	-79
			20	40,112	40,343	-231				25	-107
			25	40,111	40,343	-232					
	Change			-92	-68						
Aug. 24	3 weeks ending Sept. 15	Aug.	27	39,510	39,510	0		As of 8/27: 10%			
		Sept.	3	39,609	39,573	36			Sept.	1	111
			10	39,767	39,663	104				8	-1
			15	39,812	39,663	149				15	13
	Change			302	153						
	3 weeks ending Oct. 6	Sept.	17	40,227	39,933	294			Sept.	22	4
			24	40,279	39,784	495	As of 9/24: $ 248			29	-19
		Oct.	1	40,348	39,784	564			Oct.	6	65
			6	40,386	39,784	602					
	Change			159	-149						
Oct. 5	3 weeks ending Oct. 27	Oct.	8	40,454	40,454	0		As of 10/12: 9.50%	Oct.	13	-117
			15	40,579	40,598	-19				20	-7
			22	40,583	40,587	-4				27	-9
			27	40,578	40,587	-9					
	Change			124	133						

[1] The three weeks ending March 19, 1980, is the second subperiod between FOMC meetings on February 4-5 and March 18. The NBR path was reduced by $300 million relative to the TR path at the beginning of this subperiod to limit the size of the deviation of TR from path.

[2] The three weeks ending May 20 is the second subperiod between FOMC meetings on March 31 and May 18. The NBR path was reduced by $250 million relative to the TR path at the beginning of this second subperiod to limit the size of the deviation of TR from path.

were consistent with use of the NBR procedure for monetary control by examining the direction and magnitude of policy actions in relation to the gaps between the projections of TR and estimates of the TR path at the time of the policy actions. From this perspective, policy actions during the three weeks ending February 27, 1980, were consistent with use of the NBR operating procedure for monetary control.[20]

As of February 29, the staff projected that TR would be $626 million above path level in the second intermeeting period (the three weeks ending March 19). That day, the Fed reduced its target for NBR by $300 million relative to the TR path to limit the size of this deviation of TR from the path. As a result of that reduction in the NBR path, banks were forced to obtain more of the reserves from the discount window to meet their required reserves. The federal funds rate rose by 155 basis points in the week of this policy action.

Projections later in the period indicated that the gap between TR and the path level was continuing to grow. On March 14, the Fed imposed a surcharge of 3 percent on discount window borrowings by banks with deposits of $500 million or more that borrowed frequently, as part of President Carter's program of credit controls and monetary restraint.[21] During this first intermeeting period examined in Table 1, the Fed took four policy actions that were appropriate for monetary control with TR projected to exceed the path level: two reductions in the NBR path and two increases in the discount rate.

The FOMC met again on March 18, four days after President Carter announced a program of credit controls and monetary restraint. In support of the President's program, the FOMC tightened monetary policy by increasing the borrowings assumption substantially (Table 4). With given objectives for growth of the monetary aggregates, a larger borrowings assumption implies a lower NBR path and, therefore, a more restrictive monetary policy.

As of the beginning of the period after the March FOMC meeting (that is, the five weeks ending April 23, 1980), TR was projected to be approximately equal to the TR path. Later in that period, the projection of TR was reduced and the TR path increased, producing a widening gap between projected TR and the path level. The Fed, however, took no policy actions to limit the size of that gap. The actual level of TR ended up $435 million below the final estimate of the TR path.

General Patterns in Policy Actions

Examination of policy actions in Table 1 for the entire period from February 1980 through October 1982 indicates several patterns:[22]

Variable Pattern in the Use of Policy Tools — For given staff projections and estimates of TR, policy actions were highly variable. As noted for periods examined above, widening gaps between projections of TR and path levels induced prompt and substantial adjustments of policy tools in some periods but not in other periods. To identify relevant periods when the Fed did not take policy actions, it is necessary to specify a criterion for identifying relatively large deviations of TR from the TR path. This paper uses $200 million or more as the size of a large deviation, based on the following reasoning. Over the period of NBR targeting, TR was approximately $40 billion. A gap of $200 million is one-half of 1 percent of

[20] The last observation for TR over each intermeeting period reflects the information available to Fed staff as of the end of the period. For instance, the last estimate of TR for the three weeks ending February 27, 1980, was the staff estimate as of February 27. The data for TR over intermeeting periods reflect the information available to policymakers at the time, not subsequent revisions to TR.

[21] For more details on the discount rate surcharge, see Board of Governors (1980, pp. 315-18). For a description of the credit control program, see Gilbert and Trebing (1981).

[22] This article does not include among the policy actions some adjustments to the supply of NBR which might properly be classified as policy actions. Levin and Meek (1981) mention that on some occasions the staff of the Open Market Desk based open market operations on movements in the federal funds rate, rather than their numbers on factors affecting NBR. As they describe those actions, the objective was to use the federal funds rate as an indicator of errors in their numbers on factors affecting NBR. They do not indicate that these open market operations based on movements in the federal funds rate interfered with hitting targets for NBR over intermeeting periods.

Other adjustments to the supply of NBR raise more questions about adjustments to the supply of NBR that should be labeled as policy actions. At times, the staff adjusted the supply of NBR to prevent large movements in borrowings and in the federal funds rate just prior to FOMC meetings. Weekly Reports on Open Market Operations mention that at times the staff did not make the full adjustments to the TR path that were indicated by their information on factors affecting the relationship between reserves and the monetary aggregates, and the reports refer to occasions when the staff deliberately allowed NBR to deviate from its path level, to avoid forcing large changes in borrowed reserves just before FOMC meetings. Table 1 limits its list of policy actions to those identified clearly as policy actions in the Report on Open Market Operations.

$40 billion. An error of approximately one-half of 1 percent in hitting a target for an aggregate over a month, compounded over a year, would be an error of 6 percent, which could be interpreted as a substantial error. TR deviated from the TR path by at least $200 million, and the Fed took no policy actions in response, in each of the periods after the FOMC meetings on March 18, 1980, and December 18-19, 1980.

Directions of Policy Actions Were Appropriate for Monetary Control — Prior to the fall of 1982, the *direction* of each policy action between FOMC meetings was appropriate for monetary control. When TR was projected to be above the path level, policy actions included reductions in the target for NBR relative to the TR path or increases in the discount rate. The Fed took the opposite types of policy actions when TR was projected to be below the path level.[23]

The only exception to this pattern occurred on February 25, 1981. The Fed reduced the NBR path by $166 million when the staff projected TR to be $351 million below the TR path. At that time, the growth of M2 and M3 exceeded FOMC objectives, whereas M1 was growing more slowly than the target set by the FOMC at its meeting on February 2-3, 1981. TR was below the TR path because required reserves predominately reflected the required reserves on deposits in M1. In February 1981, the FOMC decided to put more weight on its objectives for M2 and M3 than on M1. Therefore, the FOMC decided to reduce the supply of NBR to limit the growth of M2 and M3. This reduction in the NBR path on February 25, 1981, was consistent with use of the NBR procedure for monetary targeting, even though TR was projected to be below the path at the time of the policy action.

The change in the NBR target on September 24, 1982, in contrast, illustrates a policy action that was inconsistent with use of the NBR operating procedure for monetary control. It is generally recognized that by the fall of 1982, the Fed had abandoned use of the NBR operating procedure in favor of smoothing short-term interest rates.[24] For operational purposes, however, the staff continued to calculate the numbers that had been important for conducting policy under the NBR procedure. After the FOMC meeting on August 24, 1982, projections of TR were increased gradually relative to estimates of the TR path, and by September 24, the gap had reached $495 million. A policy action appropriate for monetary targeting would have been a reduction in NBR. Instead, the Fed *increased* the target for NBR, to limit the rise in short-term interest rates in response to the rise in demand for reserves. This action, the kind of policy action illustrated in Figure 6, provides one way to date the end of the NBR operating procedure.

Size of the Policy Actions — Table 2 lists the changes in the NBR path between FOMC meetings that the Fed classified as policy actions. These changes in the NBR path generally were about half or less of the gap between TR projected by the staff and the TR path at the time of the policy actions. These observations indicate that even at those times when the Fed adjusted the NBR path as a policy action, the Fed was willing to tolerate large deviations of TR from the path over intermeeting periods. The emphasis in the policy was bringing the levels of the monetary aggregates closer to FOMC objectives over time. The policy did not call for actions to force immediate shifts of the levels of the aggregates back to the levels specified in FOMC directives.

Policy Actions Did Not Cause All of the Sharp Fluctuations in Interest Rates — The federal funds rate was more variable during the period of NBR targeting than in surrounding periods (Figure 1). These large fluctuations generated a lot of complaints from market participants and from economists critical of the procedure. In evaluating NBR targeting as a method of implementing monetary policy, it would be useful to

[23] Some changes in the gap between the NBR path and the TR path were labeled "technical adjustments" to the supply of NBR, not policy actions. The purpose of these technical adjustments was to offset the effects on interest rates of changes in the relationship between borrowings and the spread between the federal funds rate and the discount rate for TR. At times, the staff concluded that there were persistent changes in the quantity of reserves borrowed by banks for given spreads between the federal funds rate and the discount rate. In terms of Figures 1 and 4, there appeared to be shifts in the slope of the supply curve of reserves. At those times, the staff adjusted the supply of NBR to offset possible effects on interest rates of such changes in the behavior of banks. Table 1 does not include these adjustments to the supply of NBR because the purpose of this article is to examine patterns of policy actions under the NBR operating procedure. Reports by the Manager of the Open Market Account distinguish between technical adjustments and changes in the supply of NBR labeled policy actions.

[24] See Thornton (1983, 1988).

Table 2
Size of Changes in the Nonborrowed Reserves Path

Date	Change in the NBR path (millions of dollars)	Change in the NBR path as a percentage of the most current staff projection of the gap between TR and the TR path
1980		
2/15	$ - 67	21.4%
2/29	-300	47.9
5/2	+100	12.5
9/5	-150	52.6
10/3	-200	61.9
11/7	-100	45.7
11/14	- 50	16.7
12/1	-170	49.9
1981		
2/25	$ -166	N/A[1]
5/1	-250	45.3%
5/8	-234	62.6
11/6	+ 56	28.9
1982		
1/15	$ -187	38.5%
7/16	+ 85	87.6
7/30	+ 100	48.1

[1] The NBR path reduced at a time when TR were projected to be below the TR path.

know whether the relatively large fluctuations in interest rates under NBR targeting reflected frequent, aggressive policy actions to hit short-run money targets. Perhaps fluctuations in the federal funds rate under a NBR targeting procedure would be substantially smaller than the experience of 1980-82 if the Fed used the procedure less aggressively in attempting to hit short-run money targets. In contrast, many of the relatively large weekly changes in the federal funds rate may have occurred simply because the Fed placed less weight on limiting interest rate fluctuations under the NBR operating procedure than other operating procedures.

It is possible to determine whether the relatively large weekly fluctuations in the federal funds rate reflected the effects of policy actions by examining their timing and the timing of policy actions.[25] Table 3 examines the pattern of policy actions during the weeks in which the federal funds rate changed by 100 basis points or more. Changes in weekly average levels of the federal funds rate of 100 basis points or more were relatively common during the three years ending in September 1982. For example, Table 3 list 29 weekly occurrences. During the three years ending in September 1979, in contrast, there were no weeks when the federal funds rate changed by as much as 100 basis points. During the three years ending in September 1985, the three years following the period of NBR targeting, the federal funds rate changed by 100 basis points or more in only five weeks.

Seven of the relatively large changes in the federal funds rate in Table 3 occurred in the weeks just after FOMC meetings. For instance, the federal funds rate rose 154 basis points in the week ending March 26, 1980, the first week after the FOMC meeting on March 18. The decisions of the FOMC at its meeting on March 18, 1980, can be characterized as a tightening of monetary policy. Table 4 illustrates the shift in monetary policy at the FOMC meeting on March 18 in terms of an increase in the borrowings assumption relative to the level set at the prior meeting: from a level of $1.25 billion set at the meeting on February 4-5 to a level of $2.75 billion set on March 18. The rise in the federal funds rate in the week ending March 26 is consistent with a tightening of monetary policy at the FOMC meeting on March 18.

The federal funds rate fell by 244 basis points in the week ending April 30, 1980, which was the first week after the FOMC meeting on April 22. At its meeting on April 22, the FOMC decided to reverse the tightening of monetary policy at its prior meeting. Table 4 illustrates the easing of monetary policy at the meeting of April 22 with

[25] Cook (1989a, 1989b) conducted a similar analysis of the timing of policy actions and changes in the federal funds rate during the period of NBR targeting. Cook investigated the degree to which changes in the federal funds rate over periods between FOMC meetings could be explained in terms of policy actions. Cook concluded that roughly two-thirds of the changes in the federal funds rate were due to judgmental actions of the Federal Reserve. This article, in contrast, examines the timing of relatively large weekly changes in the federal funds rate and policy actions.

Table 3

Association Between Weekly Changes in the Federal Funds Rate of 100 Basis Points or More and Policy Actions

Week ending	Change in the federal funds rate from the prior week, in basis points	Change in the NBR target	Change in the discount rate or surcharge	First week after an FOMC meeting
		X indicates occurrence in the week		
1980				
2/20	+123	X	X	
3/5	+155	X		
3/26	+154			X
4/2	+161			
4/30	-244			X
5/7	-216	X	X	
5/14	-211			
5/28	-125		X	X
6/4	+128			
6/11	-106			
10/1	+153		X	
11/26	+221			X
12/10	+110		X	
12/17	+101			
1981				
1/7	+161			
1/28	-123			
3/18	-140			
4/1	+145			
5/6	+263	X	X	
7/8	+109			
7/15	-117			X
1982				
1/27	+102			
2/24	-175			
7/14	-129			
7/21	-104	X	X	
7/28	-112			
8/25	-107			
9/1	+111		X	X
10/13	-117		X	X

Table 4

Initial Assumptions for Borrowed Reserves Set by the FOMC, 1980-82

Date of FOMC meeting	Initial assumption for borrowed reserves (millions of dollars)
1980	
January 8-9	$ 1,000
February 4-5	1,250
March 18	2,750
April 22	1,375
May 20	100
July 9	75
August 12	75
September 16	750
October 21	1,300
November 18	1,500
December 18-19	1,500
1981	
February 2-3	$ 1,300
March 31	1,150
May 18	2,100
July 6-7	1,500
August 18	1,400
October 5-6	850
November 17	400
December 21-22	300
1982	
February 1-2	$ 1,500
March 29-30	1,150
May 18	800
June 30-July 1	800
August 24	350
October 5	300
November 16	250
December 20-21	200

the decline in the initial borrowings assumption to $1.375 billion.

Comparison of Tables 3 and 4 illustrates this consistent pattern: On those occasions when the federal funds rate changed by over 100 basis points in the first week after an FOMC meeting, increases in the federal funds rate coincided with increases in the initial borrowings assumptions at the FOMC meetings, and relatively large decreases in the federal funds rates were associated with reductions in the initial borrowings assumptions. This pattern prevailed until the fall of 1982, when the Fed had largely abandoned use of NBR targeting. Thus, some of the relatively large changes in the federal funds rate reflected policy actions initiated at the time of FOMC meetings.

Of the 29 weeks in Table 3 in which the federal funds rate changed by 100 basis points or more, 15 were *not* the first week after an FOMC meeting or weeks of changes in the NBR path or the discount rate. Many of the relatively large weekly changes in the federal funds rate, therefore, reflected the relatively low weight the Fed attached to limiting fluctuations in the federal funds rate under the NBR operating procedure. Also, the economy was very volatile during the period of NBR targeting. Influences other than the conduct of monetary policy may have contributed substantially to the variability of interest rates over this period.

CONCLUSIONS

The conduct of monetary policy in the United States from October 1979 through the fall of 1982 has important implications for the design of procedures for targeting monetary aggregates today. This is the only period in which daily open market operations were tied directly to objectives of the FOMC for growth of the monetary aggregates. It is our closest approximation to short-run monetary control in the United States. Some critics of the conduct of monetary policy in this period have concluded that errors in hitting the money targets of the FOMC reflected problems inherent in the design of the procedure.

This article presents information on the conduct of monetary policy in this period of nonborrowed reserves (NBR) targeting not available in other published studies. This information includes Fed staff projections of the actual levels of total reserves (TR) over periods between FOMC meetings and staff estimates of the average levels of TR between meetings that would have been consistent with FOMC objectives for money growth (the TR paths). Using this information, we can examine the timing and size of policy actions in relation to the information available to Fed policymakers at the time.

Examination of policy actions during the period of NBR targeting yields the following observations. First, the pattern of policy actions does not reflect consistent use of the procedure over time for monetary targeting. During some intermeeting periods in which the staff projected that TR would deviate substantially from the TR path, the Fed took no policy actions, whereas in other periods the Fed took aggressive actions consistent with monetary targeting. Second, when the Fed did take policy actions, they were in the *directions* appropriate for monetary control, given the staff projections and estimates available at the time. This observation contradicts assertions that there was no change in the operating procedure in October 1979. Third, the *magnitude* of policy actions often was small in relation to the gap between the projection of TR and the path. These three observations have implications for interpreting the three years ending in the fall of 1982 as an experiment in monetary targeting. The commitment of policymakers to hitting short-run money targets varied over those three years. Any conclusions derived from data for those three years concerning NBR targeting as a method of monetary control should account for variation over time in the commitment of policymakers to take actions appropriate for monetary control.

The fourth observation concerns the degree of interest rate variability under a procedure of NBR targeting. While several of the relatively large weekly changes in the federal funds rate coincided with the timing of policy actions, the Fed took no policy actions at the time of some relatively large fluctuations in the federal funds rate. Interest rate fluctuations during the period of NBR targeting reflect use of an operating procedure which left the federal funds rate largely unconstrained within wide bands. It is difficult to extrapolate from this experience to the degree of weekly interest rate variability that would exist under use of an NBR procedure now. This experience, however, is consistent with the view that targeting NBR for purposes of short-run monetary control would tend to increase weekly interest rate variability.

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Appendix 1

Illustration of Staff Projections and Estimates of Total Reserves

This appendix describes the steps involved in staff estimates of the TR path and projections of TR for the intermeeting period after the FOMC meeting on February 4-5, 1980. The staff divided the intermeeting period into two subperiods of three weeks each, ending on February 27 and March 18. They made such divisions when the periods between meetings were longer than five weeks to avoid using projections of variables several weeks into the future in determining the supply of NBR early in an intermeeting period.

To aid in clarifying the timing of relationships between deposits and reserves, Table A1 presents a calendar of January and February 1980. At its meeting on February 4-5, the FOMC specified its short-run objectives as growth of M1-B at a 5 percent rate and M2 at a 6.5 percent rate over the first quarter of 1980. To estimate the TR path for the three weeks ending February 27, the staff would do the following calculations:

1. Project the weekly levels of M1 and M2 growing at the desired rates from mid-December through the three weeks ending February 13. Deposits over the three weeks ending February 13 determine required reserves over the three weeks ending February 27. These weekly levels are projected from the seasonally adjusted data for December and then converted into nonseasonally adjusted levels using the seasonal factors for those weeks.
2. Estimate currency in the hands of the public, not seasonally adjusted, for the three weeks ending February 13.
3. Subtract the estimate of currency in the hands of the public from the projection of M1 to derive the level of checkable deposits, not seasonally adjusted, if M1 grew at the rate desired by the FOMC.
4. Multiply the average level of checkable deposits as derived in step 3 by an estimate of the average reserve requirement on checkable deposits.
5. Subtract the estimate of average currency holdings as described in step 2 and checkable deposits as described in step 3 from the projection of M2, as described in step 1.

Table A1
Calendar of January and February 1980

January

S	M	T	W	Th	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

February

S	M	T	W	Th	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	

Multiply by an estimate of the average reserve requirement on deposits in M2 but not in M1.

6. Sum estimates of required reserves as described in steps 4 and 5 and an estimate of required reserves on deposits not in M2 to derive an estimate of what required reserves would be in the three weeks ending February 27 if M1 and M2 grew at the rates specified by the FOMC at its meeting on February 4-5. Add an estimate of the average level of excess reserves for the three weeks ending February 27 to get an estimate of the TR path over the three weeks ending February 27.

The steps involved in projecting TR are similar to the steps in estimating the TR path:

1. Estimate liabilities subject to reserve requirements for the three weeks ending February 13, not seasonally adjusted. The Federal Reserve

staff generally had data on reservable liabilities eight days after the end of a reserve maintenance week. By February 7, the date of the first projection, the staff would have had information on reservable liabilities for the week ending January 30. They would have to estimate liabilities for the weeks ending February 6 and 13.

2. Estimate average reserve requirements on various categories of liabilities.

3. Sum the projections for required reserves for the three weeks ending February 27, based on calculations described in steps 1 and 2, and add an estimate of average excess reserves.

Appendix 2

A Tool for Describing the Conduct of Monetary Policy: Supply and Demand for Reserves

This paper describes the conduct of monetary policy under the NBR operating procedure using diagrams of the supply and demand for bank reserves.[1] This appendix describes the determinants of the supply and demand curves, and the following section uses this analytical tool to describe the mechanics of the NBR operating procedure.

Reserves available to meet reserve requirements include currency that banks hold in their vaults and their reserve balances at Federal Reserve Banks. The Federal Reserve supplies reserves. Banks demand reserves to facilitate their customers' transactions and to meet reserve requirements imposed by the Federal Reserve, which are based on the amount and composition of their liabilities.

Banks earn no interest on reserves. This article identifies the opportunity cost to banks of holding reserves as the federal funds rate, which is the interest rate that banks charge each other for lending reserves.[2] A bank changes its reserves by borrowing or lending at the federal funds rate.

Demand for reserves by banks is drawn as a function of the federal funds rate in Figures 4-6. Reserve requirements on deposits included in the money stock create a close relationship between the demand for money by the public and the demand for reserves by banks. Demand for reserves, therefore, depends on reserve requirements and the demand for money.

Demand for money is assumed to be a function of total spending in the economy and interest rates. Various influences can cause shifts in the demand curve for reserves. A change in total spending in the economy, which influences the demand for money, would cause the demand curve for reserves to shift. Shifts in the demand for reserves could reflect other influences: changes in the random component of money demand; the average reserve requirement on deposit liabilities included in the money stock; reserve requirements on other liabilities; or the demand for excess reserves.

Elasticity of the demand for reserves depends on the relevant time period over which average reserves are measured. The demand curves for reserves in Figures 4-6 are steeply sloped because it is for a period between FOMC meetings. Over these periods, there is little time for a change in interest rates to change the quantity of money demanded, feeding back to a change in the quantity of reserves demanded.

Factors that influence the supply of reserves can be analyzed by considering separately the

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[1] For convenience of exposition, the term "bank" refers to all depository institutions.

[2] Federal funds brokers facilitate the operation of the federal funds market. These brokers receive orders from depository institutions located throughout the nation to lend or borrow reserves, and the brokers match lenders and borrowers at mutually agreeable interest rates. Most of the transactions through the federal funds market involve borrowing and lending reserves for one day. The transfers of reserves to borrowers are made the same day through wire transfer systems, including the Fed Wire of the Federal Reserve System.

determinants of borrowed reserves and NBR. The Federal Reserve determines the amount of NBR directly through the open market operations. Banks decide the amount of reserves they borrow from the Federal Reserve, but their decisions are shaped by lending terms set by the Federal Reserve, including the discount rate and limits on the size and frequency of borrowings by individual banks. Banks try to avoid exceeding these borrowing limits to ensure that they maintain access to credit from the Fed to cover their short-term liquidity requirements. If a bank borrows now, it will be subjected to greater administrative pressure to limit its borrowings in the future, when the attractiveness of borrowing from the discount window might be greater.

The supply curve for reserves in Figure 4 is drawn as a vertical line from the level of NBR (labeled N) up to the level on the vertical axis at which the federal funds rate equals the discount rate (r_d). If the discount rate is above the federal funds rate, the amount of reserves borrowed from Federal Reserve Banks tends to be relatively low and insensitive to small changes in the federal funds rate. The supply curve of reserves is upward sloping in the range with the federal funds rate above the discount rate. Given the terms for lending set by the Federal Reserve, it takes an increase in the spread between the federal funds rate and the discount rate to induce banks to increase their borrowings from the discount window.[3]

[3] Goodfriend (1983) derives the relationship between borrowings and the rate spread from a theoretical framework that is based on profit-maximizing bank behavior.

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