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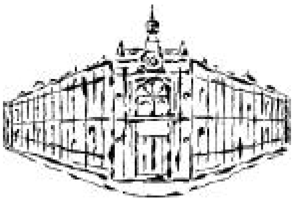

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Technology Shocks and Monetary Policy: Assessing the Fed's Performance[*]

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ABSTRACT

The purpose of the present paper is twofold. First, we characterize the Fed's systematic response to technology shocks and its implications for U.S. output, hours and inflation. Second we evaluate the extent to which that responses can be accounted for by a simple monetary policy rule (including the optimal one) in the context of a standard business cycle model with sticky prices. Our main results can be described as follows: First, we detect significant differences across periods in the response of the economy (as well as the Fed's) to a technology shock. Second, the Fed's response to a technology shock in the Volcker-Greenspan period is consistent with a optimal monetary policy rule. Third, in the pre-Volcker period the Fed's policy tended to over stabilize output at the cost of generating excessive inflation volatility. Hence our evidence reinforces recent results in the literature suggesting an improvement in the Fed's performance.

1 Introduction

Since the seminal work of Taylor (1993), many macroeconomists have shifted their attention to the analysis of the endogenous component of monetary policy, and its role in shaping the responses of nominal and real variables to different shocks. The contribution of the present paper to that research program is twofold. First, we study the behavior Federal Reserve (Fed) in response to a specific source of fluctuations: technology shocks. Second, we evaluate the extent to which such a response approximates the optimal one, or whether it can be accounted for by means of some other simple rule, using a standard dynamic sticky price model as a reference framework.[1]

We provide evidence on the economy's response to a technology shock that is based on a structural VAR, estimated using U.S. quarterly data for the period 1954-1998. Following the strategy adopted in Galí (1999), we identify a technology shock as the only source behind the unit root in labor productivity. We analyze the estimated dynamic responses of a number of real and nominal variables to that shock, and attempt to assess how the observed reaction by the Fed may have influenced the economy's response. Furthermore, and motivated by recent evidence pointing to significant changes over time in the Fed's monetary policy rule, we split the sample in two subperiods: the pre-Volcker period and the more recent Volcker-Greenspan era.[2]

Our theoretical analysis focuses on three alternative monetary policy rules. First, we derive and characterize the optimal policy. In the context of our sticky price model that policy is the one that stabilizes prices fully. We derive the equilibrium responses to a technology shock of a number of variables under such a rule, and compare those responses to the ones generated by two alternative specifications of monetary policy: a simple Taylor rule and a constant money growth rule. We then confront the three sets of theoretical responses with the empirical ones, and try to ascertain which rule– if any– provides a better approximation to the systematic response of the Fed to the supply shocks under consideration.

Our main results can be summarized as follows. First, we detect significant differences across periods in the response of interest rates, prices, and output to a technology shock. Second, the Fed's response to such a shock in the Volcker-Greenspan period is consistent with an optimal rule. Third, in the pre-Volcker period the Fed's policy tends to overstabilize output, at the cost of generating excessive inflation volatility. Hence, our evidence reinforces recent results in the literature suggesting an improvement in the Fed's performance.

The remainder of the paper is organized as follows. In section 2 we derive and characterize the economy's equilibrium under the three rules considered. In section

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[1] McGrattan (1999) and Dotsey (1999), among others, have recently emphasized the role of the systematic component of monetary policy in determining the economy's response to any type of shock.

[2] See, e.g. Taylor (1999), Judd and Rudebusch (1999), and Clarida, Galí and Gertler (2000) for evidence of a regime change around the time Paul Volcker became the Fed's chairman.

3 we present our evidence on the Fed's systematic response to technology shocks, and compare the empirical responses with the theoretical counterparts. Section 4 concludes.

2 Technology Shocks and Monetary Policy in a Sticky Price Model

2.1 A Baseline Sticky Price Model

In this section we lay out a simple sticky price model that will serve as a reference framework for the analysis of the optimal monetary policy. Our model of choice is a standard version of the Calvo (1983) model with staggered price setting. Next we describe briefly the main ingredients.[3]

We assume a continuum of firms, indexed by subscript $i \in [0,1]$, each producing a differentiated good with a technology

$$Y_t(i) = A_t \; N_t(i)$$

where (log) productivity $a_t \equiv \log(A_t)$ follows the exogenous process:

$$\Delta a_t = \rho \; \Delta a_{t-1} + \varepsilon_t$$

with $\rho \in [0,1)$. For simplicity, and given our objective, we assume that such variations in aggregate productivity are the only source of fluctuations in the economy.

The representative household is infinitely-lived and seeks to maximize

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right) \tag{1}$$

subject to a (standard) sequence of budget constraints and a solvency condition, and where $C_t \equiv \left(\int_0^1 C_t(i)^{\frac{\varepsilon-1}{\varepsilon}} \; di \right)^{\frac{\varepsilon}{\varepsilon-1}}$ is a consumption index and N denotes hours of work.

The log-linearized Euler equation associated with the consumer's problem, combined with the market clearing condition $Y_t = C_t$, yields:

$$y_t = -\frac{1}{\sigma} \; (r_t - E_t\{\pi_{t+1}\} - rr) + E_t\{y_{t+1}\} \tag{2}$$

where y_t denotes (log) aggregate output, r_t is the nominal interest rate, π_{t+1} is the rate of inflation between t and $t+1$, and $rr \equiv -\log \beta$ represents the steady state real interest rate.

The labor market is perfectly competitive, with the labor supply schedule associated with the solution to the consumer's problem being given by $w_t = \sigma \; c_t + \varphi \; n_t$,

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[3] A detailed derivation can be found in Woodford (1996) and Yun (1996), among others.

where w_t denotes the (log) real wage, and $n_t \equiv \log(N_t)$. Hence, all firms face a common real marginal cost $mc_t = w_t - a_t$, which in equilibrium is given by (in logs)

$$mc_t = (\sigma + \varphi)\ y_t - (1 + \varphi)\ a_t \tag{3}$$

Each firm faces an isoelastic demand for its product (generated by the solution to the consumer's problem), and takes the path of aggregate variables as given. If all firms adjust prices optimally each period (flexible prices), the price over marginal cost markup is common across firms, constant over time, and equal to $\mu \equiv \frac{\varepsilon}{\varepsilon-1}$. Accordingly, $mc_t = -\log\mu \equiv mc$, for all t. Hence, the equilibrium processes for (log) output, (log) employment, and the expected real rate are independent of monetary policy and given by:

$$y_t^* = \gamma + \psi\ a_t$$

$$n_t^* = \gamma + (\psi - 1)\ a_t$$

$$rr_t^* = rr + \sigma\rho\psi\ \Delta a_t$$

where $\psi \equiv \frac{1+\varphi}{\sigma+\varphi}$ and $\gamma \equiv \frac{mc}{\sigma+\varphi}$. We refer to the above equilibrium values as the *natural* levels of (log) output, (log) employment, and the real interest rate, respectively.

If, on the other hand, firms face constraints on the frequency with which they adjust prices, the markup (and, hence, the real marginal cost) will no longer be constant. As a result a gap between output and its natural level may emerge, which we denote by $x_t \equiv y_t - y_t^*$ and refer to as the *output gap*. It follows from (3) and the previous definition that the output gap will be related to the percent deviation of marginal cost from its steady state level, where the latter is assumed to correspond to mc, i.e., its level under flexible prices. Formally, we have $\widehat{mc}_t = (\sigma + \varphi)\ x_t$.

The exact form of the equation describing aggregate inflation dynamics depends on the way sticky prices are modeled. Here we follow Calvo (1983), and assume that each firm resets its price in any given period only with probability $1-\theta$, independently of other firms and of the time elapsed since the last adjustment. Thus, each period a measure $1-\theta$ of producers reset their prices, while a fraction θ keep their prices unchanged. In that case, the aggregation of optimal price-setting decisions can be shown to yield the familiar new Phillips curve:

$$\pi_t = \beta\ E_t\{\pi_{t+1}\} + \kappa\ x_t \tag{4}$$

where $\kappa \equiv \theta^{-1}(1-\theta)(1-\beta\theta)(\sigma+\varphi)$.

Finally, we can rewrite equilibrium condition (2) in terms of the output gap and the natural rate of interest:

$$x_t = -\frac{1}{\sigma}\ (r_t - E_t\{\pi_{t+1}\} - rr_t^*) + E_t\{x_{t+1}\} \tag{5}$$

Equations (4) and (5), together with a specification of monetary policy (i.e., of how the interest rate is determined), describe the equilibrium dynamics of the model economy in the presence of exogenous variations in aggregate technology. Next we analyze the economy's response to such disturbances under alternative specifications of monetary policy.

2.2 The Dynamic Effects of Technology Shocks

In this section we consider three alternative specifications of the systematic component of monetary policy: the optimal monetary policy, a simple Taylor rule, and a constant money growth rule (henceforth, a *money rule*). Our analysis focuses on how the nature of that systematic component affects the equilibrium responses of different variables to a permanent shock to technology.

2.2.1 Optimal Monetary Policy

The model economy described above may be plagued by a variety of distortions (market power, valuable money, etc.). We follow a number of recent papers in the literature and maintain the assumption that all such distortions, with the exception of the existence of nominal rigidities, have already been corrected by means of appropriate non-monetary interventions.[4] Accordingly, the natural level of output and employment coincide with their efficient levels. In such an environment monetary policy should aim at attaining the allocation associated with the flexible price equilibrium. Hence, the monetary authority focuses on correcting a distortion that is monetary in nature. The optimal policy requires that

$$x_t = \pi_t = 0$$

all t.

Our baseline model turns out to have a simple and appealing property: the allocation associated with the flexible price equilibrium can be exactly replicated with an appropriate policy, at least under the assumption that productivity can be observed contemporaneously by the monetary authority. Using (5), such allocation can be implemented in practice using the interest rate rule

$$r_t = rr + \sigma\rho\psi \ \Delta a_t + \phi_\pi \ \pi_t$$

for any $\phi_\pi > 1$.[5] Hence, the equilibrium behavior of the nominal rate r_t (as well as the real rate rr_t) is represented by the process

$$r_t = (1-\rho) \ rr + \rho \ r_{t-1} + \sigma\rho\psi \ \varepsilon_t$$

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[4] See, e.g., Rotemberg and Woodford (1999), and Galí and Monacelli (1999), among others.

[5] The addition of the last term aims at eliminating the indeterminacy that would otherwise obtain. For details see, e.g. Woodford (1999) and Galí (2000).

The equilibrium response of output and employment will match that of their natural levels:

$$\Delta y_t = \rho\ \Delta y_{t-1} + \psi\ \varepsilon_t$$

$$\Delta n_t = \rho\ \Delta n_{t-1} + (\psi - 1)\ \varepsilon_t$$

Thus, as in the flexible price case, a permanent technology shock leads to a proportional change in output under the optimal policy, while the sign of the response of employment depends on the strength of the wealth effect, as determined by the size of σ. The lack of strong evidence of a unit root in hours in postwar U.S. data suggests a value for σ (and hence ψ) equal or close to one. That property motivates the calibration used below.

Notice also that the equilibrium behavior of the interest rate depends on the persistence of productivity growth. Thus, when productivity is a pure random walk ($\rho = 0$) both nominal and real interest rates remain constant.

2.2.2 A Simple Taylor Rule

Suppose now that the central bank follows the rule

$$r_t = rr + \phi_\pi\ \pi_t + \phi_x\ x_t \tag{6}$$

i.e., the nominal rate responds systematically to the contemporaneous values of inflation and the output gap. This is a version of the rule put forward by John Taylor as a good characterization of U.S. monetary policy, and analyzed in numerous recent papers.[6]

Substituting out (6) into expressions (4) and (5) the equilibrium dynamics are represented by the system:

$$\begin{bmatrix} x_t \\ \pi_t \end{bmatrix} = \mathbf{A}_R \begin{bmatrix} E_t\{x_{t+1}\} \\ E_t\{\pi_{t+1}\} \end{bmatrix} + \mathbf{B}_R\ \Delta a_t$$

where

$$\mathbf{A}_R \equiv \Omega \begin{bmatrix} \sigma & 1-\beta\phi_\pi \\ \sigma\kappa & \kappa + \beta(\sigma+\phi_\pi) \end{bmatrix} \quad ; \quad \mathbf{B}_R \equiv \sigma\rho\psi\Omega \begin{bmatrix} 1 \\ \kappa \end{bmatrix}$$

and $\Omega \equiv \frac{1}{\sigma+\phi_x+\kappa\phi_\pi}$.

As is well known, there exists a range of values for coefficients (ϕ_x, ϕ_π) such that the equilibrium is indeterminate, giving rise to the possibility of sunspot fluctuations. A necessary and sufficient condition for the previous dynamical system to have a unique solution that depends on fundamentals only (and, hence, to have well defined responses to a technology shock) is given by[7]

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[6] See Taylor (1993, 1999).

[7] See, e.g., Bullard and Mitra (1999).

$$\kappa\ (\phi_\pi - 1) + (1-\beta)\ \phi_x > 0$$

Under that assumption the stationary solution takes the form

$$\begin{bmatrix} x_t \\ \pi_t \end{bmatrix} = \rho\ \begin{bmatrix} x_{t-1} \\ \pi_{t-1} \end{bmatrix} + \Gamma\ \varepsilon_t$$

where $\Gamma \equiv [\Gamma_x, \Gamma_\pi]' = [\mathbf{I} - \rho \mathbf{A}_R]^{-1} \mathbf{B}_R$. Given the equilibrium path for x_t it is straightforward to solve for the corresponding trajectories of output and employment:

$$y_t = \gamma + x_t + \psi\ a_t$$

$$n_t = \gamma + x_t + (\psi - 1)\ a_t$$

with the equilibrium behavior of the nominal rate given by (6). Notice that in the case of a random walk process for technology ($\rho = 0$), the Taylor rule supports the optimal allocation.

Figure 1 displays the equilibrium responses of different variables to a technology shock, under a simple Taylor rule, represented by the line with squares.The output gap measured as the deviation of output from its potencial value may be considered an unobservable variable. Therefore we calibrate the rule using the value suggested in Taylor (1993) for the inflation response, namely, $\phi_\pi = 1.5$, but with $\phi_x = 0.0$.[8] For comparison purposes we also show the corresponding responses under the optimal policy, represented by the line with triangles.The remaining parameters were set at the following values: $\sigma = 1$, $\beta = 0.99$, $\varphi = 1$, $\rho = 0.2$, and $\theta = 0.75$.

We observe that under the assumed Taylor rule output and employment increase beyond their natural levels, which leads to a temporary rise in inflation. Hence, the policy response implied by the Taylor rule appears not to be sufficiently contractionary. This is reflected in the fact that the path of the real rate under that rule lies uniformly below the path associated with the optimal policy.

Notice, however, that the deviations from the optimal policy are quantitatively small. Furthermore, they could be reduced further by choosing a more aggressive response (higher values for ϕ_π and ϕ_x). Yet, it should be clear that no finite values for those parameters could possibly replicate the optimal responses. The reason is straightforward: supporting the optimal response requires that prices remain stable and that the real rate increases. Accordingly, the nominal interest rate should also increase. But the rule will not generate a rise in the nominal rate unless a deviation from the optimal response occurs (in the form of positive inflation or output gap).[9]

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[8] The notion of output gap used in conventional Taylor rules will not generally correspond to the model based concept of output gap being used here. In addition, a zero value for the coefficient ϕ_x is also consistent with the small and insignificant coefficient of detrended output in the interest rate policy estimations since 1980 (see Clarida, Gali and Gertler (2000)).

[9] It would take setting either ϕ_π or ϕ_x equal to infinity to achieve the optimal allocation. Such

2.2.3 A Monetary Targeting Rule

Suppose next that the monetary authority targets the rate of growth of the money supply. Formally,

$$m_t - m_{t-1} = \gamma_m \tag{7}$$

where m denotes the quantity of money in circulation, expressed in logs. The demand for money holdings is assumed to take a conventional form:

$$m_t - p_t = y_t - \eta \, r_t$$

Letting $m_t^* \equiv m_t - p_t - \psi a_t$ we can rewrite the money demand in terms of stationary variables only:

$$m_t^* = x_t - \eta \, r_t$$

Furthermore, it follows from the definition of m_t^* and (7) that

$$m_{t-1}^* = m_t^* + \widetilde{\pi}_t + \psi \, \Delta a_t$$

where $\widetilde{\pi}_t \equiv \pi_t - \gamma_m$. The equilibrium dynamics are now represented by the system:

$$\begin{bmatrix} x_t \\ \widetilde{\pi}_t \\ m_{t-1}^* \end{bmatrix} = \mathbf{A}_M \begin{bmatrix} E_t\{x_{t+1}\} \\ E_t\{\widetilde{\pi}_{t+1}\} \\ m_t^* \end{bmatrix} + \mathbf{B}_M \, \Delta a_t$$

where, after letting $\Theta \equiv \frac{1}{1+\sigma\eta}$,

$$\mathbf{A}_M \equiv \Theta \begin{bmatrix} \sigma\eta & \eta & 1 \\ \kappa\sigma\eta & \beta(1+\sigma\eta)+\kappa\eta & \kappa \\ \kappa\sigma\eta & \beta(1+\sigma\eta)+\kappa\eta & 1+\sigma\eta+\kappa \end{bmatrix}$$

$$\mathbf{B}_M \equiv \psi\Theta \begin{bmatrix} \rho\sigma\eta \\ \rho\kappa\sigma\eta \\ 1+\sigma\eta(1+\rho\kappa) \end{bmatrix}$$

The line with squares in Figure 2 represents the equilibrium responses of different variables to a technology shock, under the assumption that the central bank keeps the money supply unchanged. Again, the line with triangles displays the responses under the optimal policy.

A comparison of the responses under the two rules makes clear that, in the face of a favorable productivity shock, money targeting implies a monetary stance that is too tight: the resulting path for the real interest rate lies uniformly above the optimal

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a rule would potentially lead to huge instrument-instability: any small deviation of inflation or the output gap from zero (perhaps resulting from small measurement errors or imperfect credibility) would imply infinite changes in the rate. The lack of credibility of such a policy might be more than warranted since it is inconsistent with the zero-bound on nominal rates.

one. As a consequence, output does not increase as much as would be efficient, and employment declines.[10]

Notice also that the nominal rate remains unchanged under the money rule. That result, however, is not general: it hinges on our specific calibration of σ. More generally, a money rule implies that the interest rate is given by:[11]

$$r_t = rr + \gamma_m + \left(\frac{\sigma - 1}{1 + \eta}\right) \sum_{k=1}^{\infty} \left(\frac{\eta}{1 + \eta}\right)^{k-1} E_t\{\Delta y_{t+k}\} \tag{8}$$

Hence, if utility is logarithmic in consumption, the nominal rate is constant, and independent of output dynamics.[12] Furthermore, it is easy to show that money targeting will generally lead to a suboptimal response of the economy to a technology shock. The reason is simple: the optimal response requires that $\Delta y_t = \psi \Delta a_t$ *and* $r_t = rr + \sigma \rho \psi \ \Delta a_t$, for all t. But the latter conditions are not consistent with (8), except for a very specific configuration of parameter values.[13]

How significant are the deviations from the optimal responses that follow from adherence to a strict money targeting rule under our calibrated model ? The results shown in Figure 2 suggest that they are far from negligible: thus, a one percent shock to productivity leads to a change of about 150 basis points in the rate of inflation, and more than 50 basis points in employment and the output gap (the three variables remain constant under the optimal policy). On that basis one should conclude that a money targeting rule is likely to be less desirable than a simple Taylor rule, at least when technology shocks are the dominant source of fluctuations.

3 The Fed's Response to Technology Shocks: Evidence

This section provides evidence on the Fed's systematic response to technology shocks and its implications for U.S. output, hours and inflation. We also discuss the extent to which that responses can be accounted for by any of the rules considered in the previous section.

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[10] This is consistent with the predictions of Galí (1999) and Basu et al. (1999).

[11] To see this, difference the money demand equation (imposing $\Delta m_t = \gamma_m$), combine it with (2), and solve the resulting difference equation forward.

[12] The reader may notice the connection of that result with the literature on the liquidity effect. A detailed analysis along those lines can be found in Christiano, Eichenbaum and Evans (1997) and Andrés, López-Salido and Vallés (1999).

[13] See Galí (2000) for a more detailed analysis of the deviations from optimality implied by money targeting as well as other policy rules.

3.1 Identification and Estimation

The empirical effects of technology shocks are determined through the estimation of a structural VAR. Given that limited objective we do not attempt to identify other sources of fluctuations. Our identifying restriction is that only technology shocks may have a permanent effect on the level of labor productivity, as originally proposed in Galí (1999). That restriction is satisfied in a broad range of business cycle models under standard assumptions.

Our VAR model contains four variables: labor productivity, hours, the real interest rate and inflation. We specify labor productivity in log first differences, in accordance with the maintained hypothesis of a unit root in that variable. Hours are measured in log deviations from a linear trend. Both the real rate and inflation enter in levels.[14]

Our hours series is the log of total employee hours in nonagricultural establishments. Labor productivity was constructed subtracting the previous variable to the log of GDP. Both, hours and GDP were normalize by working age population. The nominal interest rate is the three-month Treasury bill rate and the price is measured with the log of the CPI. All the series used are quarterly and were drawn from CITIBASE.

Our analysis covers the sample period 1954:I-1998:III. A number of authors have argued that U.S. monetary policy has experienced important structural changes over that period. The existing evidence suggests splitting the sample into two subperiods: the pre-Volcker years and the more recent Volcker-Greenspan era.[15] In addition, we remove the period 79:III-82:II from our analysis, because of the unusual operating procedures that were effective during that episode.[16]

Next we describe the evidence, starting with the most recent subperiod.

3.2 The Volcker-Greenspan Era

Figure 3 displays, for the 1982:3-1998:3 period, the estimated response of a number of variables to a one standard deviation technology shock with their associated two standard error confidence interval. In addition, it also shows the corresponding impulse-responses under the optimal policy.[17] Figure 4 supplements that evidence by displaying the acceptance interval for the impulse responses of hours and inflation under the null hypothesis of a zero response of all horizons.[18] That null corresponds to the optimal responses in our model.

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[14] We have also estimated the VAR model with first differenced hours and inflation. None of the results were affected.

[15] See, e.g. Taylor (1993) and Clarida, Galí and Gertler (2000).

[16] See Bernanke and Mihov (1998) for formal evidence of the idiosincracy of that period.

[17] We have calibrated the technology process so it follows a random walk and the size of the shock is such that the long run response of productivity matches the point estimated obtained with the VAR.

[18] The darker bars represent the point estimates of the impulse responses and the lighter bars represent a (+/-) two standard deviation confidence intervals.

In Figure 3, we observe an impact jump in the level of productivity of about 0.3 percent. That variable stabilizes at slightly lower level later on. The output response is of a similar magnitude and sign. As a result, hours are hardly affected by the shock even though the point estimates suggest a delayed positive effect, but one which is quantitatively very small. A similar muted responses can be observe in inflation and interest rates (both nominal and real). Thus, while the estimated impact effect on real interest rate is slightly positive, we cannot reject the null of a flat response at zero for both hours and interest rates (nominal and real) as shown in Figure 4. The latter result suggests that the Fed's response to technology shocks in the Volcker-Greenspan period is consistent with the optimal one as implied by our simple sticky price model.[19]

3.3 The pre-Volcker Period

Figures 5 and 6 report the corresponding evidence for the pre-Volcker period (1954:I-1979:II). In Figure 5, the profile of the estimated response of the productivity suggests the presence of substantial positive autocorrelation in technology in contrast with the near random walk behavior observed in the Volcker-Greenspan period. Accordingly the optimal responses display in Figure 5 are based on a calibration of the technology process that seeks to mimic the estimated productivity response.[20]

Notice that the initial output response is negative; only after five quarters the effect becomes positive and keeps building up gradually. The response of hours is significantly negatively on impact; that effect is reversed only after two years.[21] It is also apparent in the figure that there exists a large deviation between those responses and the ones associated with the optimal policy. In particular, the response of GDP remains persistently below the optimal one. This is consistent with the observation of a persistent negative inflation in response to a positive technology shock, in contrast with the requirement of price stability implied by the optimal policy. Formal evidence of the significance of the deviations in hours and inflation from their optimal path can be seen in Figure 6.

Underlying those results is the response of real interest rate. The latter lies above the optimal response at most horizons which might explain the gap between the actual and optimal output responses. Even though the nominal rate is shown to decline in response to the shock, the size of the reduction falls short that of inflation, which translates into a persistently higher real rate. In other words, changes in nominal rate are insufficient to counteract the effect of technology shock on inflation.[22]

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[19] Notice that (as discussed in the previous section) given that we assume a random walk process for technology, the optimal response can be supported by a Taylor rule.

[20] To approximate the observed path of productivity we set $\rho = 0.7$ in our calibrated model.

[21] Similar findings were obtained by Galí (1999) and Basu, Fernald and Kimball (1998).

[22] This is consistent with the estimates of the unconditional interest rates rule for the same period obtained by Clarida, Galí and Gertler (2000).

A comparison of the estimated responses for the pre-Volcker period and those generated by the money rule (see Figure 2) points to many qualitative similarities. In particular, both lead to too tight a policy in response to a positive technology shock which destabilizes hours and inflation.

4 Conclusions

In this paper we have characterized the Fed's systematic response to technology shocks and its implications for U.S. output, hours and inflation. Second we evaluated the extent to which that responses can be accounted for by a simple rule (including the optimal one) in the context of a standard business cycle model with sticky prices. Our main results can be described as follows: First, we detect significant differences across periods in the response of the economy (as well as the Fed's) to a technology shock. Second, the Fed's response to a technology shock in the Volcker-Greenspan period is consistent with a optimal monetary policy rule. Third, in the pre-Volcker period the Fed's policy tended to over stabilize output at the cost of generating excessive inflation volatility. Hence our evidence reinforces recent results in the literature suggesting and improvement in the Fed's performance.

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Figure 1. The Dynamic Effects of Technology Shocks

Optimal vs Taylor

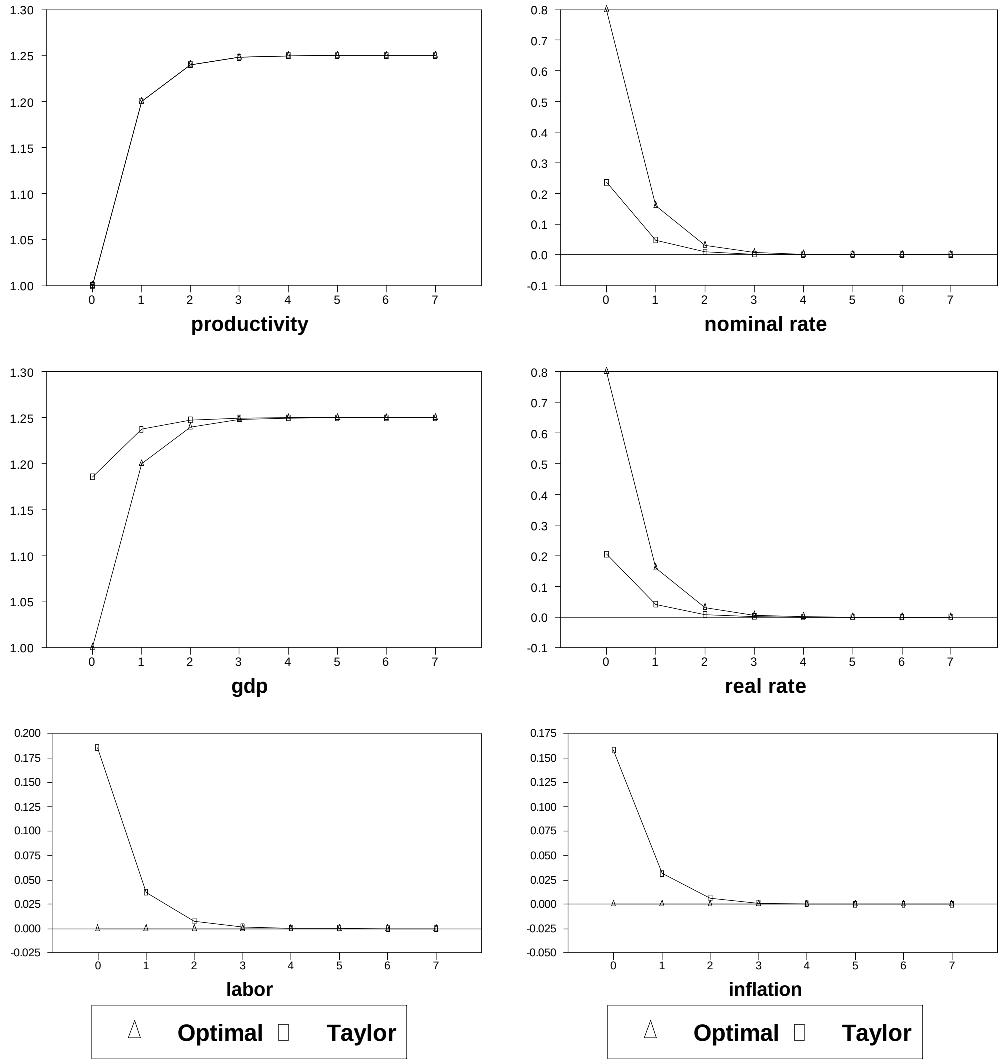

Figure 2. The Dynamic Effects of Technology Shocks

Optimal vs Money Rule

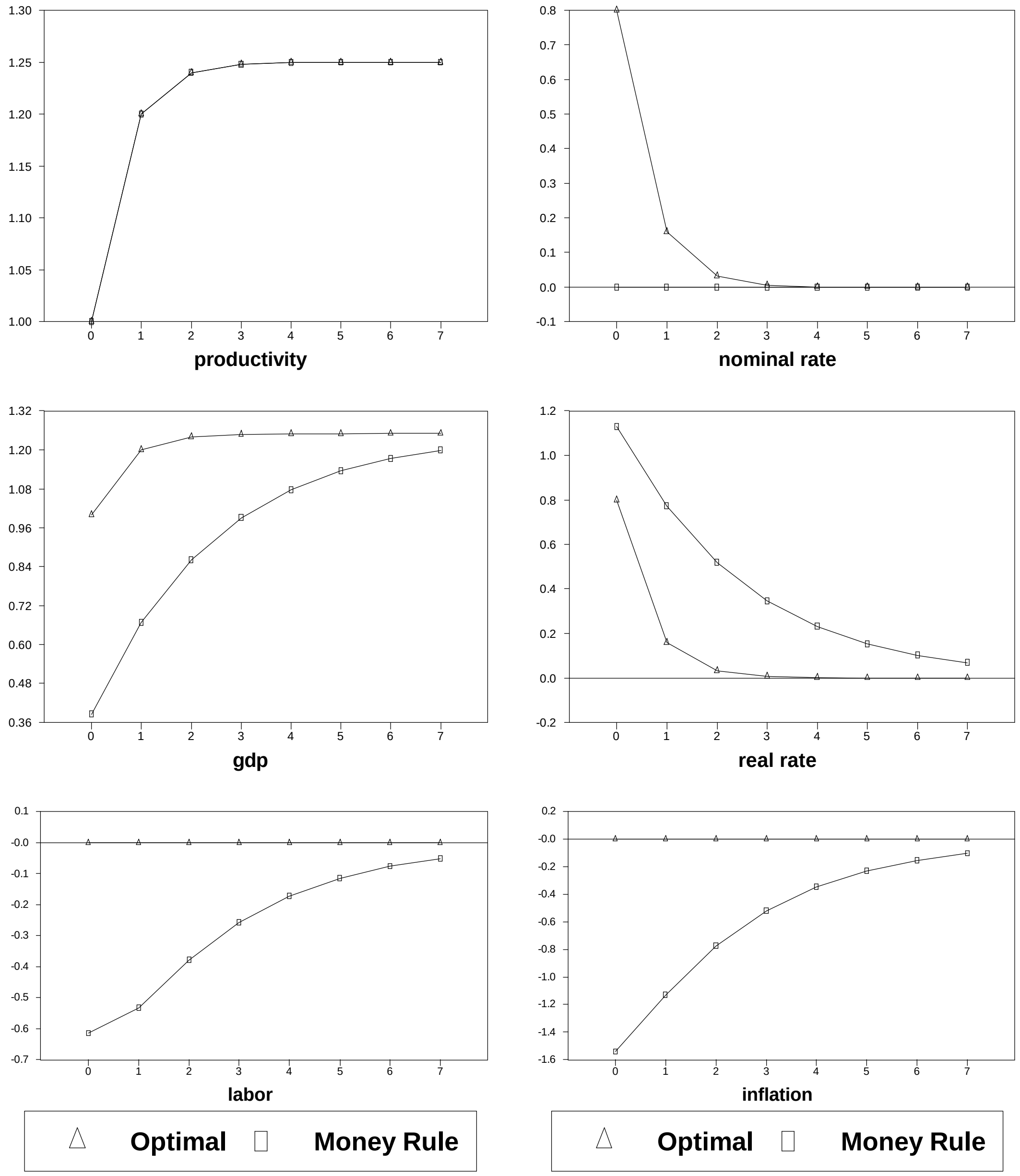

Figure 3. The Dynamic Effects of Technology Shocks

Optimal vs. Estimated (Volcker-Greenspan Period)

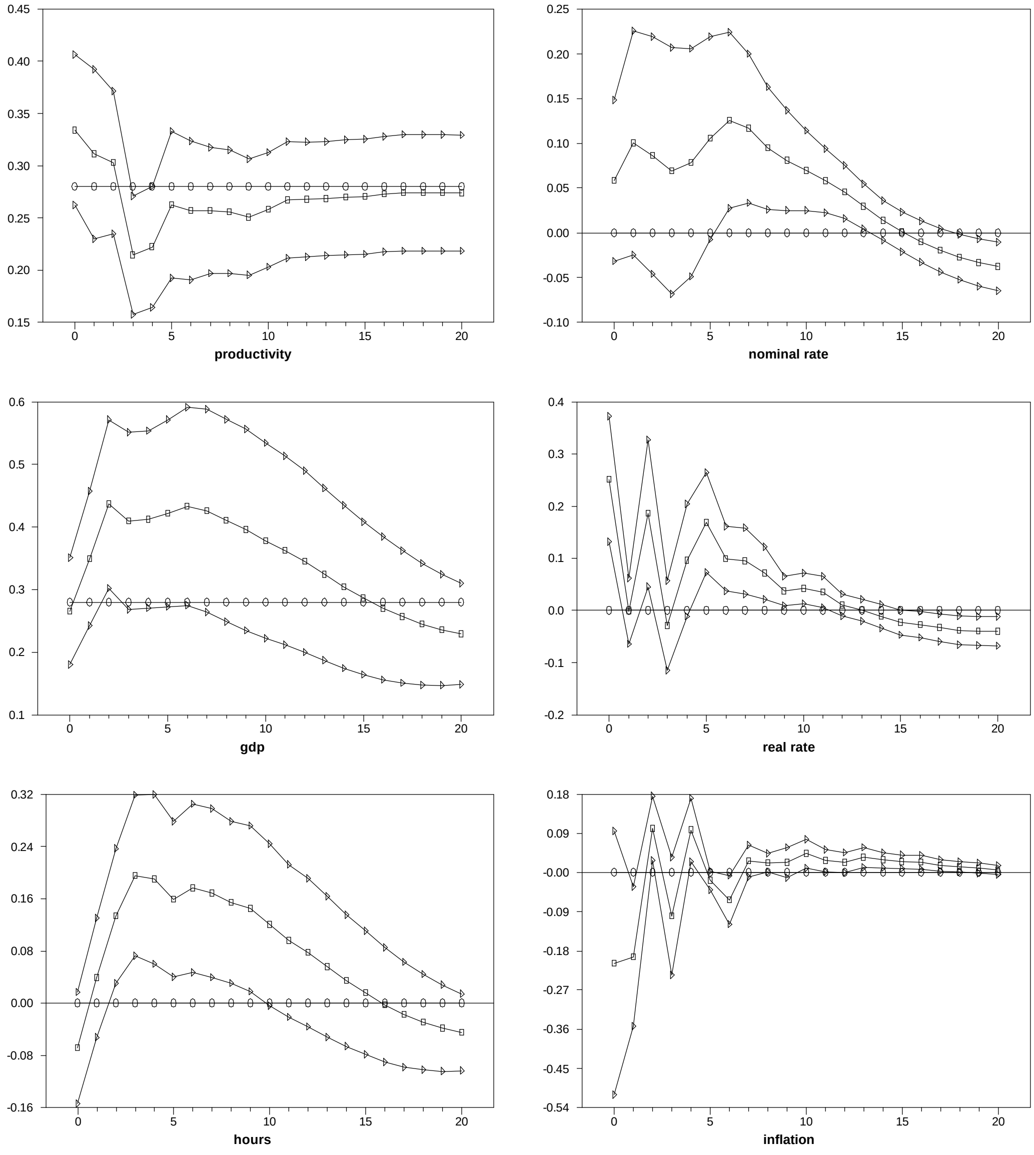

Figure 4. Testing the Optimality Hypothesis

Volcker-Greenspan

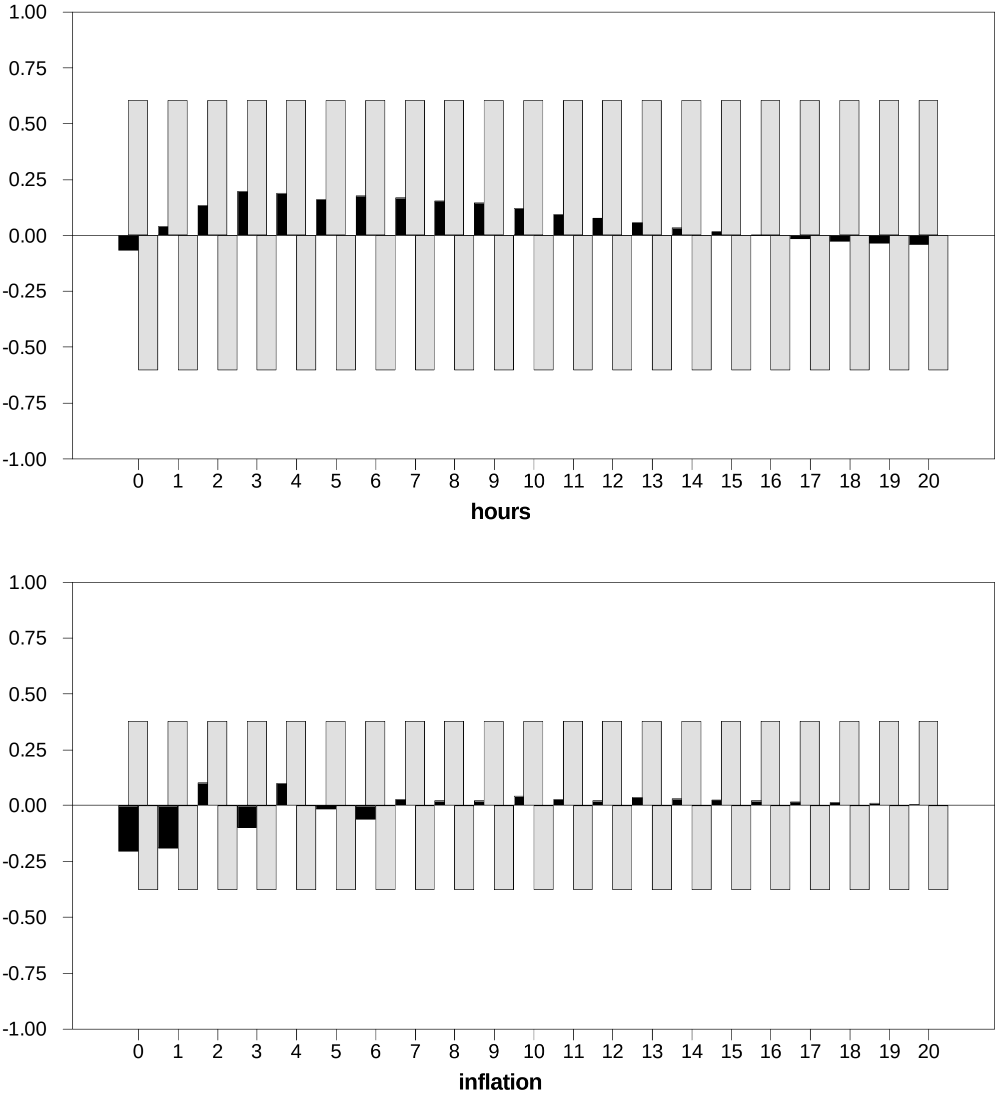

Figure 5. The Dynamic Effects of Technology Shocks

Optimal vs. Estimated (Pre Volcker Period)

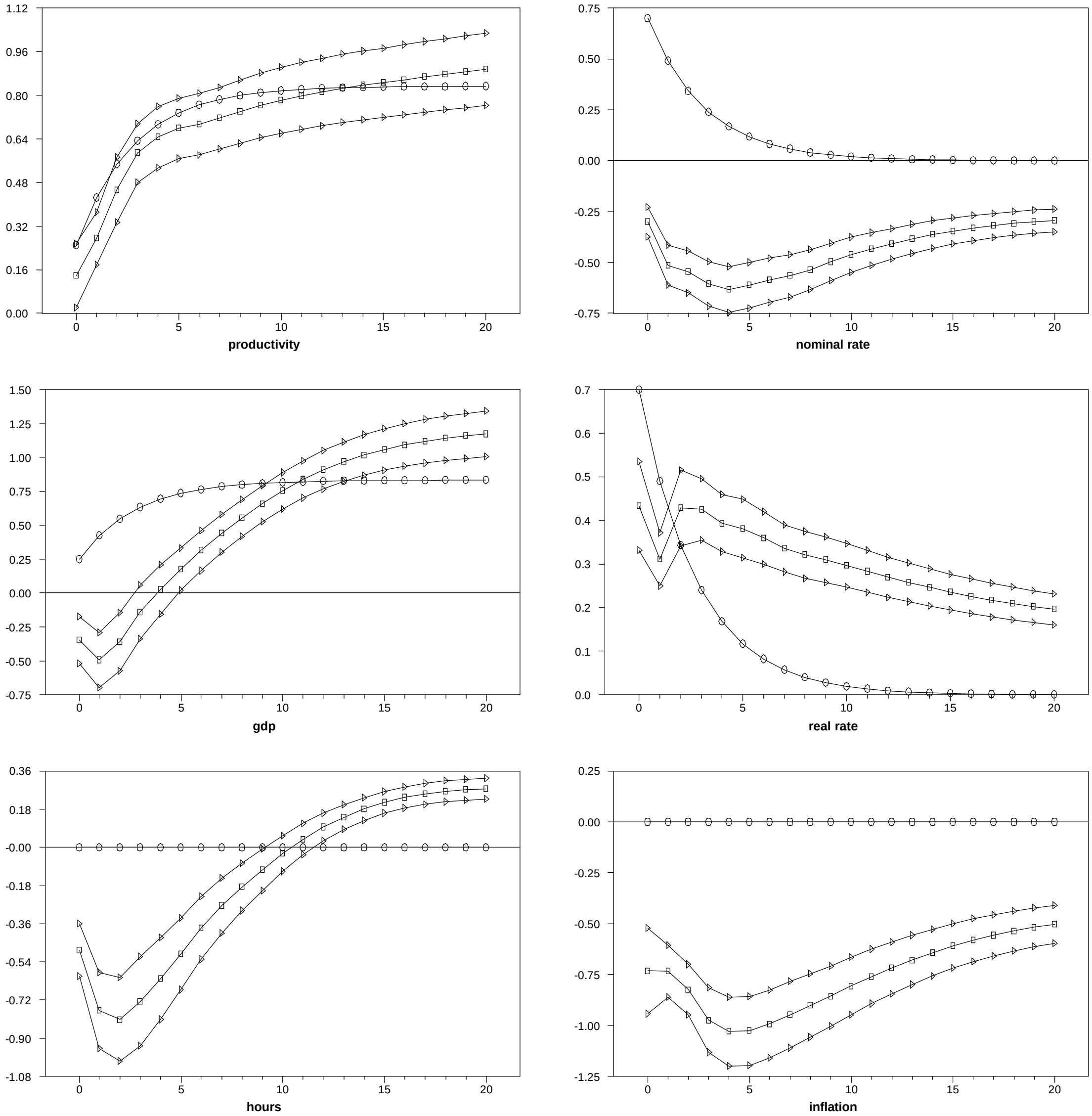

Figure 6. Testing the Optimality Hypothesis

Pre Volcker Period