The Changing Transmission Mechanism of U.S. Monetary Policy*

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ABSTRACT: We examine the relative importance of the interest rate, exchange rate, and bank-lending channels for the transmission mechanism of monetary policy in the United States over the past 50 years. Our analysis is based on a structural vector autoregressive model that includes bank loans and uses sign restrictions to identify monetary policy shocks. Given these identified policy shocks, we quantify the relative importance of different transmission channels via counterfactual analysis. Our results suggest a nontrivial role for the bank-lending channel, but its importance has been greatly diminished since the early 1980s. Despite the timing, we find no support for a link between this change in the transmission mechanism and the concurrent reduction in output volatility associated with the Great Moderation. There is, however, some evidence of a link to the reduction in inflation volatility at the time.

Keywords: Bank-Lending Channel, Sign Restrictions, Great Moderation

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I. Introduction

Although there is much agreement that monetary policy has a significant influence on the real economy (see, for example, Bernanke and Blinder, 1992, Christiano and Eichenbaum, 1995, Christiano, Eichenbaum and Evans, 1999, Leeper, Sims and Zha, 1996, Kim, 1999 and Uhlig, 2005), there is no consensus about the mechanisms through which it does so. Taylor (1995) classified different theories of the transmission mechanism of monetary policy into two broad categories. The financial market price view, also known as the "money" view, which primarily consists of the interest rate and exchange rate channels, stresses the impact of policy on prices and rates of return of financial assets and thereby on the spending decisions by firms and households. Alternatively, the "credit" view emphasizes the balance sheet and bank-lending channels, which are also hypothesized to affect spending behavior. The existence of these credit channels is contingent on assumptions about the size and nature of capital market imperfections.[1] Previous research on the importance of these channels has produced mixed results. For example, Bernanke and Gertler (1995) provide some illustrative evidence of a direct link between the credit channels and monetary policy shocks, while Romer and Romer (1990) and Ramey (1993), find that the credit channels play an insignificant role in transmitting monetary policy shocks.

In this paper, we estimate a structural vector autoregressive (SVAR) model that includes bank loans in order to examine the relative importance of the different channels associated with the money and credit views of the monetary transmission mechanism. Importantly, identification of structural shocks is based on sign restrictions (see, for example, Canova and De Nicoló, 2002, and Fry and Pagan, 2011) motivated by theory, but avoiding circularity between identification and inference. Given identified monetary policy shocks, we employ counterfactual analysis to quantify the relative importance of different transmission channels. In particular, we consider constrained versions of the SVAR model in which the transmission variable under examination is held constant. Comparisons of the responses of output to monetary policy shocks between the benchmark and the constrained models provide a measure of relative importance of a given channel.

[1] The balance sheet channel operates through the net worth of business firms and arises from the problems of adverse selection and moral hazard (Mishkin 1995). The bank-lending channel emphasizes the role of banks in determining the supply of loans in an environment where information is not symmetric.

Our results show a dramatic change in the transmission mechanism of monetary policy over the past 50 years. Estimates for U.S. data from the 1960s and 1970s indicate that the bank-lending channel and the interest rate channel were about equally important as transmission mechanisms for monetary policy during that time. However, since the early 1980s, the bank-lending channel appears to have played a strongly diminished role, while the interest rate channel has exerted a much greater influence in transmitting monetary shocks. Notably, this result has important implications for the design of nonstandard monetary policy actions during the recent zero-lower-bound period, supporting a greater focus on financial prices than the quantity of credit.

We also explore possible connections between changes in the transmission mechanism and the volatility reduction in output and inflation in the mid 1980s that has been documented in numerous studies and is often labeled as the "Great Moderation". For example, Boivin and Giannoni (2006) show that from the 1960s and 1970s to the 1980s and 1990s, the standard deviation of output growth has fallen 30% while that of inflation has decreased more than 40%. These changes raise the question of whether the volatility reduction was due to smaller and less frequent shocks in the economy or to changes in the propagation of these shocks. Clearly, changes in the transmission mechanism of monetary policy could play a role in altering the propagation mechanism in the economy. We proceed by conducting additional counterfactual experiments in the spirit of Stock and Watson (2002), Ahmed, Levin, and Wilson (2004), Boivin and Giannoni (2006), and Kim, Morley, and Piger (2008), among many others. From these experiments, we do not find a strong connection between changes in the monetary transmission mechanism and the observed reduction in volatility of output. However, we do find that these changes exert some influence in stabilizing inflation.

The rest of the paper is organized as follows. Section II provides some theoretical background for the different views of the monetary transmission mechanism. Section III presents details of our approach to identifying monetary policy shocks and the quantification of the relative importance of different channels. Section IV reports the empirical results. Section V examines the relationship between changes in the monetary transmission mechanism and the moderation of macroeconomic volatility since the early 1980s. Section VI concludes.

II. Theoretical Background for the Monetary Transmission Mechanism

In this section, we discuss in greater detail the money and credit views of the monetary transmission mechanism that provide the theoretical background for our empirical analysis. We begin with the money view, focusing on the interest rate and exchange rate channels, and then proceed to the credit view, in particular outlining the bank-lending channel. For more comprehensive discussions of the monetary transmission mechanism, see Mishkin (1995) or, more recently, Boivin, Kiley and Mishkin (2010).

Money View

Taylor's (1995) broader classification of the financial market price view originates from the argument advocated by what is traditionally known in the literature as the "money view". The money view emphasizes the role of monetary aggregates and operates via the interest rate channel. The theory underpinning the money view relies on a two-asset model with money and bonds as imperfect substitutes in portfolios. The interest rate adjusts to give equilibrium in the asset market, as widely illustrated in the literature by applying the IS–LM framework (Bernanke and Blinder, 1988). Given rational expectations and sticky prices, a contractionary monetary policy shock leads to an increase in long-term real interest rates, which increases the cost of capital, thereby causing a reduction in investment, leading to a contraction in aggregate demand and a decline in output. In addition to affecting businesses' decisions about investment, the interest rate channel is also recognized to affect consumers' decisions about spending on housing and consumer durables.

The exchange rate also potentially affects monetary transmission because of its effect on net exports. With a flexible exchange rate regime, an appreciation of the country's exchange rate will lead to the decline in exports and an increase in imports. A contractionary monetary policy shock raises the domestic real interest rate. Based on the traditional Mundell-Fleming framework, the interest rate effect on the exchange rate is determined by the movement in the flows of capital. Following the assumption of perfect capital mobility, a higher interest rate induces an inflow of capital into the country, leading to an appreciation in the value of the domestic currency relative to the other currency. The higher value of the domestic currency makes domestic goods more expensive than foreign goods. Export volume decreases due to the deterioration in the country's competitiveness in the world market while imports increase as a result of expenditure switching by residents in favor of foreign goods, thereby causing a fall in net exports. This generates a reduction in aggregate demand and output.

Credit View

The credit view emphasizes how imperfect information and other "frictions" in the credit market work as an important channel of monetary policy. Bernanke and Gertler (1995) argue that, because of information asymmetry in the credit market and costly enforcement, agency problems arise in the financial market and create an "external finance premium." The external finance premium is defined as the difference in cost between funds raised externally (by issuing equity or debt) and the opportunity cost of funds generated internally (by retaining earnings). They postulate that monetary policy shocks change the external finance premium faced by borrowers. Consequently, this channel magnifies the effect of monetary policy on real spending.

The bank-lending channel is one specific mechanism in the credit view. According to Bernanke and Gertler (1995), the bank-lending channel operates on the premise that bank loans are of special importance, particularly for small firms that rely on bank loans as their main source of financing. The change in monetary policy then affects the external finance premium through shifts in the supply of intermediated credit, particularly the quantity of loans supplied by banking institutions to the credit markets. The critical part of this argument is the presumption that monetary policy significantly affects the supply of bank loans (i.e. the assets side of the banks' balance sheet). The Bernanke and Blinder (1988) model of the bank-lending channel suggests that when monetary policy is tightened, the central bank drains reserves and hence deposits from the banking system.[2] This in turn limits the supply of bank loans by reducing banks' access to

[2] Contraction of bank loans reduces spending of firms and households that depend on bank loans. Capital market imperfections imply that some, perhaps most, agents cannot directly issue securities in imperfect capital markets. These agents depend on intermediated credit for external finance. See Fazzari, Hubbard, and Petersen (1988). Also,

loanable funds.[3] This is the key difference in the theoretical foundation between the credit and money views. According to the proponents of the credit view, the use of a two-asset model (i.e., either money or bonds) in the analysis of the money view is too simplistic. Bank loans differ from bonds, and as such are not a perfect substitute of each other. Thus, proponents of the credit view extend the basic IS-LM framework into a three-asset model, namely into money, bonds and loans. See Bernanke and Blinder (1988) for further discussion of the extended IS-LM model.

III. Methods

Studies of monetary policy transmission must grapple with the identification of monetary policy shocks and their effects. SVAR models are designed to achieve this identification without imposing much structure on the economy's dynamics and are consistent with reduced-form solutions for a range of theoretical dynamic stochastic general equilibrium models (see, for example, the discussion in Fernández-Villaverde et. al., 2007). This section briefly outlines key issues surrounding structural identification that have been the focus of debate in the SVAR literature and it presents the particular approach used in this paper. We also go over our strategy for measuring the importance of various transmission channels.

The SVAR Model

A typical model in the monetary transmission literature consists of variables that represent (i) immediate target or policy instrument; (ii) intermediate targets, i.e. transmission channels; and (iii) final targets such as output and price. Letting y_t denote an $n \times 1$ vector of such variables observed at time t, an SVAR model has the following specification:

bank loans are usually a pre-condition for bond issuance by firms (Gorton, 2009), so without a bank loan firms may be shut out of capital markets altogether.

[3] Bernanke and Gertler (1995) discuss the justification for why banks cannot easily replace the lost deposits with other source of funds. In contrast, Kashyap and Stein (1994) show that it is sufficient to argue that banks do not face a perfectly elastic demand for their open-market liabilities and, hence, central bank operations that shrink their core deposit base will force them to rely more on managed liabilities and also increases their cost of funds. The latter will shift the supply of loans inward, and in turn will negatively affect bank-dependent borrowers and raise the external finance premium.

(1) $B_0 y_t = B_1 y_{t-1} + \ldots + B_p y_{t-p} + \varepsilon_t$,

where each B is an $n \times n$ matrix of coefficients and ε_t is a vector of serially uncorrelated shocks with mean zero and variance covariance matrix D, a diagonal matrix with positive elements on the diagonal.

The reduced-form solution of the model in equation (1) is

(2) $y_t = \Phi_1 y_{t-1} + \ldots + \Phi_p y_{t-p} + e_t$,

where $\Phi_i = B_0^{-1} B_i$, $i = 1, \ldots p$ and $e_t = B_0^{-1} \varepsilon_t$ is a vector of serially uncorrelated forecast errors with variance covariance matrix, $\Sigma = B_0^{-1} D B_0^{-1'}$. Then, a vector moving average (MA) representation in terms of the forecast errors is given by

(3) $y_t = \Psi(L) e_t$,

where $\Psi(L) = I + \Psi_1 L + \Psi_2 L^2 + \ldots$, with $\Psi(L) = (I - \Phi_1 L - \ldots - \Phi_p L^p)^{-1}$. Rewriting the vector MA representation in terms of the structural shocks yields

(4) $y_t = \Psi(L) B_0^{-1} \varepsilon_t = \theta(L) \varepsilon_t$,

where $\theta(L) = \Psi(L) B_0^{-1} = \Psi_1 B_0^{-1} L + \Psi_2 B_0^{-1} L^2 + \ldots$ or $\theta_i = \Psi_i B_0^{-1}$, with $\Psi_0 = I$, capture the impulse responses to structural shocks.

Identification of Monetary Policy Shocks

Upon estimating a reduced-form model as in equation (2), the challenge is to obtain the structural shocks in equations (1) and (4). The approach used to obtain these shocks or, more technically, to derive a particular orthogonal decomposition of the vector e_t is a crucial aspect of SVAR analysis. Following Canova and De Nicoló (2002), Faust (1998), Uhlig (2005), and many others, we make use of sign restrictions to pin down a particular orthogonal decomposition.[4] Specifically, we follow the strategy developed in Canova and De Nicoló (2002) with some modifications in terms of how the admissible set of candidate impulse responses is chosen, as detailed below.

This method first involves extracting orthogonal innovations from the reduced-form model. These innovations have, in principle, no economic interpretation but they have the property of being contemporaneously and serially uncorrelated. Next, the signs of the theoretical co-movements of selected variables in response to an orthogonal innovation based on macroeconomic theory are used to study the information content of the disturbances, which then allows us to assign a structural interpretation to them. We believe there are several advantages to using this method of identification relative to competing ones such as short-run or long-run recursive restrictions. First, this procedure clearly separates the statistical problem of orthogonalizing the covariance matrix of reduced-form forecast errors from issues concerning the identification of structural shocks. Second, unlike many other SVAR approaches, it achieves identification without having to impose the zero constraints on impact responses.[5] Third, because all of the constraints are explicitly stated in the model, there is no circularity between identification and inference. Finally, the approach enables us to identify other types of structural shocks in the system when needed. By contrast, the standard practice in the SVAR literature is to identify only the dynamic response to a shock of a particular interest, namely the monetary policy shock, leaving the causal structure of the rest of the system without interpretation.

From equation (3), an orthogonal decomposition of a vector MA representation with contemporaneously uncorrelated shocks featuring unit variance will have the following form:

(5) $$y_t = C(L)\eta_t, \quad \eta_t \sim iid(0, I).$$

[4] For a critical survey of SVAR analysis based on sign restriction, see Fry and Pagan (2011).

[5] Faust (1998) provides anecdotal and quantitative examples of the danger in restricting contemporaneous interactions among variables.

Note that $C(L) = \Psi(L)T$, $\eta_t = T^{-1}e_t$ and $\Sigma = TT'$. The impulse response of each variable to any orthogonal shock, α, is therefore given by the coefficients of the vector of lag polynomials $C(L)\alpha$ where $\alpha'\alpha = 1$. It follows that for any orthonormal matrix Q such that $QQ' = I$, $\Sigma = TQQ'T' = T^*T^{*}{}'$ is an admissible decomposition of Σ. This will yield an infinite number of candidates (T^*) for the decomposition of Σ.

There are three challenges to identification here. The first is to figure out how to transform the variance covariance matrix Σ into candidates of orthogonal eigenvalue-eigenvector decompositions, T^*. Second, because the space for T^* is uncountably large, we need to develop a procedure to search through the space of T^* for particular orthogonal decompositions of Σ that satisfies a set of criteria based on economic theory. Third, after collecting a set of candidate decompositions that fit our criteria, we need to define a method to summarize and report the range of information presented by the set of possible decomposition rather than a single unique decomposition.

Following Fry and Pagan (2011), we address the first challenge by making use of the Givens rotation to construct candidate Q's, which can be used to generate candidate T^*'s. Suppose we have a four-variable system, then

$$Q = Q_{1,2}(\theta_1) \times Q_{1,3}(\theta_2) \times Q_{1,4}(\theta_3) \times Q_{2,3}(\theta_4) \times Q_{2,4}(\theta_5) \times Q_{3,4}(\theta_6),$$

where each $Q_{m,n}$ is an identity matrix with the (m, m) element replaced with $\cos\theta$; (n, n) element replaced with $\cos\theta$; (m, n) element replaced with $-\sin\theta$; and (n, m) element replaced with $\sin\theta$. For example,

$$Q_{2,3}(\theta) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta & 0 \\ 0 & \sin\theta & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

Each θ_j is a radian measure between 0 and π. The matrix Q as specified above for a four-variable system is a combination of six Givens rotation matrices. In general, for an n-variable system, Q will be constructed using a combination of $n(n\text{-}1)/2$ Givens rotation matrices. Note that each Q will be unique depending on the values of θ_j. Therefore, we can generate candidate Q matrices by conducting random draws of θ_j, where the θ_j's are taken to be uniformly distributed over (0, π).

To address the second challenge of how to search through the space of T^* for particular decompositions of Σ, we impose sign restrictions on the short-run co-movement of variables. To elaborate further, economic theory provides important information on the signs of the pair-wise dynamic cross-correlations between certain variables in response to structural shocks, and we will make use of that information to help us locate candidate decompositions. Note that the dynamic cross correlation function of y_{it} and $y_{j,t+r}$, at r = 0, 1, 2, … can be expressed as:

(6) $$\rho_{ij}(r) \equiv Corr(y_{it}, y_{j,t+r}) = \frac{\mathrm{E}[C^i(L)\eta_t C^j(L)\eta_{t+r}]}{\sqrt{\mathrm{E}[C^i(L)\eta_t]^2\,\mathrm{E}[C^j(L)\eta_{t+r}]^2}},$$

where E[.] denotes unconditional expectations and C^h indicates the h^{th} row of matrix $C(L)$ in equation (5). Hence the pair-wise dynamic cross-correlation conditional on the particular shock defined by α is

(7) $$\rho_{ij|\alpha}(r) \equiv Corr(y_{it}, y_{j,t+r} \mid \alpha) = \frac{(C^i(L)\alpha)(C^j(L+r)\alpha)}{\sqrt{(C^i(L)\alpha)^2(C^j(L+r)\alpha)^2}}.$$

Given any orthogonal candidate, we can check whether the shock α produces a $\rho_{ij|\alpha}$ that correspond to the sign of the cross-correlation between variables i and j as prescribed by economic theory.[6]

[6] Canova and De Nicoló (2002) present a model based on an economy with limited participation to derive the signs of cross correlation functions to use as sign restrictions. For example, a monetary disturbance generates a positive contemporaneous comovement between output and the price level, between the price level and real money balances, and between real money balances and output. A technology disturbance, on the other hand, would generate a negative contemporaneous comovement between output and the price level, and between the price level and real

An issue that arises in most papers that use sign/shape restrictions for SVAR identification is the lack of uniqueness in the impulse responses. Specifically, the restrictions produce a distribution of impulse responses rather than a single one. So the final challenge is how to summarize and present the range of possible results, with a common strategy being to sort the impulse responses and report the median value. This sorting is typically done forecast period by forecast period and variable by variable. What this means is that there may no longer be a single set of shocks (which is identified by a particular set of θ's that give us a particular Q and hence T^*) that generates the recorded median impulse responses.[7]

Even though reporting median responses is common in the literature, we concur with the arguments in Fry and Pagan (2011) against using this approach and adopt their solution to the reporting problem. Their median target (MT) method provides a way to choose a single model with impulse responses that are as close to the median values as possible. This preserves the idea that the median is a good summary of the central tendency of the impulse responses across models, but avoids the aforementioned problem of mixing up impulse responses produced by different SVAR models. Under the MT approach, the impulse responses for each candidate decomposition d are first standardized by subtracting off their medians and dividing by their standard deviations. Next, the standardized impulses are placed in a vector $\phi^{(d)}$ and we choose the d that minimizes MT = $\phi^{(d)\prime}\phi^{(d)}$. This chosen d is then used to produce the full set of impulse responses.

Examining the Importance of a Transmission Channel

We investigate the relative importance of different channels for monetary policy using counterfactual experiments for the SVAR model. First, an unconstrained SVAR model is

money balances, but a positive contemporaneous movement between real money balances and output. The various sign restrictions are sufficient to distinguish between monetary, fiscal, and technology shocks.

[7] For example, say we have a set of 1000 candidate decompositions. If we construct the median impulse response for output to monetary shock for on impact of the shock and 10 quarters after, the impulse responses for each forecast horizon (there are 1000 for each forecast horizon) are sorted and the median values reported. Hence, there is no guarantee that the median impulse response at one horizon is generated by the same Q as the median impulse response at another horizon.

estimated and a monetary policy shock is identified as in the preceding section. Then a benchmark impulse response function for output with respect to a monetary policy shock is calculated and plotted. Next, a channel is shut down by assuming that the related variable is exogenous. Specifically, dynamic response coefficients for the related variable are set to zero in a constrained version of the SVAR model. The resulting constrained impulse response function for output with respect to a monetary policy shock is compared to the benchmark. The difference between the benchmark and constrained impulse response functions provides a measure of the relative importance of the excluded variable in the transmission mechanism. A large change in the path of output implies that the channel that was shut down was an important part of the transmission mechanism. Conversely, the closer the constrained impulse response function is to the benchmark case, the less important the channel. This approach is similar to the approach employed in Ramey (1993).

Let the impulse response functions of output (y_y) with respect to a monetary policy shock (ε^m) for forecast period *s* be written as follows:

(8) $$\frac{\delta y_{y,t+s}}{\delta \varepsilon_t^m} = \theta_{y,m,s}^j$$

with $j = b$ or c; where *b* and *c* denote the benchmark and constrained impulse responses, respectively. We measure the distance between the benchmark and constrained impulse responses for forecast period *s* by calculating the difference of the θ's between the constrained and benchmark cases at each horizon:

(9) $$Distance = \frac{(\theta_{y,m,s}^b - \theta_{y,m,s}^c)}{\theta_{y,m,\max}^b}.$$

The measure is standardized by $\theta_{y,m,\max}^b$, the maximal impact of the monetary shock on output to give the interpretation of distance as a percentage of the maximal impact of the shock.

IV. Results

Data and SVAR Specification

Our SVAR model comprises of eight quarterly variables: output, the price level, commodity prices, nominal exchange rate, bank loans, real money balances, the risk spread, and the federal funds rate. Table 1 presents details on each variable and their sources. All data are natural logged except for the interest rate variables. The variables included in the model are fairly typical of small-scale SVAR models used to study monetary policy effects, such as those in Christiano, Eichenbaum and Evans (1999) and Ahmed, Levin and Wilson (2004), but augmented with additional variables, most notably bank loans.

Instead of using total bank loans, we opt for the "mix" variable developed by Kashap, Stein, and Wilcox (1993) (henceforth KSW). This variable is constructed as the ratio of total bank loans to the sum of bank loans and commercial paper issuance. KSW argue that the "mix" variable is better than total bank loans in identifying the bank lending channel. A fall in bank loans after monetary tightening, for example, could be due to an output-induced effect on credit demand rather than through the bank lending channel per se, so it is unclear to the researcher what the exact transmission channel is when we observe a decrease in bank loans following monetary tightening. However, if we consider commercial paper and bank loans as perfect substitutes, then, assuming a bank-lending channel exists, a monetary contraction would reduce bank credit but increase commercial paper issuance leading to a decrease in the "mix" variable. In the absence of a bank-lending channel, the "mix" variable would not decrease. So the "mix" variable should allow us to more sharply estimate the importance of the transmission channel.

In order to interpret responses to disturbances as short-term dynamics around a steady state, the SVAR should be stationary, possibly around a deterministic trend. The inability to reject the null hypothesis of a unit root in most of the series raises concerns about asymptotically-biased estimates given data in levels.[8] To address this issue, we take first differences of all series except for the "mix" (which is a ratio) and the interest rate variables. However, impulse responses are cumulated to show the impact of a monetary policy shock on the (log) levels of the variables.

The data are available for the full sample of 1959Q3-2012Q4. However, based on the timing of the Great Moderation documented in many studies (e.g., Kim and Nelson, 1999, and McConnell and Perez-Quiros, 2000), we split our sample period into two subsamples of 1959Q3-1984Q1 and 1984Q2-2012Q4.[9] This allows us to easily see if any apparent changes in the transmission mechanisms of monetary policy over these two subsamples can be linked to the reductions in output and inflation volatility associated with the Great Moderation, which we consider in Section V.

Estimation

Using the methods outlined in Section III, we estimate the specified eight-variable SVAR model for the two subsamples, both with just one lag based on the BIC lag length selection criterion. The number of candidate decompositions we have chosen to keep is 1000, and the cross correlation sign restrictions we impose in order to single out monetary policy shock are tabulated in Table 2. The restrictions hold for on impact of the shock and four quarters after ($r = 0, 1, ..., 4$), which is the minimum necessary to produce impulse responses that are consistent with those generated by typical monetary models.[10] In addition to the restrictions listed in Table 2, we also impose a normalization restriction where we confine the response of the monetary policy variable, the fed funds rate, to stay negative for 4 quarters following a contractionary shock.

[8] Many studies in the monetary policy shock literature ignore this issue and proceed to estimate in levels. See, for example, Bernanke and Blinder (1992), Eichenbaum and Evans (1995), and Leeper, Sims and Zha (1996).

[9] We also considered a shortened second subsample (1984Q1-2008Q3) to avoid the recent zero-lower-bound period. The results are qualitatively similar, hence we only report results for the full sample below.

[10] Canova and Paustian (2010) believe being too agnostic in the identification process may have important costs for inference. They advocate imposing enough sign restrictions to make the results of monetary SVAR analysis meaningful since monetary shocks are typically considered a minor source of contemporaneous output growth and inflation fluctuations. Disturbances with small relative variability and with an insufficient number of restrictions may lead to mismeasurement in transmission properties.

This way we can ensure the candidate decompositions chosen are all comparable in that the impulse response are all for an expansionary monetary policy shock.

The cross correlation sign restrictions listed in Table 2 are fairly generic and intuitive. For example, an expansionary monetary policy shock should cause both output and price to increase ($\rho_{yp|\varepsilon^m} > 0$); both price and real balance to increase ($\rho_{pm|\varepsilon^m} > 0$); both real balance and output to increase ($\rho_{my|\varepsilon^m} > 0$); and both fed funds rate and nominal exchange rate to decrease ($\rho_{ie|\varepsilon^m} > 0$).[11] Also, real balance and fed funds rate should move in opposite directions in response to a monetary policy shock ($\rho_{mi|\varepsilon^m} < 0$). This holds true for fed funds rate and the "mix" variable as well ($\rho_{il|\varepsilon^m} > 0$). These cross correlation restrictions should rule out the possibility of mislabeling a real aggregate demand shocks such as a fiscal shock (which would have $\rho_{pm|\varepsilon^m} < 0$ and $\rho_{my|\varepsilon^m} < 0$), or aggregate supply shocks such as a technology shock (which would have $\rho_{yp|\varepsilon^m} < 0$ and $\rho_{pm|\varepsilon^m} < 0$) as a monetary policy shock.

Because there are eight variables in the SVAR model, there will be eight orthogonalized disturbances to investigate for each candidate decomposition. In cases where more than one orthogonalized disturbance per decomposition passes through our list of cross-correlation restrictions, we keep the one with the largest impact on output at $r = 0$.

Impulse Response Analysis: 1959Q3 – 1984Q1

Figure 1 displays the impulse response functions for the first subsample. The solid lines are the "median" impulse responses of the eight variables to a monetary policy shock generated using the MT approach discussed above. Because all impulse responses are produced using the same

[11] The nominal exchange rate here is an index, hence an increase in the exchange rate is an appreciation of the U.S. dollar, while a decrease is a depreciation of the U.S. dollar.

candidate decomposition, it facilitates comparisons across variables, forecast horizons, and subsamples. The dashed lines are 68% symmetric bootstrapped bands.[12]

A glance at these impulse response functions confirms that all variables are responding to the monetary policy disturbance according to the predictions obtained from theory. An expansionary monetary policy shock lowers the fed funds rate, increases the real money stock, increases output and the price level, and depreciates the nominal exchange rate. However, Figure 1 shows that the peak response of output to the expansionary monetary policy shock does not occur until 5 quarters after the initial impact of the shock. The depreciation of the exchange rate also appears to be delayed with the peak effect occurring after about 6 quarters.[13] The "mix" variable increases on impact and for 5 quarters after, before flattening out, indicating an expansion of loans.

Impulse Response Analysis: 1984Q2 – 2012Q4

Figure 2 displays the impulse response functions for the second subsample. These responses to a monetary policy shock paint a similar picture to those in the first subsample, albeit with somewhat wider confidence bands. All of the impulse responses behave as expected: a decrease in the fed funds rate, increase in the real money stock, increase in output and the price level, a depreciation of the nominal exchange rate and an increase in the "mix" variable. For a similar decrease in the fed funds rate, the change in real money balances appears to be smaller and output and the price level reactions are milder as well compared with the first subsample. This difference could be due to a variety of factors, but changes in the monetary transmission mechanism are certainly a possibility. The results we presented above for the two subsamples are broadly consistent with those reported in Boivin, Kiley, and Mishkin (2010) who use a factor augmented VAR (FAVAR) approach in their study with similar sample periods.[14] They also

[12] The bootstrap bands were constructed conditional on the selected candidate decomposition using the MT approach.

[13] This delayed overshooting feature of the nominal exchange rate is not uncommon in the empirical literature. See, for example, Eichenbaum and Evans (1995).

[14] Boivin, Kiley, and Mishkin (2010) estimate their model over the sample period 1962:1-1979:9 and 1984:1-2008:12.

find the effect of monetary policy actions on output, inflation, and risk spreads smaller in the more recent subsample.

Analysis of Transmission Channels: 1959Q3 – 1984Q1

Figure 3 displays results related to the importance of the different channels of monetary policy. The lines show the response of output to a one standard deviation monetary policy shock. The line "Benchmark" is derived from the estimated model. The lines "IR Channel Blocked", "BL Channel Blocked" and "ER Channel Blocked" refer to results from excluding the impact of the interest rate, bank-lending, and exchange rate channels, respectively.

An inspection of the figure shows that, if we block off the interest rate channel, output would have reacted much less strongly to the monetary policy shock, as we would expect if interest rate is indeed an important transmission channel for monetary policy. Similarly, shutting down the bank-lending channel reduces the impact of the monetary policy shock on output. The impact of the interest rate channel and the bank-lending channel appear to be fairly similar for the first subsample. Finally, the result for blocking the exchange rate channel is a bit surprising. The impulse response function goes above the benchmark, suggesting that, in the absence of the exchange rate channel, output would have increased more in response to an expansionary monetary policy shock. This puzzling result could be due to the fact that the United States was under the fixed exchange rate arrangement of Bretton Woods for a substantial part of the first subsample.

We compute the distance measure based on the impulse response functions in order to quantify the importance of the various channels. Based on the notion that there are lags to monetary transmission, we focus our analysis on assessing the horizons r = 5 to 16 quarters. This also avoids the horizons for which we have imposed sign restrictions. Figure 4 plots the distance measure based on the constrained and benchmark impulse response functions.

From Figure 4, it is evident that the bank-lending channel matters in transmitting monetary policy shocks, and in fact, plays a greater role than the interest rate channel for longer horizons during the first subsample. At the peak it accounts for, as a proportion of the maximal impact of the monetary policy shock on output, about 22%.

As discussed in Section II, one of the fundamental assumptions for the credit view is that it is difficult for banks to replace the lost deposits following monetary tightening, which in turn shifts the supply of bank loans (Bernanke and Blinder, 1988). Together with the assumption that bank loans and bonds are not perfect substitutes, proponents of the credit view have highlighted the importance of the bank-lending channel. Thus we argue that these assumptions adequately fit in the description of the banking system for the United States in the 1960s and 1970s based on the results of our analysis for this early sample period. Indeed, prior to the 1980s, the imposition of "Regulation Q" by the Federal Reserve on banks placed a ceiling on the interest rates banks could pay depositors. It follows, therefore, that during monetary contraction, when open-market interest rates went above the ceiling, banks had no way of competing for funds and suffered great declines in deposits. Moreover, there were reserve requirements on large CDs during this period, inhibiting further the ability of banks to raise funds. In addition, the markets for bank liabilities were relatively shallow and illiquid during this period (Bernanke and Gertler, 1995). Another important aspect of the bank-lending channel is the idea that bank loans play a special role, namely for small firms which rely on bank loans as their main source of financing. The inability of small firms to raise funds elsewhere without incurring an exceptionally high cost, termed as financial constraints, is part of the reason for the importance of bank-lending channel. Many studies (for example, Fazzari, Hubbard and Petersen, 1988) find evidence that during this period firms were financially constrained. This finding strengthens the role of bank loans in propagating monetary shocks.

Yet, despite the support for the credit view in the first subsample, the money view of monetary transmission is clearly relevant as well. Figure 4 shows that, at the peak, the interest rate channel contributes close to 30% of the maximal impact of monetary policy shock on output. The interest rate channel is thought to influence output through investment or consumption, and these are important and standard features in large scale macro-econometric models used for forecasting and policy analysis in major central banks around the world, such as the Federal Reserve (FRB/US model, see Reifschneider, Tetlow, and Williams 1999) or the European Central Bank

(Area-Wide-Model, see Fagan, Henry, and Mestre 2005). The results here support these features of the large scale macro-econometric models and contrast somewhat with empirical studies based on firm or household data that tease out the importance of the interest rate channel by estimating sensitivity of investment or consumption to changes in interest rates and often end up with fairly modest results.

Analysis of Transmission Channels: 1984Q2 – 2012Q4

Figure 5 plots the impulse response functions for the benchmark and various constrained cases and Figure 6 plots the distance measure for the second subsample. The results in this case are in stark contrast to those of the first subsample. The interest rate channel is clearly the most important transmission channel of monetary policy since the early 1980s. Figure 5 shows that shutting down this channel would have produced a substantially smaller increase in output in response to an expansionary monetary policy shock. The distance measure gives us a numerical measure of the relative importance of the interest rate channel. Figure 6 reports that the interest rate channel can account for as much as 60% of the maximal impact of monetary policy shock on output.[15]

Another channel under the money view, the exchange rate channel, operates more as expected for the second subsample. Shutting down the exchange rate channel also dampens the response of output, although not by as much as shutting down the interest rate channel. Figure 6 reports that the exchange rate channel only accounts for at most about 10% of the maximal impact of monetary policy shock on output. This seems fairly consistent with research that has shown exchange rate to be somewhat insensitive to interest rate movements in the United States, which is a large but relatively less open economy (Boivin, Kiley and Mishkin, 2010).

The bank-lending channel appears to have weakened dramatically compared to the first subsample, producing an impulse response function that hovers around the benchmark in Figure

[15] Even though there are few studies that have shown an increase in the strength of the interest rate channel for the United States, Angeloni et. al. (2003) find that the interest rate channel is important and is the dominant transmission channel of monetary policy in most Euro countries using data from the 1980s to the 1990s.

5. Correspondingly, Figure 6 shows the bank-lending channel explaining almost none of the impact of the monetary policy shock on output. This result, though striking, can be related to major structural changes in the U.S. banking and financial system that occurred around the early 1980s. It is also consistent with the results reported in Perez (1998), using aggregate data, and Ashcraft (2006), and Brady (2011), using disaggregated lending data.

In terms of changes in the U.S. banking and financial system, Mishkin (2007) reports that the bank share of total nonfinancial borrowing peaked in the mid 1970s around 40%, but fell to less than 30% by the mid 1980s and has remained below since then. This decline in traditional bank lending business is related to developments in capital markets and side effects of banking regulations. For example, the rise of money market mutual funds in the 1970s was the result of the binding interest rate ceilings. This new financial innovation competed with traditional banks for funds, which prompted the banks to push for deregulation in the 1980s. However, even after the phasing out of Regulation Q when banks were no longer constrained by interest rate ceilings, their cost advantages in acquiring funds were diminished. Specifically, advancements in information technology allowed a wider set of institutions and investors to become lenders and borrowers, as seen by the spectacular growth in commercial paper and junk bond markets at the time. All of these developments meant that financial constraints were less severe.[16] In particular, there were new ways for firms and consumers to raise funds and bypass traditional banks, weakening the role of bank lending in propagating monetary policy shocks.[17]

Comparison across Subsamples

Our results can be broadly interpreted as follows. In the earlier sample, the bank-lending channel is operational and relatively important. Bank loans appear to be imperfect substitutes for

[16] Chen (2004) finds that financial constraints among firms have become less severe. Brady (2011) reports the statistical and economic significance of the consumer loan supply effect has weakened over time.

[17] A decline in the bank lending channel of monetary transmission mechanism does not necessarily imply a decline in the credit channel of monetary policy transmission, since the credit channel suggest various other avenues through which monetary policy shocks may influence aggregate output, such as the balance sheet channel or bank capital channel. In fact, post Great Recession, we have seen a resurgence of interest in the financial accelerator framework of Bernanke, Gertler, and Gilchrist (1999). Brady (2011) also finds suggestive evidence of a strengthening of the balance sheet channel.

other assets, particularly for financially constrained firms. Hence with an expansionary monetary policy shock, the demand for bank loans increase with the supply. However, the role of the bank-lending channel is much weaker in the second subsample, while the interest rate channel has become more important. Hence, a contribution of this paper to the debate on the monetary transmission mechanism is to provide evidence for some role of the bank-lending channel, but also to emphasize that the role of this channel has diminished in recent years.

Recognizing that our analysis so far is only in terms of the relative importance of channels, we also measure the absolute importance of each channel for the variation in output across the two subsamples. This analysis provides further support for a weakening role of the bank-lending channel. We calculate the absolute importance of these channels for output by evaluating the average distance measure for each of the channels over the 5 to 16 quarter horizons (same window used for the distance measure earlier), scaled by the standard deviation of a monetary policy shock in terms of its impact on output. The results are reported in Table 3.

Table 3 presents two important results. First, the bank-lending channel plays a significant role in transmitting monetary policy in the first subsample. Second, there is a drastic decline in the absolute role of the bank-lending channel over the four decades whereas the absolute role of interest rate channel has increased.

V. Transmission Changes and Volatility Reduction

Apart from illustrating the changing roles of different transmission channels over the past 50 years, the results in the previous section beg the question of whether the changes in the transmission mechanism are related to concurrent changes in output and inflation volatility associated with the Great Moderation.

Studies by Niemira and Klein (1994), Kim and Nelson (1999), and McConnell and Perez-Quiros (2000) have documented a sharp decline, or break, in the volatility of U.S. output growth in mid 1980s. These papers have motivated a huge literature that characterizes this decline in volatility and investigates the reasons for it, including Stock and Watson (2002), Kim, Nelson and Piger (2004), Ahmed, Levin and Wilson (2004), Boivin and Giannoni (2006), and Kim, Morley, and Piger (2008), among many others. These studies investigate whether the reduction in output growth volatility is associated with a reduction in its conditional variances or changes in its conditional mean. In the context of SVAR models or their reduced-form counterparts, these studies investigate whether the observed reduction in volatility is associated with a change in the magnitude of shocks and forecast errors or a change in the dynamic propagation of shocks. This section presents counterfactual experiments similar to those in the previous literature motivated by the conjecture that the changes in transmission channels may alter the dynamic propagation of monetary policy shocks and hence lead to the reduction in volatility of output growth and inflation.

Variance Counterfactuals

The basic idea of the counterfactual analysis of structural change can be illustrated as follows. Recall equation (2), which gives us the reduced-form version of the model. This reduced-form equation can be expanded to give us the following:

(10) $$y_t = c^{(i)} + \Phi_1^{(i)} y_{t-1} + ... + \Phi_p^{(i)} y_{t-p} + e_t, \quad \mathrm{Var}(e) = \Sigma^{(i)}.$$

The superscript i = 1, 2 denotes the subsample under investigation (i.e. 1 indicates before the structural break and 2 after). Let $\Psi_k^{(i)}$ be the matrix of coefficients of the k^{th} lag in the matrix polynomial $\Psi_k^{(i)} = (\mathrm{I} - \Phi_1^{(i)} L - ...... - \Phi_p^{(i)} L^p)^{-1}$. With this notation, the variance of the n^{th} series in y_t can be written as:

(11) $$\mathrm{Var}(y_n)^{(i,j)} = \sum_{k=0}^{\infty} \Psi_k^{(i)} \Sigma^{(j)} \Psi_k^{(i)'} = \sigma_n^2$$

Note here that the superscript j = 1,2 also denotes the subsample. From (11), we can see that the standard deviation of y_{nt} is a function of Ψ (and hence Φ) and Σ. So standard deviation of y_{nt} in subsample 1 is $\sigma_n = (\Phi^{(1)}, \Sigma^{(1)})$ and in subsample 2 is $\sigma_n = (\Phi^{(2)}, \Sigma^{(2)})$. By evaluating expression (11) for different Φ (propagation) and Σ (shocks), we can compute counterfactual variance of y_{nt} that would have been obtained had either Φ or Σ had taken on different values. For instance, $\sigma_n = (\Phi^{(1)}, \Sigma^{(2)})$ would be the counterfactual standard deviation of y_{nt} had the propagation from the first subsample been associated with the shocks of the second subsample rather than its own shocks. See Kim, Morley and Piger (2008) for a full discussion of the issues surrounding variance counterfactual experiments.

Results from Counterfactuals

We utilize the benchmark models estimated for the two samples 1959Q3-1984Q1 and 1984Q2-2012Q4 from the preceding section to investigate how much of the reduction in output and inflation volatility was due to changes in the reduced-form VAR coefficients and how much is due to changes in the covariance matrix for the forecast errors.

Table 4 shows the results of our counterfactual experiments. The first two columns provide the sample standard deviation of the output growth and inflation series calculated from actual data for the two subsample periods. The last two columns give the counterfactual standard deviations. First, consider the results for output growth. The estimated counterfactual standard deviation for the first subsample propagation matched up with second subsample shocks (0.0091) is of a similar magnitude to the actual standard deviation before the structural break (0.0109). By contrast, the counterfactual standard deviation corresponding to a change in shocks but not propagation for the second subsample (0.0098) is of closer magnitude to the actual standard deviation before the structural break (0.0091) rather than after. Intuitively, these results suggest that if the shocks of the second subsample had occurred in the 1960s and 1970s, output growth would have been almost as stable as it has been during the Great Moderation. Similarly, had the first subsample shocks occurred in the second subsample, output growth would have been much more volatile in recent years. Hence, we can deduce that the change in the size of the shocks across the two subsamples is the primary driver of the reduction in the observed volatility of output growth. Thus, we are therefore unable to make any connection between the changes in the transmission mechanisms of monetary policy observed in Section IV and the concurrent reduction in U.S. output volatility.

The same experiments for inflation suggest a different conclusion. In this case, the magnitude of the counterfactual standard deviation corresponding to a change in shocks but not propagation is very similar to the actual standard deviation calculated for the first subsample. It follows, therefore, that changes in the propagation mechanism of shocks in the economy in the recent sample may have made inflation less sensitive to shocks, and this change in propagation mechanism could be due to the changes in transmission mechanism of monetary policy we illustrated in Section IV.

However, we must be somewhat cautious in interpreting our results. Boivin, Kiley and Mishkin (2010) argue that increasing attention should be paid to the changes in the systematic nature of monetary policy and expectations formation. Monetary policy has become substantially more focused on inflation stabilization since the Volcker era. Boivin, Kiley and Mishkin (2010) postulate that the change in policy preferences has affected the volatility of inflation and the response of output to non-monetary disturbances. The Federal Reserve's focus on price stability means that they will accommodate increases in output coming from the supply side, but defend against such changes coming from the demand side. This implies that a greater emphasis on inflation stabilization is likely to lead to greater stability in inflation but not necessarily in output. The timing of this shift in policy preferences coincides with the various other structural changes occurring in the credit and financial markets detailed earlier. Hence, the results in Table 4 could be driven by a change in the transmission mechanism, a change in policy preferences, or some complex interaction of both.

VI. Conclusion

We have analyzed the transmission mechanism of monetary policy in the U.S. economy, with special attention paid to the relative importance of the interest rate and bank-lending channels. Our analysis makes use of short-run sign restrictions to identify structural shocks in an SVAR model. Contrary to most other SVAR approaches, this does not arbitrarily impose restrictions on the contemporaneous impact of the shocks. This approach also avoids recurrent problems of circularity between identification and inference since all of the constraints are explicitly stated in the model. Having identified our monetary policy shocks, we use counterfactual experiments to compare the strength and importance of different transmission channels.

The results point towards a role for both the bank-lending and interest rate channels over the past 50 years. However, the bank-lending channel is more important in the earlier sample covering 1959Q3-1984Q1, while the interest rate channel plays a significantly greater role in transmitting policy impulses in the sample of 1984Q2-2012Q4. Results from analysis of the absolute importance of these channels to the variation in output growth provide further justification for the weakening of the role of the credit channel in the recent years. We note that this weakening is consistent with financial liberalization that occurred over the same time period and has important implications for the design of non-standard monetary policy during the zero-lower-bound period. Specifically, policies focusing on financial prices should be more effective than those focusing on quantities of credit.

The evidence that the U.S. monetary transmission mechanism has undergone discernible changes over the past 50 years motivates the last part of our study. Again using counterfactual experiments, we look for connections between changes in the transmission mechanism and increased economic stability with the Great Moderation. Perhaps surprisingly, we do not find any link between changes in the nature of the transmission mechanism of monetary policy and the observed reduction in volatility of output growth. However, we find suggestive evidence that a change in monetary transmission reduced the volatility of inflation, although our result is also consistent with the view expressed in Boivin, Kiley, and Mishkin (2010) that changes in monetary policy preferences have led to a stabilization of inflation expectations and hence inflation, but not necessarily a stabilization of output fluctuations.

References

Ahmed, S., Levin, A., Wilson, B.A., 2004. Recent U.S. Macroeconomic Stability: Good Policy, Good Practices, or Good Luck? Review of Economics and Statistics. 86(3), 824-832.

Angeloni, I., Kashyap A., Mojon B., Terlizzese D., 2003. Monetary Transmission in the Euro Area: Does the Interest Rate Channel Explain All? NBER Working Paper No. 9984.

Ashcraft, A., 2006. New Evidence on the Lending Channel. Journal of Money, Credit, and Banking. 38(3), 751-775.

Bernanke, B., Blinder, A., 1988. Credit, Money, and Aggregate Demand. The American Economic Review. 78(2), 435-439.

Bernanke, B., Blinder, A., 1992. The Federal Funds Rate and the Channels on Monetary Transmission. The American Economic Review. 82(4), 901-921.

Bernanke, B., Gertler, M., 1995. Inside the Black Box: The Credit Channel of Monetary Policy Transmission. Journal of Economic Perspectives. 9(4), 27-48.

Bernanke, B., Gertler, M., Gilchrist S., 1999. The Financial Accelerator in a Quantitative Business Cycle Framework, in: Taylor J.B., Woodford M. (Eds.), Handbook of Macroeconomics, Vol.1. Elsevier Science, Amsterdam, pp.1341-1393.

Boivin, J., Giannoni, M., 2006. Has Monetary Policy Become More Effective? Review of Economics and Statistics. 88(3), 445-462.

Boivin, J., Kiley M., Mishkin, F., 2010. How Has The Monetary Transmission Mechanism Evolved Over Time? NBER Working Paper No. 15879.

Brady, R., 2011. Consumer Credit, Liquidity, and the Transmission Mechanism of Monetary Policy. Economic Inquiry. 49(1), 246-263.

Canova, F., De Nicoló, G., 2002. Monetary Disturbances Matter for Business Fluctuations in the G-7. Journal of Monetary Economics. 49(6), 1131-1159.

Canova, F., Paustian, M., 2010. Measurement with Some Theory: A New Approach to Evaluate Business Cycle Models. Barcelona Economics Working Paper Series Working Paper no. 511.

Chen, S., 2004. Dynamic Cash Flow Effects on Investment. Ph.D. Dissertation, Washington University in St. Louis, May 2004.

Christiano, L.J., Eichenbaum, M., 1995. Liquidity Effects, Monetary Policy and the Business Cycle. Journal of Money, Credit and Banking. 27(4), 1113-1136.

Christiano, L.J., Eichenbaum, M., Evans, C., 1999. Monetary Policy Shocks: What Have We Learned And To What End? in: Taylor J.B. and Woodford M. (Eds.), Handbook of Macroeconomics, Vol.1. Elsevier Science, Amsterdam, pp. 65-148.

Eichenbaum, M., Evans, C., 1995. Some Empirical Evidence on the Effects of Shocks to Monetary Policy on Exchange Rate. The Quarterly Journal of Economics. 110(4), 975-1009.

Fagan, G., Henry J., Mestre R., 2005. An Area-Wide Model for the Euro Area. Economic Modelling. 22(1), 39-59.

Faust, J., 1998. The Robustness of Identified VAR Conclusions About Money. Carnegie-Rochester Conference Series on Public Policy, 49, 207-244.

Fazzari, S., Hubbard, G.R., Petersen B.C., 1988. Financing Constraints and Corporate Investment. Brookings Papers on Economic Activity. 1988(1), 141-206.

Fernández-Villaverde, J., Rubio-Ramírez, J.F., Sargent, T., Watson, M.W., 2007. ABCs (and Ds) of Understanding VARs. The American Economic Review. 97(3), 1021-1026.

Fry, R., Pagan A., 2011. Sign Restrictions in Structural Vector Autoregressions: A Critical Review. Journal of Economic Literature. 49(4), 938-960.

Gorton, G., 2009. Slapped in the Face by the Invisible Hand: Banking and the Panic of 2007. Prepared for the Federal Reserve Bank of Atlanta's 2009 Financial Markets Conference: Financial Innovation and Crisis, May 11-13, 2009.

Kashyap, A., Stein, J., 1994. Monetary Policy and Bank Lending, in: Mankiw, N.G. (Eds.), Monetary Policy. University of Chicago Press for NBER, Chicago, pp. 221-256.

Kashyap, A., Stein, J., Wilcox D., 1993. Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance. The American Economic Review. 83(1), 78-98.

Kim, S., 1999. Do Monetary Policy Shocks Matter in the G-7 Countries? Using Common Identifying Assumptions About Monetary Policy Across Countries. Journal of International Economics. 48(2), 387-412.

Kim, C.-J., Morley, J., Piger, J., 2008. Bayesian Counterfactual Analysis of the Sources of the Great Moderation. Journal of Applied Econometrics. 23(2), 173-191.

Kim, C.-J., Nelson, C.R., 1999. Has the U.S. Economy Become More Stable? A Bayesian Approach Based on a Markov-Switching Model of the Business Cycle. The Review of Economics and Statistics. 81(4), 608-616.

Kim, C.-J., Nelson, C.R., Piger, J., 2004. The Less Volatile U.S. Economy: A Bayesian Investigation of Timing, Breadth, and Potential Explanations. Journal of Business and Economic Statistics. 22(1), 80-93.

Leeper, E.M., Sims, C.A., Zha, T., 1996. What Does Monetary Policy Do? Brookings Papers on Economic Activity. 1996(2), 1-63.

McConnell, M., Perez-Quiros, G., 2000. Output Fluctuations in the United States: What Has Changed since the Early 1980s? The American Economic Review. 90(5), 1464-1476.

Mishkin, F., 1995. Symposium on the Monetary Transmission Mechanism. Journal of Economic Perspectives. 9(4), 3-10.

Mishkin, F., 2007. The Economics of Money, Banking, and Financial Markets, 8th Edition. Pearson Addison Wesley.

Niemira, M. P., Klein, P.A., 1994. Forecasting Financial and Economic Cycles. John Wiley & Sons, Inc., New York.

Perez, S., 1998. Causal Ordering and 'The Bank Lending Channel.' Journal of Applied Econometrics. 13(6), 613-626.

Ramey, V.A., 1993. How Important is the Credit Channel in the Transmission of Monetary Policy? Carnegie-Rochester Conference Series on Public Policy. 39, 1-45.

Reifschneider, D., Tetlow R., Williams, J., 1999. Aggregate Disturbances, Monetary Policy, and the Macroeconomy: the FRB/US Perspective. Federal Reserve Bulletin, Board of Governors of the Federal Reserve System. 1999(January), 1-19.

Romer, C.D., Romer, D.H., 1990. New Evidence on the Monetary Transmission Mechanism. Brookings Papers on Economic Activity. 1990(1), 149-214.

Stock, J.H., Watson, M.W., 2002. Has the Business Cycle Changed and Why? In: Gertler M., Rogoff K. (Eds.), NBER Macroeconomics Annual 2002 Vol. 17. MIT Press, pp. 159-218.

Taylor, J.B., 1995. The Monetary Transmission Mechanism: An Empirical Framework. Journal of Economic Perspectives. 9(4), 11-26.

Uhlig, H., 2005. What Are The Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure. Journal of Monetary Economics. 52(2), 381-419.

FIGURE 1

IMPULSE RESPONSES TO A MONETARY POLICY SHOCK (1959Q3 – 1984Q1)

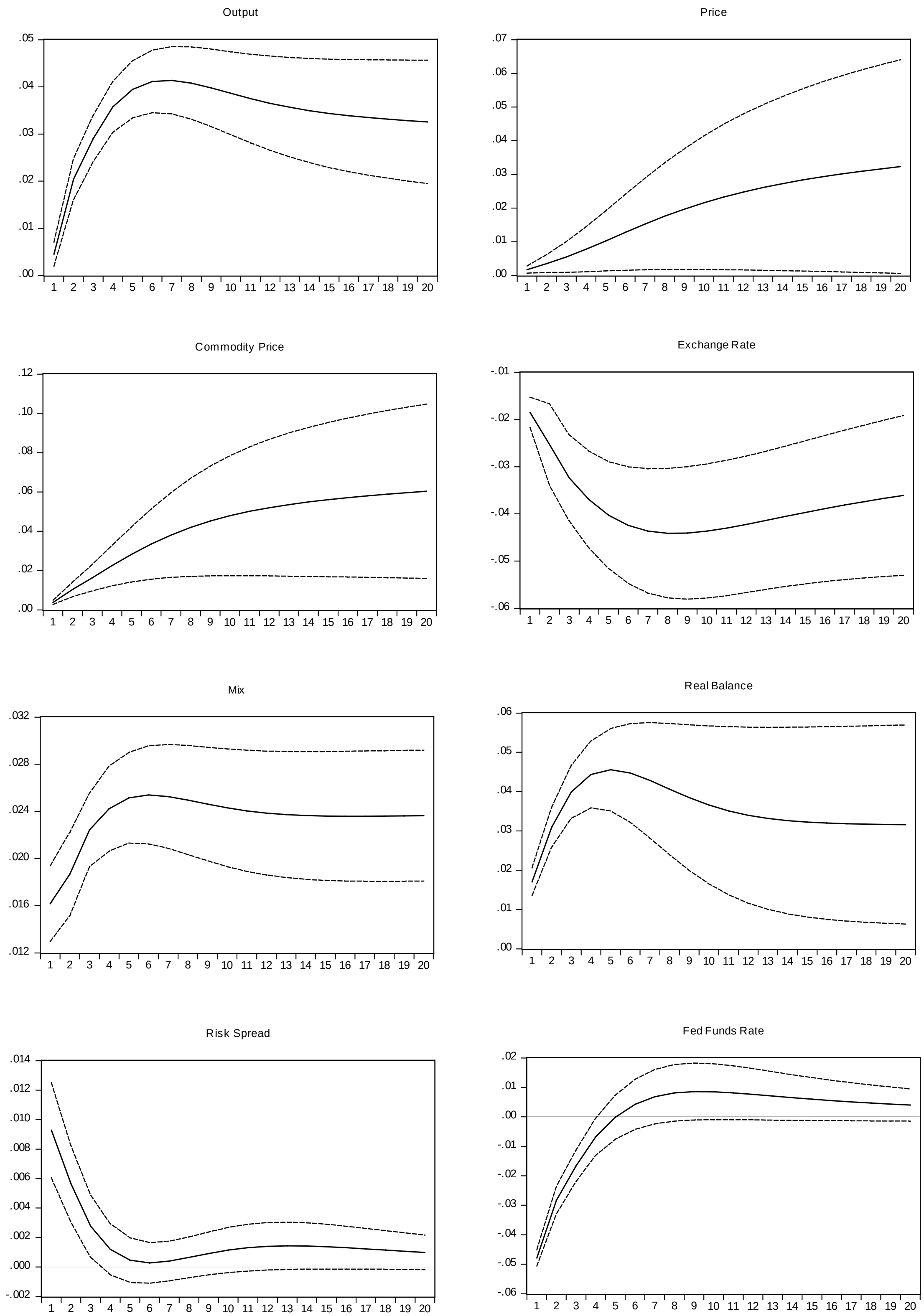

FIGURE 2

IMPULSE RESPONSES TO A MONETARY POLICY SHOCK (1984Q2 – 2012Q4)

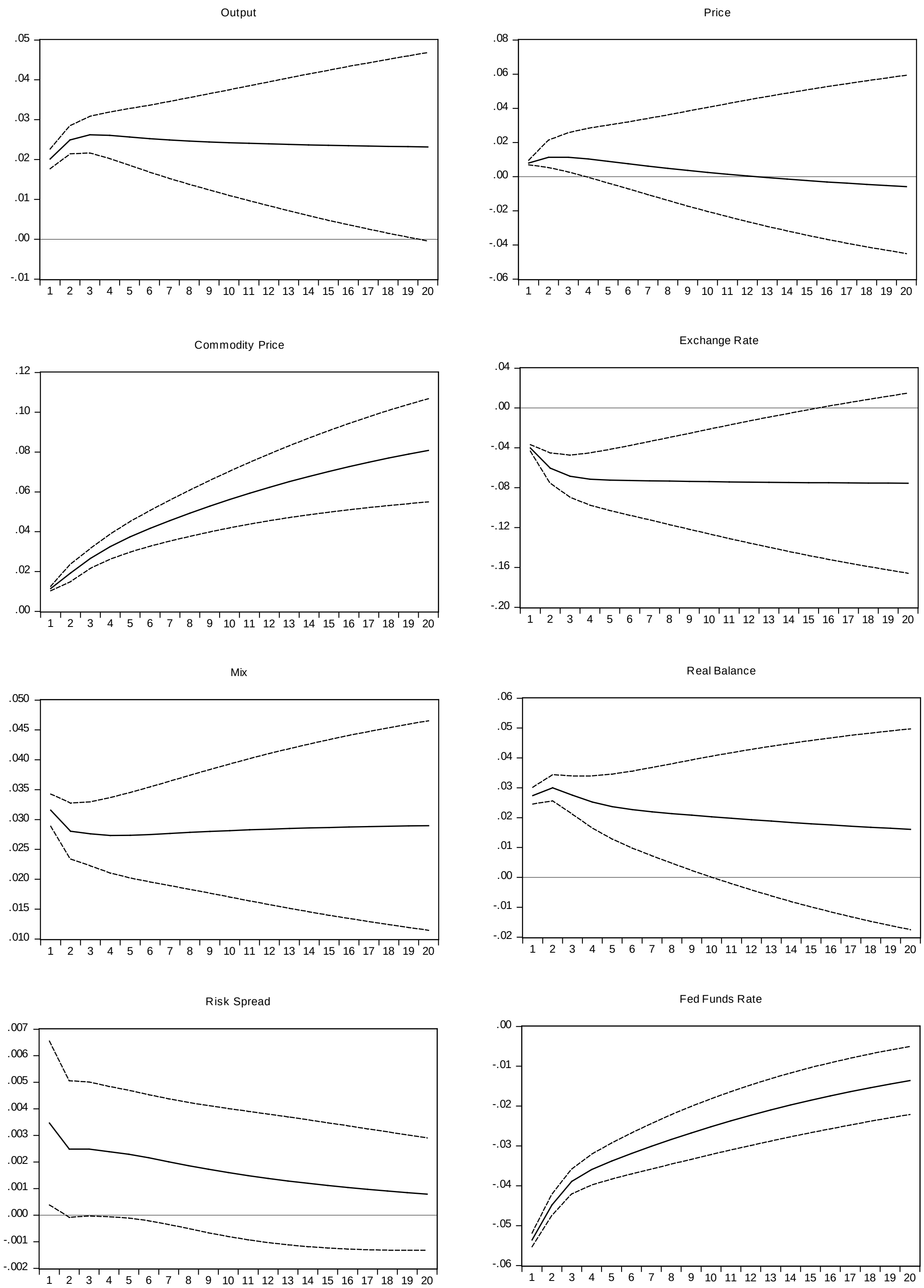

FIGURE 3

IMPULSE RESPONSE OF OUTPUT TO A MONETARY POLICY SHOCK WITH DIFFERENT CHANNELS BLOCKED (1959Q3 – 1984Q1)

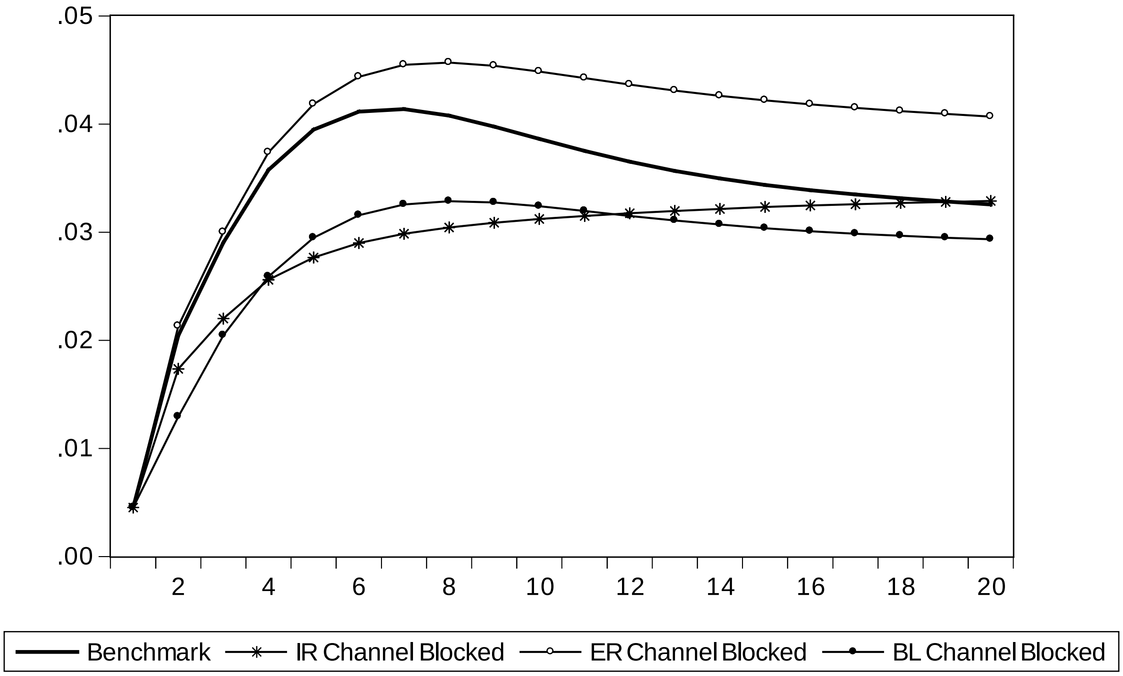

FIGURE 4

IMPORTANCE OF DIFFERENT CHANNELS (1959Q3 – 1984Q1)

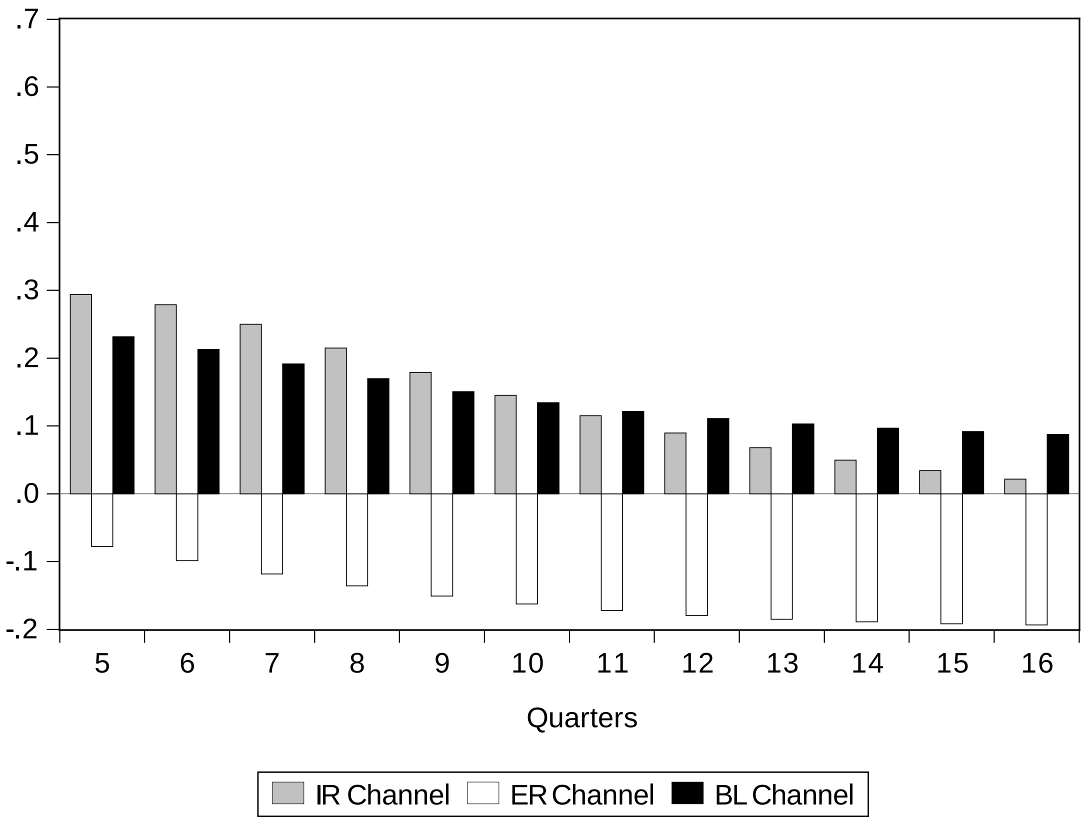

FIGURE 5

IMPULSE RESPONSE OF OUTPUT TO A MONETARY POLICY SHOCK WITH DIFFERENT CHANNELS BLOCKED (1984Q2 – 2012Q4)

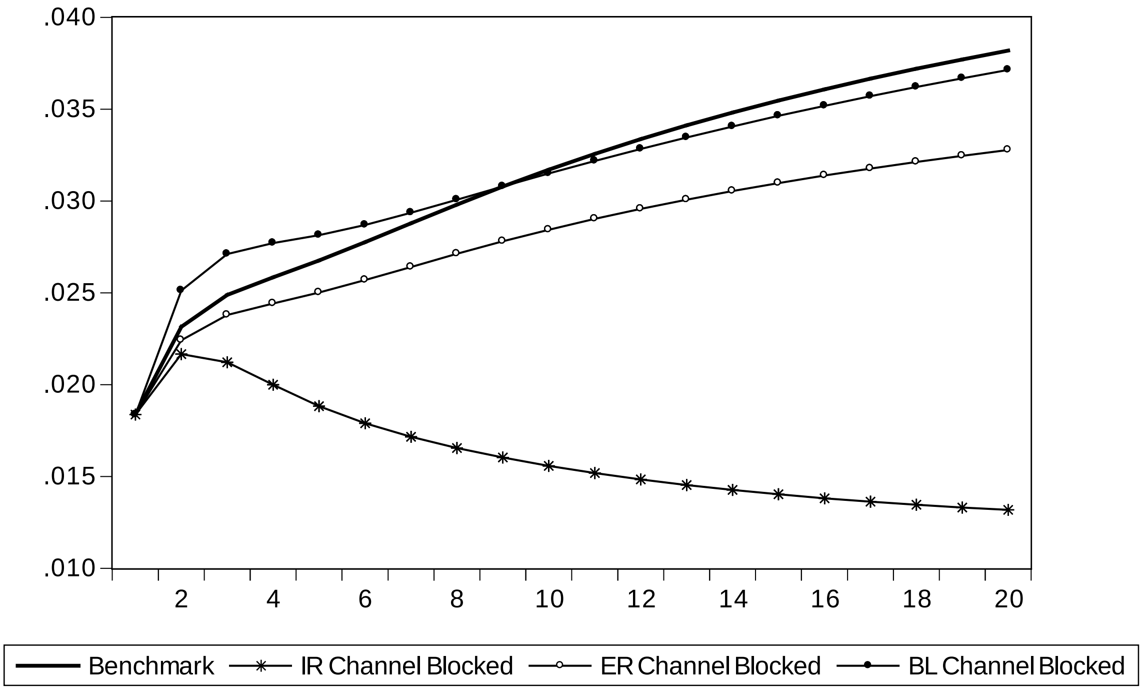

FIGURE 6

IMPORTANCE OF DIFFERENT CHANNELS (1984Q2 – 2012Q4)

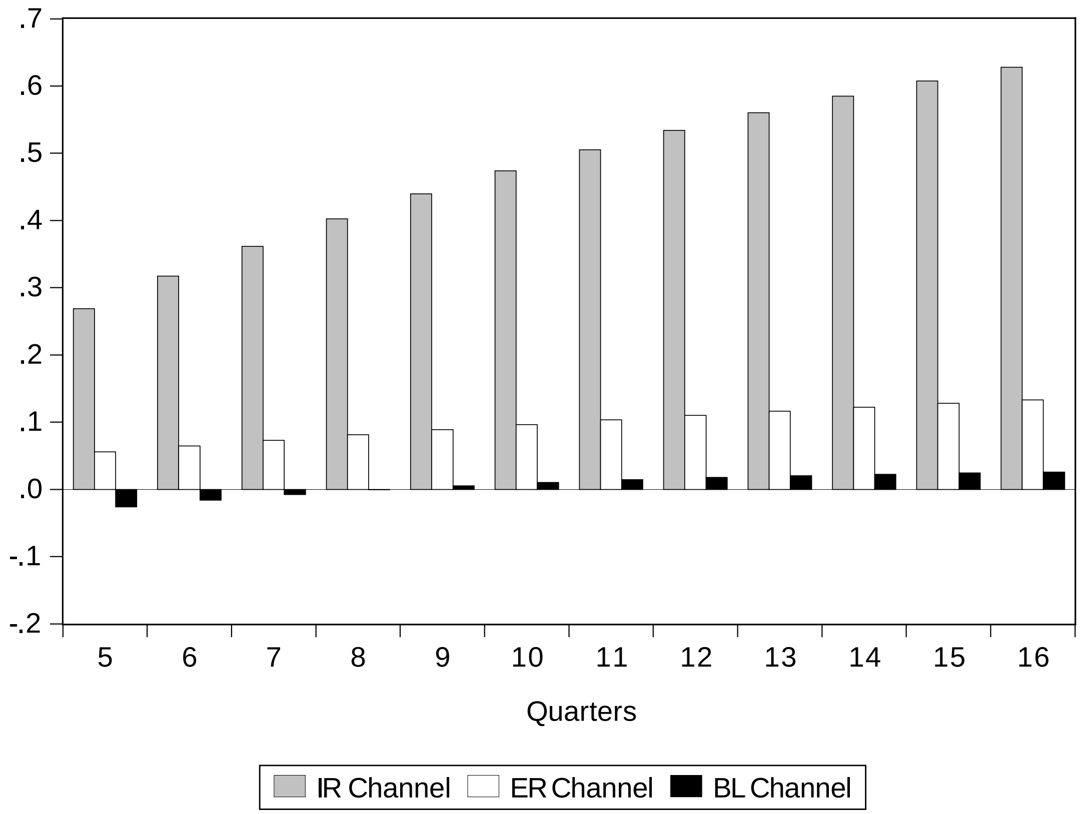

TABLE 1

VARIABLE DEFINITIONS AND DATA SOURCES

Variable	Definition and Sources
Output (*y*)	U.S. Real Gross Domestic Product (FRED: GDPC1)
Price Level (*p*)	Personal Consumption Expenditures, 2005 = 100 (FRED: PCECTPI)
Commodity Prices (*cp*)	Producer Price Index: All Commodities, 1982 = 100, Average (FRED: PPIACO)
Nominal Exchange Rate (*e*)	Trade Weighted U.S. Dollar Index: Major Currencies, March 1973 = 100, End of Period (FRED: TWEXMMTH)
KSW "Mix" (*l*)	Total Loans/(Commercial Paper + Total Loans) Total Loans = Nonfinancial corporate business depository institution loans, n.e.c. + Nonfinancial noncorporate business depository institution loans, n.e.c. (Flow of Funds Accounts of the U.S., Board of Governors of the Federal Reserve System) Commercial Paper = Nonfinancial corporate business commercial paper (Flow of Funds Accounts of the U.S., Board of Governors of the Federal Reserve System)
Real Money Balances (*m*)	M2 Money Stock, Average (FRED: M2SL) deflated by Personal Consumption Expenditure.
Risk Spread (*rs*)	Moody's Seasoned Baa Corporate Bond Yield – 10 Year Treasury Constant Maturity Rate, End of Period (FRED: BAA and GS10)
Fed Funds Rate (*i*)	Effective Federal Funds Rate, End of Period (FRED: FEDFUNDS)

TABLE 2

CROSS CORRELATION SIGN RESTRICTIONS FOR A MONETARY POLICY SHOCK

Comovement Between	Cross Correlation Sign
Output and Price	Positive
Price and Real Balance	Positive
Real Balance and Output	Positive
Real Balance and Fed Funds Rate	Negative
Fed Funds Rate and Mix	Negative
Fed Funds Rate and Nominal Exchange Rate	Positive

TABLE 3

ABSOLUTE IMPORTANCE OF CHANNELS FOR A 3-YEAR WINDOW (STANDARD DEVIATION)

	Sample 1: 1959Q3-1984Q1	Sample 2: 1984Q2-2012Q4
Size of Monetary Policy Shock	0.0029	0.0022
Bank-Lending Channel	1.9960	0.0944
Interest Rate Channel	2.0406	5.9235

Note: Absolute importance of channels calculated by dividing the average distance measure for each of the channels over the 5th to 16th quarter horizon by the standard deviation of a monetary policy shock in terms of its impact on output reported in the first row of the table.

TABLE 4

RESULTS FROM COUNTERFACTUAL VARIANCE EXPERIMENT

	Sample Standard Deviation		Standard Deviation Using Counterfactual Experiments	
	1st Subsample: 1959Q3-1984Q1	2nd Subsample: 1984Q2-2012Q4	1st Subsample Propagation 2nd Subsample Shocks	2nd Subsample Propagation 1st Subsample Shocks
Output Growth	0.0109	0.0063	0.0091	0.0098
Inflation	0.0074	0.0038	0.0081	0.0039