Federal Reserve Credibility and Inflation Scares

Chan G. Huh
and Kevin J. Lansing

Huh is an Economist at the Federal Reserve Bank of San Francisco, currently on leave at the Korea Economic Research Institute. Lansing is an Economist at the Federal Reserve Banks of Cleveland and San Francisco. We thank Jeff Fuhrer for generously providing us with his computer programs and for assistance in modifying them for this paper. For helpful comments and suggestions, we also thank Marvin Goodfriend, John Judd, and Ken Kasa. Melissa Leung provided excellent research assistance. This paper was written while Lansing was a national fellow at the Hoover Institution, whose hospitality is gratefully acknowledged.

We develop a simple, quantitative model of the U.S. economy to demonstrate how an "inflation scare" may occur when the Federal Reserve lacks full credibility. In particular, we show that the long-term nominal interest rate may undergo a sudden increase if an adverse movement in the inflation rate triggers a deterioration in the public's beliefs about the Federal Reserve's commitment to maintaining low inflation in the future. We find that simulations from our model capture some observed patterns of U.S. interest rates in the 1980s.

After two decades of rising inflation during the 1960s and 1970s, the Federal Reserve under Chairman Paul Volcker undertook a deliberate disinflationary policy that was successful in reducing the U.S. inflation rate from well over 10 percent in 1980 to around 3 percent by 1985. The cost of this victory, however, was an extremely severe recession: the civilian unemployment rate peaked at about 11 percent in 1982—the highest level observed in the U.S. economy since the Great Depression.

It is widely recognized that an important factor governing the cost of disinflationary policies is the degree of central bank credibility.[1] Credibility is important because it influences the public's expectations about future inflation.[2] These expectations, in turn, affect the *current* state of the economy because they are incorporated into wages via forward-looking labor contracts and into the level of long-term nominal interest rates, which govern borrowing behavior. When the central bank enjoys a high degree of credibility, rational agents will quickly lower their inflation expectations in response to an announced policy to reduce the prevailing rate of inflation. This shift in expectations helps to lower current inflation, leading to a faster and less costly disinflation episode. In contrast, when central bank credibility is low, agents' expectations respond only gradually as they become convinced of the central bank's commitment to reducing inflation. In such an environment, nominal wages and long-term interest rates adjust slowly to the new inflation regime, contributing to a misallocation of resources and a more costly transition to low inflation.

The above reasoning suggests that low credibility on the part of the Federal Reserve may help to explain the severity of the recession induced by the Volcker disinflation. Indeed, it seems likely that the Federal Reserve's commitment to reducing inflation was viewed with considerable skepticism in 1980. Two previous attempts to reduce inflation begun in April 1974 and August 1978 had

1. See, for example, Sargent (1982, 1983), Taylor (1982), and Fischer (1986).

2. This idea is the basis for many game theoretic models of credibility in monetary policy. See, for example, Barro and Gordon (1983), Backus and Driffill (1985a,b), Barro (1986), and Cukierman and Meltzer (1986). For an excellent survey of this literature, see Blackburn and Christensen (1989).

proven unsuccessful.[3] Contributing to this skepticism in the early stages of the disinflation were large and erratic fluctuations of monetary aggregates, which were frequently outside their target ranges.[4] Moreover, U.S. fiscal policy during the early 1980s was characterized by large and growing federal budget deficits which, if projected forward, might have been seen to imply the need for future monetization of the debt to maintain solvency of the government's intertemporal budget constraint.[5]

In this paper, we develop a simple, quantitative model of the U.S. economy to demonstrate how imperfect credibility on the part of the Federal Reserve may give rise to an episode known as an "inflation scare." Following Goodfriend (1993), we define an inflation scare as a significant increase in the long-term nominal interest rate that takes place in the absence of any aggressive tightening by the Fed that would serve to push up short-term rates. Hence, during an inflation scare, the increase in the long rate is driven primarily by an upward shift in agents' expectations about future inflation. In our model of an inflation scare, an adverse movement in the inflation rate triggers a deterioration in the public's beliefs about the Federal Reserve's commitment to maintaining low inflation in the future. This leads to a sudden increase in the long-term nominal interest rate, even while the short-term rate can actually be falling. We find that simulations from our model capture some observed patterns of U.S. interest rates in the 1980s.

The framework for our analysis is a version of the rational expectations macroeconomic model developed by Fuhrer and Moore (1995a,b). This model is quite tractable and has the advantage of being able to reproduce the dynamic correlations among U.S. inflation, short-term nominal interest rates, and deviations of real output from trend. The model consists of an aggregate demand equation, a nominal wage contracting equation (that embeds a version of an expectations-augmented Phillips curve), a Fed reaction function that defines monetary policy, and a term structure equation. A simple version of Okun's law relates the unemployment rate to the deviation of real output from trend.

We consider an experiment where the economy is initially in a regime of high and variable inflation and the Fed announces a program to reduce both the mean and variance of the inflation rate. The announced program (which is immediately implemented) involves a change to the parameters of the reaction function. Specifically, the inflation target is lowered and more weight is placed on minimizing the variance of inflation versus stabilizing output. We formalize the notion of credibility as the public's subjective probabilistic belief that the reaction function parameters have in fact been changed. The true parameters are assumed to be unobservable due to the presence of exogenous stochastic shocks that enter the reaction function. These policy shocks, together with stochastic disturbances to other parts of the economy, give rise to a distribution of observed inflation rates around any given inflation target.

Under full credibility, the economy is assumed to be populated by agents who, upon hearing the Fed's announcement, assign a probability of one to the event that the reaction function has changed. These agents continue to assign a probability of one regardless of the time path of inflation that is subsequently observed. In contrast, partial credibility implies that agents update their prior assessment of the true reaction function in a (quasi) Bayesian way on the basis of the Fed's success or failure in reducing inflation over time. Our setup is similar to one used by Meyer and Webster (1982) in which agents' expectations are constructed as a probability weighted average of the expectations that would prevail under an "old" and "new" policy rule.[6]

The behavior of the long-term nominal interest rate in the model is governed by the pure expectations hypothesis, that is, the long-term rate is a weighted average of current and expected future short-term rates. If the short rate rises as a result of tighter monetary policy, the implications for the long rate are theoretically ambiguous. In particular, upward pressure stemming from the increase in the current short rate may be offset by downward pressure from the anticipation of lower short rates in the future, due to lower expected inflation. Thus, by affecting the level of expected inflation, the degree of Fed credibility can exert a strong influence on the long-term nominal interest rate.

Using reaction function parameters estimated over the two sample periods 1965:1 to 1979:4 and 1980:1 to 1996:4 we trace out the economy's dynamic transition path for the

3. See Shapiro (1994) for an analysis of the relative success of Federal Reserve attempts to reduce inflation following seven postwar dates marking the start of an explicit disinflationary policy, as identified by Romer and Romer (1989, 1994).

4. For details on monetary policy in the early 1980s, see Friedman (1984), Blanchard (1984), Hetzel (1986), and Goodfriend (1993, 1997).

5. The crucial importance of the fiscal regime in determining the credibility of disinflationary policies is emphasized by Sargent (1982, 1983, 1986). For applications of this idea, see Flood and Garber (1980) and Ruge-Murcia (1995).

6. Other research that applies Bayesian learning to models of monetary policy includes Taylor (1975), Flood and Garber (1980), Backus and Driffill (1985a,b), Barro (1986), Lewis (1989), Baxter (1989), Bertocchi and Spagat (1993), Gagnon (1997), and Andolfatto and Gomme (1997). For related models with least squares learning, see Friedman (1979), Fuhrer and Hooker (1993), and Sargent (1998).

two specifications of credibility described above. The speed at which agents adjust their inflation expectations in response to the change in monetary policy depends crucially on the Fed's credibility: expectations adjust quickly with full credibility and slowly with partial credibility.

Under both specifications of credibility, we find that the inflation rate exhibits damped oscillations as the economy transitions to the new stationary equilibrium. Following the change in Fed policy, the inflation rate undergoes an initial drop, but ends up overshooting the new target level. The inflation rate then starts to increase as it approaches the new target from below. When the Fed does not have full credibility, agents interpret this interval of rising inflation as evidence that monetary policy has not in fact changed and therefore will continue to tolerate an environment of high and variable inflation. Consequently, agents' expectations of future inflation are revised upward, and the long-term nominal interest rate experiences a sudden increase. In this way, our model generates an endogenous inflation scare.

Numerical simulations of our model produce a 2 percentage point jump in the long-term nominal interest rate that begins about 24 quarters after the change in Fed policy. A similar pattern can be observed in the U.S. data about 29 quarters after the start of the Volcker disinflation.[7] Specifically, from 1986:4 to 1987:4, the yield on a 10-year Treasury bond increased sharply, despite only a small increase in the 3-month Treasury bill rate. Over this same period, the inflation rate (based on the GDP deflator) was rising. This pattern suggests that the increase in the U.S. long rate was driven by an upward shift in the public's expectations about future inflation, thus conforming with our definition of an inflation scare. Given this interpretation of the data, the 1987 scare episode illustrates the long memory of the public in recalling the high and variable inflation of the 1970s, and serves as an important reminder of the fragility of Federal Reserve credibility.

Although Goodfriend (1993) identifies three other inflation scare episodes in U.S. data that occurred much closer to the start of the Volcker disinflation,[8] we choose to emphasize the 1987 scare for two reasons: First, the magnitude and timing of the 1987 episode is reasonably close to the inflation scare that we are able to generate using the model, and second, the episode stands out readily in a plot of quarterly U.S. data. Interestingly, the 1987 scare occurred shortly after U.S. inflation "bottomed out" and again started to rise. This feature of the data resembles the dynamic overshooting behavior of inflation in our model. The point of the exercise, however, is simply to illustrate the mechanics by which an inflation scare may occur—not to identify any one episode as being more significant than the others.

The remainder of the paper is organized as follows. Section I describes the model and our specification of Federal Reserve credibility. Section II presents our parameter estimates and examines their sensitivity to different sample periods. Section III presents our simulation results. Section IV concludes.

I. THE MODEL

The model is a version of the one developed by Fuhrer and Moore (1995a,b). This framework has the advantage of being able to reproduce the pattern of dynamic correlations exhibited by an unconstrained vector autoregression system involving U.S. inflation, short-term nominal interest rates, and deviations of real output from trend. In the model, agents' expectations are rational and take into account the nature of the monetary policy regime, as summarized by the parameters of the Fed reaction function. However, since the other parts of the economy are specified as reduced-form equations, the model is susceptible to Lucas's (1976) econometric policy critique. Our estimation procedure attempts to gauge the quantitative importance of the Lucas critique for our results by examining the stability of the model's reduced form parameters across different sample periods. The equations that describe the model are as follows:

Aggregate Demand / I-S Curve

$$(1) \qquad \tilde{y}_t = a_1\tilde{y}_{t-1} + a_2\tilde{y}_{t-2} + a_\rho\,(\rho_{t-1} - \bar{\rho}) + \varepsilon_{yt},$$

where $\tilde{y}_t$ is the so-called "output gap" defined as the deviation of log per-capita real output from trend and ρ_{t-1} is the lagged value of the ex ante long-term real interest rate. The error term $\varepsilon_{yt} \sim N(0,\sigma^2_{\varepsilon y})$ captures random fluctuations in aggregate demand. We assume that the steady-state value of $\tilde{y}_t$ is zero, which implies that $\bar{\rho}$ is the steady-state real interest rate.

7. We take the starting date of the Volcker disinflation to be October 6, 1979, which coincides with Fed's announcement of a new operating procedure for targeting nonborrowed reserves. This starting date is consistent with the findings of Romer and Romer (1989), who use evidence from the minutes of Federal Open Market Committee meetings to identify October 1979 as a date when the Federal Reserve decided to undertake an explicit disinflationary policy.

8. The approximate dates of these episodes are: (1) December 1979 to February 1980, (2) December 1980 to October 1981, and (3) May 1983 to June 1984.

Wage Contracting Specification / Short-Run Phillips Curve

(2) $$\pi_t = \tfrac{1}{2}(\pi_{t-1} + E_t\pi_{t+1}) + \tfrac{\gamma}{2}(\tilde{y}_t + \tilde{y}_{t-1}) + \varepsilon_{\pi t},$$

where π_t is the inflation rate defined as the log-difference of the price level, E_t is the expectation operator conditional on information available at time t, and $\varepsilon_{\pi t} \sim N(0, \sigma^2_{\varepsilon\pi})$ is an error term. Fuhrer and Moore (1995a) show that (2) can be derived from a two-period model of staggered nominal wage contracts, where the real value of the contract price negotiated at time t is a simple average of the real contract price negotiated at $t - 1$ and the real contract price that agents expect to negotiate at $t + 1$, adjusted for the level of aggregate demand. The forward-looking nature of wage contracts creates an environment where current inflation depends on expected inflation. The error term represents a stochastic disturbance that affects labor supply decisions.[9]

Equation (2) can also be interpreted as a version of an expectations-augmented Phillips curve.[10] Evidence of a short-term Phillips curve trade-off can be found in the positive correlation between inflation and the real output gap in postwar U.S. data, and the corresponding negative correlation between inflation and the unemployment rate.[11] The steady-state version of (2) implies that there is no long-run trade-off between inflation and real output.

Federal Reserve Reaction Function

(3) $$r_t = r_{t-1} + \alpha_\pi(\pi_t - \bar{\pi}) + \alpha_y\tilde{y}_t + \varepsilon_{rt},$$

where r_t is the short-term nominal interest rate $\bar{\pi}$ is the inflation target, and $\varepsilon_{rt} \sim N(0, \sigma^2_{\varepsilon r})$ is an exogenous stochastic shock that is not directly observed by the public. The policy rule implies that the Fed strives to smooth short-term interest rates, but responds to deviations of inflation from target and to deviations of output from trend. The strength of the interest rate response to these deviations is governed by the parameters α_π and α_y.[12] We interpret ε_{rt} as capturing random, nonsystematic factors that arise from the political process or the interaction of policymakers with different preferences, different target rates of inflation, etc. Alternatively, we could interpret ε_{rt} as reflecting operational or institutional features that preclude perfect control of r_t.[13] The presence of the unobservable shock term is crucial for our credibility analysis because it prevents agents from being able to quickly learn the true values of $\bar{\pi}$, α_π, and α_y from a sequence of four observations on r_t, π_t, and $\tilde{y}_t$. Equation (3) implies that the steady-state inflation rate is $\bar{\pi}$.

Real Term Structure

(4) $$\rho_t - D(E_t\rho_{t+1} - \rho_t) = r_t - E_t\pi_{t+1},$$

where D is the duration of a real consol that is used here to approximate a finite maturity long-term bond. Equation (4) is an arbitrage condition that equates the expected real holding-period return on a long-term bond (interest plus capital gains) with the expected real yield on a short-term Treasury security. In steady-state, (4) implies the Fisher relationship: $\bar{r} = \bar{\rho} + \bar{\pi}$. By repeatedly iterating (4) forward and solving the resulting series of equations for ρ_t, we obtain the following expression:

(5) $$\rho_t = \tfrac{1}{1+D}E_t\sum_{i=0}^{\infty}\left(\tfrac{D}{1+D}\right)^i(r_{t+i} - \pi_{t+1+i}),$$

which shows that the ex ante long-term real rate is a weighted average of current and expected future short-term real rates.[14]

Nominal Term Structure

(6) $$R_t - D(E_tR_{t+1} - R_t) = r_t,$$

(7) $$R_t = \tfrac{1}{1+D}E_t\sum_{i=0}^{\infty}\left(\tfrac{D}{1+D}\right)^i r_{t+i},$$

where R_t is the nominal yield on the long-term bond. The above equations are the nominal counterparts of (4) and (5). In steady-state, equation (6) implies $\bar{R} = \bar{r}$.

Okun's Law

(8) $$u_t = (1 - b_1)\bar{u} + b_1u_{t-1} + b_2\tilde{y}_t + b_3\tilde{y}_{t-1} + b_4\tilde{y}_{t-2} + \varepsilon_{ut},$$

9. We do not explicitly link the supply shock $\varepsilon_{\pi t}$ to the real price of oil. Fuhrer and Moore (1995a, footnote 15) report that oil prices are uncorrelated with the residuals of their contracting equation, suggesting that their omission does not affect the model's performance. See Bernanke, Gertler, and Watson (1997) for an empirical study of the potential links between oil prices and monetary policy.

10. See Roberts (1997).

11. King and Watson (1994) document the robust negative correlation between inflation and unemployment at business cycle frequencies.

12. The policy rule is similar to one proposed by Taylor (1993), which takes the form: $r_t = (\bar{\rho} + \pi_t) + \alpha_\pi(\pi_t - \bar{\pi}) + \alpha_y\tilde{y}_t$, where $\bar{\rho}$ is the steady-state real interest rate. The Taylor rule uses $\bar{\rho} = 0.02$, $\alpha_\pi = \alpha_y = 0.5$, and $\bar{\pi} = 0.02$. See Taylor (1998) and Judd and Rudebusch (1998) for historical analyses of how policy rules of this form fit U.S. interest rate data.

13. Cukierman and Meltzer (1986) develop a model in which the central bank intentionally adopts an imprecise monetary control process in order to obscure its preferences, and thereby exploit a more favorable output-inflation trade-off.

14. In going from (4) to (5) we have applied the law of iterated mathematical expectations.

where u_t is the unemployment rate, $\bar{u}$ is the corresponding steady-state, and $\varepsilon_{ut} \sim N(0, \sigma^2_{\varepsilon u})$ is an error term.[15]

Credibility

In modeling the role of credibility during the Volcker disinflation, we abstract from the Fed's adoption of a new operating procedure for targeting nonborrowed reserves from October 1979 to October 1982. Studies by Cook (1989) and Goodfriend (1993) indicate that the majority of federal funds rate movements during this period were the result of deliberate, judgmental policy actions by the Fed, and not automatic responses to deviations of the money stock from its short-run target.[16] Moreover, it has been suggested that the Fed's emphasis on monetary aggregates during this period was simply a device that allowed it to disclaim responsibility for pushing up short-term nominal interest rates to levels that would otherwise have been politically infeasible. Based on the above reasoning, we interpret the Fed's statement on October 6, 1979, as an announcement of a change in the parameters of the reaction function.[17]

We consider an experiment where the economy is initially in a regime of high and variable inflation and the Fed announces a program to reduce both the mean and variance of the inflation rate. The announced program (which is immediately implemented) involves a change to the parameters of the reaction function (3). Specifically, the inflation target $\bar{\pi}$ is lowered, the parameter α_π is increased, and the parameter α_y is decreased. This constitutes a regime shift that is consistent with the empirical evidence of a statistical break in U.S. inflation occurring around October 1979.[18] The increase in α_π relative to α_y implies a decision on the part of the Fed to place more emphasis on minimizing the variance of inflation and less emphasis on stabilizing output.[19] It is important to recognize that we have simply posited the Fed's decision to change monetary policy, since our model abstracts from any economic benefits of low and stable inflation. Moreover, we do not attempt to explain how the Fed allowed inflation to become too high and variable in the first place.[20]

We define credibility as the public's subjective probabilistic belief that the announced policy change has in fact occurred. To formalize this idea, we endow agents with the knowledge of two possible reaction functions and the corresponding equilibrium distributions of π_t that arise under each. The two reaction functions are defined by the parameter combinations $\{\bar{\pi}^H, \alpha^H_\pi, \alpha^H_y\}$ and $\{\bar{\pi}^L, \alpha^L_\pi, \alpha^L_y\}$, where $\bar{\pi}^L < \bar{\pi}^H$, $\alpha^L_\pi > \alpha^H_\pi$, and $\alpha^L_y < \alpha^H_y$. In a stationary equilibrium, the linearity of the model, together with the assumptions that ε_{yt}, $\varepsilon_{\pi t}$, and ε_{rt} are i.i.d. normal implies

$$\pi_t \sim N(\bar{\pi}, \sigma^2_\pi), \tag{9}$$

where the mean of the inflation distribution is the steady-state and the variance σ^2_π depends on the variances of the stochastic shocks.

We assume that the economy is initially in a stationary equilibrium with the reaction function parameters $\{\bar{\pi}^H, \alpha^H_\pi, \alpha^H_y\}$. These parameters give rise to the distribution $\pi_t \sim N(\bar{\pi}^H, \sigma^2_{\pi H})$. At $t = t^*$ the Fed adopts the new reaction function parameters $\{\bar{\pi}^L, \alpha^L_\pi, \alpha^L_y\}$ and announces this action to the public. The unobservable error term ε_{rt} in (3) prevents the public from being able to verify the Fed's announcement from a sequence of four observations of r_t, π_t, and $\tilde{y}_t$. Hence, the public's beliefs regarding the reaction function parameters are used to form expectations while the true parameter values are used in (3) to compute the period-by-period values of r_t. Learning takes place (as described below), and the economy eventually converges to a new stationary equilibrium with $\pi_t \sim N(\bar{\pi}^L, \sigma^2_{\pi L})$, where $\sigma^2_{\pi L} < \sigma^2_{\pi H}$. In other words, the change in Fed policy ultimately brings about an inflation distribution with a lower mean and a lower variance.

We consider two specifications of credibility, labeled "full" and "partial." Full credibility implies that agents assign the probability $p_t = 1$ to the parameter combination $\{\bar{\pi}^L, \alpha^L_\pi, \alpha^L_y\}$ for all $t \geq t^*$. Under partial credibility, agents assign a "prior" probability to the parameter combination $\{\bar{\pi}^L, \alpha^L_\pi, \alpha^L_y\}$ at the time of the Fed's announcement. This prior is a free parameter that is influenced by the Fed's past track record in maintaining control over inflation. Agents compute a sequence of posterior probabilities $\{p_t\}^\infty_{t=t^*}$ by updating their prior in a (quasi) Bayesian way on the basis of observed realizations of the inflation rate and knowledge of the two (long-run) distributions of inflation centered at $\bar{\pi}^H$ and $\bar{\pi}^L$. The degree of Fed credibility is indexed by p_t.

15. Since $\bar{u}$ is independent of π_t, it can be interpreted as the "Natural Rate of Unemployment."

16. It is straightforward to append a money demand equation that determines how much money the Fed must supply in order to achieve the value of r_t given by (3). This would have no effect on the model's dynamics.

17. Evidence that the public perceived the statement in this way can be found in published newspaper reports of the time. See, for example, "Fed Takes Strong Steps to Restrain Inflation, Shifts Monetary Tactic," *The Wall Street Journal*, October 8, 1979, p. 1.

18. See, for example, Walsh (1988).

19. See Svensson (1997) and Ball (1997) for analyses of "efficient" monetary policy rules that minimize a discounted weighted-sum of the variances of inflation and output.

20. See Sargent (1998) for a model that seeks to endogenize the rise and fall of U.S. inflation.

We make the simplifying assumption that agents do not take into account the evolving nature of the inflation distribution during the transition to the new stationary equilibrium. Furthermore, we follow Meyer and Webster (1982), Baxter (1989), and Fuhrer and Hooker (1993), in assuming that the Fed's policy action is a once-and-for-all change. Thus, agents do not consider the possibility of any future regime shifts when forming their expectations.[21]

Under partial credibility, the public's beliefs regarding the reaction function parameters for $t \geq t^*$ evolve according to a version of Bayes' rule:

(10)
$$p_t = \frac{p_{t-1}\Pr(\pi_t \leq \pi_{t-1}|\bar{\pi}^L,\alpha_\pi^L,\alpha_y^L)}{p_{t-1}\Pr(\pi_t \leq \pi_{t-1}|\bar{\pi}^L,\alpha_\pi^L,\alpha_y^L)+(1-p_{t-1})\Pr(\pi_t \leq \pi_{t-1}|\bar{\pi}^H,\alpha_\pi^H,\alpha_y^H)},$$

with p_{t^*-1} given. The posterior probability $p_t \equiv \Pr(\bar{\pi}^L, \alpha_\pi^L, \alpha_y^L | \pi_t \leq \pi_{t-1})$ is computed by combining the prior probability $p_{t-1} \equiv \Pr(\bar{\pi}^L, \alpha_\pi^L, \alpha_y^L)$ with in-sample information. Specifically, the prior is weighted by $\Pr(\pi_t \leq \pi_{t-1} | \bar{\pi}^L, \alpha_\pi^L, \alpha_y^L)$, which represents the probability that inflation in period t will be lower than inflation observed in period $t-1$, conditional on the parameter combination $\{\bar{\pi}^L, \alpha_\pi^L, \alpha_y^L\}$. The relevant probability weights in (10) are given by

(11) $$\Pr(\pi_t \leq \pi_{t-1}|\bar{\pi}^L,\alpha_\pi^L,\alpha_y^L) = \int_{-\infty}^{\pi_{t-1}} l(z)dz,$$

(12) $$\Pr(\pi_t \leq \pi_{t-1}|\bar{\pi}^H,\alpha_\pi^H,\alpha_y^H) = \int_{-\infty}^{\pi_{t-1}} h(z)dz,$$

where $l(z)$ and $h(z)$ are the normal density functions that describe the stationary inflation distributions centered at $\bar{\pi}^L$ and $\bar{\pi}^H$, respectively.

Three features of the above specification warrant comment. First, the integrals in (11) and (12) are computed using the observation of π_{t-1}, *not* π_t. This is done to preserve the model's linearity in π_t. In particular, since p_t is used to construct the expectation $E_t\pi_{t+1}$ (as described below), the specification $p_t = p(\pi_t)$ would imply that (2) is nonlinear in the current period inflation rate. Maintaining linearity in π_t is desirable because it greatly simplifies the model solution procedure.[22]

Second, (11) and (12) imply that probability inferences are made using observations of a single economic variable (inflation), and that the relevant data sample includes only the most recent inflation rate, not the whole history of inflation rates $\{\pi_{t-i}\}_{i=1}^{t-t^*}$ observed since the announcement.[23] While our setup maintains tractability, it introduces some non-rationality into agents' forecasts to the extent that they ignore the potentially valuable information contained in the history of joint observations on inflation, interest rates, and the real output gap.[24]

Third, equation (10) differs from the standard classification formula for computing the conditional probability that a given observation comes from one of two populations with known densities.[25] In our model, the standard formula would take the form

(10′) $$p_t = \frac{p_{t-1}l(\pi_{t-1})}{p_{t-1}l(\pi_{t-1})+(1-p_{t-1})h(\pi_{t-1})},$$

which says that p_t depends on the relative *heights* of the two density functions evaluated at π_{t-1}. In contrast, equation (10) says that p_t depends on the relative *areas* of the two density functions to the left of π_{t-1}. In quantitative simulations, we find that (10) quickens the pace of learning in comparison to (10′) and thus leads to more a realistic transition time between steady states. This occurs because (10) introduces an implicit bias into agents' inferences such that p_t is higher than that implied by (10′) for any given value of p_{t-1}. For the parameter values we consider, both specifications exhibit the desirable property that the credibility index p_t declines monotonically as inflation rises, for any given p_{t-1}.[26]

After computing the posterior probability, agents' expectations are formed as a weighted average of the rational forecasts that would prevail under each of the two possible reaction functions:

(13) $$E_t\pi_{t+1} = p_tE_t\left[\pi_{t+1}|\bar{\pi}^L,\alpha_\pi^L,\alpha_y^L\right] + (1-p_t)E_t\left[\pi_{t+1}|\bar{\pi}^H,\alpha_\pi^H,\alpha_y^H\right],$$

(14) $$E_t\rho_{t+1} = p_tE_t\left[\rho_{t+1}|\bar{\pi}^L,\alpha_\pi^L,\alpha_y^L\right] + (1-p_t)E_t\left[\rho_{t+1}|\bar{\pi}^H,\alpha_\pi^H,\alpha_y^H\right],$$

21. See Gagnon (1997) for a univariate model of inflation that relaxes both of the foregoing assumptions.

22. Our solution procedure is described in Section II.

23. The history of inflation *does* influence credibility, however, because it is incorporated into agents' prior beliefs, which are summarized by p_{t-1} in (10).

24. See Ruge-Murcia (1995) for a model where credibility is inferred using joint observations on fiscal and monetary variables.

25. See Anderson (1958), Chapter 6.

26. This property will obtain when the ratios
$$\left(\int_{-\infty}^{\pi} l(z)dz\right)\Big/\left(\int_{-\infty}^{\pi} h(z)dz\right) \text{ and } \left(l(\pi)\right)/\left(h(\pi)\right)$$
are monotonically decreasing in π.

(15) $$E_t R_{t+1} = p_t E_t\left[R_{t+1}|\bar{\pi}^L, \alpha_\pi^L, \alpha_y^L\right] + (1-p_t)E_t\left[R_{t+1}|\bar{\pi}^H, \alpha_\pi^H, \alpha_y^H\right],$$

where p_t is given by (10). Since p_t is a function of past inflation, the model with rational expectations and partial credibility will now exhibit some of the backward looking characteristics of a model with adaptive expectations.[27]

II. ESTIMATION AND CALIBRATION

For the purpose of estimating parameters, we adopt a baseline model specification that incorporates full credibility. The resulting parameter set is then used for both credibility specifications in order to maintain comparability in the simulations. The data used in the estimation procedure are summarized in Table 1.

The model's reduced-form parameters are assumed to be "structural" in the sense that they are invariant to changes in the monetary policy reaction function (3). We attempt to gauge the reasonableness of this assumption by examining the sensitivity of the parameter estimates to different sample periods. Following Fuhrer (1996), we do not estimate the duration parameter but instead calibrate it to the value $D = 28$. This coincides with the sample average duration (in quarters) of a 10-year constant maturity Treasury bond. Equations (1) through (4) form a simultaneous system that we estimate using full-information maximum likelihood.[28] The estimation results are summarized in Table 2.

Despite small differences in our model specification and data, estimates from the full sample (1965:1 to 1996:4) are very much in line with those obtained by Fuhrer and Moore (1995b). With the exception of a_ρ and γ, the parameter estimates are all statistically significant. In contrast, the estimates from the first subsample (1965:1 to 1979:4) are highly imprecise, most likely due to the strong upward trends in U.S. inflation and nominal interest rates over this period. Estimates from the second subsample (1980:1 to 1996:4) are much closer to the full-sample results. Evidence of subsample instability seems to be concentrated mostly in the I-S curve parameters a_1, a_2, and a_ρ. Notice, however, that all subsample point estimates lie within one standard error of each other. We interpret these results to be reasonably supportive of the hypothesis that the reduced-form parameters a_1, a_2, a_ρ, $\bar{\rho}$ and γ do not vary across monetary policy regimes.

TABLE 1

QUARTERLY DATA, 1965:1 TO 1996:4

VARIABLE	DEFINITION
$\tilde{y}_t$	Deviation of log per capita real GDP from its linear trend.
π_t	Log-difference of GDP implicit price deflator.
r_t	Yield on 3-month Treasury bill.
R_t	Yield on 10-year constant-maturity Treasury bond.
u_t	Nonfarm civilian unemployment rate.

A comparison of the subsample point estimates of α_π and α_y suggests that the Fed has placed more emphasis on targeting inflation and less emphasis on stabilizing output in the period after 1980. For the simulations, we choose $\alpha_\pi^H = \alpha_y^H = 0.07$ for the high inflation regime and $\alpha_\pi^L = 0.10$ and $\alpha_y^L = 0.05$ for the low inflation regime. To complete the specification of the reaction function, we require values for $\bar{\pi}^H$ and $\bar{\pi}^L$. We choose $\bar{\pi}^H = 0.06$ to coincide with the sample mean from 1965:1 to 1979:4. Thus, we assume that the U.S. inflation rate prior to October 1979 can be characterized by a stationary distribution centered at 6 percent. While this assumption is undoubtedly false, it serves to illustrate the effects of partial credibility on the disinflation episode. Since $\bar{\pi}^L$ is intended to represent the new steady-state after the disinflation has been completed, we choose $\bar{\pi}^L = 0.03$ to coincide with the sample mean from 1985:1 to 1996:4. In computing this average, we omit the period of rapidly falling inflation from 1980:1 to 1984:4 because this can be interpreted as the transition to the new steady state.[29] For the other model parameters, we adopt the full-sample estimates in Table 2.

Our disinflation simulations abstract from stochastic shocks because these have the potential to obscure differences between the dynamic propagation mechanisms of

27. A similar effect obtains in the models of Fisher (1986), Ireland (1995), King (1996), Bomfim and Rudebusch (1997), and Bomfim, et al. (1997). In these models, credibility is determined by a backward-looking, linear updating rule. In contrast, Ball (1995) models credibility using a purely time-dependent probability measure.

28. We use the Matlab programs developed by Fuhrer and Moore (1995b), as modified to reflect the differences in our model specification and data.

29. The values $\bar{\pi}^H = 0.06$ and $\bar{\pi}^L = 0.03$ are very close to those used by Fuhrer (1996, figure IIb) to help reconcile the pure expectations theory of the term structure with U.S. nominal interest rate data.

TABLE 2

MAXIMUM LIKELIHOOD PARAMETER ESTIMATES

	1965:1 TO 1996:4		1965:1 TO 1979:4		1980:1 TO 1996:4	
PARAMETER	ESTIMATE	STANDARD ERROR	ESTIMATE	STANDARD ERROR	ESTIMATE	STANDARD ERROR
a_1	1.23	0.09	0.94	4.97	1.24	0.10
a_2	-0.26	0.08	0.10	4.62	-0.31	0.09
a_ρ	-0.20	0.12	-0.57	2.17	-0.05	0.05
$\bar{\rho}$	0.02	0.01	0.02	0.36	0.00	0.04
γ	0.01	0.01	0.04	0.47	0.01	0.01
α_π	0.06	0.03	0.07	1.04	0.10	0.05
α_y	0.08	0.03	0.07	1.05	0.05	0.06
$\bar{\pi}$	0.05	0.01	0.04	0.45	0.05	0.01

the two credibility specifications.[30] We assume, however, that agents make decisions *as if* stochastic shocks were present. This assumption is necessary for a meaningful analysis of credibility because without stochastic shocks, agents can always learn the true values of $\bar{\pi}$, α_π, and α_y within four periods. To compute the integrals in (11) and (12), we simply calibrate the standard deviations of the two long-run inflation distributions centered at $\bar{\pi}^H$ and $\bar{\pi}^L$. For the high inflation regime, we choose $\sigma_{\pi H} = 0.023$ to coincide with the sample standard deviation from 1965:1 to 1979:4. For the low inflation regime, we choose $\sigma_{\pi L} = 0.011$ to coincide with the sample standard deviation from 1985:1 to 1996:4. In computing this statistic, we once again exclude the transition period from 1980:1 to 1984:4.

For the steady-state unemployment rate, we choose $\bar{u} = 0.06$ to coincide with the average over the full sample. Given $\bar{u}$, we estimate the parameters of Okun's law (8) using ordinary least squares to obtain $b_1 = 0.96$, $b_2 = -0.30$, $b_3 = 0.10$, and $b_4 = 0.18$, which are all statistically significant.

Our solution procedure can be briefly summarized as follows. Given a set of parameters, we solve the full-information version of the model for each of the two reaction functions described by $\{\bar{\pi}^H, \alpha_\pi^H, \alpha_y^H\}$ and $\{\bar{\pi}^L, \alpha_\pi^L, \alpha_y^L\}$. In each case, the solution consists of a set of time-invariant linear decision rules for π_t, ρ_t, and R_t, defined in terms of the "state" vector $s_t = \{\tilde{y}_{t-1}, \tilde{y}_{t-2}, \pi_{t-1}, \rho_{t-1}, r_{t-1}\}$. The decision rules for $\tilde{y}_t$ and r_t are simply given by (1) and (3), respectively. For each reaction function, we use the decision rules to construct linear expressions for the conditional expectations $E_t\,[\pi_{t+1}|\,\bar{\pi}^i, \alpha_\pi^i, \alpha_y^i]$, $E_t\,[\rho_{t+1}|\,\bar{\pi}^i, \alpha_\pi^i, \alpha_y^i]$, and $E_t\,[R_{t+1}|\bar{\pi}^i, \alpha_\pi^i, \alpha_y^i]$, $i = L, H$. Next, we form the unconditional expectations $E_t\,\pi_{t+1}$, $E_t\rho_{t+1}$, and E_tR_{t+1} using the current value of p_t (which does not depend on π_t) and (13) through (15). Finally, the unconditional expectations are substituted into (2), (4), and (6) which, together with (1) and (3), form a system of five linear equations in the five unknowns $\tilde{y}_t$, π_t, ρ_t, r_t, and R_t.

Under full credibility, it is straightforward to show that the model possesses a unique, stable equilibrium for the parameter values we employ.[31] Under partial credibility, agents use observations of an endogenous variable (inflation) to form expectations that are crucial for determining the period-by-period values of that same variable. The presence of this dynamic feedback effect between the trajectory of inflation and the inputs to the learning process may create an environment where learning goes astray. In particular, there is no way to guarantee that the model will converge to a new steady state with $\bar{\pi} = \bar{\pi}^L$.[32] However, for the parameter values we employ, we find that convergence is achieved in the quantitative simulations.[33]

30. For studies that explore disinflation dynamics in models subject to stochastic shocks, see Meyer and Webster (1982), Orphanides, et al. (1997), and Bomfim and Rudebusch (1997).

31. The steady states associated with the two reaction functions both exhibit the well-known saddle point property.

32. In contrast, Taylor (1975), Meyer and Webster (1982), Baxter (1989), and Andolfatto and Gomme (1997), among others, consider Bayesian learning models in which agents' expectations do not affect the evolution of the variables they form expectations about. Hence, convergence follows from standard results on the asymptotic properties of estimators.

33. Marcet and Sargent (1989) develop an analytical framework for proving the convergence of "self-referential" models in which the evolution of an endogenous variable is governed by an adaptive learning process.

III. QUANTITATIVE RESULTS

Deterministic Disinflation Simulations

In our experiments with the model, we find that a very low prior p_{t^*-1} is needed for the model to generate an endogenous inflation scare. Therefore, in our specification with partial credibility, we set the initial prior to 0.001 percent. This choice also reflects our view (noted earlier) that the Federal Reserve had very little credibility at the start of the Volcker disinflation.[34]

The evolution of credibility is shown in Figure 1A. With full credibility, p_t jumps immediately to 100 percent on the strength of the Fed's announcement at $t^* = 0$. With partial credibility, p_t increases slowly over time as agents observe that π_t is falling (see Figure 1B). This feature of the model is consistent with the findings of Hardouvelis and Barnhart (1989) who show that an empirical proxy for Fed credibility increased only gradually in the period following October 1979. Moreover, they find that credibility is statistically linked to the rate of inflation.[35]

Credibility approaches the value p_t = 100 percent approximately 16 quarters after the change in Fed policy. Once full credibility is reached, Bayes' rule (10) implies that p_t = 100 percent will be sustained forever. However, as long as p_t < 100 percent by even a single decimal point, the economy will be susceptible to an inflation scare. In the simulation, credibility peaks at a value of 99.97742 percent and then begins to deteriorate rapidly. This loss of credibility is triggered by the period of rising inflation (observed in Figure 1B) that results from the dynamic overshooting characteristics of the model.[36]

Figure 1B shows that disinflation proceeds more slowly under partial credibility. The intuition for this result follows directly from equation (2). With partial credibility, the sluggish behavior of $E_t\pi_{t+1}$ delays the response of current inflation π_t to the policy change. This, in turn, delays the accumulation of credibility, which feeds back to inflation expectations.[37]

Figure 2A shows that both credibility specifications imply an initial monetary contraction, as evidenced by an increase in the short-term nominal interest rate r_t.[38] With partial credibility, the Fed undertakes a greater degree of monetary tightening, as measured by the peak level of r_t. This is due to the form of the reaction function (3) that makes r_t an increasing function of the distance $\pi_t - \bar{\pi}^L$. Since π_t falls more slowly under partial credibility, the level of r_t implied by (3) is higher. Moreover, the sluggish adjustment of $E_t\pi_{t+1}$ means that a higher level of inflation is built into expectations of *future* short rates. These two effects combine to raise the level of the current long rate R_t in comparison to the model with full credibility. Figure 2B shows that, under partial credibility, the inertia built into agents' inflation forecasts is sufficient to cause R_t to increase slightly in response to the tighter monetary policy. In contrast, full credibility generates an immediate *fall* in R_t as agents quickly lower their inflation expectations. Empirical studies generally indicate that tighter monetary policy leads to an increase in long-term nominal interest rates.[39]

The key feature of Figure 2B is the inflation scare that occurs about 24 quarters after the change in Fed policy. The scare produces a 2 percentage point jump in the long-term rate R_t that coincides with the interval of deteriorating credibility and rising inflation described above. Notice that the jump in R_t takes place in the absence of any aggressive tightening by the Fed. In fact, Figure 2A shows that the short-term rate r_t is actually *falling* during the inflation scare. Equation (13) implies that a decrease in p_t will cause expectations of future inflation to be revised upward. This forecast of higher inflation implies higher future values of r_t which, in turn, are incorporated into R_t via the term structure equation (7). In this way, the model generates an endogenous inflation scare.

Figures 3 and 4 show that the Fed's tighter monetary policy leads to a prolonged recession: real output declines relative to trend, and the unemployment rate goes up. Notice that the recession is considerably more severe in the case of partial credibility. This result helps to provide some insight into the high unemployment rates observed during the Volcker disinflation which, as we argued earlier, was initiated when the Fed's credibility was very low.

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34. A similar view is put forth by Mankiw (1994), who shows that forecasts made by the Council of Economic Advisers in January 1981 predicted a gradual and moderate decline in the inflation rate, in contrast to the rapid and pronounced disinflation that actually occurred under Fed Chairman Volcker.

35. The Hardouvelis-Barnhart measure of credibility is inversely proportional to the response of commodity prices (such as gold and silver) to unanticipated changes in the M1 money stock.

36. For the parameter values we employ, the model's dynamical system exhibits complex eigenvalues which give rise to damped oscillatory behavior.

37. In the words of Fed Chairman Volcker: "Inflation feeds in part on itself, so part of the job of returning to a more stable and more productive economy must be to break the grip of inflationary expectations." See Volcker (1979), pp. 888–889.

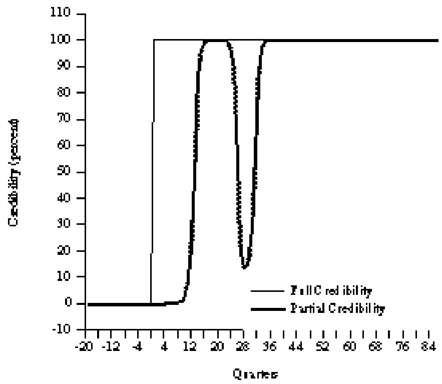
38. Since r_t rises and $\tilde{y}_t$ falls, a traditional Keynesian money demand equation with a predetermined price level would imply a contraction of the nominal money stock.

39. See Akhtar (1995) for a survey of the enormous empirical literature on this subject.

Figure 1

Credibility and Inflation

A. Model Credibility
Prior = 0.001%



B. Model Inflation Rate
Prior = 0.001%

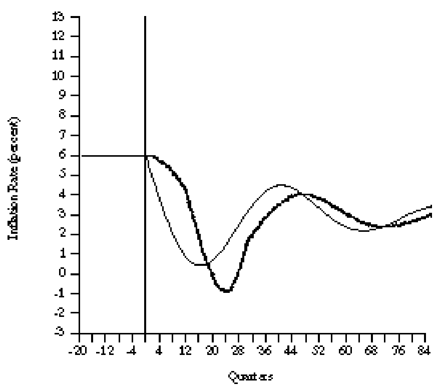
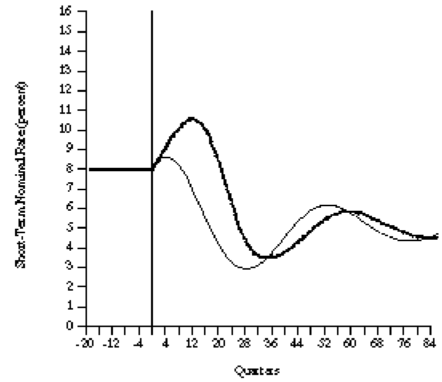


Figure 2

Nominal Interest Rates

A. Model Short-Term Nominal Interest Rate
Prior = 0.001%



B. Model Long-Term Nominal Interest Rate
Prior = 0.001%

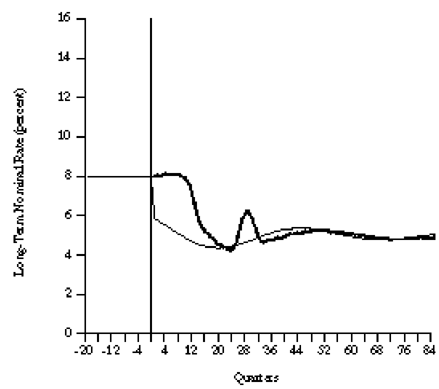


Figure 3

Model Real Output Gap

Prior = 0.001%

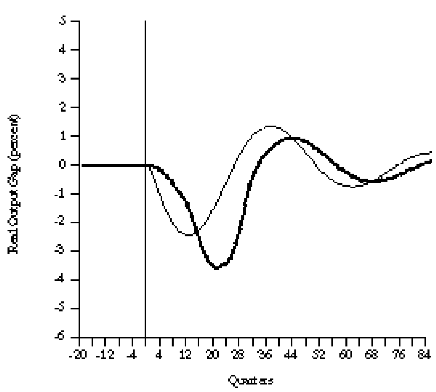


Figure 4

Model Unemployment Rate

Prior = 0.001%

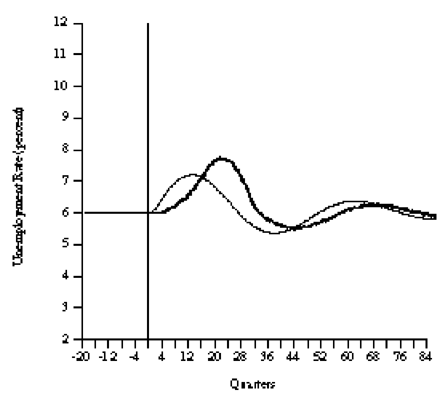
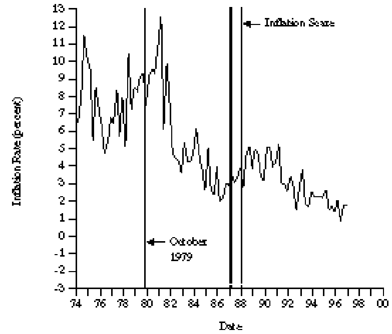


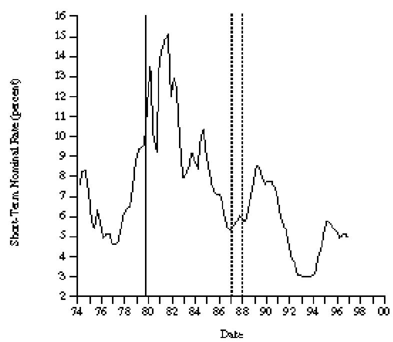
FIGURE 5

U.S. DATA

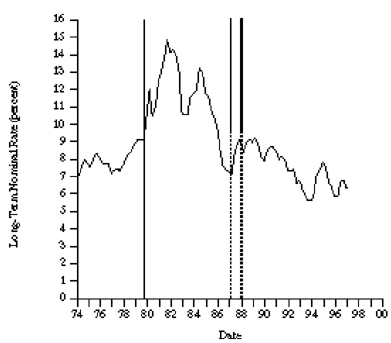
A. U.S. INFLATION RATE



B. U.S. SHORT-TERM NOMINAL INTEREST RATE



C. U.S. LONG-TERM NOMINAL INTEREST RATE

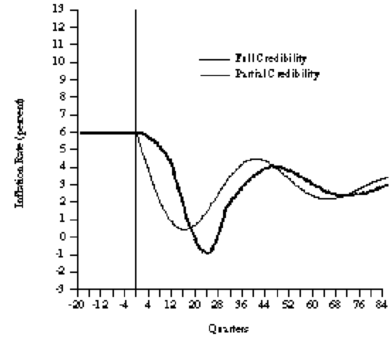


D. U.S. REAL OUTPUT GAP

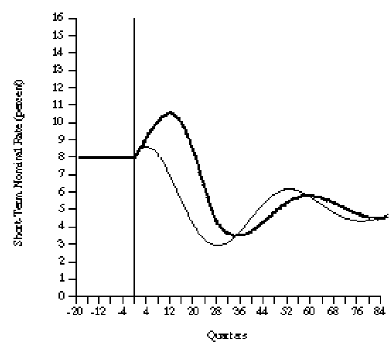
FIGURE 6

MODEL SIMULATIONS

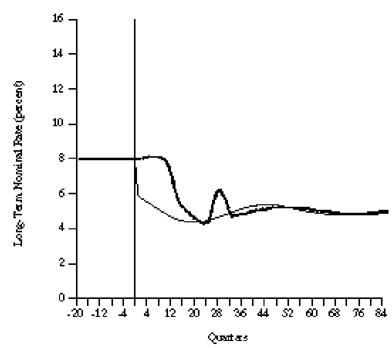
A. MODEL INFLATION RATE: PRIOR = 0.001%



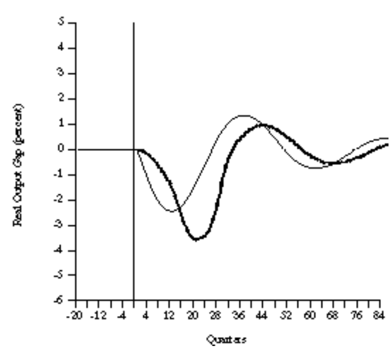
B. MODEL SHORT-TERM NOMINAL INTEREST RATE: PRIOR = 0.001%



C. MODEL LONG-TERM NOMINAL INTEREST RATE: PRIOR = 0.001%



D. MODEL REAL OUTPUT GAP: PRIOR = 0.001%



The time paths of the model variables in Figures 3 and 4 illustrate a potentially important stabilization property of full credibility. In particular, stabilization of the model is aided by the elimination of the backward-looking dynamics associated with the learning process. This result is consistent with the findings of Fuhrer (1997), who shows that a stronger *forward-looking* component in the contracting equation (2) helps to stabilize the model.[40]

Comparison with Volcker Disinflation

Figures 5 and 6 compare the evolution of U.S. macroeconomic variables during the Volcker disinflation with the corresponding variables in our model. The vertical line in the U.S. figures marks the start of the Volcker disinflation in October 1979. The model captures many of the qualitative features of the Volcker disinflation. Notice that the U.S. variables appear to exhibit some low frequency, damped oscillations that resemble the dynamic overshooting characteristics of the model variables. It should be noted, however, that the 16-year period following October 1979 may include some additional monetary policy actions that are not present in the model. For example, Taylor (1993) shows that the time path of the federal funds rate since 1987 is well-described by a policy rule with an inflation target of 2 percent (see footnote 12). In addition, Romer and Romer (1994) find evidence that the Federal Reserve made a deliberate decision to reduce inflation in December 1988.

In Figures 5A–C, we highlight the classic pattern of an inflation scare that can be observed in U.S. data about 29 quarters after the start of the Volcker disinflation. Specifically, from 1986:4 to 1987:4, the yield on a 10-year Treasury bond increased sharply from 7.3 percent to 9.1 percent (Figure 5C), despite only a small increase in the 3-month Treasury bill rate from 5.3 to 6.0 percent (Figure 5B). Over this same period, the inflation rate increased from 2.9 to 3.9 percent (Figure 5A). This pattern fits our definition of an inflation scare, suggesting that the increase in the U.S. long rate was driven by an upward shift in the public's expectations of future inflation. Notice that the 1987 scare episode occurred shortly after U.S. inflation "bottomed out" and again started to rise. Interestingly, this feature of the data resembles the dynamic overshooting behavior of inflation in the model (Figure 6A). Given our intepretation of the data, the 1987 scare episode illustrates the long memory of the public in recalling the high and variable inflation of the 1970s, and serves as an important reminder of the fragility of Federal Reserve credibility.[41]

As noted earlier in the introduction, Goodfriend (1993) identifies three other inflation scare episodes in U.S. data that occur much closer to the start of the Volcker disinflation. Our model does not capture these episodes because the dynamic overshooting behavior of the inflation rate (which triggers the inflation scare) takes a long time to evolve. We note, however, that our simulations abstract from stochastic shocks which may have played a role in triggering these earlier episodes.

Another feature of the U.S. data that we do not capture is the dramatic increase in the long-term nominal interest rate in the period following October 1979 (Figure 5C). In Huh and Lansing (1998), we show that a version of this model that combines adaptive expectations with partial credibility can exhibit more sluggish adjustment in inflation expectations. As a result, we find that R_t can rise significantly in response to a tightening of monetary policy.

IV. Conclusion

This paper developed a simple, quantitative model of the U.S. economy to show how an inflation scare may occur when the Federal Reserve lacks full credibility. Our simulation exercise was reasonably successful in capturing the magnitude and timing of the 1987 U.S. inflation scare episode that produced a sharp increase in the 10-year Treasury bond yield. Our model also captures many of the qualitative features of the Volcker disinflation of the early 1980s.

The potential for an inflation scare will continue to exist so long as the public believes that the U.S. economy may someday return to an environment of high and variable inflation. One way of addressing this problem is through legislation designed to enhance credibility by requiring the Fed to pursue some notion of "price stability" as its primary or sole objective. An arrangement such as this was put in place for the central bank of New Zealand in 1989.[42]

40. For a related discussion, see Taylor (1980, section IV).

41. See Gagnon (1996) for some cross-country evidence that inflation expectations exhibit a "long memory" of past inflation.

42. See Romer and Romer (1997) for a discussion regarding the merits of legislated rules and other institutional arrangements for the conduct of monetary policy.

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Disability and Work: The Experiences of American and German Men

Richard V. Burkhauser
and Mary C. Daly

The authors are, respectively, Professor of Policy Analysis and Management at Cornell University, and Economist, Federal Reserve Bank of San Francisco. Helpful comments were received from Ken Kasa, Mark Spiegel, and Robert Valletta.

This paper compares the economic well-being of men with disabilities in the United States and Germany. The results indicate that while the prevalence of disability is similar, the social institutions developed in the two countries result in quite different patterns of employment, transfer receipt,and economic well-being among the population with disabilities. However, while work is more important among German men with disabilities, it also is a very important component of the economic well-being of American men with disabilities. Furthermore, at least initially, a significant fraction of men are able to adjust to their disability and maintain their work status and income.

Modern industrial societies attempt to ameliorate the consequences of work-related health impairments on the earning capacity and economic well-being of their citizens through a mix of government programs. Transfer programs are used to replace lost earnings or to provide a means-tested income floor. Employment-centered programs are used to offset the effects of an impairment or to encourage employers to hire people with disabilities.

Historically, disability policy in the United States has been dominated by transfer programs and, to a much lesser extent, rehabilitation. There has been very little direct intervention in the job market on behalf of people with disabilities. European countries, in general, have been much more willing to make continued employment a major policy goal of their disability programs. Many have been willing to intervene directly in the labor market through quotas or direct job creation in order to achieve this goal.

In 1990 the United States moved closer to this two-pronged European approach of transfers and employment protection by enacting the Americans with Disabilities Act (ADA). The ADA requires private sector employers to make reasonable efforts, through accommodation, to employ persons with disabilities. One of the hopes underlying the ADA is that accommodation at the onset of a health impairment will delay job exit and subsequent movement onto the disability rolls. Yet, before the ADA was enacted and even now, in 1998, little is known about the labor force experiences of Americans with disabilities and how these experiences compare to people with disabilities in other, more interventionist, countries.

A common misperception about people with disabilities is that very few of them work in the market place. One reason for this misperception is that most research on people with disabilities focuses on the "official" disability transfer population and thus restricts the analysis to individuals who are either receiving transfers or working less than full-time. While this is a reasonable approach for some questions, it severely limits our ability to examine the role that employment can and does play in the economic lives of people with disabilities. A broader picture of the population with disabilities would include those who, despite their health condition, continue to work full-time. This broader view is particularly important when considering the effectiveness of policies that extend and support employment for people with disabilities and when comparing the economic well-being of Americans with disabilities to people with disabilities in other countries, where full-time employment is a major goal of disability policy.

Another common misperception about people with disabilities is that they are a homogeneous group. However, the population with disabilities is quite diverse with respect to age, health condition, work, and income (Bennefield and McNeil, 1989; Burkhauser and Daly, 1996a). In addition, the great majority of people with disabilities were able-bodied for most of their work life (Burkhauser and Daly, 1996b). Thus, to capture fully the experiences of this population it is necessary to take a more dynamic perspective toward disability. Cross-sectional data limit the analyses to those persons with and without disabilities at a given time. Yearly comparisons of cross-sectional data allow one to track gross movements in the work and economic well-being of these populations. But such analyses cannot distinguish between changes in the population with disabilities and changes in the individual circumstances of population members. Since the vast majority of those with disabilities were not born with them, the transition into disability and subsequent changes in economic well-being and work take on added meaning. Multiperiod data allow individual transitions into disability to be evaluated.

In this paper we expand the scope of the investigation of the economic well-being of the population with disabilities: we include people with disabilities who work full-time; we look at this broader population both in the cross-section and over the critical transition years before and after the onset of the disability; and we compare the outcomes of Americans with disabilities to their counterparts in Germany. Because Germany combines transfers with employment support to mitigate the risk of economic loss following a disabling health impairment, our comparison provides a first glimpse of what such a mixed program might offer to Americans with disabilities.

The results indicate that while the prevalence of disability is similar in the United States and Germany, the social institutions developed in the two countries result in quite different patterns of employment, transfer receipt, and economic well-being among the population with disabilities. However, while work is more important among German men with disabilities, it also is a very important component of the economic well-being of the American men with disabilities. Furthermore, cross-sectional data overstate the drop in labor earnings and economic well-being associated with a disability, implying that, at least initially, a significant fraction of men are able to adjust to their disability and maintain their work status and income.

I. Brief Synopsis of Disability Policies in the United States and Germany

United States. In the United States, rehabilitation and job programs are secondary to transfer payments as a means of helping people with disabilities.[1] The primary public disability transfer programs are: Social Security Disability Insurance (SSDI), Supplemental Security Income (SSI), Veterans' Disability Benefits, and Workers' Compensation. SSDI and SSI are limited to those who are unable to perform any substantial gainful activity; the other two programs require the disability to have been work-related.

In the 1990s, anti-discrimination laws—such as the ADA—supported by cultural pressures to incorporate and accommodate diversity have emerged as major tools to keep people with disabilities in the work force. Title I of the ADA requires employers to make reasonable accommodations to workers with disabilities unless this would cause undue hardship on the operation of business. On July 26, 1992, all employers of 25 or more workers were subject to its rules. On July 26, 1994, the standards of antidiscrimination were extended to all employers of 15 or more workers. Workers who feel they have been discriminated against due to a disability have the right to sue their employer. (For a more complete discussion of the ADA and its provisions, see West 1996.)

The primary goal of Title I of the ADA is to ensure equal access to employment for people with disabilities. Underlying this goal is a belief that the removal of disability-related barriers to employment will allow greater numbers of individuals with disabilities to choose work over disability benefit receipt, which will, in turn, increase their economic well-being.

Germany. The goal of the German system is to provide early detection, rehabilitation, job retraining, and employment whenever possible and to award transfers only when other mechanisms fail. When disability benefits are awarded they can come from the statutory pension system, the unemployment insurance system, the workers' accident insurance fund, or the universal health care system. None of these benefits are conditioned on complete withdrawal from the labor market.

1. Burkhauser and Hirvonen (1989), for instance, show that, in 1985, 25 people were in supported work or vocational rehabilitation programs for every 100 persons receiving disability transfer benefits in the United States. In contrast, Germany, where medical and vocational rehabilitation as well as a mandated job quota system are the main policy tools for assisting those with disabilities, had a ratio of 45 per 100 in 1995.

Toward the aim of prolonging employment, the government requires employers to seek permission from the local unemployment office to discharge a worker with disabilities. In addition, the government has a quota system mandating all public and private enterprises to employ a handicapped worker for every 16 employees or about 6 percent of their workforce. A fine of 200 DM per month per unfilled quota position is charged to employers who do not comply. This is a rather small fine (approximately $125), and only 19 percent of employers fulfilled their quotas in 1990. The average proportion of handicapped workers in that year was only 4.5 percent. Although they did not fulfill their quota, 44 percent of the employers employed some officially recognized people with disabilities. The remaining 37 percent employed no persons with disabilities.[2]

II. DATA SOURCES AND MEASUREMENT ISSUES

The empirical results in this study come from two longitudinal data sets: the *1989 Family-Individual Response-Nonresponse File of the Panel Study of Income Dynamics* (PSID) for the United States; and the *1993 Syracuse University Public Use File of the German Socio-Economic Panel* (GSOEP) for Germany. Although these surveys are not commonly used for studies of disability, their longitudinal nature and their consistent collection of information related to employment behavior, transfer receipt, and economic well-being make them useful sources for studying economic transitions associated with the onset of a disability.

The PSID data span more than two decades from 1968 to 1989. Since 1968, the PSID has interviewed annually a sample of some 5,000 families, representing a disproportionate number of low-income individuals. The PSID currently contains data on over 35,000 persons, approximately 20,000 of whom are current respondents. The GSOEP is a more recent longitudinal data set developed at the Universities of Frankfurt and Mannheim in cooperation with the Deutsches Institut für Wirtschaftsforschung, Berlin (DIW). The GSOEP began with a sample of 5,921 households, representing a disproportionate number of non-German "guest-workers." The GSOEP currently contains data on 6,699 households and 13,669 adult respondents.[3]

Defining the Sample. The investigation focuses on the experiences of men aged 25 to 59. This limited age range avoids confusing reductions in work or economic well-being associated with disability with reductions or declines associated with retirement at older ages or initial transitions into and out of the labor force related to job shopping at young ages. This is particularly important for the cross-national comparisons. In Germany individuals may be eligible for retirement as early as age 60. In addition, since the experiences of men and women with disabilities are quite different, and treating them both is beyond the scope of this article, the analysis here is limited to men.[4]

Defining Disability. Disability is not a static classification but a dynamic process. It varies with both the health of the individual and the socio-economic environment in which the person functions, confounding attempts to measure it objectively and consistently. Nagi (1969) created the most widely accepted research definition of disability. Nagi's definition distinguishes among three states of diminished health, ranging from a purely medical classification of individuals to one that recognizes the interaction of personal characteristics, the social environment, and health in creating disability:

1. *pathology* - the presence of a physical or mental malfunction and/or the interruption of normal processes;
2. *impairment* - physiological, anatomical, or mental losses or abnormalities that limit a person's capacities and level of functioning;
3. *disability* - inability or limitations in performing roles and tasks that are socially expected.

In Nagi's definition, being disabled—as defined by a work reduction or disability benefit receipt—is not only a function of health, but of personal drive, education, age, and family structure, as well as the incentives to continue working or to apply for disability benefits that spring from the interaction of market forces and public policy in a given country. Until the passage of the ADA, this definition of disability was consistent with most United States public policies targeted at those with disabilities.

The ADA definition of disability significantly broadened the concept of disability proposed by Nagi. Under the

2. For a fuller discussion of the German disability system, see Burkhauser and Hirvonen (1989), Jacobs, Kohli, and Rein (1991), Frick (1991), and Sadowski and Frick (1992).

3. For a fuller discussion of the PSID data, see Hill (1992). For a fuller discussion of the GSOEP data, see Wagner, Burkhauser, and Behringer (1993).

4. In both the United States and Germany, men are the primary earners in a household. Thus the economic well-being of women with disabilities is not as dependent on women's employment and earnings and, in fact, changes very little following the onset of an impairment. In labor market effort, however, men and women are similar and, with caution, the findings for men can be generalized to women with disabilities. For a discussion of women with disabilities in the United States and Germany, see Burkhauser and Daly (1994).

ADA, a person is classified as disabled if he/she has a physical or mental impairment that substantially limits one or more major life activities, a record of such an impairment, or being regarded as having such an impairment. Under the ADA, the population with disabilities is not limited to those whose impairments prevent work, but includes all individuals with pathologies or impairments, regardless of their work-related functional abilities.

Measuring Disability. In most surveys of income and employment the data available on health come from a small set of questions that ask respondents to assess whether their health limits the kind or amount of work that they can perform. Other surveys ask respondents to rate their health relative to others in their age group. Researchers have been suspicious of these measures for a number of reasons. First, self-evaluated health is a subjective measure that may not be comparable across respondents. Second, these measures may not be independent of the observed variables one wants to explain—such as economic well-being, employment status, or family structure (Chirikos and Nestel 1984). Third, since social pressures make it undesirable to retire before certain ages, reasonably healthy individuals who wish to exit the labor force prematurely may use health as their excuse (Parsons 1980, 1982 and Bazzoli 1985). Finally, in the United States, federal disability transfer benefits are available only to those judged unable to perform any substantial gainful activity, so individuals with some health problems may have a financial incentive to identify themselves as incapable of work because of their health. Misclassification based on self-reported health can underestimate the true number of persons who suffer from a particular condition and overestimate the negative effects of health on economic well-being. These problems are exacerbated when these measures are used to track changes in the population with disabilities over time.

Although the problems inherent in disability measures based on self-evaluated health have led some researchers (Myers 1982, 1983) to conclude that no useful information can be gained from self-evaluated health data, objective measures of health, which are much less available, also suffer from inherent biases (Bound 1991). Moreover, as Bound and Waidmann (1992) show, even when a clear relationship between changes in public policy and changes in disability prevalence rates is demonstrated, it does not imply that those who come under the disability classification are erroneously classified.

Although the information available in most micro-data sources does not allow one to determine the extent to which changes in pathology have contributed to changes in the prevalence of disability, it is possible to inform the policy debate about the relationship among health, employment, and public policy by consistently applying a definition of disability and being cautious when interpreting the results. To approximate the ADA definition of disability and to ensure that the measures are both longitudinally consistent and comparable across countries, this article relies on self-reported data collected in both the PSID and GSOEP surveys.

In the PSID, the population with disabilities is defined using a survey question that asks respondents, “Do you have any physical or nervous condition that limits the type or the amount of work that you can do?” To eliminate from the analysis individuals whose health limitations are short-term, only those individuals who report a limitation for two consecutive years are included in the sample. In this way the analysis is restricted to the population whose disabilities are long-term.

Unlike surveys in the United States, the GSOEP does not consistently ask respondents if their health limits their ability to work.[5] Instead respondents are asked to report both their overall health satisfaction and whether they have any chronic conditions or persistent disabilities. In addition, respondents are asked whether they have received an official disability certificate. Those with official certificates are asked to report their official assigned disability percentage, which can range from 10 to 100 percent. From these questions we construct a measure of disability that captures a German population with disabilities comparable to the population selected in the United States. We include in our German population with disabilities those men who report they are dissatisfied with their health, those whose official disability certificate ranks them as greater than 50 percent disabled, and those who self-report a chronic impairment or persistent disability. As in the United States the population is limited to those who are classified as disabled (by our definition) for two consecutive periods.

Measuring Economic Well-Being. This analysis makes cross-national comparisons of economic well-being. To

5. For the first four years (1984–1987) the GSOEP asked the work limits question: “Disregarding short periods of illness, does your health constitute an impediment in carrying out day-to-day activities, e.g., job or training?” However, since we want to create a longitudinally consistent measure of disability through 1989 we must rely on the health satisfaction question asked in each year of the panel. The health satisfaction question asks: “How satisfied are you with your health?” to which respondents reply on a 0–10 scale. Correlation tests suggest that the first four points (0–3) are highly correlated with the work limits question.

account for differences in income levels between the two countries and to eliminate biases that may be introduced by calculating exchange rates and living standards, all comparisons are based on the relative position of men with disabilities in each country. Economic well-being is measured in both the presence and absence of government taxes and transfers. Before-government income is the sum of all private sources of income available to the family. After-government income combines private and public income flows and deducts taxes.[6] To account for differences in family size, an equivalence scale weighting factor is applied to each individual household income. There is no universally accepted equivalence scale, so the scale used to set poverty thresholds in the United States is chosen and applied in both countries.[7] (See the Appendix for a description of these weights).

Measuring Wage Earnings and Labor Force Activity. The analysis focuses on the role that employment and labor earnings play in the economic well-being of men with disabilities. The measure of labor force activity used throughout the analysis distinguishes among men who work full-time, part-time, or not at all. Men who report that they work more than 1,820 hours per year (more than 35 hours per week) are considered full-time workers.[8] Men who report positive work hours or positive wages but whose annual work hours are less than 1,820 are considered part-time workers. Men with no labor earnings and zero work hours are considered detached from the labor market.[9] Wage earnings account for all income from labor market sources including primary and secondary jobs, professional practices, and bonus income, including the labor portion of self-employment income.[10]

Measuring Government Transfer Receipt. An important component of income for many individuals with disabilities is government-provided transfers. Throughout this study transfers are classified in two ways: individually based and disability related (disability benefits) and family based and of any type or form (public transfers). In the United States, disability transfers include income from workers' compensation, the Social Security Disability Program, veterans' benefits, and Supplemental Security Income. In Germany, all benefits based on being classified as disabled are included as disability transfers. Public transfers include all cash and near cash benefits not specifically received based on health.

III. RESULTS

Prevalence of Disability. Table 1 provides estimates of the prevalence of disability in 1988 in the United States and Germany for the male working-age population, aged 25 to 59. Our estimates are consistent with those from other studies.[11] Overall, the prevalence of disability in the United States and Germany is similar—9.0 and 10.2, respectively. In both countries the risk of disability increases with age, although the rate of increase varies. In the United States the percentage of younger men with a disability is much higher and the percentage of older men with a disability much lower than is the case in Germany. Thus, the risk of disability is steeper across the age distribution in Germany than in the United States. This is

6. The tax burden for those families in the GSOEP was computed using tax calculation routines first developed by the Special Collaborative Group 3 - project C-8 in Frankfurt Mannheim, FRG. A detailed discussion of the simulations is found in van Essen, Kassella, and Landau (1986). We used updated and modified tax calculation routines developed by Berntsen and described in Berntsen (1992). For the United States we used the tax routine developed by Greg Duncan for PSID families.

7. See Buhmann, Rainwater, Schmaus, and Smeeding (1988) for a discussion of the sensitivity of different equivalence scales in cross-national comparative research.

8. The PSID and GSOEP annual hours variables include paid vacation time. Therefore, 1,820 hours per year or 35 hours per week and 52 weeks per year constitute the correct break point between full-time and part-time workers.

9. This category includes men who are out of the labor force and men who are long-term unemployed (i.e., did not work during the measurement year).

10. For the United States we use the annual hours worked and annual labor market income variables provided in the PSID. There are no equivalent variables in the GSOEP so we construct a measure of annual hours worked and annual labor market income using the following procedures. Annual labor market income is found by multiplying the average monthly earnings from primary and secondary jobs by the number of months the respondent reports working at that job. This sum is added to wage income from special bonuses including 13th and 14th month pay, Christmas pay, and profit sharing. Unlike the income variables which are asked retrospectively about the previous income year, the hours worked questions refer only to the circumstances at the time of the interview. For all waves but the first we are able to reorganize the data and match the income year with the hours worked year and compute an annual hours variable equal to the average hours worked multiplied by the number of months employed on that job. For the first wave of the data we simply assume that the hours worked in the present are a good proxy for the hours worked in the previous year.

11. See Burkhauser and Daly (1994, 1996a) for a comparison of disability prevalence rates across different data sources.

consistent with the German policy of targeting rehabilitation and full-time reemployment at younger workers who develop work limitations and targeting disability transfer benefits at older unemployed workers with health limitations (see Aarts, Burkhauser, and de Jong, 1992).

A Cross-Sectional View. Table 2 compares the work and transfer circumstances of U.S. and German working age males with and without disabilities in 1988. The percent employed of men with disabilities in the United States is 71.8 percent. The percent employed of German men with disabilities is 67.8 percent. When these employment rates are compared with those of men without disabilities, the resulting employment ratios in the two countries are nearly the same—0.73 in the United States versus 0.72 in Germany. Hence, the relative employment experience of men with disabilities compared to men without disabilities in the United States is approximately the same as that of men with disabilities in Germany. In both countries, work is a common activity for the majority of men with disabilities.

However, while U.S. and German men with disabilities have similar employment rates, German men are much more likely to work full-time. Nearly 85 percent of German men with disabilities who work do so full-time, compared to just 64 percent of working American men with disabilities who work full-time. This difference in the level of attachment to the labor force is mirrored by the returns from work earned by men with disabilities in the two countries. Men with disabilities in the United States on average received only 49 percent of the labor earnings of men without disabilities. In Germany men with disabilities on average received 65 percent of the labor earnings of men without disabilities.

Table 2 also shows the proportion of men who live in families in which government transfers are received. Receipt of transfer income in the United States and in Germany is high for men with disabilities. However, because of the broad German social welfare system, receipt of transfers also is high among those without disabilities. In the United States the likelihood that the families of those without disabilities will receive a government transfer is much smaller. Therefore, transfer receipt by men with disabilities relative to men without disabilities is substantially higher in the United States than in Germany—3.2 compared to 1.1, respectively. Yet as subsequent tables show, a greater likelihood of receiving transfer income does not overcome the substantial gap in labor earnings between those with and without disabilities.

In Table 3 we focus on the relative economic well-being of men with disabilities in the United States and Germany

TABLE 1

Percent of Working Age Males in the United States and Germany with Disabilities

	United States	Germany
Aged 25 to 59	9.0	10.2
Aged 25 to 34	6.5	3.7
Aged 35 to 49	8.5	8.0
Aged 50 to 59	15.0	22.2

Source:1989 Response-Nonresponse File of the Panel Study on Income Dynamics and the Syracuse University Public Use File of the German Socio-Economic Panel.

TABLE 2

Employment, Earnings, and Transfer Receipt among Working Age Men with and without Disabilities in the United States and Germany

	United States					Germany				
	Percent Employed					Percent Employed				
	Total	Full-time	Part-time	Mean Labor Earnings	Receiving Transfers	Total	Full-time	Part-time	Mean Labor Earnings	Receiving Transfers
Men										
with disabilities	71.8	45.9	25.9	19,369	48.7	67.8	58.2	9.6	34,252	65.6
without disabilities	97.8	84.2	13.6	39,819	15.2	95.0	81.4	13.6	53,226	60.4
Ratio	0.73	0.55	1.9	0.49	3.2	0.72	0.72	0.71	0.65	1.1

All amounts are reported in 1991 dollars and 1991 DM for the United States and Germany, respectively.

Source: 1989 Response-Nonresponse File of the Panel Study on Income Dynamics and the Syracuse University Public Use File of the German Socio-Economic Panel.

using a single year of data. We report mean before- and after-government household income adjusted for family size for persons with and without disabilities. We find that, in the absence of government, household income of the average man with a disability in the United States is less than two-thirds that of his counterpart without disabilities. This gap approximates the difference in privately generated income that government tax and transfer policies must fill to offset losses from disability. In Germany there is a substantially smaller gap in the privately generated income of those with and without a disability. Thus, direct tax and transfer policies need to do much less in Germany than in the United States in order to offset the effect of disability on economic well-being.

Government tax and transfer policies clearly reduce the gap in before-government income between those with and without disabilities in the United States. The after-government mean income of men with disabilities rises, while the mean income of those without disabilities falls. Despite this equilibrating change, the gap between those with and without disabilities remains. The mean man with a disability lives in a household with income equal to only 73 percent of that of the average man without a disability. The smaller gap in before-government income in Germany is consistent with a disability policy designed to minimize the economic losses surrounding disability by maintaining a worker's connection to the labor market. Hence, in Germany when tax and transfers are included, mean income falls for both men with and without disabilities—tax payments exceed transfers for both. Still, the gap in income between men with and without disabilities is substantially reduced. In Germany tax and transfer policies virtually equalize household income between those with and without disabilities.

These findings suggest that on average the economic well-being of working age males with disabilities in the United States is improved by government tax and transfer policies in general and by disability transfer policy in particular, but that the large difference in labor earnings between those with and without disabilities is not fully offset by such policies. In contrast, because the labor earnings difference is much smaller in Germany, tax and transfer policies virtually bridge the gap for the average working age male with disabilities in Germany.

A Multi-Period View. Tables 2 and 3 show that Germans with disabilities are more reliant on labor earnings and less reliant on transfers to generate household income than are American men with disabilities. However, this kind of yearly data cannot reveal why this difference exists. A number of alternatives are possible including (1) the differences are a direct result of the disability, (2) the differences predate the disability, and (3) the differences are a statistical artifact arising from the fact that cross-sectional data oversample "long-stayers" (Cox, 1972; Bane and Ellwood, 1983).[12] To examine which of these explanations is correct we use longitudinal data to follow men who experience a disability during the survey period and to track changes in their labor earnings and household income as they transition into disability.

12. That is, the cross-section of men with disabilities in 1988 will have a greater percentage of men whose disability occurred long ago than would a random sample of completed spells of men who experience the onset of a work-limiting health condition. If work and economic well-being deteriorate as one's spell of disability lengthens, then cross-sectional comparisons may exaggerate the typical experience of a worker following the onset of a health-related work limitation.

TABLE 3

ECONOMIC WELL-BEING OF WORKING AGE MEN WITH AND WITHOUT DISABILITIES IN THE UNITED STATES AND GERMANY

	UNITED STATES (MEAN 1991 DOLLARS)		GERMANY (MEAN 1991 DM)	
	BEFORE-GOVERNMENT INCOME	AFTER-GOVERNMENT INCOME	BEFORE-GOVERNMENT INCOME	AFTER-GOVERNMENT INCOME
MEN				
with disabilities	25,419	23,968	40,562	34,382
without disabilities	38,851	32,434	51,789	39,186
RATIO	0.65	0.73	0.78	0.88

Source: 1989 Response-Nonresponse File of the Panel Study on Income Dynamics and the Syracuse University Public Use File of the German Socio-Economic Panel.

The longitudinal sample is constructed from the 1983 to 1989 waves of the PSID and GSOEP and contains men who report two consecutive periods of non-disability followed by two consecutive periods of disability. The analysis is restricted to men who experience the onset of their disability after their 25th but before their 60th birthday.

Changes in Absolute Economic Well-Being. Table 4 shows the short-run consequences of disability by tracing the path of changes in work and the absolute economic well-being of men with disabilities surrounding the onset of a disability. The first row of Table 4 shows that two years prior to the onset of their health-related work limitation, about 96 percent of both American and German males worked. Subsequent rows show that after the onset of the disability, work declines in both countries, but more so in the United States. But as was true in Table 2, it is in the United States that labor earnings are most seriously affected. Mean labor earnings fall from about $29,000 the year before onset to about $25,000 the year following onset and to about $23,000 two years after onset, declines of 15.8 and 18.8 percent, respectively. In Germany there is a similar decline one year after onset, but by two years after onset mean labor earnings return to their pre-onset level.

Two points are worth noting from this comparison. First, American men experience larger declines in labor earnings than their German counterparts. This difference is related, in part, to the larger percentage of American men compared to German men who stop working following the onset of their disability. Second, although the decline in labor earnings among American men with disabilities is substantially larger than the decline among their German counterparts, it is much smaller than might be inferred from the cross-sectional differences in labor earnings reported in Table 2.

This same surprising pattern is found with respect to economic well-being. Mean real household size-adjusted income remains virtually unchanged in both countries immediately following the onset of a disability. This is true for both before-government income as well as for after-government income. In the United States, before-government income dropped from $28,147 one year before to $28,073 one year after onset. In Germany, before-government income actually increased from DM 43,735 one year before onset to DM 43,911 one year after onset. Changes in after-government income are even more surprising. In both countries, mean after-government income rises from one year before to one year after onset. Looking at the mean percentage change over the one-year period, before-government income falls by less than 1 percent in the United States and actually increases in Germany. After-government income increases in both countries. The mean change in the United States was an increase of 4.0 percent. In Germany it was 3.8 percent. These findings suggest that the drop in economic well-being implied by cross-sectional comparisons may exaggerate the importance of disability as its cause.

Differences in Initial Conditions. One explanation for the large discrepancy between the cross-sectional and longitudinal characterizations of disability is that the earnings and income differences observed in the cross-section pre-

TABLE 4

Short-Run Economic Consequences of a Disability among Working Age Men in the United States and Germany

	United States				Germany			
			Equivalent Mean 1991 Dollars				Equivalent Mean 1991 DM	
Disability Event	Percent Employed	Mean Labor Earnings	Before-Government Income	After-Government Income	Percent Employed	Mean Labor Earnings	Before-Government Income	After-Government Income
Two Years Prior	95.6	28,428	26,128	22,196	96.3	52,765	45,862	34,733
One Year Prior	96.7	29,300	28,147	24,066	96.3	47,553	43,735	33,739
Year of Disability Event	89.5	27,636	27,853	24,191	95.4	47,644	45,861	34,867
One Year After	80.1	24,663	28,073	25,028	89.9	39,794	43,911	35,014
Two Years After	78.0	23,777	27,916	25,273	83.3	47,680	49,727	39,464

Source: 1989 Response-Nonresponse File of the Panel Study on Income Dynamics and the Syracuse University Public Use File of the German Socio-Economic Panel.

date the disability. In other words, men with low economic status in the United States are more likely to become disabled. To test whether this explanation is true we compare the pre-disability earnings and income distributions (periods *t*-2 and *t*-1) of men with disabilities to the earnings and income distributions among all men ages 25 to 59. The statistical significance of any differences is examined using a Chi-Squared Goodness of Fit test.[13]

Table 5 shows that in the United States where the differences were large in the cross-section, there is no significant difference between the distribution of labor earnings for men with and without disabilities in either periods *t*-2 or *t*-1. In Germany where the differences in the cross-section were small, the labor earnings distribution for men with disabilities prior to onset were significantly lower than for men without disabilities prior to onset. In the two years preceding the onset of a work-limiting health condition, more than 50 percent of German men fell into the lowest two labor earnings quintiles. Less than 40 percent of German men without disabilities had labor earnings in these two quintiles. Thus, while American men with disabilities are surprisingly similar to American men without disabilities, some of the small cross-sectional difference in labor earnings between men with and without disabilities in Germany can be explained by differences in their initial positions in the labor earnings distribution.

In contrast to the labor earnings results, the distributions of before- and after-government income of German men with disabilities are not significantly different from those without disabilities in the year prior to onset. Moreover, in the United States, only the before-government income of those who subsequently have a disability is significantly lower in the year prior to onset compared to the rest of the population. Taken together, these results suggest that the discrepancies observed between the cross-section and multi-period analysis cannot be explained by differences in initial conditions.

Changes in Relative Economic Well-Being. The analysis thus far suggests that the onset of a disability does not dramatically alter the absolute economic well-being of American or German men. However, for many of these men, staying near or at the same absolute income level, over time, may translate into a significant decline in their relative income position. In Tables 6–8 we explore whether U.S. and German men with disabilities maintain or lose their relative standing in the income distribution after the onset of their disability. The relative position of men with disabilities is measured by assigning each sample member to a labor earnings, before-government, and after-government income quintile in each year surrounding the transition into disability. The quintile cutoffs are computed over the entire population of men 25 to 59 with and without disabilities between 1983 and 1989.

Table 6 reports the results for the labor earnings distribution. In the United States the labor earnings distribution of men with disabilities shifts down following onset. One year prior to onset just over 45 percent of these men were in the lowest two quintiles of the labor earnings distribution. One year after onset almost 54 percent had labor earnings in the lowest two quintiles of the distribution. This finding is consistent with the falling mean labor income reported in Table 2.

In Germany, the mean change in labor earnings among men with disabilities just after onset was small, but the relative position of these men declined over the period from just before to just after onset. One year prior to onset 43 percent of German men with disabilities were in the two lowest quintiles, with less than 15 percent falling into the bottom quintile. One year after onset over 50 percent were in the lowest two quintiles and more than 30 percent had fallen into the bottom quintile. Thus, although the mean change in labor earnings among men with disabilities over this period was zero, real growth in labor earnings among men without disabilities left men with disabilities relatively worse off.

As shown in Tables 7 and 8, the experiences of American and German men are very similar with respect to before- and after-government income. Although before-government relative economic well-being for men with disabilities declines following the onset of a work-limiting health condition, it does not fall by as much as the labor earnings distribution. Moreover, much of the relative decline in before-government income is eliminated by the tax and transfer system. In the United States 48.4 percent of men with disabilities fell into the bottom two quintiles of before-government income one year after onset but only 44.4 percent did with respect

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13. The specific test used was a test of association that relies on the computation of a Pearson chi-square statistic. The null hypothesis is that there is no association between income and the onset of disability. The alternative hypothesis is that some general association is present. Essentially this test compares the expected to the observed frequencies for those with and without disabilities and rejects the null if at least one of the distributions differs from the expected or mean distribution. The exact computation of the test statistic is:

$$Q_p = \Sigma_i \Sigma_j (n_j - m_{ij})^2 / m_{ij} \quad (r-1)(c-1) \text{ degrees of freedom}$$

where

$$m_{ij} = n_j n_j / n$$

$$n_{j\cdot} = \Sigma_j n_j \quad \text{(row total)}$$

$$n_{\cdot j} = \Sigma_i n_{ij} \quad \text{(column total).}$$

See Fienberg (1977).

TABLE 5

PRE-ONSET COMPARISON GROUP FOR MEN WITH DISABILITIES IN THE UNITED STATES AND GERMANY

	UNITED STATES											
	LABOR EARNINGS				BEFORE-GOVERNMENT INCOME				AFTER-GOVERNMENT INCOME			
	MEN WITH DISABILITIES		MEN WITHOUT DISABILITIES		MEN WITH DISABILITIES		MEN WITHOUT DISABILITIES		MEN WITH DISABILITIES		MEN WITHOUT DISABILITIES	
QUINTILE	*t*-2	*t*-1	*t*-2	*t*-1	*t*-2	*t*-1*	*t*-2	*t*-1*	*t*-2	*t*-1	*t*-2	*t*-1
Lowest	22.8	22.2	17.9	17.7	24.4	26.7	18.6	18.2	25.0	22.8	18.8	18.4
Next Lowest	22.2	20.0	19.9	18.9	18.9	15.6	20.1	19.8	20.0	15.6	20.2	19.8
Middle	18.3	21.7	20.1	19.9	25.0	21.1	20.5	20.2	22.2	23.9	20.4	20.2
Next Highest	21.1	18.9	20.9	21.3	16.7	18.9	20.8	20.9	17.2	19.4	20.6	20.9
Highest	15.6	17.2	21.2	22.2	15.0	17.8	20.1	20.8	15.6	18.3	20.0	20.7

	GERMANY											
	LABOR EARNINGS				BEFORE-GOVERNMENT INCOME				AFTER-GOVERNMENT INCOME			
	MEN WITH DISABILITIES		MEN WITHOUT DISABILITIES		MEN WITH DISABILITIES		MEN WITHOUT DISABILITIES		MEN WITH DISABILITIES		MEN WITHOUT DISABILITIES	
QUINTILE	*t*-2	*t*-1*	*t*-2	*t*-1*	*t*-2	*t*-1	*t*-2	*t*-1	*t*-2	*t*-1	*t*-2	*t*-1
Lowest	13.6	15.5	17.5	16.9	15.5	17.3	19.3	18.9	16.4	20.0	19.4	19.3
Next Lowest	29.1	28.2	20.5	20.3	20.0	20.0	20.7	20.7	23.6	21.8	20.3	20.3
Middle	14.5	18.2	20.6	20.8	21.8	24.5	19.6	19.9	19.1	20.0	20.1	20.2
Next Highest	20.0	17.3	20.9	21.3	22.7	18.2	20.9	20.5	22.7	18.2	20.7	20.5
Highest	22.7	20.9	20.6	20.7	20.0	20.0	19.6	19.9	18.2	20.0	19.5	19.8

*Significant at the 5 percent level.
Source: 1989 Response-Nonresponse File of the Panel Study on Income Dynamics and the 1993 Syracuse University Public Use File of the German Socio-Economic Panel.

TABLE 6

LABOR EARNINGS BY QUINTILE FOR WORKING AGE MEN WITH DISABILITIES IN THE UNITED STATES AND GERMANY

	UNITED STATES					GERMANY				
QUINTILE	*t*-2	*t*-1	*t*	*t*+1	*t*+2	*t*-2	*t*-1	*t*	*t*+1	*t*+2
Lowest	22.8	22.2	29.4	35.6	32.5	13.6	15.5	19.1	31.8	27.1
Next Lowest	22.2	20.0	17.2	17.8	23.9	29.1	28.2	27.3	20.0	16.5
Middle	18.3	21.7	17.8	18.9	16.2	14.5	18.2	14.5	12.7	15.3
Next Highest	21.1	18.9	19.4	17.2	15.4	20.0	17.3	17.3	17.3	23.5
Highest	15.6	17.2	16.1	10.6	12.0	22.7	20.9	21.8	18.2	17.6
Mean	28,428	29,300	27,636	24,663	23,777	52,765	47,553	47,644	39,794	47,680

Source: 1989 Response-Nonresponse File of the Panel Study on Income Dynamics and the 1993 Syracuse University Public Use File of the German Socio-Economic Panel.

TABLE 7

BEFORE-GOVERNMENT EQUIVALENT FAMILY INCOME BY QUINTILE FOR WORKING AGE MEN WITH DISABILITIES IN THE UNITED STATES AND GERMANY

	UNITED STATES					GERMANY				
QUINTILE	*t*-2	*t*-1	*t*	*t*+1	*t*+2	*t*-2	*t*-1	*t*	*t*+1	*t*+2
Lowest	24.4	26.7	26.1	30.6	27.4	15.5	17.3	20.0	21.8	20.0
Next Lowest	18.9	15.6	18.9	17.8	18.8	20.0	20.0	17.3	24.5	17.6
Middle	25.0	21.1	17.8	20.0	20.5	21.8	24.5	26.4	21.8	27.1
Next Highest	16.7	18.9	19.4	10.6	14.5	22.7	18.2	15.5	17.3	21.2
Highest	15.0	17.8	17.8	21.1	18.8	20.0	20.0	20.9	14.5	14.1
Mean	26,128	28,147	27,853	28,073	27,916	52,765	47,553	47,644	39,794	47,680

Source: 1989 Response-Nonresponse File of the Panel Study on Income Dynamics and the 1993 Syracuse University Public Use File of the German Socio-Economic Panel.

TABLE 8

AFTER-GOVERNMENT EQUIVALENT FAMILY INCOME BY QUINTILE FOR WORKING AGE MEN WITH DISABILITIES IN THE UNITED STATES AND GERMANY

	UNITED STATES					GERMANY				
QUINTILE	*t*-2	*t*-1	*t*	*t*+1	*t*+2	*t*-2	*t*-1	*t*	*t*+1	*t*+2
Lowest	25.0	22.8	23.9	23.3	19.7	16.4	20.0	18.2	18.2	16.5
Next Lowest	20.0	15.6	19.4	21.1	21.4	23.6	21.8	17.3	23.6	16.5
Middle	22.2	23.9	18.3	19.4	24.8	19.1	20.0	28.2	27.3	28.2
Next Highest	17.2	19.4	17.8	13.9	14.5	22.7	18.2	15.5	13.6	17.6
Highest	15.6	18.3	20.6	22.2	19.7	18.2	20.0	20.9	17.3	21.2
Mean	22,196	24,066	24,191	25,028	25,273	34,733	33,739	34,867	35,014	39,464

Source: 1989 Response-Nonresponse File of the Panel Study on Income Dynamics and the 1993 Syracuse University Public Use File of the German Socio-Economic Panel.

to after-government income. In Germany the relevant numbers are 46.3 percent and 41.8 percent.

IV. DISCUSSION

All modern industrial societies maintain social programs to protect and assist workers who develop health impairments that reduce their earning capacity. In addition, many nations have implemented employment support programs to keep such workers in the labor market. In this paper we examined the economic well-being of men with disabilities in the United States and compared them with their counterparts in Germany. We find, using cross-sectional data, that the mean German with a disability lives in a household whose income is virtually the same as that of the mean German without a disability. This is not the case in the United States, where the income gap between those with and without disabilities is approximately one-quarter. An even more important finding from a policy perspective is that in Germany the pre-tax and transfer income (composed largely of own wage earnings) of men with disabilities is nearly 80 percent of that of men without disabilities. In the United States the pre-tax and transfer income gap for men is almost 35 percent.

However, based on our longitudinal data, we suggest that the large difference in wage earnings and household income found in the cross-section may exaggerate the influence that disability has on income in the United States. While the mean household income of men with disabilities in the United States fell somewhat following a disability, this fall was more modest than the income gap found between those with and without disabilities in the cross-section.

What we learn from both our longitudinal and cross-sectional findings is that the labor earnings of those with disabilities are a primary determinant of their economic well-being. Our results indicate that, while Americans and Germans with disabilities are employed at about the same ratio with respect to those without disabilities, the labor earnings of Germans with disabilities are much closer to those of Germans without disabilities than is the case in the United States. This difference, in large part, explains the disparity in economic well-being between people with disabilities in the United States and Germany.

These pieces of information suggest that Germany's commitment to employment for people with disabilities contributes to the relatively solid record of labor earnings by men in Germany. Hence, if the Americans with Disabilities Act and other government initiatives to encourage accommodation of people with disabilities in the labor market are successful in increasing the labor earnings of people with disabilities, this will then reduce some of the income gap between those with and without disabilities. However, our longitudinal results suggest that there are limits to what policy can do. While German men with disabilities did not experience dramatic absolute declines in their economic well-being, they did lose their relative position in the income distribution. This suggests that guaranteeing Americans with disabilities more than their absolute pre-disability standard of living may be beyond the scope of current policy.

APPENDIX

UNITED STATES EQUIVALENCE WEIGHTS FOR ADJUSTING HOUSEHOLD INCOME

HOUSEHOLD SIZE	WEIGHT
Single person	1
Couple	1.29
Couple plus child	1.55
Couple plus 2 children	1.95
Couple plus 3 children	2.29
Couple plus 4 children	2.57
Couple plus 5 children	2.88
Couple plus 6 children	3.16
Couple plus 7 children	3.87

Notes: The equivalence weights for the United States are derived from the Census poverty thresholds. U.S. Department of Commerce, 1991.

Equivalence weights for alternative family compositions are not shown here but were included in the calculations of equivalent income.

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Is Mortgage Lending by Savings Associations Special?

Elizabeth Laderman
and Wayne Passmore

The authors are respectively, Economist, Federal Reserve Bank of San Francisco, and Senior Economist, Board of Governors of the Federal Reserve System. The authors would like to thank Rajuram Rajan, Fred Furlong, and the members of the editorial committee, Simon Kwan and Glenn Rudebusch, for helpful comments. Jamie Ingpen and Judy Peng provided excellent research assistance.

In this paper, we investigate whether elimination of the savings association charter might reduce lending to "nontraditional" (e.g., low-income) mortgage borrowers. We present a theoretical model of lender portfolio choice, in which nontraditional lenders have some market power and traditional lenders are price-takers in the mortgage market. The comparative statics indicate differences between nontraditional and traditional lenders in terms of their asset allocation responses to changes in borrower income and house prices. Empirical tests indicate the absence of such differences between savings associations and commercial banks, suggesting that elimination of the savings association charter would not impair lending to nontraditional mortgage borrowers.

During the past several years, Congress has debated eliminating the federal savings and loan (S&L) industry by merging the federal S&L charter into the commercial bank charter.[1] As the number of savings associations has declined sharply over the past decade (from 2,961 savings banks and savings and loans with either national or state charters in 1986 to 1,997 at the end of 1997), the elimination of the federal S&L charter might seem to be simply one more step in financial consolidation.

Some critics of the plan, however, point out that the initial policy goal of chartering a separate set of depository institutions was to create institutions with a special commitment to a particular type of lending, and, in the case of savings associations, the goal was to have a set of institutions with a special commitment to the housing market. In spite of the rapid growth of mortgage securitization and the prevalence of commercial and mortgage banks in mortgage lending, they argue that a depository institution with a special commitment to mortgage lending still is needed.

According to these critics, commercial and mortgage banks are "cream-skimmers" who make easy real estate loans, but who do not develop the relationships with unusual or nontraditional borrowers, that are required to lend successfully to these borrowers or institutions. A corollary to this view is that commercial banks provide only conforming mortgages that can be sold in the secondary mortgage market, while savings associations make "hard" mortgages that often must be held in the institution's portfolio. As illustrated later, these types of institutions may behave differently in their asset allocation in response to changes in borrower income or house prices. Such differences may provide tests of whether or not special borrowers are served by these institutions.[2]

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1. Under some of these proposals, the regulator of most savings associations (the Office of Thrift Supervision, or OTS) would be consolidated with commercial bank regulators (the Federal Deposit Insurance Corporation, the Office of the Comptroller of the Currency, and the Federal Reserve). The savings association industry has argued that charter elimination, if any, should be of the "charter-up" variety, giving all thrift powers to banks rather than limiting thrift powers to those of banks.

2. Even with a "special commitment" by savings associations, the question persists as to why a special charter is needed to promote this commitment, since most mortgage-related activities, with the exception of some real estate development loans, can be undertaken by an institution

In this paper, we present a theoretical model of lender portfolio choice between home mortgages and an alternative investment in a government security. We distinguish between traditional lenders, who are price-takers in the mortgage market, and nontraditional lenders, who invest in information in order to obtain some market power in a nontraditional mortgage market. We then use realistic parameter values to simulate the comparative statics of the model. These simulations inform the structure of our estimated equations, where we find no evidence that savings associations are more oriented to nontraditional mortgage borrowers than commercial banks. Thus, the savings association charter does not appear to make savings associations behave more like nontraditional lenders.

I. THE GOVERNMENT'S COMMITMENT TO A SPECIAL DEPOSITORY FOR THE HOUSING SECTOR

Savings associations had existed for about 100 years prior to the Great Depression as cooperatives that pooled the savings of members and then made loans to members for housing. But during the 1930s, the federal government transformed the industry into a tool of public policy and made it a symbol of the government's commitment to housing (National Commission 1993).

This tool worked well until the mid-1960s, when the S&L industry encountered the first of many crises. Because the industry funds longer-term mortgages with shorter-term deposits, each market or regulatory development that made it easier for depositors to place their funds elsewhere and receive higher yields placed pressure on industry profitability. By 1970, the need for the S&L industry to adopt new strategies for funding mortgages was evident to many observers, but, as the National Commission (1993) points out, "Congress' insistence that S&Ls continue to function almost totally as vehicles for achieving national housing goals prevented needed adjustments from occurring" (p. 23).

By 1988, the S&L industry was in the midst of a full-blown crisis, but even then the industry and Congress were able to block changes because of a fear that national housing policy would be damaged if the special nature of the S&L were altered.[3] As stated by Danny Wall (1988), Chairman of the Federal Home Loan Bank Board (then regulator of the S&L industry) at the height of the thrift crisis (p. 237):

> …it seems clear to me that the Congress is absolutely committed to this industry, because of the predominance of its responsibility is focused on housing finance….
>
> It is clear to me that the Congress, as the policy maker, wants an industry like this to exist, with a charter in community after community, unlike the mortgage bankers…. Mortgage bankers expand and contract with the market, and that kind of ability is necessary and desirable. On the other hand, in the down times, the savings institution industry has still financed housing.

Now, ten years later, the debate about "modernizing" bank charters still evokes concern that smaller depositories, particularly thrifts, are needed to accomplish important policy goals in housing and community development. For example, Nicolas Retsinas—Assistant Secretary of Housing and Urban Development and Federal Housing Commissioner—states (1997):

> …any proposal to modernize financial services must ensure that institutions are not discouraged and precluded from continuing to concentrate in mortgage lending. Public policy in this country has always recognized the value of promoting home ownership.
>
> …We should not force institutions that focus on housing finance to abandon a business that not only is profitable but also fulfills a very important public purpose.

II. THE DEMAND FOR MORTGAGES AND ASSET ALLOCATION BY FINANCIAL INSTITUTIONS

Banks invest in understanding their customers as part of understanding the risks of lending. Evaluating loan applicants and monitoring loan borrowers allows banks to build up expertise, and this information may then be used to extend credit to borrowers who find it difficult to obtain elsewhere.[4] Savings associations, with higher proportions of lending focused on mortgages, may build up special expertise in the mortgage market.

There are, in essence, two residential mortgage markets: the traditional mortgage market, which usually provides fixed-rate mortgages with a 20 percent down payment to borrowers with well-known credit characteristics, and the nontraditional market. To illustrate how these markets might become segmented, consider a simple model with two types of borrowers—one type that has well-known risk

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with either a commercial bank or savings association charter. One answer is that it is the regulator of the industry—in this case the Office of Thrift Supervision—that creates the special commitment because it is focused on the industry and understands it better, and therefore allows more "relationship lending." Beyond this argument, it is difficult to understand why changing the charter of savings associations would change the activities of the savings associations.

3. There were, of course, many causes of the 1980s S&L crisis, and there are literally hundreds of publications about it. Some of the better ones are Barth (1991), Kane (1989), National Commission (1993), and White (1991).

4. See Blinder and Stiglitz (1983).

characteristics and the other with nontraditional risk characteristics. Both types of borrowers have housing values as part of their Cobb-Douglas utility functions, as used by Stein (1995), and both are constrained by their budgets or:

$$(1)\quad U = \alpha_i \ln V_i + (1-\alpha_i)\ln F_i - \theta\,(r_M^D M_i + pF_i - I_i - r_f(S_i - D_i)),$$

where V is the house price, F is the quantity demanded of other goods (called food), r_M^D is the rate demanded by borrowers for mortgage credit, M is the amount of mortgage credit demanded, p is the price of food, I is the borrower's income, r_f is the risk-free interest rate, which here is the opportunity cost of the down payment, S is the borrower's savings, D is the down payment on the mortgage, α is a parameter of the utility function, θ the marginal utility of income, and the subscript i denotes the type of borrower (which will be indicated only when needed for clarity). By definition, $V=M+D$, and we assume that the mortgage rate is higher than the risk-free interest rate and that the borrower is certain about his or her income. Thus, the borrower uses all savings for the down payment, or $S=D$. The borrower chooses the value of the house and the quantity of goods he or she wishes to consume, yielding the first-order conditions:

$$(2)\quad \begin{aligned} \partial U/\partial V &= \alpha/V - \theta r_M^D = 0 \\ \partial U/\partial F &= (1-\alpha)/F - \theta p = 0 \\ I &= r_M^D(V-S) + pF. \end{aligned}$$

By solving for the marginal rate of substitution between the value of the house and food, and using the income constraint, we find the mortgage amount desired by the borrower:

$$(3)\quad M = \frac{\alpha(I + r_M^D S)}{r_M^D} - S.$$

The Traditional Mortgage Lender

We assume that financial institutions minimize the variance of a portfolio for any given level of expected return and then integrate this standard model of asset allocation with the supply and demand conditions in the mortgage markets. First, consider a traditional mortgage lender, who holds two types of assets—Treasury securities and traditional mortgages. By traditional mortgages, we mean mortgages that meet well-understood and standardized underwriting criteria. The technology for creating such a firm—one that underwrites conventional, conforming mortgages—is readily available.

The traditional mortgage lender's expected return on a traditional mortgage is:

$$(4)\quad \mu_c = [r_M(1-d_c) + d_c l_c - \chi_c - r_f]$$

where d_c is the probability of default for a traditional borrower, l_c is the loss rate on a defaulted traditional mortgage ($l_c < 0$), and χ_c is the cost of underwriting a traditional borrower. Since the traditional mortgage lender can invest in Treasury securities as well, the expected return on the portfolio of this type of institution is:

$$(5)\quad \psi_c = x_c \mu_c + x_t r_f,$$

where x_c and x_t (which here equals $1–x_c$) are the proportions of traditional mortgages and Treasury securities held in portfolio.

The variance in return on a traditional mortgage (the institution holds assets until maturity, so there is no variance in the return on Treasury securities) is:

$$(6)\quad v_c = (r_M - l_c)^2 d_c(1-d_c),$$

and the traditional mortgage lender solves the problem:

$$(7)\quad \prod_c = \text{Min}\; x_c^2 v_c \quad \text{s.t.}\; u_p = \psi_c,$$

where μ_p is the firm's target rate of return, and the traditional mortgage lender solves for x_c and x_t.

Solving for x_c, we find:

$$(8)\quad x_c^* = \frac{\mu_p - r_f}{\mu_c - r_f}.$$

With free entry and exit in the traditional mortgage industry, the target rate of return is driven by competition to equal the expected risk-adjusted return on capital in the economy. We solve for the contractual traditional mortgage rate (r_M) so that:

$$(9)\quad \mu_c = (\mu_m - r_f)\frac{v_c}{v_m} + r_f,$$

where (μ_m, ν_m) is the accepted risk-return trade-off in the economy (similar to a long-run or equilibrium return to capital).[5]

5. Equation (9) is similar to the equation for a capital market line, but instead of suggesting that an exogenous covariance exists between the market portfolio and the default risk of a mortgage (which we believeis difficult, if not impossible, to define and estimate), we argue that the entry and exit of firms in the market brings about an adjustment in mortgage rates that equates the firms' willingness to take risk with the willingness of investors generally.

Using equation (9), we find r_M* from equation (4), and then solve equation (8) for x_M*, the *equilibrium* proportion of mortgages held by a traditional mortgage lender. The solution is complicated, but can be calculated without difficulty using Mathematica.[6]

The Nontraditional Mortgage Lender

Making nontraditional mortgages requires an "up-front" fixed cost investment by the lender, so that the lender "knows the market." This initial investment makes the lender's market idiosyncratic, partly protecting the nontraditional lender from competitors. Having paid to be a monopolist, the nontraditional lender chooses the nontraditional mortgage rate to maximize total revenues or:

$$\text{(10)} \qquad \text{Max } r_M^n M_n,$$

where r_M^n is the mortgage rate offered by the lender to a nontraditional mortgage borrower, and M_n is the demand for mortgages in the lender's nontraditional market.

Like the traditional lender, the nontraditional lender minimizes the variance of its portfolio subject to its target rate of return. However, the nontraditional lender can invest in Treasury securities and traditional mortgages, as well as nontraditional mortgages, or:

$$\text{(11)} \qquad \prod_n = \text{Min } x_c^2 v_c + x_n^2 v_n \quad \text{s.t.} u_p = \psi_n,$$

where ψ_n is $x_c\mu_c + x_n\mu_n + (1 - x_c - x_n)r_f$, and μ_n is the expected return on a nontraditional mortgage (defined in a manner similar to that for the traditional mortgage).

The nontraditional mortgage lender solves for the proportion of traditional and nontraditional mortgages to hold, subject to the contract mortgage rate in the nontraditional market (determined by equation (10)) and the contract rate in the traditional market (determined by equation (9)). Again, the solution is complicated but easily derived using Mathematica.

III. SIMULATION OF COMPARATIVE STATICS

To illustrate the effect of interest rate and income shocks, we use realistic parameters for our model and graph the effect of changes in interest rates, borrower income, and down payment amount on the proportion of mortgage holdings for each type of lender. For simplicity, we assume that the parameters in the utility functions and the income and savings of traditional and nontraditional mortgage borrowers are the same. We also assume that the covariance between the expected return on traditional and nontraditional mortgages is zero, although it is straightforward to use a given covariance structure. The complete list of parameter assumptions is given in the Appendix.

The cumulative default rate for Freddie Mac mortgages during the 1980s and early 1990s was about 2.16 percent, with default rates ranging from 0.79 to 6.2 percent, depending on the loan-to-value ratio for the mortgage. This range implies annual default rates from under 0.08 percent to as high as 0.6 percent. For FHA loans, the cumulative default rates range from 5 percent to 15 percent, implying annual default rates ranging from 0.5 to 1.5 percent.[7] We will assume that traditional mortgage borrowers default at an annual rate of 0.08 percent and that nontraditional default at 0.50 percent.

For Freddie Mac, losses on a foreclosure run about 40 percent on their typical *conforming* mortgage of roughly \$110,000.[8] Losses on FHA mortgages range from 45 to 55 percent. Thus, once a mortgage defaults, there seems to be little variance in the losses incurred as a proportion of the mortgage. We assume that losses on defaults are 40 percent of the loan amount for both traditional and nontraditional borrowers.

Another parameter of interest is the cost of underwriting. We assume that traditional borrowers cost 1 percent of the mortgage amount to underwrite, and nontraditional cost 3 percent. The average cost of mortgage origination in 1989 has been estimated to range from 1 to 2 percent.[9] According to the trade press, total origination costs for the average mortgage in 1994 appear to be somewhat above 2 percent, but this cost involves much more than underwriting.

For the returns on investments, we base parameters on data from 1986 to 1996. In our simulations, we use the return and standard deviation for Treasury bonds for the market's expected risk-return trade-off on a portfolio of mortgages and bills. We use the return on Treasury bills for the bank's cost of funds in those simulations where we vary parameters other than the bank's cost of funds. From 1986 to 1996, Treasury

6. Laderman and Passmore (1998) is an expanded version of this paper, containing the Mathematica code.

7. For Fannie Mae and Freddie Mac delinquency rates, see their 1995 annual reports. For Freddie Mac's cumulative default rate and losses on foreclosure, see R. Van Order and P. Zorn (1995). For FHA default rates, see Berkovec, et al. (1998). For an analysis which includes a comparison of the default and loss rates of these institutions see G. Canner, W. Passmore, and B. Surette (1996).

8. However, if mortgage payments are brought up to date through either a loan modification or a home sale prior to foreclosure, the losses may fall to a range of 6 percent to 22 percent. See "Examining Secondary Market Trends," *America's Community Banker,* April 1996.

9. See Passmore (1992).

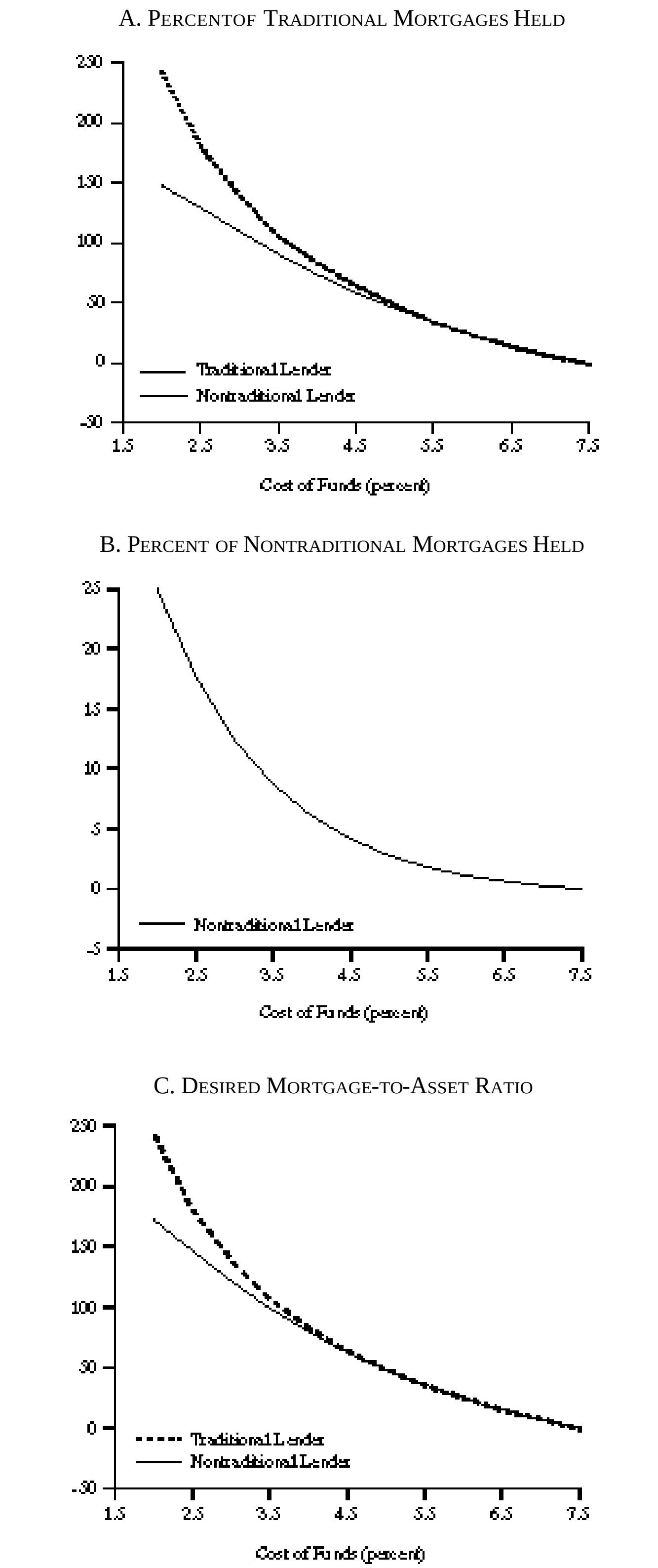
bonds yielded 7.5 percent, with a standard deviation of 1 percent, while Treasury bills yielded 6.01 percent.[10]

We first examine the effect on the proportion of mortgages held by traditional and nontraditional lenders of a change in their cost of funds. The yield paid for their funds is r_f, the yield paid on the risk-free investment alternative available to the lenders. As the depository's cost of funds increases with interest rates, the proportion of total mortgages held in lenders' portfolios declines because the relative attractiveness of Treasury securities rises (top panel, Figure 1). The traditional lender contracts its share of traditional mortgages (the only type of mortgages it holds) more quickly than the nontraditional lender because the marginal profit on a traditional mortgage, while falling rapidly compared to a Treasury security, is not falling as rapidly as the marginal profitability of a nontraditional mortgage. Thus, the traditional-only lender is substituting Treasuries for traditional mortgages, while the nontraditional lender is substituting Treasuries for both traditional and nontraditional mortgages, and also is substituting traditional for nontraditional mortgages. As shown in the middle panel of Figure 1, the proportion of nontraditional mortgages held by the nontraditional lender falls rapidly as rates rise.[11]

When examining the mortgage-to-asset ratio (bottom panel of Figure 1), which will be the variable of interest in the empirical work that follows, the traditional lender contracts more rapidly than the nontraditional lender at lower levels of interest rates, but the contraction by these lenders becomes almost identical at higher levels of interest rates. These representative simulations suggest that changes in mortgage-to-asset ratios of lenders in response to interest rate shocks are unlikely to differ much by type of lender.[12]

FIGURE 1

THE EFFECT OF INTEREST RATE SHOCKS ON MORTGAGE HOLDINGS



10. We also conducted simulations using return parameters based on long-run historical data from 1926 to 1991. (See Laderman and Passmore 1998.) These simulations showed responses that were qualitatively similar to the simulations based on the more recent data.

11. Note that the level of the nontraditional mortgage-to-asset ratio is usually very small relative to the level for the traditional mortgage-to-asset ratio. There is little empirical evidence about the level of nontraditional mortgages. For a brief time, the OTS collected information from savings associations on the amount of mortgages they made with greater than 80 percent loan-to-value ratios and with no private mortgage insurance. This type of mortgage often is extended to nontraditional borrowers. Many of the institutions had less than 5 percent of their mortgages in this category.

12. Note that the desired amount of mortgages can be negative or can exceed 100 percent, depending on their relative return. If the institution has the ability to "short" mortgage securities or Treasury securities, it might pursue these strategies. Otherwise, we could assume the mortgage-to-asset ratio is capped at zero or 100 percent. For the discussion of the comparative statics, this makes no difference.

Similarly, changes in the expected return on a market portfolio (Figure 2) are very similar for lenders with high or low proportions of nontraditional mortgages in their portfolios. In addition, these changes affect the proportion of mortgages of all lenders in a linear and direct fashion, with increases as the expected return on the portfolio increases (holding risk—which results only from holding mortgages—constant) resulting in larger relative holdings of mortgages.

Income shocks have very different effects on traditional and nontraditional lenders (Figure 3). In our model, traditional mortgages are provided by a classic, atomistic group of suppliers. Changes in the level of income of traditional mortgage borrowers result in changes in the overall size of the traditional mortgage market, but do not result in changes in the relative proportion of assets allocated to mortgages by traditional lenders (top panel, Figure 3). In contrast, nontraditional mortgages are provided by lenders who "know their community" and see the downward slope of the community's demand curve. Thus, an increase in these borrowers' incomes raises the profitability of providing mortgages to these borrowers, causing the ratio of nontraditional mortgages to assets to rise (middle panel, Figure 3) and the ratio of traditional mortgages to assets to fall at nontraditional lenders (top panel, Figure 3).

As shown in the bottom panel, the fall in traditional mortgages can exceed the rise in nontraditional mortgages at nontraditional lenders, with the result that a positive income shock has a negative effect on the mortgage-to-asset ratio at nontraditional lenders. (But a nonnegative relationship between income and the mortgage-to-asset ratio, or one that is only slightly different from that experienced by traditional lenders, is also possible.) As will be seen below, the possibility of a non-zero response is a key distinction in our effort to separate lenders who provide a commodity-like mortgage product from those who serve markets with nontraditional borrowers.

Similarly, changes in house prices (which, in our model, are equal to changes in down payment requirements) have different effects on traditional and nontraditional lenders (Figure 4). Higher home prices (or higher down payment requirements) cause consumer demand for mortgages to contract. The effects are equivalent to a negative income shock, with the marginal profitability of nontraditional mortgages falling as housing prices or down payment requirements rise, and lenders then contracting the proportion of nontraditional mortgages in their portfolios (middle panel). However, overall mortgage-to-asset ratios at nontraditional lenders rise, as relatively more traditional mortgages (with their small marginal profits) are added to compensate for the decline (bottom panel). Traditional lenders, who do not see consumer demand in their

FIGURE 2

THE EFFECT OF MARKET PORTFOLIO RETURN ON MORTGAGE HOLDINGS

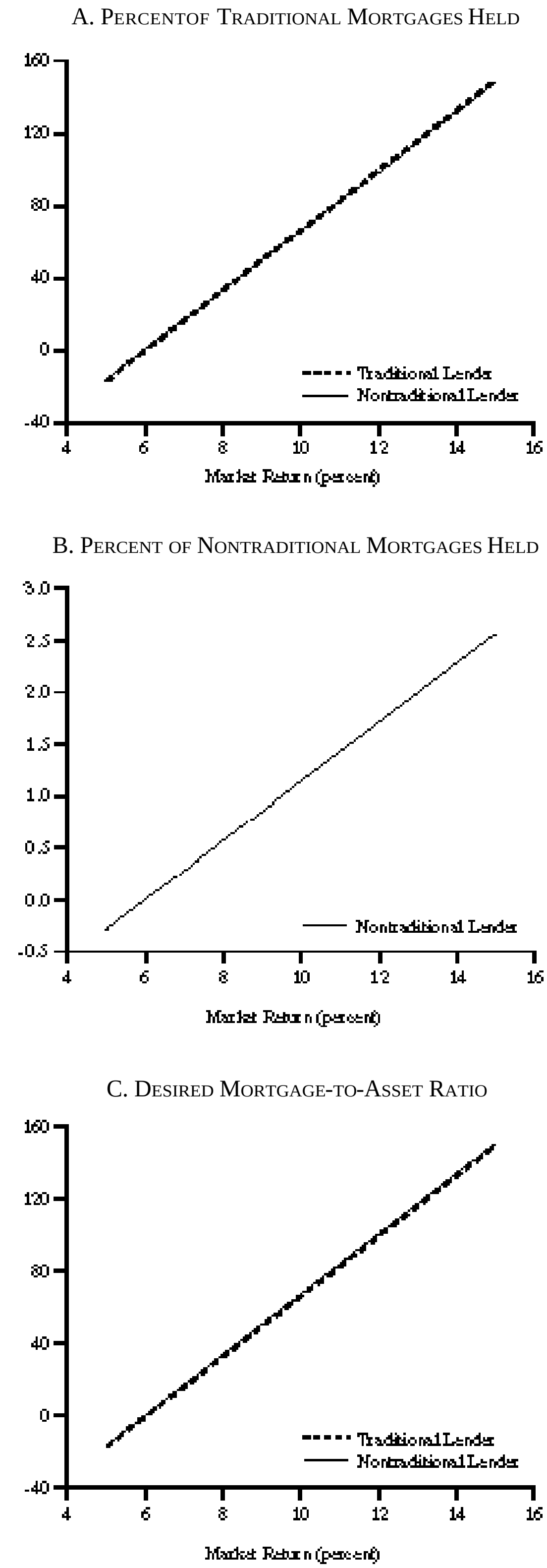
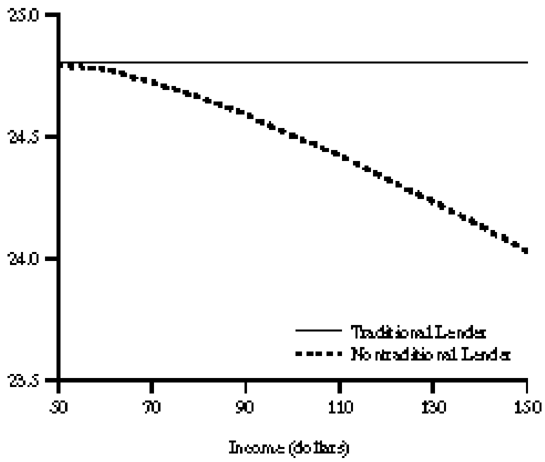


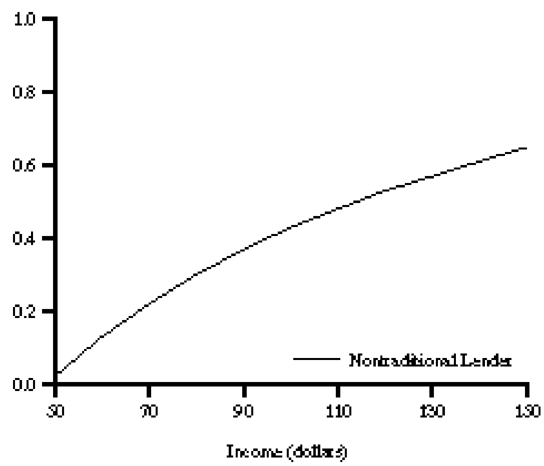
FIGURE 3

THE EFFECT OF INCOME SHOCKS ON MORTGAGE HOLDINGS

A. PERCENT OF TRADITIONAL MORTGAGES HELD



B. PERCENT OF NONTRADITIONAL MORTGAGES HELD



C. DESIRED MORTGAGE-TO-ASSET RATIO

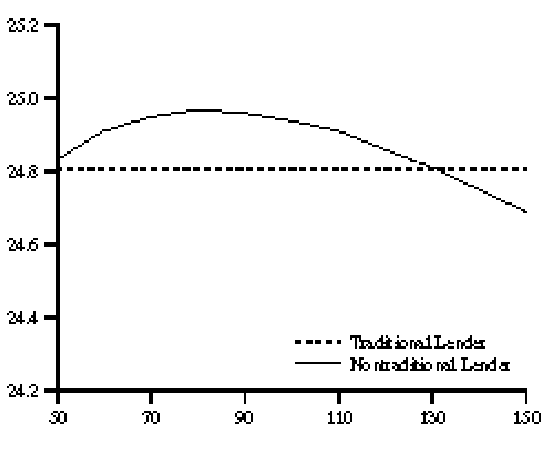
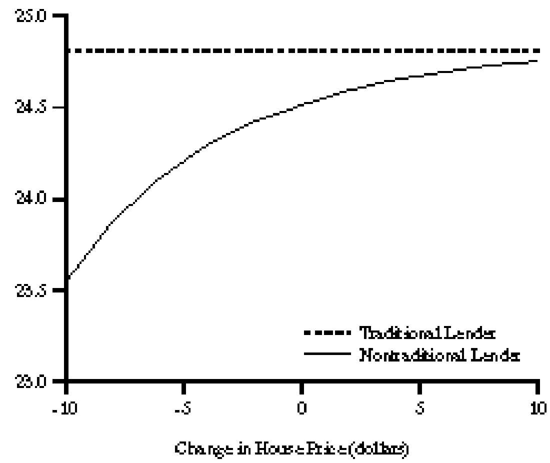


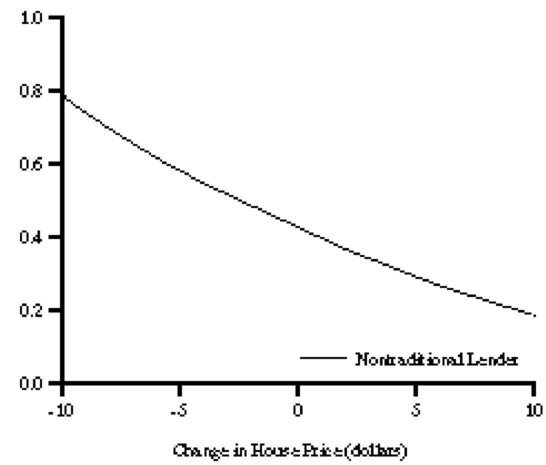
FIGURE 4

THE EFFECT OF HOUSE PRICE ON MORTGAGE HOLDINGS

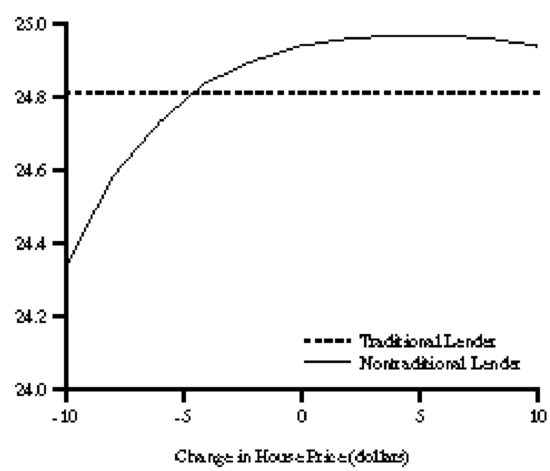
A. PERCENT OF TRADITIONAL MORTGAGES HELD



B. PERCENT OF NONTRADITIONAL MORTGAGES HELD



C. DESIRED MORTGAGE-TO-ASSET RATIO



objective functions, do not change the relative proportions of their portfolios.

Finally, we calculated the mortgage rates implied by our model (Figure 5). Traditional mortgage rates vary with interest rates and span a reasonable range of values. Nontraditional mortgage rates are set at the revenue-maximizing level and are not influenced by other interest rates. Generally, the nontraditional rate derived from our simulations is higher than the traditional rate.

IV. A REGRESSION ANALYSIS OF BANK AND SAVINGS ASSOCIATION LENDING BEHAVIOR

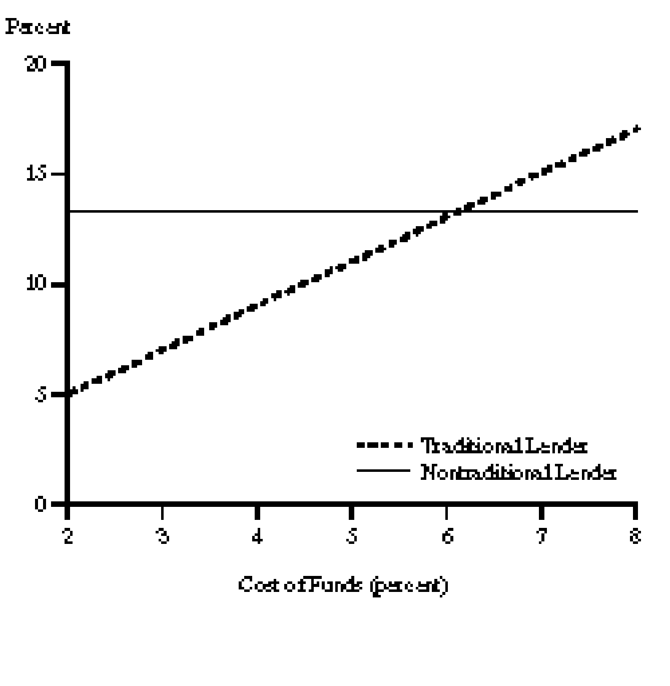
To test our theory and to describe the differences in lending behavior between commercial banks and savings associations, we develop a regression model based on the theory presented earlier. Our theory suggests that interest rates have a negative and nonlinear effect on the mortgage-to-asset ratio at both traditional and nontraditional lenders, while the market return has a positive and linear effect. For nontraditional lenders, both the income of borrowers and house prices can affect the mortgage-to-asset ratio, but for traditional lenders, income and house prices have no effect.

Let m_t be the mortgage-to-asset ratio, and assume that the depository institution desires to move this ratio to a ratio of m_t*. We assume a partial-adjustment process:

$$m_t = m_{t-1} + k(m_t^* - m_{t-1}), \tag{12}$$

FIGURE 5

MORTGAGE RATES



where t is a time subscript. The optimal mortgage-to-asset ratio, m_t*, is modeled as a function of interest rates, market returns, borrower incomes, house prices, and delinquency rates, as well as control variables for the region of the country and the size class of the institution.

The Linear Model

Despite the nonlinear nature of our theoretical model, our first regression has a simple linear specification. This regression provides us with initial values for the parameters in the nonlinear regression estimation, as well as a check on the robustness of other results. The linear model for the optimal mortgage-to-asset ratio is:

$$\begin{aligned} m_t^* = c &+ \alpha r_{f_t} + \beta I_t + \gamma V_t + \lambda \mu_{m_t} \\ &+ \theta_1 NE + \theta_2 S + \theta_3 MW + \theta_4 LARGE \\ &+ \theta_5 MED + \theta_6 MNPDNA. \end{aligned} \tag{13}$$

In our empirical work, we use the one-year Treasury bill interest rate for r_f, real average hourly earnings in the state in which the institution is located for I, the weighted average real value of median house prices in the state in which the institution is located for V, and the 10-year Treasury bond interest rate for μ_m.[13] *MNPDNA* is the long-run average of the ratio of the institution's past-due and nonaccruing mortgage loans to total mortgage loans, measured in percent.[14] The interest rates are measured in percent, as is the dependent variable in the regression. Real average hourly earnings are in dollars. The house price is in thousands of dollars.

---

13. The house price variable was constructed in several steps. First, median house prices for 1987 were obtained from the National Association of Realtors. These data are in thousands of nominal dollars and are available by Metropolitan Statistical Area (MSA). Next, MSA data were aggregated to the state level using population weights. Then, for each state, a time series of house prices was generated by multiplying the 1987 house price by a time series of repeat sales house price indices for that state. The house price index is normalized to be 100 in every state in 1987, so the resulting house price time series was divided by 100 to yield a time series of nominal house prices, in thousands of dollars. Nominal house prices were then converted into real house prices using the Consumer Price Index.

14. The past due and nonaccruing ratio was taken as the sum of mortgage loans past due 90 days or more plus nonaccruing mortgage loans, divided by total mortgage loans. The long-run average was taken over the years in the sample period for which data were available: 1990.Q1–1996.Q4 for savings associations and 1991.Q1–1995.Q3 for commercial banks.

The control variables *NE*, *S*, and *MW* are dummy variables, with values of 1 indicating that the institution is in the Census-defined Northeast, South, or Midwest, respectively. (The West is the omitted category.) The variable *LARGE* takes a value of 1 if the institution has total assets greater than or equal to $1 billion as of the third quarter of 1988, and the variable *MED* takes a value of 1 if the institution has total assets greater than or equal to $500 million, but less than $1 billion, as of the same date.

Our data are quarterly and cover the period from the third quarter of 1988 to the fourth quarter of 1996.[15] We screened our sample to include only institutions that existed throughout the sample period and that were well-capitalized as of the third quarter of 1988. We also excluded savings associations with unusually high (≥85 percent) or unusually low (≤10 percent) mortgage-to-assets ratios in any quarter of the sample.[16] We applied the same screens to commercial banks that we applied to savings associations. After applying these screens, we had 3,230 banks and 693 savings associations in our sample.

Figure 6 presents the time series of the cross-sectional means of the dependent variable for commercial banks and saving associations. Savings associations do much more residential mortgage lending than commercial banks; the mean mortgage-to-asset ratio over our savings association sample ranges from 48.8 percent to 54.8 percent, whereas for banks it ranges from 20.4 percent to 24.2 percent. Also, savings associations responded to the credit crunch of the early 1990s by cutting back mortgage lending sharply, while banks increased their mortgage lending at a steady pace. Table 1 presents sample statistics for the regression variables.

Model Estimation and Results

Inserting equation (12) into equation (13) and dropping the t subscripts on r_f, I, V, and μ_m, we estimate the following regression equation:

$$
\begin{aligned}
(14)\qquad m_t = {} & (1-k)m_{t-1} + kc + k\alpha r_f \\
& + k\beta I + k\gamma V + k\lambda\mu_m + k\theta_1 NE \\
& + k\theta_2 S + k\theta_3 MW + k\theta_4 LARGE \\
& + k\theta_5 MED + k\theta_6 MNPDNA + \varepsilon,
\end{aligned}
$$

where ε is a normally distributed error term.

The regression results are presented in the second and third columns of Table 2. Except for m_{t-1}, we present only the long-run coefficients, which affect the desired mortgage-to-asset ratio. The results suggest that the banks behave as predicted by the theoretical model: the long-run

15. Since the regression includes the lagged dependent variable on the right-hand side, the first observation for the dependent variable is in the fourth quarter of 1988.

16. In addition, we use only savings associations whose regulator—the OTS—is separate from the regulators of commercial banks.

FIGURE 6

MEAN OF THE MORTGAGE-TO-ASSET RATIO

A. COMMERCIAL BANKS

B. SAVINGS ASSOCIATIONS

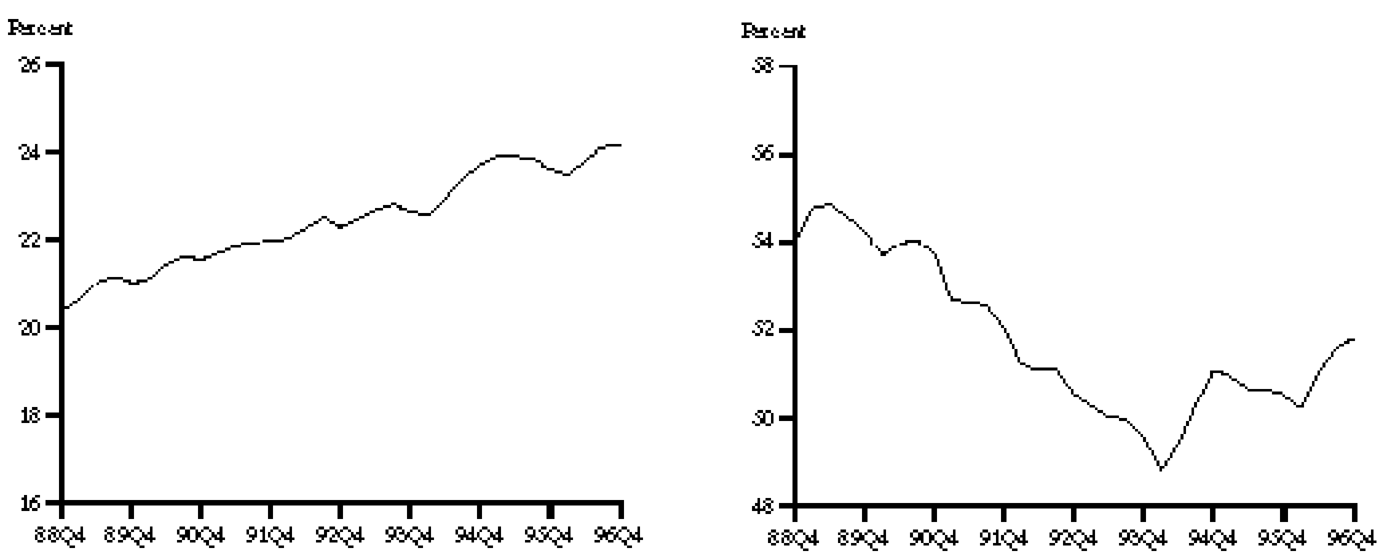


TABLE 1

SAMPLE STATISTICS FOR REGRESSION VARIABLES
COMMERCIAL BANKS

VARIABLE	MEAN	MEDIAN	MINIMUM	MAXIMUM	S.D.
m_t	22.44	20.77	10	80.89	8.21
r_f	5.89	5.64	3.18	9.57	1.77
I	2.76	2.79	2.02	3.75	0.31
V	29.15	28.05	13.83	83.98	7.04
μ_m	7.26	7.2	5.36	9.36	1.05
NE	0.1	0	0	1	0.29
S	0.39	0	0	1	0.49
MW	0.47	0	0	1	0.5
LARGE	0.005	0	0	1	0.07
MED	0.009	0	0	1	0.09
MNPDNA	0.91	0.64	0	11.93	0.95

SAVINGS ASSOCIATIONS

VARIABLE	MEAN	MEDIAN	MINIMUM	MAXIMUM	S.D.
m_t	51.79	52.63	10.37	84.81	51.41
r_f	5.89	5.64	3.18	9.57	1.77
I	2.82	2.83	2.02	3.75	0.3
V	31.05	28.5	13.83	83.98	8.96
μ_m	7.26	7.2	5.36	9.36	1.05
NE	0.2	0	0	0.1	0.4
S	0.32	0	0	0.1	0.47
MW	0.4	0	0	0.1	0.49
LARGE	0.03	0	0	0.1	0.16
MED	0.04	0	0	0.1	0.18
MNPDNA	1.26	0.83	0	17.34	1.43

coefficient on the risk-free rate is negative and significant, and the coefficient on the market return is positive and significant. In contrast, for savings associations, the coefficient on the risk-free rate is positive and significant, while the coefficient on the market return is negative and significant.[17]

The estimation also indicates that there is no statistically significant difference between how banks' and savings associations' mortgage-to-asset ratios respond to changes in income or changes in house prices. We calculated 90 percent confidence intervals for the estimates of the long-run coefficients on income and house prices for the two types of institutions and found that they overlapped.

To check our results that the responses of the mortgage-to-asset ratio to changes in income and the home price at banks and savings associations are not significantly

17. Both the risk-free interest rate and the 10-year Treasury bond rate were on a declining trend from the end of 1988 to about the end of 1993, and then turned up for about a year before leveling off.

TABLE 2

LINEAR REGRESSION RESULTS FOR MORTGAGE-TO-ASSET RATIO: FULL SAMPLE

EXPLANATORY VARIABLE	COMMERCIAL BANKS (98,408 OBSERVATIONS, ADJUSTED R^2=0.96)	SAVINGS ASSOCIATIONS (21,177 OBSERVATIONS, ADJUSTED R^2=0.974)	
		UNCONSTRAINED REGRESSION	CONSTRAINED REGRESSION
m_{t-1}	0.981*** (0.001)	0.985*** (0.001)	0.985*** (0.001)
constant	-0.993 (4.45)	43.8*** (16.9)	-7.03 (16.2)
r_f	-1.11*** (0.302)	9.64*** (1.41)	0 (0)
I	4.35*** (1.15)	1.17 (4.82)	2.14 (4.87)
V	0.142*** (0.043)	-0.23 (0.161)	-0.169 (0.162)
μ_m	3.91*** (0.537)	-6.21*** (2.14)	7.85*** (1.2)
NE	8.87*** (1.63)	-8.91* (5.09)	-8.78* (5.14)
S	1.26 (1.49)	-1.56 (5.04)	-0.737 (5.09)
MW	1.79 (1.45)	-0.168 (5.21)	0.396 (5.27)
LARGE	-3.78 (4.09)	6.68 (7.38)	0.617 (7.45)
MED	-5.14* (3.02)	-6.93 (6.24)	-7.04 (6.31)
MNPDNA	-3.0*** (0.317)	-2.42*** (0.887)	-2.49*** (0.898)

NOTE: Except for m_{t-1}, reported numbers are partial derivatives of m^*; standard errors are in parentheses.

* (***) statistically significant at the 10 (1) percent level

different, we also estimate the linear model with our theoretical constraints imposed on the long-run coefficients for the risk-free rate and the market return in the savings association regression. Specifically, we restrict the coefficient on the risk-free rate to be less than or equal to zero and the coefficient on the market return to be greater than or equal to zero.

Imposing the constraints on the estimation of the risk-free rate and market return coefficients results in a zero coefficient for the risk-free rate and a positive and significant coefficient for the market return for savings associations (last column). These results are more consistent with the simulations of the theoretical model than were the unconstrained regression results for savings associations.

As in the unconstrained regression, the savings associations' long-run income and home price coefficients are not significantly different from those of banks. Based on these results, one cannot say that savings associations behave more like the theoretically modeled nontraditional lender than do commercial banks. However, two considerations cloud the interpretation of this result. First, our model suggests that the partial derivative of the mortgage-to-asset ratio with respect to home prices is dependent on the levels of other variables. Second, the unconstrained savings associations' results depart from the predictions of the theoretical model about how the mortgage-to-asset ratio is affected by the risk-free interest rate and the market return. We can correct for the first problem by turning to a nonlinear model.

The Nonlinear Model

The basic nonlinear model for the desired mortgage-to-asset ratio is:

$$(15) \quad m_t^* = \delta r_f^{\alpha} I^{\beta_0} V^{\gamma_0} + \beta_1 I + \gamma_1 V + \lambda \mu_m + \theta_1 NE + \theta_2 S + \theta_3 MW + \theta_4 LARGE + \theta_5 MED + \theta_6 MNPDNA.$$

The form of equation (15) was suggested by three features of the simulation results shown in Figures 1–4. First, the partial derivatives of the mortgage-to-asset ratio with respect to the risk-free interest rate, income, and the value of the house can be nonlinear, while the partial derivative with respect to the market return is linear for both traditional and nontraditional lenders. Second, the shapes of the partial derivatives of nontraditional lenders' mortgage-to-asset ratios with respect to the risk-free rate, income, and house price depend on the other variables. Third, the simulation results show that the partial derivatives of nontraditional lenders' mortgage-to-asset ratios with respect to income and home price may be concave. Including the parameter and the linear income and home price terms permits enough flexibility in the functional form so that the partial derivatives of the mortgage-to-asset ratio with respect to income and home price can be concave.

Inserting equation (12) into equation (15), we attempted to estimate the following nonlinear equation[18]:

$$(16) \quad m_t = (1-k)m_{t-1} + k\delta r_f^{\alpha} I^{\beta_0} V^{\gamma_0} + k\beta_1 I + k\gamma_1 V + k\lambda\mu_m + k\theta_1 NE + k\theta_2 S + k\theta_3 MW + k\theta_4 LARGE + k\theta_5 MED + k\theta_6 MNPDNA + \varepsilon.$$

The estimation of this model converged for savings associations but not for banks, so we simplified the specification to exclude the linear terms in income and home price. This restricts the partial derivatives with respect to income and home price to be either positive or negative throughout (with the slope either decreasing or increasing throughout), constant, or zero. Note that this excludes the possibility of a positive and decreasing slope turning to a negative and decreasing slope as income or home price increases. In other words, it excludes the possibility of a concave shape for the derivative.[19]

18. In order to do the nonlinear estimation, we had to provide initial values for each of the parameters. Setting δ=1 and β_1=γ_1=0, and using sample means for the explanatory variables, we assigned initial parameter values so as to equate the value of each of the partial derivatives in the nonlinear regression with the corresponding partial derivative in the corresponding (bank or savings association) unconstrained linear regression.

19. We also attempted to estimate the following equation:

$$= \delta(\alpha_0 r_{f_t})^{\alpha_1}(\beta_0 I_t)^{\beta_1}(\gamma_0 V_t)^{\gamma_1} + \beta_2 I_t + \lambda \mu_m + \theta_1 NE + \theta_2 S + \theta_3 MW + \theta_4 LARGE + \theta_5 MED + \theta_6 MNPDNA.$$

The estimation converged for savings associations, but not for banks.

TABLE 3

NONLINEAR REGRESSION RESULTS FOR MORTGAGE-TO-ASSET RATIO: FULL SAMPLE

EXPLANATORY VARIABLE	COMMERCIAL BANKS (98,408 OBSERVATIONS, ADJUSTED R^2=0.96)	SAVINGS ASSOCIATIONS (21,177 OBSERVATIONS, ADJUSTED R^2=0.974)
m_{t-1}	0.981***	0.985***
	(0.001)	(0.001)
r_f	-0.629***	9.13***
	(0.009)	**(0.0001)**
I	0.986*	-1.23
	(0.055)	**(0.794)**
V	0.038*	-0.06
	(0.07)	**(0.735)**
μ_m	4.03***	-4.98**
	(0.202)	(2.08)
NE	9.1***	-7.17
	(1.53)	(5.06)
S	2.26*	0.802
	(1.28)	(4.95)
MW	3.62***	3.67
	(1.28)	(5.05)
$LARGE$	-4.15	5.89
	(4.07)	(7.42)
MED	-4.88	-7.53
	(3.0)	(6.3)
$MNPDNA$	-2.99***	-2.48***
	(0.315)	(0.898)

NOTE: Except for m_{t-1}, reported numbers are partial derivatives of m^*; standard errors are in unbolded parentheses; significance levels are in bold parentheses.

* (**) (***) statistically significant at the 10 (5) (1) percent level

The simplified regression model then is:

$$(17)\quad m_t = (1-k)m_{t-1} + k\delta r_f^{\alpha} I^{\beta} V^{\gamma} + k\lambda\mu_m + k\theta_1 NE + k\theta_2 S + k\theta_3 MW + k\theta_4 LARGE + k\theta_5 MED + k\theta_6 MNPDNA + \varepsilon.$$

The estimation of equation (17) converged for both banks and savings associations (Table 3). Again, except for m_{t-1}, we report only the partial derivatives of the optimal mortgage-to-asset ratio with respect to each of the variables. For both banks and savings associations, we evaluate these partial derivatives at the pooled sample (banks and savings associations together) means for the explanatory variables. Using the same values for the relevant explanatory variables to calculate the partial derivatives that depend on these variables in the bank and savings association regressions ensures that any differences in these partial derivatives are due to factors other than differences in the underlying variables.

As in the linear regressions, there is no statistically significant difference between banks and savings associations in the estimated partial derivatives of their mortgage-to-asset ratios with respect to income or the house price.[20]

20. We attempted to estimate equation (17) with constraints imposed in the savings associations regression on the signs of the partial derivatives of the mortgage-to-assets ratio with respect to the risk-free interest rate and the market return, but the estimation did not converge.

High Mortgage-Ratio Banks

The regression results so far suggest that there is no difference between banks and savings associations in terms of their responses to shifts in the demand-side variables. Yet these results were derived assuming that our model adequately describes the behavior of commercial banks and

FIGURE 7

Mean of the Mortgage-to-Asset Ratio for High Mortgage Ratio Banks

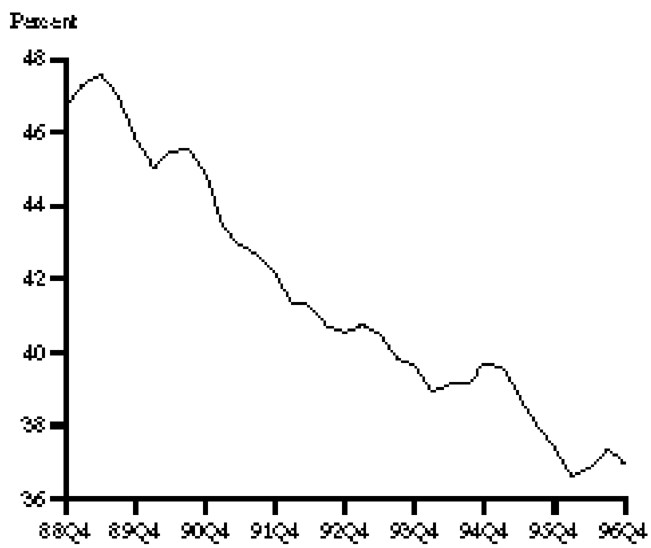


TABLE 4

Sample Statistics for Regression Variables for High Mortgage Ratio Banks

Variable	Mean	Median	Minimum	Maximum	S.D.
m_t	41.51	42.43	7.44	80.89	11.08
r_f	5.89	5.64	3.18	9.57	1.77
I	2.79	2.81	2.02	3.75	0.31
V	32.87	30	13.83	67.54	8.56
μ_m	7.26	7.2	5.36	9.36	1.05
NE	0.33	0	0	1	0.47
S	0.34	0	0	1	0.47
MW	0.26	0	0	1	0.44
LARGE	0	0	0	0	0
MED	0	0	0	0	0
MNPDNA	1.15	0.88	0.03	5.54	1.01

savings associations. Empirically, commercial banks seem to conform to our model, whereas savings associations do not, suggesting that our model may not correctly capture the behavior of depository institutions that specialize in mortgage lending.

By selecting a group of banks that specialize in mortgage lending, we can extend our comparison of mortgage-lending behavior and, in the process, determine if our model of a depository institution is adequately capturing the response of mortgage-oriented lenders. We create a set of mortgage-oriented banks—those with a mortgage-to-asset ratio of at least 40 percent as of the third quarter of 1988. This cutoff results in only 80 banks in the sample, highlighting the strong differences in the degree of specialization in mortgages by banks and savings associations. Mortgage-oriented banks show a mean mortgage-to-asset ratio that declines in a fashion similar to the mean savings association mortgage ratio suggesting that these commercial banks undertake mortgage adjustments in a manner similar to savings associations (Figure 7).

To test this theory, we estimate equation (14) for the high mortgage ratio banks. Table 4 shows the sample statistics. (Note that all of the high mortgage ratio banks are small.) The results are reported in Table 5. The results for high mortgage ratio banks' long-run responses to changes in the home price or changes in income are not statistically significantly different from the unconstrained or constrained results for savings associations. This provides further support to the hypothesis that the savings association charter does not give savings associations special market power in mortgage lending, as compared with commercial banks.

We also estimate the nonlinear equation (17) for the high mortgage ratio banks. These results again suggest that there is no difference between high mortgage ratio banks and savings associations in terms of their responses to shifts in home price or borrower income. Finally, the negative coefficients on the interest rate and the positive coefficients on the market return in Table 5 suggest that our model does capture the behavior of depository institutions that specialize in mortgage lending.

V. CONCLUSION

This paper presents a theoretical model of lender portfolio choice between home mortgages and an alternative investment in a government security. A distinction is made between traditional lenders, who are price takers in the mortgage market, and nontraditional lenders, who invest in information in order to obtain some market power in a nontraditional mortgage market. Traditional lenders may allocate assets between government securities and mortgages to traditional borrowers, whereas nontraditional lenders may allocate assets between government securities, mortgages to traditional borrowers, and mortgages to nontraditional borrowers (those about whom the nontraditional lender has some special knowledge).

Using realistic parameter values, the comparative statics of the model are simulated, providing information on the signs and relative sizes of the partial derivatives of total mortgages with respect to the model's variables. The simulation results highlight that the traditional lender's port-

TABLE 5

REGRESSION RESULTS FOR MORTGAGE-TO-ASSETS RATIO: HIGH MORTGAGE RATIO BANKS

EXPLANATORY VARIABLE	LINEAR REGRESSION (2,478 OBSERVATIONS, ADJUSTED R^2=0.923)	NONLINEAR REGRESSION (2,478 OBSERVATIONS, ADJUSTED R^2=0.923)
m_{t-1}	0.963*** (0.006)	0.963*** (0.006)
constant	-39.4* (22.9)	—
r_f	-0.232 (1.76)	-0.232 **(0.601)**
I	17.4** (6.75)	6.48 **(0.459)**
V	-0.505** (0.235)	-0.147 **(0.429)**
μ_m	4.95 (3.02)	3.45*** (0.78)
NE	13.5* (7.12)	13.49** (6.82)
S	16.5** (6.9)	14.66** (6.28)
MW	3.69 (7.65)	3.54 (7.13)
LARGE	—	—
MED	—	—
MNPDNA	-4.54** (1.91)	-4.61** (1.92)

NOTE: Except for m_{t-1}, reported numbers are partial derivatives of m^*; standard errors are in unbolded parentheses; significance levels are in bold parentheses.

** (***) statistically significant at the 5 (1) percent level folio choice is independent of changes in demand-side variables, whereas the nontraditional lender's is not.

The model is then estimated using data for commercial banks and savings associations to determine whether savings associations are "special," that is, whether they behave more like nontraditional lenders than do commercial banks. For a large panel of banks and savings associations, the regression results suggest that savings associations are no more sensitive to changes in borrower income or home prices than are banks. However, we have concerns about how well our model describes the behaviors of savings associations, and therefore we also estimated the model using a sample of high mortgage ratio banks. Our results for high mortgage ratio banks imply that our model is not inappropriate for mortgage-oriented depository institutions, as well as confirming that savings associations do not behave more like nontraditional lenders than do banks. Therefore, it appears that the savings association charter could be eliminated without impairing lending to nontraditional mortgage borrowers.

APPENDIX: PARAMETER VALUES USED IN SIMULATIONS

PARAMETER	SIMULATION VALUE
Annual Default Rate on Conforming Mortgage	0.08 percent
Annual Default Rate on Nonconforming Mortgage	0.5 percent
Cost of Underwriting a Conforming Mortgage	1 percent
Cost of Underwriting a Nonconforming Mortgage	3 percent
Loss Rate on Both Conforming and Nonconforming Defaulted Mortgages	40 percent
Mean Return on Market Portfolio	7.5 percent
Variance on Market Portfolio	0.01 percent
Return on Short-Term Treasury Bills	6.01 percent
Income of Conforming and Nonconforming Borrowers	$100
Price of Non-housing Goods	$1
Down Payment Requirement on Both Conforming and Nonconforming Mortgages	$20
Relative Preference for Housing versus Other Goods for Both Conforming and Nonconforming Borrowers	0.1

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