On the Role of Financial Depth in Determining the Asymmetric Impact of Monetary Policy

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Abstract

This paper examines the asymmetric impact of monetary policy shocks on real output growth considering the role of financial depth. We carry out our examination using quarterly US data over 1980:q1-2011:q4 and implement an instrumental variables Markov regime switching methodology to account for the endogeneity between monetary policy and output growth. Our investigation shows that the impact of monetary policy shocks on output growth is stronger during recessions than expansions. More interestingly, we show that financial depth dampens the real effects of monetary policy shocks. We show that the results are robust to several alternative financial depth measures.

Keywords: Output growth; asymmetric effects; monetary policy; financial depth; Markov switching; instrumental variables.

JEL classification: E32, E52

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1 Introduction

A vast empirical literature examines the effects of monetary policy on output. Although some researchers suggest that monetary policy has an ambiguous or no significant impact on real output, several researchers provide evidence that over the business cycle monetary policy has asymmetric effects on the real economy.[1] For instance, it has been proposed that the asymmetric effect of monetary policy on output over the business cycle may arise from the convexity of the aggregate supply curve. Since output is initially low in the flatter part of the supply curve when the economy is in a recession, shifts in the aggregate demand due to the changes in monetary policy would result in a larger impact on output but a smaller impact on prices. In contrast, at the steeper part of the supply curve when the economy is in a state of expansion, changes in monetary policy will cause a weaker impact in output.

To explain business cycle fluctuations, several other researchers also point out at the role that financial market frictions play. According to this literature, the impact of monetary policy shocks on output will be higher during recessions for any change in interest rates will not only affect the cost of capital but also the premiums that firms face due to frictions in the credit markets. Hence, a monetary contraction will lead to a greater drop in demand for fixed investment capital when the economy is in recessions than in expansions.[2] In particular, Raddatz (2006) stresses that in an environment with financial market imperfections a decline in a firm's net worth will adversely affect its fixed investment decisions rendering a reduction in future output. Any decline in future output will further reduce the firm's future net worth amplifying the initial impact of the shock.

In this paper, different from the literature, we scrutinize the importance of financial market depth in conjunction with the asymmetric effects of monetary policy shocks on the economy. More concretely, we ask whether the extent of financial depth extenuates or amplifies the impact of monetary policy shocks on the economy over the business cycle. In fact several researchers point out that the level of financial depth is closely related to the scope of credit market imperfections in that economy.[3] This research suggests that an economy with higher financial depth is more likely to solve problems that arise due to asymmetric information problems as it would be easier to match a borrower with a lender mitigating the adverse effects of shocks. That is, deeper financial markets promote

[1]For example, Caballero and Engel (1992), Ball and Mankiw (1994), Clarida et al. (2000), Senda (2001) and Lubik and Schorfheide (2004) provide evidence that monetary policy has an asymmetric effect on output over the business cycle. In contrast, Stock and Watson (2003), Uhlig (2005) and Sims and Zha (2006) suggest that monetary policy has no significant impact.

[2]See, for instance Bernanke and Gertler (1989), Bernanke et al. (1996).

[3]See including Easterly et al. (2001), Denizer et al. (2002), Raddatz (2006), Beck et al. (2006).

investment efficiency and productivity growth as innovative firms can continue to raise funds from the financial markets even during economic downturns.[4]

We carry out our empirical investigation by implementing an instrumental variables Markov regime switching framework. We estimate a growth model which incorporates a measure of financial depth, monetary policy shock, an interaction term between measures of monetary policy shock and financial depth, and the lagged dependent variable. The Markov switching approach allows us to examine the asymmetric effects of monetary policy shocks and financial depth on output growth over the business cycle. The interaction term allows us to examine the interlinkages between the monetary policy and financial markets so that we can scrutinize whether there is a regime-dependency and whether the extent of financial depth dampens or amplifies the impact of monetary policy shocks over the business cycle.

Overall, a Markov regime switching framework allows the researcher to scrutinize several issues.[5] For instance, this framework allows the dependent variable (in our case the output growth rate) to depend on a latent state variable which characterizes an expansion or a recession permitting one to investigate asymmetries in the data. Also, the model gives larger relative weight to observations which are likely to coincide with recessions while estimating the recession coefficients. Hence, one can use this approach to endogenously identify the recession dates. However, in some cases the use of standard maximum likelihood estimator to estimate the Markov regime switching model may not be suitable. In particular, if the estimator does not take into account the correlation between the explanatory variables and the disturbance term when some of the explanatory variables are endogenous, the estimates will be inconsistent and suffer from within-regime orthogonality failures. Here, to overcome the endogeneity problem, we simultaneously estimate an output growth equation and an instrumenting equation for the monetary policy measure while we determine the state dependent parameters for the variables in question.

We carry out our investigation using quarterly US data over the period 1980:q1–2011:q4. This choice is due to the observation that the effectiveness of monetary policy in the US has changed since the 1980s. For instance, Barth and Ramey (2000), Boivin and Giannoni (2002) argue that since the beginning of the 1980s real effects of monetary policy have diminished in the US. Boivin and Giannoni (2002) point out that the reason behind the diminishing real effects of monetary policy in the US is the increased emphasis on output and inflation stabilization over time. Their argument is in line with that of Leeper et al. (1996) who show that only a minor part of the variance in output in the

[4] Greenwood et al. (2010) provide an analytical model along these lines.

[5] See Garcia and Schaller (2002) further along these lines.

US since 1960s can be explained by changes in the monetary policy. Furthermore, Barth and Ramey (2000) state that the financial innovations introduced with the beginning of the 1970s and the deregulations of the early 1980s have increased the available sources of funds for banks and firms and thereby removed the restrictions on the availability of working capital. They argue that the weakening of the real effects of monetary policy in the US since the 1980s may be explained with these changes in the financial structure. On this account, to avoid the possibility of overestimating the effects of monetary policy on output growth, we do not use the pre-1980 period in our investigation.

We carry out our examination for three different financial depth measures including i) the ratio of claims on the nonfinancial private sector to total domestic credit (excluding credit to money banks); ii) the ratio of claims on the nonfinancial private sector to GDP[6]; iii) the value of credits by financial intermediaries to the private sector divided by GDP.[7]

The empirical results obtained for all three measures are similar and can be summarized as follows. Monetary policy has a regime dependent impact on output growth. The impact of an increase in interest rates is negative and significant during recessions, and negative but insignificant during expansions. Furthermore, the magnitude of the impact of monetary policy shocks is more than ten times higher in recessions than that in expansions. When we examine the role of the interaction term between monetary policy shocks and the financial depth, we observe that financial deepening significantly mitigates the adverse impact of monetary policy shocks in recessions. In this context, in recessions, the total impact of monetary policy shocks on output growth becomes much milder while its adverse effects diminish as financial depth increases. Our investigation also provides evidence that higher financial depth fosters output growth during recessions and that it does not exert a significant impact during expansions. This makes sense for firms suffer from financial frictions mostly during periods of bottlenecks as they are hampered by falling revenues and increasing interest payments which affect firms' net worth eventually debilitating their borrowing capacity.

In what follows, we summarize the empirical literature to date in Section 2. We present the instrumental variables Markov regime switching methodology, the empirical model and the data in Section 3. Empirical results are discussed in Section 4. Section 5 concludes the paper.

[6]See King and Levine (1993) for the first two measures.

[7]This measure includes only credits issued by banks and other financial intermediaries to private sector deflating the nominal measures of financial intermediary liabilities and assets. See Levine et al. (2000) for more information.

2 Brief Literature Review

There is a substantial literature which examines the asymmetric impact of monetary policy on real economic activities. Several studies have considered the differential effects of monetary policy on the economy with respect to the type of shocks (positive *versus* negative) as well as the size of the shock (small *versus* large). Cover (1992), De Long et al. (1988), Morgan (1993), Thoma (1994), Karras (1996), Karras and Stokes (1999), Florio (2005) show that output growth reacts more to a contractionary monetary policy than to an expansionary monetary policy. Ravn and Sola (2004) report that only small negative shocks have real effects on the economy.

In this literature a substantial body of work implements nonlinear methods to examine the asymmetric impact of monetary policy shocks over the business cycles. For example, using the Markov regime switching model of Hamilton (1989, 1990), Garcia and Schaller (2002) show that monetary policy shocks, measured by the change in the Federal funds rate and the monetary policy innovations obtained from a structural VAR model, have larger effects during a recessionary period than an expansionary period. Based on a Markov regime switching model, Peersman and Smets (2002) asses whether euro area wide monetary policy shocks obtained from a VAR model have asymmetric effects across the business cycle in seven euro area countries. Their study shows that these countries exhibit the same business cycle, and area-wide shocks have more profound effects on output during recessions than expansions.[8] Kaufmann (2002), using data from Austria, provides evidence that the effects of monetary policy on output growth are significantly negative during economic downturn while this effect is insignificant during periods of normal or above average output growth. Similarly, Dolado and María-Dolores (2006) show that the effects monetary policy shocks on real output growth in the euro area depend upon the state of the business cycle using a multivariate version of Hamilton (1989)'s Markov switching model.

The observation that monetary policy shocks exert a strong and negative impact on economic activity in recessions also receives support from Weise (1999) who models the asymmetries with a logistic smooth transition vector autoregressive (LSTVAR) model. Using UK data and implementing a smooth transition regression (STR) model Sensier et al. (2002) show that monetary policy is more effective in a recession than in an expansion. To that end, Lo and Piger (2005) using an unobserved-component model with regime switching and time varying transition probabilities, argue that the monetary policy changes have stronger real effects in the US during recessions than during booms. Subsequently, Höppner et al. (2008) applying a time-varying coefficient VAR model con-

[8] Also see Peersman and Smets (2005) which arrive at similar results.

firm the asymmetry of monetary policy over the business cycle for the US.

When we turn to examine the importance of financial development and financial frictions on productivity and growth, we come across a large and growing body of work which argues that credit market imperfections act as a propagator of shocks and play a significant role in magnifying output fluctuations.[9] In this context empirical researchers agrue that countries with developed financial systems experience a higher and a more stable output growth. For instance, Easterly et al. (2001) suggest that better access to credit in a deeper financial system leads to less output volatility in the economy. Denizer et al. (2002) provide evidence that countries with well-developed financial markets have less volatility in real per capita output, consumption and investment growth. Bekaert et al. (2005) show that financial liberalization leads to lower volatility in consumption growth and output growth. Subsequently, Beck et al. (2006) provide evidence that financial development may reduce the impact of macroeconomic shocks on growth volatility. Dynan et al. (2006) conclude that financial innovation contribute to the stabilization of economic activity in the mid 1980s.

Overall, the empirical evidence suggests that development and deepening of financial markets provide firms to have easier access to external funds when they wish to carry out investment expenditures, dampening the impact of aggregate shocks on the economy.[10] In providing support to these claims, several researchers have examined industry or firm level data as well. Raddatz (2006) finds that higher financial depth significantly reduces output volatility especially in sectors which need high liquidity to function properly. He argues that the results provide strong evidence for the importance of financial development in reducing output fluctuations as financial market depth improves the ability of the financial system to provide liquidity to firms during periods of economic downturn. Larrain (2006) concludes that industrial output is less volatile the greater the size of bank credit. His results further show that a well-developed banking system absorbs the shocks to the economy particularly providing liquidity through short-term debt. More recently, Beck, Büyükkarabacak, Rioja, and Valev (2012) show that although the share of household credit in total credit increases as countries become more developed and financial sector becomes deeper it is only the bank lending to firms that leads to faster output growth. Beck, Chen, Chen, and Song (2012) find that higher level of financial innovation not

[9] Levine (2005) and Papaioannou (2007) provide detailed surveys of the literature. Kiyotaki and Moore (1997), Bernanke et al. (1999), Mendoza (2010) and Jermann and Quadrini (2012) present analytical foundations to explain the importance of financial markets on output fluctuations. Also see Aghion et al. (2010) who provide empirical support for their analytical model using cross-country data that financial development reduces economic volatility and promotes long-run growth.

[10] Several researchers suggest that tightening of financing conditions contribute significantly to the downturn in output and labor markets. Campello et al. (2010) show that financially constrained firms seem to reduce more investment, technology, marketing, and employment compared to financially unconstrained firms during the financial crisis of 2008.

only increases the country's growth opportunities, capital and GDP per capita growth but also raises growth rates in industries which depend more on external finance and financial innovation.[11] Cowan and Raddatz (2013) show that in those countries where firms experience higher financial frictions, output in sectors with higher external financing needs contract relatively more following sharp reductions in international capital flows.

Another area of debate concerns the impact of financial development on an economy over the business cycle. For instance Ferreira da Silva (2002) implements generalized method of moments methodology using data from 40 countries over 1960-1997 and finds that countries with deeper financial markets experience smoother business cycles. Tharavanij (2007) documents that countries with well-developed capital markets are likely to have shorter periods of recession yet he finds no evidence that the frequency of the recessions is affected by the extent of capital market development. Separately, Balke (2000), using a threshold vector autoregression model, empirically examines whether credit plays a role as a nonlinear propagator of shocks. Using nonlinear impulse response functions, he finds that monetary shocks have a larger effect on output in the tight credit regime than in a normal credit regime. Following Balke (2000)'s methodology, similar findings are reported for the UK by Atanasova (2003).[12]

In what follows below, we present our empirical framework which examines the interlinkages between monetary policy shocks and financial market deepening. To pursue our goal, we implement an instrumental variables Markov regime switching framework. The use of instrumental variable approach is relevant in our study for the endogeneity problem may affect the results given the potential correlation between the monetary policy shocks and the disturbance term. Further details follow below.

3 Data and Methodology

3.1 Data

Data are obtained from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). As commonly used in the literature, we proxy for monetary policy shocks by the first difference logarithm of the Federal Funds rate (mp_t), IFS line 60b.[13] We

[11] They add that higher level of financial innovation leads to higher growth volatility in these industries which particularly have higher idiosyncratic bank fragility.

[12] See Easterly et al. (2001), Deidda and Fattouh (2002) and Rioja and Valev (2004) for empirical evidence in favor of non-monotone relationship between financial depth and the volatility of output growth.

[13] For instance see including McCallum (1983), Bernanke and Blinder (1992), Sims (1992), Christiano et al. (1996), Bernanke and Mihov (1998), Clarida et al. (2000), Mihov (2001), Fernández-Villaverde et al. (2010).

measure output growth (y_t) in period t, by the first difference of the logarithm of the real GDP index (2005=100), IFS line 99b. We use three different proxies to measure financial depth, (fd_t). Our first financial depth proxy is the ratio of claims on the nonfinancial private sector to total domestic credit (excluding credit to money banks).[14] This measure, originally proposed by King and Levine (1993), is used in subsequent studies by several researchers.[15] Credit to private sector is a critical key variable which reflects the "depth" of the financial market. This proxy provides information on the percentage of credit allocated to private firms in the economy. Thus, it measures the extent to which credit is allocated to the private rather than the public sector.

To check for the robustness of our findings, we use two additional measures of financial depth. The second measure, also suggested by King and Levine (1993), is defined as the ratio of claims on the nonfinancial private sector to GDP.[16] However this measure is later criticized by Levine et al. (2000) that it is a proxy of gross claims on financial sector and that it includes credits issued by the monetary authority and government institutions. They propose to use the ratio of credits by financial intermediaries to the private sector divided by GDP which is defined as: $0.5 * \left[\frac{F(t)}{P_{end}(t)} + \frac{F(t-1)}{P_{end}(t-1)}\right] / \frac{GDP(t)}{P_{ave}(t)}$ where F is quarterly credit by deposit money banks and other financial institutions to the private sector (IFS lines 22d+42d), P_{end} is end-of period quarterly CPI (IFS line 64), P_{ave} is the average CPI for the quarter (IFS line 64) and GDP is nominal quarterly gross domestic product which is seasonally adjusted (IFS line 99b). Specifically, this depth measure includes only credits issued by banks and other financial intermediaries. Moreover, this definition improves upon the previous measures of financial depth by correctly deflating the nominal measures of financial intermediary liabilities and assets. As pointed out by Levine et al. (2000) the items in financial intermediary balance sheets are measured at the end of the period but GDP is measured over the period. Thus, Levine et al. (2000) deflate the end-of-period items in financial intermediary balance sheets by the end of period consumer price indices (CPI) while deflate the GDP series by the average CPI for the period. Then, they compute the average of the item in period t and $t-1$ and divide the average by the real GDP measured in period t.[17] We estimate our empirical model using the data between the first quarter of 1980 and the last quarter of 2011.

[14]Total domestic credit (excluding credit to money banks) is composed of claims on central government, claims on state and local governments, claims on public nonfinancial corporations and claims on the nonfinancial private sector. Claims on the nonfinancial private sector is extracted from IFS line 32d and domestic credit (excluding credit to money banks) is taken from IFS lines 32a through 32f excluding 32e.

[15]See, for instance Denizer et al. (2002).

[16]This measure has been recently used by Rousseau and Wachtel (2011) and Aggarwal et al. (2011).

[17]For instance Hasan et al. (2009) and Lins et al. (2010) also use this variable as a measure of financial depth.

3.2 Methodology

To examine whether the impact of monetary policy on real output growth differs over the business cycle we implement a Markov switching framework. In doing so, we use changes in the short-term interest rate as a measure of monetary policy shocks. The complication that may arise from this approach is due to the endogeneity of the short-term interest rate which we use as an explanatory variable in the output growth equation.[18] In this case, a regime switching model which is estimated using a standard maximum likelihood approach yields inconsistent parameter estimates as a result of the within-regime correlation between the regressors and the disturbance term. To overcome this problem, we follow an approach suggested in Spagnolo et al. (2005) and estimate the following system of equations for output growth and the instrumenting equation for monetary policy shocks:

$$
\begin{aligned}
y_t = {} & \left[\alpha_0 (1-s_t) + \alpha_1 s_t\right] + \left[\gamma_0^{(1)} (1-s_t) + \gamma_1^{(1)} s_t\right] y_{t-1} + \left[\gamma_0^{(2)} (1-s_t) + \gamma_1^{(2)} s_t\right] y_{t-2} + \dots \\
& + \left[\gamma_0^{(j)} (1-s_t) + \gamma_1^{(j)} s_t\right] y_{t-j} + \left[\beta_0 (1-s_t) + \beta_1 s_t\right] \widehat{mp}_{t-1} + \left[\varphi_0 (1-s_t) + \varphi_1 s_t\right] fd_t \\
& + \left[\eta_0 (1-s_t) + \eta_1 s_t\right] \widehat{mp}_{t-1} \times fd_t + \left[\sigma_0 (1-s_t) + \sigma_1 s_t\right] \varepsilon_t
\end{aligned} \tag{1}
$$

$$
\begin{aligned}
mp_{t-1} = {} & \left[\kappa_0 (1-s_t) + \kappa_1 s_t\right] + \left[\delta_0^{(1)} (1-s_t) + \delta_1^{(1)} s_t\right] y_{t-1} + \left[\delta_0^{(2)} (1-s_t) + \delta_1^{(2)} s_t\right] y_{t-2} + \dots \\
& + \left[\delta_0^{(k)} (1-s_t) + \delta_1^{(k)} s_t\right] y_{t-k} + \left[\phi_0^{(1)} (1-s_t) + \phi_1^{(1)} s_t\right] mp_{t-2} + \dots \\
& + \left[\phi_0^{(l)} (1-s_t) + \phi_1^{(l)} s_t\right] mp_{t-l-1} + \left[\theta_0 (1-s_t) + \theta_1 s_t\right] \xi_t
\end{aligned} \tag{2}
$$

The first equation models the real output growth (y_t), and the second equation models the monetary policy shock (mp_t) while all explanatory variables have state dependent effects. Output growth equation includes the lagged dependent variable, a measure of financial depth (fd_t), and once lagged expected monetary policy ($\widehat{mp}_{t-1}$) to capture the observation that output growth reacts to changes in monetary policy with a lag. Here, $\widehat{mp}_t = E\left[mp_t \mid s_t, \Omega_t\right]$ is the fitted value of the monetary policy shock obtained from equation (2) where s_t is the state variable and Ω_t is the information set available at time t. Output growth equation also includes an interaction term between financial depth and monetary policy shocks ($\widehat{mp}_{t-1} \times fd_t$). The impact of this variable on output growth is

[18] A standard Taylor rule argues that the short term interest rate reacts to contemporaneous values of inflation and output-gap. Thus, a growth equation where one of the regressors is the change in the short term interest rate is subject to endogeneity problem for the short term interest rate will be correlated with the error term of the model.

expected to vary across different states of the economy allowing us to examine whether financial depth mitigates or intensifies the impact of monetary policy shocks on real output over the business cycle. Equation (2) is a reduced-form model for the endogenous regressor, mp_{t-1}, which is assumed to respond asymmetrically as a function of lagged output and lagged dependent variable.

The state variable, s_t, is a homogenous first order Markov chain on $\{0, 1\}$ with the following transition probabilities:

$$\begin{aligned} q &= P\left[s_t = 0 \mid s_{t-1} = 0\right], \\ p &= P\left[s_t = 1 \mid s_{t-1} = 1\right]. \end{aligned} \tag{3}$$

To summarize, the system of equations we present in (1-3) allows us to examine whether monetary policy shocks and financial depth exert asymmetric impact on the real economy over the business cycle or not. Furthermore, the interaction term between financial depth and monetary policy shock can help us to determine whether the financial depth mitigates or intensifies the impact of monetary policy shocks on the real economy.

To estimate the above framework we use a form of recursive algorithm explained in Hamilton (1994) as we do not directly observe neither the error terms in equations (1) and (2) nor the state variable.[19] This process yields a sample likelihood function which can be maximized numerically with respect to $\nu = (\alpha_0, \alpha_1, \gamma_0^{(1)}, \gamma_1^{(1)}, \gamma_0^{(2)}, \gamma_1^{(2)}, \cdots, \gamma_0^{(j)}, \gamma_1^{(j)}, \delta_0^{(1)}, \delta_1^{(1)}, \delta_0^{(2)}, \delta_1^{(2)}, \cdots, \delta_0^{(j)}, \delta_1^{(j)}, \phi_0^{(1)}, \phi_1^{(1)}, \phi_0^{(2)}, \phi_1^{(2)}, \cdots, \phi_0^{(j)}, \phi_1^{(j)}, \beta_0, \beta_1, \eta_0, \eta_1, \sigma_0, \sigma_1, \varphi_0, \varphi_1, \kappa_0, \kappa_1, \theta_0, \theta_1)$, subject to the constraint that p and q lie in the open unit interval. As a consequence, we can write the conditional probability density function of the data $w_t = (y_t, mp_t)$ given the state s_t and the history of the system as follows:

$$\begin{aligned} pdf\left(w_t \mid w_{t-1}, ..., w_1; \nu\right) = & \frac{1}{\sqrt{2\pi}\sigma_{s_t}} exp \\ & \left[-\frac{1}{2}\left(\frac{y_t - \alpha_{s_t} - \sum_{j=1}^{J} \gamma_{s_t}^{(j)} y_{t-j} - \beta_{s_t} \widetilde{mp}_{t-1} - \varphi_{s_t} fd_t - \eta_{s_t} \widetilde{mp}_{t-1} fd_t}{\sigma_{s_t}}\right)^2\right] \\ & \times \frac{1}{\sqrt{2\pi}\theta_{s_t}} exp \\ & \left[-\frac{1}{2}\left(\frac{mp_{t-1} - \kappa_{s_t} - \sum_{k=1}^{K} \delta_{s_t}^{(k)} y_{t-k} - \sum_{l=1}^{L} \phi_{s_t}^{(l)} mp_{t-l-1}}{\theta_{s_t}}\right)^2\right] \end{aligned} \tag{4}$$

Here $\widetilde{mp}_{t-1} = \kappa_{s_t} + \sum_{k=1}^{K} \delta_{s_t}^{(k)} y_{t-k} + \sum_{l=1}^{L} \phi_{s_t}^{(l)} mp_{t-l-1}$ is the state-dependent instrumenting

[19] See Spagnolo et al. (2005) for more details on estimation.

equation for mp_{t-1} where parameters are estimated from equation (2).

4 Empirical Results

In this section, we present the empirical observations gathered from the system of equations (1-3) which incorporates financial depth, monetary policy shocks and an interaction term between financial depth and monetary policy shocks. Using this framework we estimate three separate equation systems as we use a different financial depth measure in each case. The results obtained for each financial depth measure are similar in nature and can be summarized as follows.

i) Monetary policy has a regime dependent impact on output growth. For all models, we find that the effect of monetary policy on output growth during downturns is negative and significant. Although we also find that the impact of monetary policy shocks during expansions is negative, this effect is insignificant. ii) The interaction term between financial depth and monetary policy assumes a positive and significant coefficient during recessions suggesting that financial depth mitigates the adverse effects of monetary policy shocks in recessionary periods. In expansionary states, this effect becomes insignificant. This observation is consistent across all measures of financial depth. iii) The impact of financial depth on output growth is regime dependent. Financial depth has a positive impact on output growth during recessions, but this effect is significant in one out of three cases. In expansions, though negative, financial depth does not assume a significant coefficient.

4.1 Private sector to total domestic credit

Table 1 presents the results for the system of equations (1-3) when we use the ratio of claims on the nonfinancial private sector to total domestic credit (excluding credit to money banks).[20] Observe that the state dependent growth rates (α_0 and α_1) are both significant while α_0 is negative and α_1 is positive. Based on these estimates we assume that state 0 depicts recessions and state 1 depicts expansionary periods. Furthermore, the filter probabilities of state 1 (expansionary regime) are plotted in Figure 1. The shaded areas in Figure 1 depicts recessions acknowledged by the NBER over the period under investigation. We observe that, except for the 1990 recession, the model successfully captures the major downturns announced by the NBER which are presented in Table 2. The reason why the model fails to capture the 1990 economic downturn could be due to the fact that this recession was relatively moderate and lasted only for two quarters.

[20]We present only the results for the output growth equation. The results for the instrumenting equation for each model are available upon request from the authors.

Given that the model provides a good match between the expansion and contraction dates with those announced by the NBER, we believe that the movements over the business cycle are captured successfully within the context of our system of equations (1-3).

Insert Table 1 about here
Insert Figure 1 about here
Insert Table 2 about here

To scrutinize the impact of monetary policy shocks on output growth we examine the coefficients associated with monetary policy, β_0 and β_1. Although both of these coefficients are negative only the former is significant, implying that the impact of monetary policy is asymmetric over the business cycle. Furthermore, the negative impact of monetary policy on output growth in a recession is about ten fold more than that in an expansion. Given the point estimates our model suggests that a one percentage point increase in interest rates during a recession leads to a reduction of 0.68 percentage point in output growth. These results are in line with the theoretical models and empirical findings which suggest for the presence of asymmetric impact of monetary policy shocks.[21]

We next turn to examine whether financial depth fosters economic growth and whether its impact changes across different stages of the business cycle. As we can observe from Table 1, in recessions, the impact of financial depth on growth is positive and differs from zero at the 10% significance level, φ_0. In expansions, the impact of financial depth on output growth, φ_1, is negative but insignificant. Given the point estimates it appears that one percentage point increase in financial depth increases output growth about 0.49 percentage point. This is a considerable push for any economy which is fighting to escape from the grip of a recession. As documented in the investment literature, firms experience severe credit constraints in periods of contraction due to heightened asymmetric information problems exacerbated by reductions in sales. In this context our finding suggests that financial market depth can help an economy to overcome such difficulties that may arise during economic downturns. This finding is consistent with, for example, Braun and Larrain (2005) who show that financial frictions in the capital markets amplify output fluctuations particularly when firms and industries are highly dependent on external finance in the recessionary periods.

Last we asses whether the real effects of monetary policy shocks vary over the business cycle with the level of financial depth. Given the literature that explores the effects of financial depth on output growth volatility, we expect to find that the impact of monetary policy should be dampened with the deepening of financial markets. Firms that operate

[21] See amongst others, Garcia and Schaller (2002) and Lo and Piger (2005).

in an economy with deeper financial markets have generally easier access to credit. It is the existence of credit lines in times of turmoil that helps to smooth output fluctuations and firms do not have to cut back employment or investment expenditures as severely. Observing the estimated coefficients associated with the interaction term between financial depth and monetary policy shocks, η_0 and η_1, we see that our expectations receive support as each coefficient estimate is positive. Furthermore, we see that while η_0 is significant η_1 is insignificant. This observation points out the significant role financial depth plays during recessions. The insignificance of η_1 can be explained by the fact that in expansions firms have access to a wider variety of options.

Overall, our findings suggest that financial market depth dampens the adverse effects of monetary policy shocks on output growth in both regimes while this effect is especially important when the economy goes through a bottleneck.

4.2 The Full Impact of Monetary Policy

So far we have shown that monetary policy shocks exert a significant negative impact on real output growth during recessions and that financial depth mitigates the adverse effects of monetary policy. We have also shown that during expansions monetary policy has a negative impact on output growth while this effect is not significant. Furthermore, we find that the coefficient associated with the interaction term becomes insignificant in expansions implying that the interlinkages between financial depth and monetary policy becomes less clear during expansions. These results accord with intuition and point out at the significant role financial markets play in transmission of monetary policy shocks.

However, the evidence we have presented so far does not provide us the full impact of monetary policy shocks on output growth over the business cycle. To gauge the full impact of monetary policy shocks we must evaluate the total derivative of output growth with respect to monetary policy shocks

$$\partial y_t / \partial \widehat{mp}_{t-1} = \left[\widehat{\beta}_0 (1 - s_t) + \widehat{\beta}_1 s_t\right] + \left[\widehat{\eta}_0 (1 - s_t) + \widehat{\eta}_1 s_t\right] \widehat{fd}_t^{\,*} \tag{5}$$

at various levels of financial depth for each state. To compute the total impact of monetary policy shocks on output growth, we use the point estimates for $\widehat{\beta}_i$ and $\widehat{\eta}_i$ given in Table (1). The estimates $\widehat{\beta}_i$ and $\widehat{\eta}_i$ capture the impact of monetary policy shocks on output growth which arises from the policy change as well as that arises from the interaction between monetary policy and financial markets as captured by the interaction term, respectively. The index $s_t = 0, 1$ denotes the states of the economy where 0 depicts recessions and 1 depicts expansions. $\widehat{fd}_t^{\,*}$ refers to a particular level of financial market depth at which we compute the derivative including the $10th$, $25th$, $50th$, $75th$, and $90th$

percentiles. For each state of the economy, we present in Table (3) the full impact of monetary policy on output growth along with the associated standard errors.[22] In Figure 2, we plot these point estimates along with the corresponding 95% confidence interval.

Insert Table 3 about here

Insert Figure 2 about here

Inspecting Panel A in Table (3), (also see the upper panel of Figure (2)), we observe that an adverse monetary policy shock (an increase in the interest rate) has a significant negative impact on output growth in recessions but this impact weakens as financial depth increases. To put it differently, the adverse impact of an increase in interest rate would have been stronger in a recession if the the economy were to experience tighter credit market conditions. In fact when financial deepening were to exceed slightly above its first quartile level, the effect of monetary policy shocks on output growth becomes insignificant. This suggests that as liquidity dries up, the economy suffers considerably for businesses and firms cannot keep operating in an environment where borrowing is compromised due to frictions in the financial markets. Our findings in this context is particularly relevant in the light of events that followed the 2008/09 financial crises with businesses shedding employment and delaying capital investment expenditures and central banks injecting billions of dollars of funds into the system to keep the financial markets afloat.

The lower Panel in Table (3), (also see the lower panel of Figure (2)), provides information on the total impact of an adverse monetary policy shock on output growth in expansions. Panel B shows that the total impact of monetary policy shocks on output growth is almost always (except for the 10th percentile level of financial depth) positive. But in all cases this impact is insignificant.

Our results are of interest to researchers and policy makers who examine the impact of monetary policy on output growth also for the following reasons. Several papers in the literature argue that the monetary policy does not significantly affect the real economy. In particular, several researchers implementing structural VAR models conclude that the impact of monetary policy shocks on the real economy is ambiguous.[23] We show here that monetary policy affects output growth asymmetrically (more so in recessions but not in expansions) while financial depth plays an important role in transmission of monetary policy shocks. Hence, any suggestion that the impact of monetary policy on output growth is ambiguous may be a consequence of ignoring the presence of asymmetries in the data. In such cases it is quite possible to argue that the role of monetary policy on

[22]Note that financial depth is defined as the ratio of claims on the nonfinancial private sector to total domestic credit (excluding credit to money banks).

[23]See for instance Uhlig (2005).

output is limited, whereas the true answer might depend on the state of the business cycle. Furthermore, our investigation shows that the impact of monetary policy also depends on whether financial markets operate properly providing liquidity and depth. As a result those structural models which exclude this variable will be misspecified and yield inaccurate conclusions.

4.2.1 Robustness

To check for the robustness of the results that we present in Table (1), we estimate the system of equations (1-3) for two additional measures of financial depth. For each case we calculate the filter probabilities for state 1 and check the state-dependent growth rates to determine the state of the economy. Although we do not provide them to conserve space, the filter probabilities for each proxy are similar to that we present in the previous section.[24] In what follows below, we provide the coefficient estimates obtained for these two sets of models. Table (4) gives the results when financial depth is measured by the ratio of the claims on the nonfinancial private sector to GDP. Table (5) provides the results for the case when we measure financial depth by the value of credits by financial intermediaries to the private sector divided by GDP.

Insert Table 4 about here
Insert Table 5 about here

Observe for both models that the mean growth rate in state 0 is negative but insignificant. Yet, the same coefficient is positive and significant in state 1. Given this information along with that we gather from the filter probabilities, we classify state 0 as a period of recession and state 1 as a period of expansion. Further notice that, in each table, the point estimate of the coefficient associated with monetary policy shocks is always negative, But this effect is significant only in state 0, (β_0), while it is insignificant in state 1, (β_1). Similar to that in Table (1), the size impact of monetary policy shocks is much higher in recessions than in expansions. When we examine the impact of financial depth, in both tables, we see that the associated coefficient (φ) is positive during a recession and negative during an expansion, yet insignificant for both periods. However, when we turn to asses the role of financial depth in transmission of monetary policy shocks, we see that the coefficient of the interaction term is significant and positive in recessions, mitigating the adverse impact of monetary policy shocks as we have shown earlier. As in the previous subsection, however, in expansionary periods financial depth has no effect on monetary policy shocks. These results provide support for our claim

[24] The filter probabilities for each model are available upon request from the authors.

that i) monetary policy affects output growth asymmetrically over the business cycle and ii) financial depth plays a significant role in mitigating the adverse impact of monetary policy shocks during recessions. Last but not the least our results are robust in relation to alternative financial depth measures.

5 Conclusion

In this study we empirically examine the impact of monetary policy on output growth over the business cycle while we consider the role of financial markets. In particular we ask whether monetary policy shocks have an asymmetric impact on the real output growth and whether this impact depends on the depth of the financial markets as the economy evolves across recessions *versus* expansions. To carry out our investigation, we use quarterly US data over 1980:q1–2011:q4.

To consider the presence of asymmetric effects of monetary policy shocks and financial market depth on output growth, we implement a Markov regime switching model which allows state dependent coefficients and the variances to vary over expansions *versus* contractions. Furthermore, our model includes an interaction term between financial depth and monetary policy allowing us to examine whether financial depth influences the impact of monetary policy shocks on output growth. To overcome problems that may arise due to endogeneity of the monetary policy measure, we apply instrumental variables approach as suggested in Spagnolo et al. (2005).

Our findings can be summarized as follows. Our model provides evidence that monetary policy shocks have asymmetric impact on output growth: an increase in interest rates leads to a fall in output growth while this effect is only significant during recessions. When we turn to examine the interaction term, we see that financial depth plays a significant role in mitigating the adverse effects of monetary policy in recessions. In fact we find that as financial depth increases, adverse effects of an increase in interest rate are completely nullified. This finding provides strong support for the theoretical models which point out at the importance of the financial deepening. Our analysis also provides evidence that financial market depth has a significant positive impact on output growth during recessions.

Our results have important policy implications as they point out at the importance of financial deepening in transmission of monetary policy shocks. Given the difficulties that the western economies have been going through due to the 2008-2009 financial crises, we argue that authorities should provide a regulatory framework which will stimulate the financial institutions to provide the markets with much needed depth and liquidity so that businesses can begin to operate properly. Otherwise, it will take a very long time for the economies to experience decent growth rates. We suggest that it would be fruitful to scrutinize data from other countries and examine to what extent cash injections into the financial system have helped economies on either sides of the ocean and whether financial deepening has been achieved. Such an investigation can help us to understand and to develop tools in monitoring the health of the financial markets and how liquidity and depth in financial markets can pull the economies out of recessions. More research on the interactions between financial markets and monetary policy would help us to answer several related questions.

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Table 1: Asymmetric Effects of Monetary Policy Shocks on Output Growth: 1980:q1-2011:q4

$$
\begin{aligned}
y_t = {} & \left[\alpha_0 (1-s_t) + \alpha_1 s_t\right] + \left[\gamma_0^{(1)} (1-s_t) + \gamma_1^{(1)} s_t\right] y_{t-1} \\
& + \left[\gamma_0^{(2)} (1-s_t) + \gamma_1^{(2)} s_t\right] y_{t-2} + \ldots + \left[\gamma_0^{(4)} (1-s_t) + \gamma_1^{(4)} s_t\right] y_{t-4} \\
& + \left[\beta_0 (1-s_t) + \beta_1 s_t\right] \widehat{mp}_{t-1} + \left[\varphi_0 (1-s_t) + \varphi_1 s_t\right] fd_t + \left[\eta_0 (1-s_t) + \eta_1 s_t\right] \widehat{mp}_{t-1} fd_t \\
& + \left[\sigma_0 (1-s_t) + \sigma_1 s_t\right] \varepsilon_t
\end{aligned}
$$

$$
\begin{aligned}
mp_{t-1} = {} & \left[\kappa_0 (1-s_t) + \kappa_1 s_t\right] + \left[\delta_0^{(1)} (1-s_t) + \delta_1^{(1)} s_t\right] y_{t-2} \\
& + \left[\delta_0^{(2)} (1-s_t) + \delta_1^{(2)} s_t\right] y_{t-3} + \left[\delta_0^{(k)} (1-s_t) + \delta_1^{(k)} s_t\right] y_{t-4} \\
& + \left[\phi_0^{(1)} (1-s_t) + \phi_1^{(1)} s_t\right] mp_{t-2} + \left[\phi_0^{(2)} (1-s_t) + \phi_1^{(2)} s_t\right] mp_{t-3} + \left[\theta_0 (1-s_t) + \theta_1 s_t\right] \xi_t
\end{aligned}
$$

Parameter	Estimate	Standard Error
α_0	-0.403*	0.236
$\gamma_0^{(1)}$	0.667***	0.126
$\gamma_0^{(2)}$	-0.612*	0.326
$\gamma_0^{(3)}$	-0.049	0.333
$\gamma_0^{(4)}$	0.033	0.300
β_0	-0.680***	0.137
φ_0	0.488*	0.283
η_0	0.816***	0.180
σ_0	0.005***	0.001
α_1	0.041*	0.023
$\gamma_1^{(1)}$	0.160	0.097
$\gamma_1^{(2)}$	0.530***	0.091
$\gamma_1^{(3)}$	-0.177*	0.098
$\gamma_1^{(4)}$	-0.086	0.098
β_1	-0.075	0.366
φ_1	-0.045	0.028
η_1	0.097	0.451
σ_1	0.005***	0.000
q	0.810***	0.081
p	0.915***	0.033
Log-likelihood	577.91	

Notes: *, **, *** denote significance at the 10%, 5% and 1% levels. State 0 and State 1 capture recession and expansion, respectively. Financial depth is measured by the ratio of the claims on the nonfinancial private sector to total domestic credit (excluding credit to money banks).

Table 2: NBER Dates of Expansions and Contractions

Business Cycles Reference Dates		Duration in Months	
Peak	Trough	Contraction	Expansion
April 1960(II)	February 1961(I)	10	24
December 1969(IV)	November 1970(IV)	11	106
November 1973(IV)	March1975(I)	16	36
January 1980(I)	July 1980(III)	6	58
July 1981(III)	November 1982(IV)	16	12
July 1990(III)	March 1991(I)	8	92
March 2001(I)	November 2001(IV)	8	120
December 2007(IV)	June 2009(II)	18	73

Source: National Bureau of Economic Research (NBER),
Quarterly dates are in parentheses.

Table 3: Total Effects of Monetary Policy Shock

Panel A: State 0

	P10	P25	P50	P75	P90
Financial depth	0.772	0.785	0.803	0.829	0.849
$\frac{\partial y}{\partial_{mp}}$	-0.050	-0.039	-0.025	-0.003	0.013
Std. Err.	0.013	0.014	0.015	0.018	0.021
t statistic	-3.802	-2.823	-1.649	-0.173	0.611

Panel B: State 1

	P10	P25	P50	P75	P90
Financial depth	0.772	0.785	0.803	0.829	0.849
$\frac{\partial y}{\partial_{mp}}$	0.000	0.001	0.003	0.005	0.007
Std. Err.	0.023	0.019	0.016	0.018	0.023
t statistic	-0.005	0.061	0.177	0.308	0.316

Table 4: Asymmetric Effects of Monetary Policy Shocks on Output Growth; Robustness Check 1: 1980:q1-2011:q4

$$\begin{aligned} y_t &= [\alpha_0 (1-s_t) + \alpha_1 s_t] + \left[\gamma_0^{(1)} (1-s_t) + \gamma_1^{(1)} s_t\right] y_{t-1} \\ &+ \left[\gamma_0^{(2)} (1-s_t) + \gamma_1^{(2)} s_t\right] y_{t-2} + ... + \left[\gamma_0^{(4)} (1-s_t) + \gamma_1^{(4)} s_t\right] y_{t-4} \\ &+ [\beta_0 (1-s_t) + \beta_1 s_t] \widehat{mp}_{t-1} + [\varphi_0 (1-s_t) + \varphi_1 s_t] fd_t + [\eta_0 (1-s_t) + \eta_1 s_t] \widehat{mp}_{t-1} fd_t \\ &+ [\sigma_0 (1-s_t) + \sigma_1 s_t] \varepsilon_t \end{aligned}$$

$$\begin{aligned} mp_{t-1} &= [\kappa_0 (1-s_t) + \kappa_1 s_t] + \left[\delta_0^{(1)} (1-s_t) + \delta_1^{(1)} s_t\right] y_{t-2} \\ &+ \left[\delta_0^{(2)} (1-s_t) + \delta_1^{(2)} s_t\right] y_{t-3} + \left[\delta_0^{(k)} (1-s_t) + \delta_1^{(k)} s_t\right] y_{t-4} \\ &+ \left[\phi_0^{(1)} (1-s_t) + \phi_1^{(1)} s_t\right] mp_{t-2} + \left[\phi_0^{(2)} (1-s_t) + \phi_1^{(2)} s_t\right] mp_{t-3} + [\theta_0 (1-s_t) + \theta_1 s_t] \xi_t \end{aligned}$$

Parameter	Estimate	Standard Error
α_0	-0.009	0.217
$\gamma_0^{(1)}$	0.608***	0.168
$\gamma_0^{(2)}$	-0.132	0.347
$\gamma_0^{(3)}$	-0.003	0.026
$\gamma_0^{(4)}$	-0.235	0.237
β_0	-0.511*	0.273
φ_0	0.014	0.335
η_0	0.796*	0.435
σ_0	0.007***	0.001
α_1	0.011*	0.007
$\gamma_1^{(1)}$	0.258**	0.118
$\gamma_1^{(2)}$	0.390***	0.128
$\gamma_1^{(3)}$	-0.161	0.127
$\gamma_1^{(4)}$	0.033	0.111
β_1	-0.023	0.202
φ_1	-0.015	0.012
η_1	0.048	0.386
σ_1	0.005***	0.000
q	0.882***	0.085
p	0.951***	0.030
Log-likelihood	569.29	

Notes: *, **, *** denote significance at the 10%, 5% and 1% levels. Notes: *, **, *** denote significance at the 10%, 5% and 1% levels. State 0 and State 1 capture recession and expansion, respectively. Financial depth is measured by the ratio of the claims on the nonfinancial private sector to GDP.

Table 5: Asymmetric Effects of Monetary Policy Shocks on Output Growth; Robustness Check 2: 1980:q1-2011:q4

$$
\begin{aligned}
y_t = &\left[\alpha_0 (1 - s_t) + \alpha_1 s_t\right] + \left[\gamma_0^{(1)} (1 - s_t) + \gamma_1^{(1)} s_t\right] y_{t-1} \\
&+ \left[\gamma_0^{(2)} (1 - s_t) + \gamma_1^{(2)} s_t\right] y_{t-2} + ... + \left[\gamma_0^{(4)} (1 - s_t) + \gamma_1^{(4)} s_t\right] y_{t-4} \\
&+ \left[\beta_0 (1 - s_t) + \beta_1 s_t\right] \widehat{mp}_{t-1} + \left[\varphi_0 (1 - s_t) + \varphi_1 s_t\right] fd_t + \left[\eta_0 (1 - s_t) + \eta_1 s_t\right] \widehat{mp}_{t-1} fd_t \\
&+ \left[\sigma_0 (1 - s_t) + \sigma_1 s_t\right] \varepsilon_t
\end{aligned}
$$

$$
\begin{aligned}
mp_{t-1} = &\left[\kappa_0 (1 - s_t) + \kappa_1 s_t\right] + \left[\delta_0^{(1)} (1 - s_t) + \delta_1^{(1)} s_t\right] y_{t-2} \\
&+ \left[\delta_0^{(2)} (1 - s_t) + \delta_1^{(2)} s_t\right] y_{t-3} + \left[\delta_0^{(k)} (1 - s_t) + \delta_1^{(k)} s_t\right] y_{t-4} \\
&+ \left[\phi_0^{(1)} (1 - s_t) + \phi_1^{(1)} s_t\right] mp_{t-2} + \left[\phi_0^{(2)} (1 - s_t) + \phi_1^{(2)} s_t\right] mp_{t-3} + \left[\theta_0 (1 - s_t) + \theta_1 s_t\right] \xi_t
\end{aligned}
$$

Parameter	Estimate	Standard Error
α_0	-0.070	0.942
$\gamma_0^{(1)}$	0.670***	0.136
$\gamma_0^{(2)}$	-0.205	0.236
$\gamma_0^{(3)}$	-0.053	0.714
$\gamma_0^{(4)}$	-0.030	0.396
β_0	-0.250**	0.107
φ_0	0.039	0.503
η_0	0.134**	0.060
σ_0	0.005***	0.001
α_1	0.009**	0.003
$\gamma_1^{(1)}$	0.258**	0.106
$\gamma_1^{(2)}$	0.409***	0.124
$\gamma_1^{(3)}$	-0.163	0.115
$\gamma_1^{(4)}$	-0.045	0.138
β_1	-0.035	0.039
φ_1	-0.003	0.002
η_1	0.023	0.026
σ_1	0.005***	0.000
q	0.944***	0.048
p	0.965***	0.022
Log-likelihood	576.240	

Notes: *, **, *** denote significance at the 10%, 5% and 1% levels. Notes: *, **, *** denote significance at the 10%, 5% and 1% levels. State 0 and State 1 capture recession and expansion, respectively. Financial depth is measured by $\frac{\{0.5*[\frac{F(t)}{Pe(t)}+\frac{F(t-1)}{Pe(t-1)}]\}}{\frac{GDP(t)}{Pa(t)}}$ where F is credit by deposit money banks and other financial institutions to the private sector.

Figure 1: Filter Probabilities for State 1 (Expansion Regime)

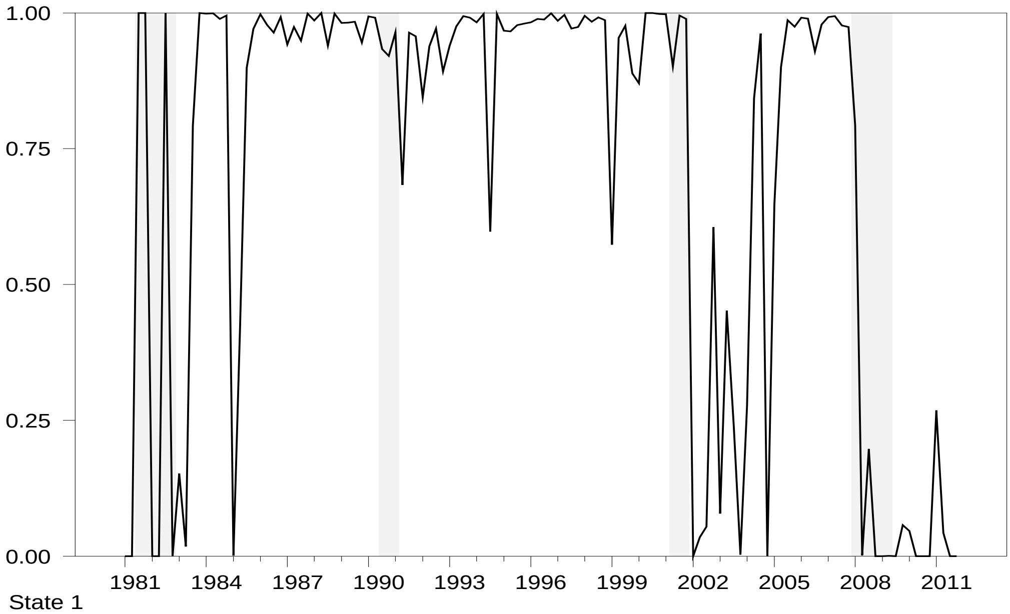

Figure 2: Total Effects of Monetary Policy Shock