Has Monetary Policy Maintained its Effectiveness?

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Abstract

Can monetary authority nowadays use the same conventional instruments to accommodate undesirable effects of shocks as effectively as at the beginning of the Volcker era? Or has the (changed) economic environment characterizing the last thirty years diminished its effectiveness? The answer is *no* to the first question and, consequently, *yes* to the second question. We estimate a dynamic structural general equilibrium model in the two subsamples, 1955-1979 and 1984-2012, and find that the effectiveness of monetary policy, i.e. its ability to counteract undesired shocks that influence inflation, has declined. We document that the main reason behind this decline is related to the changed properties of the labor market.

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1 Introduction

The U.S. economy has experienced some fundamental changes around the early 1980s, which were undoubtedly manifested in a reduction of macroeconomic volatility, a phenomenon referred to as the "Great Moderation". While one strand of the literature attributes most of this reduction to smaller macroeconomic shocks, another strand of the literature attributes it mainly to the more systematic response of monetary policy to fluctuations in economic conditions.[1] In their paper, Boivin and Giannoni (2006) found that monetary policy, conducted through Taylor rule manipulation, became more effective after the early eighties; by responding more aggressively to economic fluctuations, and to inflation fluctuations, in particular, the monetary authority assured to adjust nominal interest rates to avoid inflationary periods that characterized the 1960s and especially 1970s. As a result, inflation became more stable and, arguably, as a consequence, economic fluctuations diminished. In other words, the change in the monetary policy conduct that occurred around the early 1980s was particularly effective.

In this paper we ask a novel question, not previously explored in the literature: has monetary policy, conducted through Taylor rule manipulation, maintained the same effectiveness after thirty years? We find that the effectiveness of monetary policy in stabilizing inflation has actually declined. This is not to say that monetary policy has not helped stabilize inflation after the early 1980s. On the contrary, we also find that monetary policy was particularly effective at that time, but we argue that the specific structure of the economy in the early 1980s was particularly favorable to achieving this high effectiveness. In fact, any change in the overall structure of the economy can alter the effectiveness of monetary policy since, intuitively, the channel through which monetary policy affects macroeconomic outcomes depends upon all the structural parameters. Recognizing this fact, we estimate possible sources of changes in the structure of the economy, and find that the effectiveness of monetary policy declined mainly because of changes in the properties of the labor market. Importantly, in this paper we focus only on conventional monetary policy tools and we abstract from any

[1] This first explanation of the Great Moderation is known as the "good luck" hypothesis. See, for example, Kim and Nelson (1999), Stock and Watson (2003a,b), Ahmed, Levin, and Wilson (2004), Primiceri (2005a), Gambetti and Galí (2009), and Liu, Waggoner, and Zha (2009). The second explanation is known as the "good policy" hypothesis. See, for example, Clarida, Galí, and Gertler (2000), Cogley and Sargent (2001, 2005), Blanchard and Simon (2001), and Boivin (2006) . Other explanations have also been proposed in the literature; for example, a change in inventories management, McConnell and Perez-Quiros (2000) and Kahn, McConnell, and Perez-Quiros (2002), and financial innovation, Dynan et al. (2006), among others.

non-conventional tools, such as quantitative easing, since we believe the latter was prompted by the exceptional severity of the recent crisis and it is likely that monetary policy will revert to conventional tools once the economy recovers. Therefore, it is of our interest to explore whether the use of conventional tools as policy instruments has maintained its effectiveness.

We formally define the *effectiveness* of monetary policy as the effect that a marginal change in the monetary policy parameters has on the variance of an endogenous variable.[2] In order to abstract from any level effects, we also define the *elasticity* of this measure, which depicts how responsive are the variations of the same endogenous variable to the same change in the monetary policy parameter, ceteris paribus. The effectiveness depends upon many factors. First, shifts in the parameters of the model would certainly lead to a different degree of effectiveness. The parameters of a model might change for different reasons, such as due to a change in the conduct of monetary policy, as the one documented during the Volcker era, due to a change in the structure of the economy, as documented by Kahn, McConnell, and Perez-Quiros (2002), or due to a change in the propagation of the shocks, as documented by Pancrazi (2015). Second, the effectiveness will also be altered by an unequal change in the variances of the shocks, as it alters the relative weights of the shocks that drive the dynamics of macroeconomic variables.

By using a structural medium-scale dynamic stochastic general equilibrium macroeconomic model as in Smets and Wouters (2007) as our laboratory, we first estimate the *effectiveness* and *elasticity* of the monetary policy and then thoroughly investigate which of the above factors in particular is responsible for their behavior.[3] We estimate the model with Bayesian techniques in the two subsamples, pre-1980 sample period (1955-1979) and post-1980 sample period (1984-2012). The estimated model reveals that the *effectiveness* of monetary policy

[2] When analyzing the effects of monetary policy parameters, we focus only on the inflation parameter in the Taylor rule. Our choice is motivated by the two facts. First, most of the literature equates good policy, or a changed monetary policy conduct in the early 1980s, with the more aggressive response of monetary policy to inflation. Second, our estimates will also show that the policy response to output gap was almost identical before and after 1980s. In addition, we focus on analyzing two endogenous variables, inflation and output gap, which is also very standard in the literature.

[3] The use of this model is quite standard in the literature. The model features several frictions, both nominal and real. In particular, it features sticky nominal price and wages setting that allows for backward inflation indexation, habit formation in consumption and investment adjustment costs, variable capital utilization and fixed costs in production. The dynamics is driven by seven orthogonal structural shocks: neutral and investment-specific technology shocks, risk premium shock, price and wage markup shocks, exogenous spending shock and monetary policy shock.

in stabilizing inflation has drastically declined, from -1.53 in the first subsample to -0.06 in the second subsample. Whereas the negative sign reflects the stabilizing effects of a more aggressive monetary policy, the reduction in the magnitude signals the loss of monetary policy effectiveness. Similarly, the *elasticity* of the effectiveness has largely declined as well, from -1.89 in the first subsample to -0.35 in the second subsample. This finding reveals that although monetary policy was very effective in accommodating adverse shocks in the early 1980s, this task might be much more challenging now because of the changed economic environment. In particular, our results imply that if the economy were to be hit by some large unexpected shocks, the stabilizing effect of monetary policy adjustments on inflation would be rather weak.

We then perform several counterfactual exercises to disentangle the factors that lead to the decline of monetary policy effectiveness. In particular, following a similar approach as in Boivin and Giannoni (2006), we divide all parameters into four subsets: policy parameters (Taylor rule parameters), structure parameters (technology, preference, etc.), variance of the shocks, and the persistence of the shocks, and we ask the following question. What would have been the effectiveness of monetary policy in the last thirty years had a subset of parameters remained the same as in the pre-Volcker era? One could argue that an already large response of monetary policy to inflation during the post-1980 period would limit its ability to further stabilize macroeconomic volatility by responding to inflation even more aggressively. However, our counterfactuals suggest that even if the inflation parameter in the Taylor rule was at its pre-Volcker period level, the marginal effect of a change in this parameter would have also been much lower than it actually was in the pre-1980 period (-0.45 instead of -1.89). Therefore, the fact that monetary policy became more aggressive during the Volcker era is not the main reason why its effectiveness to further stabilize fluctuations has declined. In contrast, our counterfactuals suggest that the decline in the effectiveness of monetary policy can mostly be attributed to the changes in the propagation of the shocks. When all the parameters are kept at their second subsample values except for the persistence parameters of the exogenous processes which are kept at their first subsample values, the resulting effectiveness of the monetary policy remains large. Additional counterfactual scenarios reveal that the wage markup shock is crucial for explaining the result. In fact, if all the parameters of the model except for the persistence of the wage markup process are kept at their second subsample values, the effectiveness of monetary policy would still be quite large, equal to -1.28, which is the value much closer to its first subsample estimate.

While the importance of the wage markup shock in explaining overall aggregate fluctuations has been recognized by the proponents of the New Keynesian model, and Smets and Wouters (2007) model as the most common variant, at the same time this model has been heavily criticized by Chari, Kehoe, and McGrattan (2009). In particular, they point out that four of the seven shocks considered in this model, with the wage markup shock being one of them, are not structural. They show that introducing the wage markup shock amounts to mechanically inserting a labor wedge into the model, where the wedge can be interpreted in at least two ways, for example as fluctuations in the bargaining power of unions or as fluctuations in the value of the leisure of consumers. While this feature might be problematic for giving specific policy recommendations, the specific interpretation of this shock does not diminish our results, as we do not need to take the stand on the nature of this shock. Our results simply point out that the properties of this shock have changed and that this particular change is the main reason why potential effectiveness of monetary policy declined.

Finally, in order to gain some intuition for our result we refer to a very simple New Keynesian model, as described in Galí (2009). This model is stylized, but it nevertheless helps to understand our results by revealing a non-monotonic relationship between the Taylor rule parameter with inflation, persistence of labor market shock and the variance of inflation. This relationship suggests that for a rather large value of that persistence, monetary policy exhibits a very high degree of effectiveness in stabilizing inflation variations. However, the effectiveness of monetary policy significantly decreases with the decrease in the persistence of the labor market shock. Interestingly, the relationship between monetary policy parameters, persistence of the labor market shock, and effectiveness of monetary policy is highly nonlinear. Fortunately, the simplified model is tractable enough so that we can derive analytical expressions for this relationship and provide some insights for it.

The rest of the paper is organized as follows. Section 2 starts from the state space representation of a generic dynamic stochastic general equilibrium model in order to illustrate how the effectiveness of monetary policy can be influenced by various factors in the economy.

Section 3 lays out a modeling choice as well as the estimated parameters of the model in the two subsamples. Section 4 uses these estimates to construct counterfactual scenarios which help us in identifying the causes of the decline in the effectiveness. Section 5 offers some intuition for the obtained results by using a simple three-equation New Keynesian model in which all the results can be derived analytically, as in Galí (2009). Section 6 concludes.

2 Monetary Policy Effectiveness - A Simple Theoretical Illustration

In this section we define the variables of interest for our analysis, namely the effectiveness of monetary policy both in terms of level and elasticity. Our goal is to compute how this effectiveness, measured by the sensitivity of macroeconomic variables to monetary policy changes, has evolved with the changes in the economic environment.

Consider an equilibrium of a dynamic stochastic general equilibrium (DSGE) model that has the following $ABCD$ representation, in its first order approximation form, as in Fernandez-Villaverde et al. (2007):

$$X_t = A(\Theta, \Phi, \Psi)X_{t-1} + B(\Theta, \Phi, \Psi)\varepsilon_t, \tag{1}$$

$$Y_t = C(\Theta, \Phi, \Psi)X_{t-1} + D(\Theta, \Phi, \Psi)\varepsilon_t. \tag{2}$$

Here, X_t is an $n_X \times 1$ vector of state variables, Y_t is an $n_Y \times 1$ vector of control variables, and ε_t is an $n_\varepsilon \times 1$ vector of white noise exogenous disturbances with the variance-covariance matrix Σ_ε. The matrices A, B, C and D are functions of parameters that can generally be divided into three sets. The first set of parameters, Θ, characterizes the overall structure of the economy, such as preferences, production technology, etc. The second set of parameters, Φ, characterizes monetary policy behavior, described, for example, by the Taylor rule parameters. The third set of parameters, Ψ, characterizes the autoregressive structure of the exogenous processes. For example, if we assumed that these processes had a first order autoregressive structure, Ψ would gather all the first order autoregressive coefficients. We also define a fourth set of parameters, Σ_ε, which collects the variances of the exogenous shocks. Since the $ABCD$

representation is derived from the first order approximation of the model, the fourth set of parameters, Σ_ε, will not affect the matrices A, B, C, and D, but will directly affect the second moments of the macroeconomic variables, as explained next.

The $ABCD$ representation above delivers simple analytical expressions for the second moments of the model. For example, the variances of X_t and Y_t are given by:

$$\begin{aligned}
\Sigma_Y = \quad & \mathbb{E}(YY') = \quad & C(\Theta,\Phi,\Psi)\Sigma_X C'(\Theta,\Phi,\Psi) + D(\Theta,\Phi,\Psi)\Sigma_\varepsilon D'(\Theta,\Phi,\Psi), \\
\Sigma_X = \quad & \mathbb{E}(XX') = \quad & A(\Theta,\Phi,\Psi)\Sigma_X A'(\Theta,\Phi,\Psi) + B(\Theta,\Phi,\Psi)\Sigma_\varepsilon B'(\Theta,\Phi,\Psi).
\end{aligned}$$

These expressions clearly show that the variance of macroeconomic variables depends upon the deep structure of the economy, characterized by the reduced form parameters A, B, C and D, and upon the variance of the shocks, Σ_ε.

One of the most prominent explanations of the causes of the Great Moderation is the so called "good policy" hypothesis. This hypothesis states that a change in the policy parameters, Φ, and in particular an increase in the response to inflation in the Taylor Rule during the Volcker era, was the main contributor to the reduction of the overall macroeconomic volatility.[4] Given our notation, this hypothesis can technically be written as:

$$\Sigma_Y(\Theta_1, \Phi_1, \Psi_1) > \Sigma_Y(\Theta_1, \Phi_2, \Psi_1),$$

where the two subscripts denote the sets of parameters that describe the economy in the first subsample (pre-1980 period) and in the second subsample (post-1980 period), respectively. In other words, the good policy hypothesis has been tested in the literature by isolating the role that a change in the monetary policy conduct, captured by the shift from Φ_1 to Φ_2, has played in the reduction of macroeconomic volatility. This statement can be rigorously written as $\frac{\Delta\mathbb{E}(Y'Y)}{\Delta\Phi} < 0$, implying that a change in the response of the monetary policy to inflation at the beginning of the Volcker era, from Φ_1 to Φ_2, caused a large reduction in the volatility of macroeconomic variables. In other words, a change in the monetary policy conduct that occurred around the early 1980s was particularly effective.

[4] Several works, for example, Clarida, Galí, and Gertler (2000), Cogley and Sargent (2001), Romer and Romer (2002), and Boivin and Giannoni (2006), have concluded that it indeed played a dominant role in this reduction.

In this paper we investigate a novel question, which has not been yet studied in the literature: has monetary policy maintained the same effectiveness after thirty years? Notice that the effect of a change in monetary policy on the second moments of macroeconomic variables does depend on the characteristics of the economy, described by the set of parameters A, B, C, and D. For example, let us assume that Volcker in 1979 decided to increase the monetary policy response to inflation. In such a case, the effects of this change on the macroeconomic variables would depend on the value of the parameters A, B, C, and D at that particular moment. If a new Chairman in the future were to make the exact same change in an economy characterized by a different structure, the effect on macroeconomic variable would potentially be different. In fact, if the structure of the economy changes, a similar monetary policy change would, in principle, have a different effect. Therefore, in this paper we first estimate the changes in the structure of the economy in the two subsamples (pre-1980 and post-1980) and then investigate how these estimated changes over the last three decades have modified the ability of monetary policy to further stabilize the economy.

Let us now define the objects of interest for our analysis. In particular, we define the *effectiveness* of monetary policy, denoted by ϵ, as the effect of a marginal change in the monetary policy parameters, Φ, on the variance of an endogenous variable, i.e.:

$$\epsilon\left(\Theta, \Phi, \Psi, \Sigma_{\varepsilon}\right) = \frac{\partial \mathbb{E}(YY')}{\partial \Phi}. \tag{3}$$

A change in the effectiveness of monetary policy defined as above can be induced in two ways. First, any change in the parameters of the matrices A, B, C and D in equations (1) - (2) will alter the effectiveness. The parameters might change for different reasons, such as due to a change in the conduct of monetary policy, as the one documented in the post-1980 era, due to a change in the structure of the economy, as documented by Kahn, McConnell, and Perez-Quiros (2002), or due to a change in the propagation of the shocks, as documented by Pancrazi (2015). Second, the effectiveness will also be altered by an unequal change in the variances of the shocks, captured by a change in the elements of the matrix Σ_{ε}, which alters the relative weights of the shocks in driving the dynamics of macroeconomic variables.

This measure of the effectiveness is affected by the level effects. In fact, it depends on the value of variance of the variable in question and on the value of the monetary policy parameter itself. To avoid potential problems caused by this issue, we construct a measure which specifically takes these effects into account. In particular, we construct a measure of the *elasticity* of the effectiveness, denoted by ϵ^L, and define it as:

$$\epsilon^L\left(\Theta, \Phi, \Psi, \Sigma_\varepsilon\right) = \frac{\partial \mathbb{E}(YY')}{\partial \Phi} \frac{\Phi}{\mathbb{E}(YY')}. \tag{4}$$[5]

In the next section, we compute both measures using a standard DSGE model. In addition to quantifying the changes in both of these measures, by conducting various counterfactual experiments we identify the sources behind these changes as well. Also, equation (3) allows us to identify which shocks have become easier/harder to accommodate, ultimately altering monetary policy effectiveness.

3 Empirical Strategy

3.1 DSGE model

We use a medium-scale DSGE model as in Smets and Wouters (2007) as our laboratory for computing an accurate measure of the monetary policy effectiveness and its elasticity. Importantly, this approach allows us to estimate possible changes in the macroeconomic environment that, as seen in the last section, might alter the ability of monetary policy to affect macroeconomic stability. Since this model is standard in macroeconomics literature and since it is thoroughly elaborated in the original paper, we do not report all the equations of the model here. Instead, here we simply summarize its main components.

The estimated model features several frictions, both nominal and real. In particular, it features sticky nominal price and wages setting that allows for backward inflation indexation, habit formation in consumption and investment adjustment costs, variable capital utilization and fixed costs in production. As in the original Smets and Wouters (2007)'s model, the dynamics are driven by seven orthogonal structural shocks: neutral and investment-specific technology shocks, risk premium shock, price and wage markup shocks, exogenous spending shock and monetary policy shock.

[5] The division and the product are element-by-element operations.

In this model, the monetary authority follows a generalized Taylor rule by gradually adjusting the policy-controlled interest rate, r_t, in response to inflation, π_t and output gap, $y_t - y_t^p$, defined as the difference between actual and potential output (see Taylor (1993)), as follows:

$$r_t = \phi_r r_{t-1} + (1-\phi_r)\{\phi_\pi \pi_t + \phi_Y (y_t - y_t^p\} + \phi_{\Delta y}\left[(y_t - y_t^p) - (y_{t-1} - y_{t-1}^p)\right]. \qquad (5)$$

Potential output is defined as the level of output that would prevail under flexible prices and wages in the absence of the two markup shocks. The parameter ϕ_r captures the degree of interest rate smoothing, ϕ_π captures the response to inflation, ϕ_Y captures the response to output gap, and $\phi_{\Delta y}$ captures the short-run feedback from the change in the output gap.

3.2 Estimation Strategy

We estimate the model with Bayesian techniques using as observables the same seven quarterly macroeconomic U.S. time series as in Smets and Wouters (2007): the log difference of real GDP, real consumption, real investment and the real wage, log hours worked, the log difference of the GDP deflator, and the federal funds rate. We update the dataset to take into account observations until 2012. We estimate the model for the 1955-1979 sample and for the 1984-2012 sample. As in Stock and Watson (2007), Boivin and Giannoni (2006) and Ahmed, Levin, and Wilson (2004), among others, we omit the transition period between 1979-1983 to better account for possible breaks between the two subsamples. Nevertheless, our results are robust to including this period in the second subsample. In addition, one might argue that the results will be affected when we include a Great Recession period, a period characterized by the nominal interest rates close to zero and numerous unconventional monetary policy interventions as a consequence. To address this issue, we perform a robustness check where we restrict the second subsample to the period 1984-2007. We show that our main findings are not affected by the sample choice.

Table 1 – Estimated Model Parameters

	1955-1979	1984-2012	1984-2007
Standard Deviation of the Shocks		Σ_ε	
Sd technology	0.562	0.386	0.360
Sd risk-premium	0.195	0.080	0.088
Sd govt-spending	0.411	0.345	0.348
Sd investment specific	0.561	0.533	0.489
Sd monetary	0.196	0.100	0.094
Sd price markup	0.145	0.097	0.091
Sd wage markup	0.266	0.458	0.306
Persistence of the Shocks		Ψ	
AR(1) technology	0.435	0.639	0.622
AR(1) risk-premium	0.678	0.875	0.846
AR(1) govt-spending	0.545	0.578	0.574
AR(1) investment specific	0.358	0.204	0.242
AR(1) monetary	0.207	0.633	0.554
AR(1) price markup	0.823	0.818	0.801
AR(1) wage markup	0.957	0.476	0.487
Monetary Policy		Φ	
Taylor Rule: inflation	1.02	1.53	1.55
Taylor Rule: interest rate smoothing	0.75	0.85	0.85
Taylor Rule: output gap	0.20	0.19	0.20
Taylor Rule: previous output gap	0.14	0.11	0.12
Structure		Θ	
Price markup	0.60	0.69	0.67
Wage markup	0.93	0.48	0.30
Adjustment cost	2.98	5.04	5.61
Intertemporal elasticity of substition	0.88	0.81	0.80
Habit formation parameter	0.66	0.67	0.66
Wage stickiness	0.68	0.57	0.56
Labor supply elasticity	1.56	0.25	1.13
Price stickiness	0.50	0.73	0.70
Wage indexation wages	0.43	0.40	0.42
Price indexation prices	0.37	0.20	0.24
Capacity utilization elasticity	0.64	0.83	0.78
Share of fixed costs	1.46	1.36	1.49
Quarterly steady state inflation rate	0.68	0.58	0.61
100*(discount factor - 1)	0.19	0.19	0.23
Steady state hours worked	0.08	0.14	0.16
Gov spending equation	0.65	0.46	0.46
Share of capital	0.16	0.11	0.16

Note: This table reports the estimated parameters as the median of the posterior distribution of the Smets and Wouters (2007) model estimated in the first subsample (1955-1979, first column) and the second subsample, including the Great Recession period (1984-2012, second column) and excluding the Great Recession period (1984-2007, third column). The parameters are divided into four groups as described above. The technical parameters of the estimation procedure, including prior distributions, are the same as in Smets and Wouters (2007).

3.3 Parameter Estimates

Table 1 reports the posterior means of all the parameters in the first subsample (1955-1979) and in the second subsample (1984-2012).[6] As mentioned above, in order to check if our results are driven by the last crisis, we also report the results when Great Recession period is excluded from the sample. Several interesting results emerge.

First, the different magnitudes of the standard deviations of the shocks in the two subsamples, gathered in the Σ_ε matrix, are consistent with the findings of the Great Moderation literature, as in Stock and Watson (2003b), Primiceri (2005b), Sims and Zha (2006), Arias, Hansen, and Ohanian (2007), Mojon (2007), among others. In fact, the standard deviation of all the shocks (technology, risk premium, government spending, investment specific, monetary, and price markup) except the wage markup shock has declined, although unevenly. For example, the standard deviation of the investment specific shock decreased by only 5 percent, while the standard deviation of the risk premium shock decreased by 60 percent. Also, the changes in the standard deviations of the shocks are very similar even when the most recent observations are excluded.

Second, the estimates suggest that also the propagation of the shocks has somewhat changed during the second subsample. Technology, risk premium, and monetary shocks became more persistent, whereas the persistence of the wage markup shock largely declined. The latter finding is crucial since we will show that changes in the effectiveness of monetary policy can be largely attributed to the changes in the nature of the labor market shocks. Recently Chari, Kehoe, and McGrattan (2007, 2009) have highlighted the importance of disturbances in the labor-market equilibrium equation for explaining the overall variations, but have at the same time criticized Smets and Wouters (2007)'s interpretation of the wage markup shock. In particular, they point out that four of the seven shocks considered in this model, with the wage markup shock being one of them, are not structural. That is, they argue that introduc-

[6] The priors used for the Bayesian estimation are the same as the ones reported in Table 1A and Table 1B in Smets and Wouters (2007).

ing the wage markup shock amounts to mechanically inserting a labor wedge into the model, where the wedge can be interpreted in at least two ways, for example as fluctuations in the bargaining power of unions or as fluctuations in the value of the leisure of consumers. While this feature might be problematic for giving specific policy recommendations, the specific interpretation of this shock does not diminish our results as we do not need to take the stand on the nature of this shock. Our finding supports the idea that the labor market sector of the model is crucial for evaluating policy effectiveness, as the change in its properties after 1980s has played a major role in reducing monetary policy effectiveness in stabilizing inflation.

Third, regarding the monetary policy parameters, our estimates capture the more aggressive monetary policy that characterized the post-1980 period, as also estimated by Taylor (1999), Clarida, Galí, and Gertler (2000), Cogley and Sargent (2001), Romer and Romer (2002), and Boivin and Giannoni (2006), among others. In fact, the response of the monetary authority to inflation has largely increased from values around 1 to values around 1.5. Since the inflation response in the Taylor rule is the policy parameter that has changed the most, and since the literature agrees that this is in fact the key policy parameter, in the rest of the paper we will focus on measuring the effectiveness of monetary policy in terms of changes of this parameter.

Finally, the bottom panel of Table 1 reports the estimates of all the remaining parameters, labeled as structure parameters. The vast majority of the structure parameters appears to be stable across the two subsamples. The notable exception are the parameters related to labor market conditions (wage markup and labor supply elasticity) and the adjustment cost parameters.

The estimation results conducted in the two subsamples provide an estimate of the changes in the macroeconomic environment between the pre- and post-1980. Given our notations from the previous section, they provide the estimates of the four sets of parameters, Φ, Θ, Ψ and Σ_ε, in the two subsamples. We can now use these estimates to compute the effectiveness of monetary policy in the two subsamples, as illustrated in the next section.

4 Computing Monetary Policy Effectiveness

Using the parameter estimates from the previous section, here we first compute the two measures of interest, the effectiveness of monetary policy, ϵ, and its elasticity, ϵ^L. Given the complexity of the analytical form of this model, we obtain these two measures by numerically computing the derivatives in equations (3) and (4) instead. For simplicity, we focus on two endogenous variables, namely inflation and output gap. In addition, as noted above, we focus on the variations of only one policy rule parameter, a response to inflation in the Taylor rule, ϕ_π.[7] Hence, we measure effectiveness as a change in the volatility of inflation and output gap induced by a marginal change in ϕ_π.

The top panel of Table 2 reports the effectiveness of monetary policy and its elasticity in stabilizing inflation, while the bottom panel reports the effectiveness and elasticity in stabilizing output gap. The estimated model reveals that the effectiveness of monetary policy in stabilizing inflation has drastically declined, from -1.53 in the first subsample to -0.06 in the second subsample. The negative signs are consistent with the theory which suggests that stronger response to inflation in the Taylor rule reduces inflation volatility. However, these results also suggest that the stabilizing effect of a marginal change in the monetary policy is essentially zero in the second subsample. Since one can interpret the value of the effectiveness as the slope of inflation and output gap standard deviations with respect to ϕ_π, a very low effectiveness in the second subsample suggests a drastic decline in the ability of monetary policy to further smooth out the variance of inflation. Importantly, this result is not a mere consequence of the different levels of the variables involved in the definition of effectiveness (i.e. the variance of inflation and the value of the Taylor rule parameter ϕ_π), since also the elasticity of the effectiveness largely declined, from -1.89 in the first subsample to -0.35 in the second subsample. In other words, this finding implies that in the post-1980

[7] Our choice to focus only on the Taylor rule parameter linked to inflation is motivated by two observations. First, the large majority of the literature documents a tighter response to inflation during the Volcker era, thus arguably pointing to that parameter as the indicator of a hawkish or dovish monetary policy stand. Second, the estimates reported in Table 2 show that the policy response to output gap was almost identical across the two subsamples.

a marginal increase in the monetary authority's response to inflation in the Taylor rule leads to a much weaker inflation stabilization than the one that could have been achieved by the same marginal change in the very early 1980s.

Our results also suggest that the ability of monetary policy to stabilize output gap by changing ϕ_π is relatively low and has almost not changed in the two subsamples.[8] Therefore, in the next subsection we mostly focus on identifying the changes in the economy that diminished the effectiveness of monetary policy to further stabilize inflation. We will use the estimated DSGE model as our laboratory.

Table 2 – Effectiveness and Elasticity

	Sample 1: 1955-1979	Sample 2: 1984-2012
	Inflation	
Effectiveness, ϵ	-1.53	-0.06
Elasticity, ϵ^L	-1.89	-0.35
	Output Gap	
Effectiveness, ϵ	-0.10	-0.06
Elasticity, ϵ^L	-0.10	-0.12

Note: This table reports the effectiveness of monetary policy, ϵ, measured as the derivative of the standard deviation of the macroeconomic variable of interest, namely inflation (top panel) and output gap (bottom panel), with respect to a change in the Taylor rule parameter with inflation ϕ_π, and the elasticity of this effectiveness measure, ϵ^L, in the two subsamples, 1955-1979 and 1984-2012. As displayed in equations (3) and (4), these two measures are functions of the structural parameters of the model, and, thus, will depend on their estimated values in the two subsamples, reported in Table 1.

4.1 Counterfactuals

What are the main differences between the two sample periods that weakened monetary policy's potential to stabilize economic fluctuations? The DSGE model described above allows us to answer this question by performing various counterfactual scenarios with the following idea. Since we estimate that the elasticity with inflation has dropped from -1.89 in the first

[8] The results when analyzing the second sample that excludes the Great Recession are essentially identical. In fact, in the period 1984-2007 the elasticity for inflation and output gap is -0.31 and -0.10 respectively, and the effectiveness is -0.06 and -0.06 respectively. These values are in fact very similar to the ones for the sample 19984-2012 reported in Table 2.

subsample to -0.35 in the second subsample, the counterfactuals would shed some light on the role that different sets of parameters played in this reduction.

Following a similar approach as Boivin and Giannoni (2006) we ask the following question. What would have been the elasticity of monetary policy effectiveness in stabilizing inflation and output gap in the last thirty years had a subset of parameters been the same as in the pre-Volcker era? Namely, when one set of parameters is kept at its first subsample values with all the other parameters updated to their second subsample values, the implied difference between the counterfactual effectiveness elasticity and the actual effectiveness elasticity (-0.35) would reveal how important that particular set of parameters is in explaining the elasticity reduction. In particular, if the implied difference is small so is the role of that particular set of parameters. Table 3 reports the effectiveness elasticity, ϵ^L, in the two subsamples (top panel) and in the four counterfactuals scenarios (bottom panel). The notations of the four counterfactuals are quite intuitive. For example, the notation *Policy* refers to the scenario where all the parameters of the model are kept at their post-1980 estimates, except for the monetary policy parameters which are kept at their pre-Volcker period estimates. We denote this counterfactual effectiveness elasticity as $\epsilon^L(\Theta_2, \Phi_1, \Psi_2, \Sigma_{\varepsilon,2})$. Similarly, the notation *Persistence Shock* refers to the scenario where all the parameters of the model are updated to their post-1980 values, except for the persistence parameters of the exogenous shocks which are kept at their pre-Volcker period values. The effectiveness elasticity in this case is denoted as $\epsilon^L(\Theta_2, \Phi_2, \Psi_1, \Sigma_{\varepsilon,2})$.

There are two important results. The first result concerns the role that a changed conduct of monetary policy during the Volcker era played in the reduction of its effectiveness. A conventional wisdom would suggest that an already large increase in the response to inflation in the Taylor rule during the post-1980 period (estimated from 1.02 to 1.53) would have limited the ability of monetary policy to further stabilize macroeconomic volatility by responding to inflation even more aggressively. However, the result of the first counterfactual challenges this view. In particular, the scenario *Policy* in Table 3 suggests that even if the inflation parameter in the Taylor rule was at its pre-Volcker period level, the marginal effect of a

Table 3 – COUNTERFACTUAL EFFECTIVENESS ELASTICITY, ϵ^L

		Inflation	*Output Gap*
Sample 1: 1955-1979	$\epsilon^L(\Theta_1, \Phi_1, \Psi_1, \Sigma_{\varepsilon,1})$	-1.89	-0.10
Sample 2: 1984-2012	$\epsilon^L(\Theta_2, \Phi_2, \Psi_2, \Sigma_{\varepsilon,2})$	-0.35	-0.12
Policy	$\epsilon^L(\Theta_2, \Phi_1, \Psi_2, \Sigma_{\varepsilon,2})$	-0.45	-0.11
Structure	$\epsilon^L(\Theta_1, \Phi_2, \Psi_2, \Sigma_{\varepsilon,2})$	-0.54	-0.20
Variance Shocks	$\epsilon^L(\Theta_2, \Phi_2, \Psi_2, \Sigma_{\varepsilon,1})$	-0.44	-0.16
Persistence Shock	$\epsilon^L(\Theta_2, \Phi_2, \Psi_1, \Sigma_{\varepsilon,2})$	-1.12	-0.17

Note: The table reports the estimated elasticity of monetary policy effectiveness in stabilizing inflation and output gap in the two subsamples (top panel) and in the four counterfactual scenarios (bottom panel). In each scenario we recompute the same statistic by keeping one set of parameters at its first sample period value and the remaining three sets of parameters at their second sample period values.

change in ϕ_π would have been much lower than it actually was in the pre-1980 period (-0.45 instead of -1.89). This important result suggests that the fact that monetary policy became more aggressive during the Volcker era is not the main reason why its effectiveness to further stabilize fluctuations has declined.

The second result concerns the role of structure parameters and of the seven exogenous shocks. In particular, the scenario *Structure* suggests that even if the structure-parameters of the model, gathered in the vector Θ, were fixed to their pre-Volcker period values, the elasticity of the effectiveness of monetary policy would have been much lower (-0.54 instead of -1.89). The scenario *Variance Shocks* also confirms that simply the different weights that the exogenous shocks have in the economy in the second subsample cannot be the main source of the effectiveness reduction. In fact, when standard deviations of the shocks are kept at their pre-Volcker period values, the effectiveness of monetary policy still drops from -1.89 to -0.44. Therefore, the decline in the effectiveness of monetary policy can most likely be attributed to the changes in the propagation of the shocks. In fact, our fourth counterfactual confirms this view. As the *Persistence Shocks* scenario suggests, when all the parameters are kept at their post-1980 values except for the persistence of the exogenous processes which are kept at their pre-Volcker period values, the resulting effectiveness of monetary policy remains large (equal to -1.12). These results imply that a change in the propagation of the shocks (or at least some shocks) is likely the main driver of the decline in the effectiveness of monetary policy. Therefore, we address this issue in more details below and investigate which shocks in particular played a dominant role in this decline.[9]

4.2 Propagation of the Shocks

Here we further explore the results of the counterfactual *Persistence Shocks* above, which suggest that a changed propagation of the exogenous shocks is the single most important cause behind the decline of the monetary policy effectiveness. In fact, we explore which shock(s) in particular contributed to this decline. We do so by running seven additional counterfactual scenarios, where we recompute the effectiveness of monetary policy by keeping the persistence of only one shock at a time at its pre-Volcker period value while keeping all the other parameters at their post-1980 values. We denote these counterfactual scenarios as $\epsilon^L(\Theta_2, \Phi_2, \Psi_{-i,2}, \Psi_{i,1}, \Sigma_2)$, where $\Psi_{i,1}$ indicates the persistence parameter of a shock i, which is kept at its first subsample value, while $\Psi_{-i,2}$ indicates the persistence parameters of the remaining shocks, which are kept at their second subsample values.

The additional counterfactuals suggest that the changed properties of the wage markup shock play crucial role in explaining our results. As displayed in Table 4, the declined persistence of the wage markup shock is the major contributor to the reduced effectiveness of monetary policy. In fact, if all the parameters of the model except for the persistence of the wage markup process were kept at their second sample values, the effectiveness of monetary policy would still be quite large, equal to -1.28. This value is much closer to its pre-Volcker period estimate.[10] On the contrary, keeping the persistence of any other shock at its first

[9] As Table 3 displays, the elasticity of monetary policy effectiveness in stabilizing output gap has not significantly changed. In particular, it increased from -0.10 in the first subsample to -0.12 in the second subsample. Therefore, exploring the factors behind this change might not be as relevant as exploring the factors behind the much bigger change with inflation stabilization effectiveness. Nevertheless, we report the results of the same counterfactual exercises and show that the most important role in explaining this very small change is played by structure-parameters and persistence of the shocks, respectively.

[10] As a robustness check we run the opposite counterfactual which consists of keeping all the parameters at their first sample values, except for the persistence of the wage markup shock. In this case, the elasticity of effectiveness is -0.31. Therefore, most of the decline in the effectiveness is solely due to the propagation of the wage markup shock.

sample value causes the effectiveness to remain still very low (in the range from -0.26 to -0.32), and almost identical to the one estimated in the second sample (-0.35), suggesting that the propagation of these shocks did not have much influence on the changed effectiveness. Therefore, it is a change in the persistence of the wage markup shock rather than any other exogenous shock that contributed to the decline in monetary policy effectiveness.

Table 4 – Persistence of the Shocks and the Effectiveness

		Inflation	*Output Gap*
Sample 1: 1955-1979	$\epsilon^L(\Theta_1, \Phi_1, \Psi_1, \Sigma_1)$	-1.89	-0.10
Sample 2: 1984-2012	$\epsilon^L(\Theta_2, \Phi_2, \Psi_2, \Sigma_2)$	-0.35	-0.12
	$\epsilon^L(\Theta_2, \Phi_2, \Psi_{-i,2}, \Psi_{i,1}, \Sigma_2)$		
i=Technology		-0.31	-0.10
i=Inv. Specific		-0.31	-0.10
i=Risk Premium		-0.26	-0.04
i=Gov't		-0.31	-0.10
i=Wage Markup		-1.28	-0.16
i=Price Markup		-0.32	-0.09
i=Monetary		-0.28	-0.08

Note: This table reports the estimated elasticity of monetary policy effectiveness in stabilizing inflation and output gap in the first sample 1955-1979 period (first row) and in the second sample 1984-2012 period (second row). The next seven rows report the results of seven counterfactual scenarios. Each counterfactual scenario recomputes the effectiveness of monetary policy by keeping the persistence of only one shock (denoted by i) at a time at its first sample period value while keeping all the other parameters, including the persistence of the remaining six shocks (denoted by $-i$), at their second sample period values.

Recall from Table 1 that the persistence of the wage markup shock halved, decreasing from 0.95 in the pre-Volcker era to 0.47 in the post-1980 sample. At the same time, its standard deviation almost doubled, increasing from 0.26 in the pre-Volcker era to 0.46 in the post-1980 sample. Since these two changes have opposite effects on the unconditional variance of the wage markup process, it is not clear whether the contribution of this shock to the overall variance of endogenous variables has changed. More generally one might wonder whether also the changes in the exogenous processes, in the monetary policy, and in the structure of the economy have affected the contribution of different shocks on the dynamics of inflation. To investigate this issue, in Table 5 we report the variance decomposition of inflation in the two subsamples. Two facts are worth noticing. First, the contribution of the wage markup shock to inflation variations is extremely large in the first subsample, amounting to almost 80 percent. In the second subsample, however, the contribution of this shock sharply declined to less than 10 percent. At the same time, the contribution of the risk premium shock, monetary policy shock, and the price markup shock increased.[11] This observation also goes in line with our claim that the reduction of the persistence of the wage markup has played a crucial role in reducing the effectiveness of monetary policy in stabilizing inflation. When the persistence of the wage markup shock is large, monetary policy is particularly effective in stabilizing inflation. A reduction in the persistence diminishes the effectiveness in two dimensions. First, inflation is harder to stabilize if it is driven by less persistent wage markup shocks, and, second, less persistent wage markup shocks reduce the role of an easier-to-accommodate shocks (the wage markup shock) and increases the role of harder-to-accommodate shocks for inflation. We are confident that persistence plays the major rule in this argument, since, as shown in the counterfactual scenario displayed in Table 3 we know that a pure change in the magnitude of the shock could not explain the reduction of the effectiveness. This result suggests that the properties of the wage markup shock are likely the main reason of the reduction of the effectiveness of monetary policy. In the next section we introduce labor shocks in a simple three-equations DSGE model, which allows us to derive simple analytical expressions that illustrate how persistence of wedges in the labor market equilibrium condition can undermine the stabilizing role of monetary policy.

5 Simple Model

In order to gain intuition for the results obtained above, here we investigate the relationship between the properties of the shock to the labor market and the effectiveness of monetary policy, using a simple three-equation New Keynesian model as in Galí (2009). In the previous

[11] The importance of the wage-markup shock for inflation is a common finding in the literature. Even when adding unemployment as observable, as in Gali, Smets, and Wouters (2012), that shock is a large determinant of inflation.

Table 5 – Variance Decomposition of Inflation

	Inflation	
	Sample 1: 1955-1979	Sample 2: 1984-2012
	Supply Shocks	
Technology	0.8	0.5
Inv. Specific	0.1	0.0
	Demand Shocks	
Risk Premium	5.1	28.3
Gov't	0.0	0.0
	Markup Shocks	
Wage Markup	78.1	9.4
Price Markup	14.3	44.0
	Policy Shocks	
Monetary	1.5	17.8

Note: This table reports the estimated percentage contribution of seven shocks to the variance of inflation in the first sample 1955-1979 period (first column) and in the second sample 1984-2012 period (second column). The seven shocks are divided into four groups: supply shocks, demand shocks, markup shocks, and policy shocks.

sections we showed that the conditions on the labor market, manifested through changed properties of the wage markup shock, are responsible for the decrease in the monetary policy effectiveness. In addition, Chari, Kehoe, and McGrattan (2007) show that fluctuations in the labor wedge, which distort the static relationship between the marginal rate of substitution of consumption for labor and the marginal product of labor, are crucial for explaining aggregate fluctuations. At the same time, they point out that the labor wedge can be interpreted in different ways, for example as fluctuations in the bargaining power of unions or as fluctuations in the value of the leisure of consumers. While the exact interpretation and therefore a modeling choice is crucial when giving policy recommendations, the interpretation of the wedge is not important for our purposes. Introducing fluctuations on the labor market through the first channel (fluctuations in the bargaining power) as in the fully-fledged model above would defeat the purpose of using a simple model as it would not allow us to derive the analytical solution. Therefore, we introduce labor market shocks through the second channel (fluctuations in the value of the leisure of consumers). As also Smets and Wouters (2007) point out (p.591), in their fully specified model there is a natural mapping between the first and the second channel of introducing the shocks to the labor market. The purpose of the simple model is then to analyze how changes in the dynamics of this labor wedge, abstracting from any structural interpretation, can alter the effectiveness of monetary policy.

5.1 A Simple NK Model with Labor Shock

In addition to the monetary policy shock, v_t, and technology shock, a_t, we also introduce a shock d_t which operates directly as a labor-market shock. Namely, we introduce a shock to labor in the instantaneous utility function given by,

$$u\left(C_t, N_t\right) = \frac{C_t^{1-\sigma}}{1-\sigma} - \exp^{d_t} \frac{N_t^{1+\phi}}{1+\phi},$$

where $d_t = \rho_d d_{t-1} + \varepsilon_{t,d}$. The presence of this shock affects the optimality condition which relates marginal rate of substitution between consumption and leisure with the real wage or marginal product of labor:

$$\exp^{d_t} \frac{N_t^{\phi}}{C_t^{-\sigma}} = \frac{W_t}{P_t}.$$

After taking logs, the intratemporal and intertemporal optimality conditions are given by,

$$d_t + \phi n_t + \sigma c_t = w_t - p_t, \tag{6}$$

$$c_t = c_{t+1} - \frac{1}{\sigma}\left(i_t - E_t \pi_{t+1} - \rho\right), \tag{7}$$

where lowercase letters denote the natural logs of the corresponding variable. As evident in equation (6), the labor supply shock, d_t, affects the real wage dynamics in exactly the same way as the wage markup shock does in a fully specified DSGE model.

We interpret the output in the economy with monopolistic competition and flexible prices as the *natural* level of output, with the corresponding interest rate as the *natural* interest rate given by,

$$r_t^n = \rho + \sigma \frac{1+\phi}{\sigma(1-\alpha)+(\alpha+\phi)} E_t \Delta a_{t+1} - \sigma \frac{1-\alpha}{\sigma(1-\alpha)+(\alpha+\phi)} E_t \Delta d_{t+1}. \tag{8}$$

The difference with respect to the scenario without the labor market shock is the last term in (8), which clearly depends on the properties of the d_t process. When we also add price stickiness, we can compute the level of output gap as the deviation of the output in this economy from the natural level of output defined above. Let us denote $\frac{1-\alpha}{\sigma(1-\alpha)+(\alpha+\phi)} = \tilde{\psi}$ and $\frac{1+\phi}{\sigma(1-\alpha)+(\alpha+\phi)} = \psi_{ya}$. Then, output gap denoted as $\tilde{y} = y - y^n$, can be written as:

$$\tilde{y}_t = E_t \tilde{y}_{t+1} - \frac{1}{\sigma}(i_t - E_t \pi_{t+1} - \rho - \sigma \psi_{ya}(\rho_a - 1)a_t + \sigma \tilde{\psi}(\rho_d - 1)d_t), \tag{9}$$

where we assume that the shocks follow a first order autoregressive process, i.e. $E_t \Delta a_{t+1} = (\rho_a - 1)a_t$ and $E_t \Delta d_{t+1} = (\rho_d - 1)d_t$. The solution of this simple model has the following form:

$$\tilde{y}_t = \Lambda_{ya} a_t + \Lambda_{yd} d_t + \Lambda_{yv} v_t,$$
$$\pi_t = \Lambda_{\pi a} a_t + \Lambda_{\pi d} d_t + \Lambda_{\pi v} v_t.$$

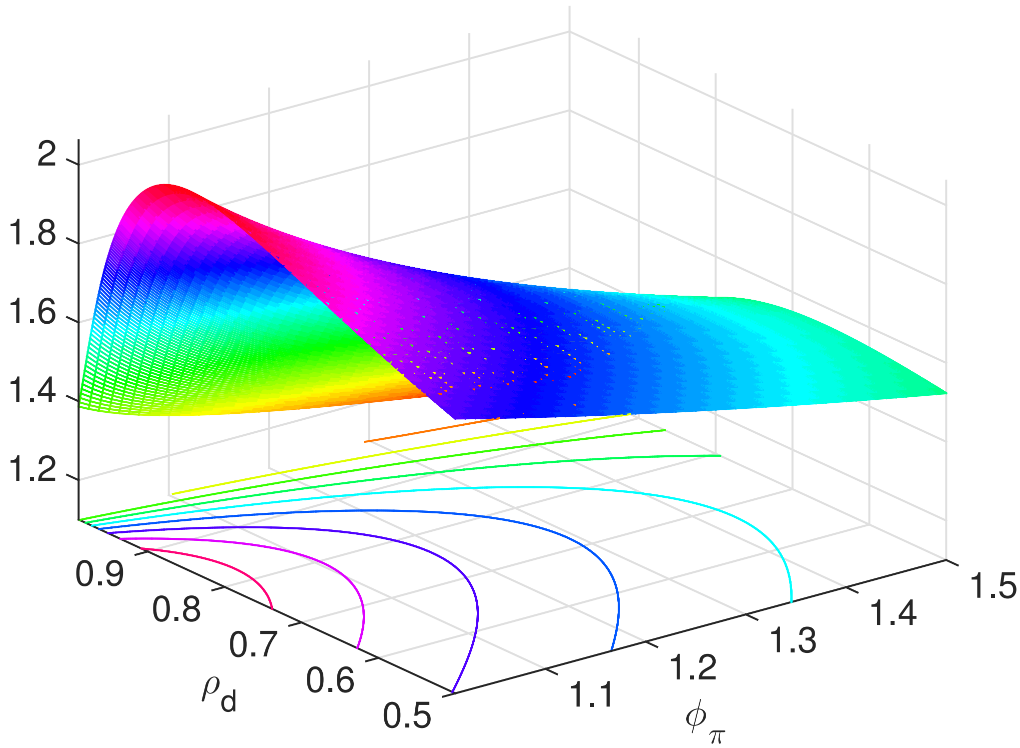
Applying the method of undetermined coefficients, we can obtain the expressions for the reduced form equilibrium parameters, as reported in Appendix A

Given this simple analytical form, it is straightforward to derive the variance of inflation. Since we assume that shocks are orthogonal, the implied variance of inflation is

$$\sigma_\pi^2 = \Lambda_{\pi a}^2 \frac{\sigma_a^2}{1-\rho_a^2} + \Lambda_{\pi d}^2 \frac{\sigma_a^2}{1-\rho_d^2} + \Lambda_{\pi v}^2 \frac{\sigma_v^2}{1-\rho_v^2}.$$

In order to visualize the relationship between inflation standard deviation, σ_π, persistence of the labor market shock, ρ_d, and the response of monetary policy to inflation, ϕ_π, we assign values to the parameters of the model following the calibration of Galí (2009). For simplicity, we assume that σ_a is equal to zero. This assumption is consistent with the estimated minimal

Figure 1 – Standard Deviation of Inflation



Note: The figure displays the standard deviation of inflation, σ_π, as a function of the persistence of labor supply shock, ρ_d, and the monetary policy parameter ϕ_π. Persistence parameter takes the values $[0.5, 1]$, while the monetary policy parameter takes the values $[1, 1.5]$. The model considered is the New Keynesian model as in Galí (2009) augmented with the labor supply shock.

role of technology shocks in explaining inflation variability as displayed in Table 5. We fix the standard deviation of the monetary shock, σ_v, to 0.03 and its persistence, ρ_v, to 0.5. Figure 1 displays the resulting standard deviation of inflation (in percent) as a function of the persistence of labor supply shock, ρ_d, and the monetary policy parameter ϕ_π.[12] As expected, a stronger response of the monetary policy to inflation reduces inflation variance for any value of ρ_d. However, the slope of this reduction, which is the measure of the effectiveness of monetary policy as introduced in Section 2, varies with ρ_d. This unequal decline stems from the non-monotone relationship between inflation variance and the persistence of the labor market shock. What drives this non-monotone relationship? In order to obtain intuition,

[12] In this figure, we fix the unconditional variance of the labor-supply process by adjusting the σ_d when ρ_d varies. Importantly, this non-monotonic relationship between σ_π, ρ_d, and ϕ_π is not an artefact of the simple model studied in this section, since we can obtain a similar figure by numerically computing the relationship between σ_π, ρ_d, and ϕ_π originated by the fully-fledged DSGE model as in Smets and Wouters (2007).

assume that the only shock in the economy is the labor market shock. Recall that the real effect of nominal rigidities in this model stems from the assumption of the price adjustment a lá Calvo (1983). In each period, firms that are exogenously allowed to set their prices recognize that they might not have the same opportunity in the following periods. Therefore, they forecast future exogenous variables in order to calculate the expected marginal costs they will face in the future. Notice that marginal costs are related to the deviations of output from its natural level, or, equivalently, to the deviations of the real interest rate from its natural level. As equation (8) displays, if the exogenous labor market shock was the only shock in the economy and it was a random walk, then $E_t \Delta d_{t+1} = 0$ and the natural rate of interest would be constant and, consequently, by equation (9), output gap would always be zero. In such a case, in fact, even firms that would be able to adjust their prices would choose to not update them, because the random walk nature of the exogenous process does not help in forming forecast for the evolution of its future realizations. As a result, the price would be always stable and nominal rigidities would not affect macroeconomic variables. This limit case helps to explain the declining values of the standard deviation of inflation for values of ρ_d close to unity as displayed in Figure 1.[13] As persistence parameter of the exogenous shock declines, the Calvo setting at first (which up to values of persistence close to 0.9) creates a large wedge between the optimizing and non-optimizing firms, thus increasing the standard deviations of inflation, but then, when the persistence of the process reduces further, inflation variance reduces. The highly non-linear effects of changes in the forecastability of shocks can be visualised by the expression for the reduced form equilibrium parameters, reported in Appendix A,

5.2 Monetary Policy Effectiveness and its Elasticity

This relevantly simple setup allows us to analytically compute the effectiveness of monetary policy, and also its elasticity. That is, we compute how effective monetary policy is

[13] For the values of ρ_d close to one the figure does not display zero inflation because the monetary shock in the model is not set to zero.

in stabilizing variations of inflation attributable to a specific shock, i.e. shock-specific effectiveness of monetary policy. For each of the shocks we compute by how much would the variance of inflation attributable to that particular shock change after a marginal increase in the monetary policy parameter, ϕ_π:

$$\epsilon_j = \frac{\partial \Lambda^2_{\pi,j}}{\partial \phi_\pi}, \text{ with } j = \{a, v, d\}. \tag{10}$$

Let us denote

$$\Delta_j = (1 - \beta\rho_j)(\sigma(1-\rho_j) + \phi_y) + \kappa(\phi_\pi - \rho_j), \text{ with } j = \{a, v, d\},$$

and the analytical expressions for the shock-specific effectiveness will be given by:

$$\begin{aligned} \epsilon_v &= \frac{-2\kappa^2}{\Delta_v^3} \\ \epsilon_a &= \frac{-2\kappa \left(\sigma\psi_{ya}(1-\rho_a)\right)^2}{\Delta_a^3} \\ \epsilon_d &= \frac{-2\kappa^3 \left(\sigma\tilde{\psi}(1-\rho_d)\right)^2}{\Delta_d^3}. \end{aligned}$$

Given the assumption of independent exogenous shocks, the total effectiveness is then simply given by

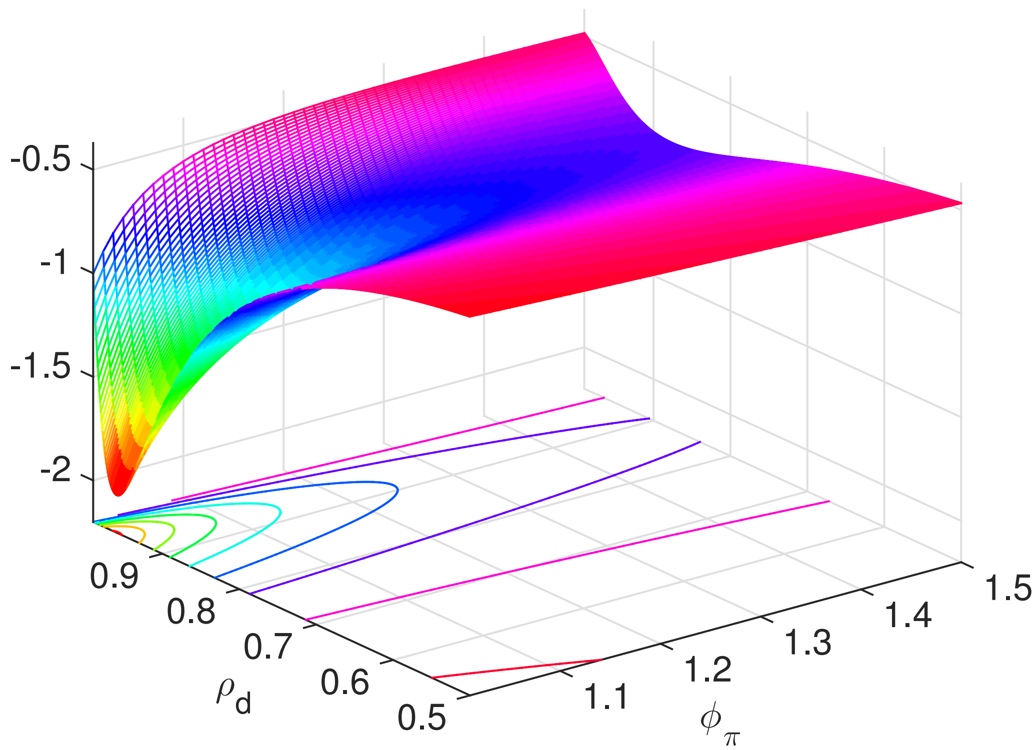
$$\epsilon = \sum_{j=\{a,v,d\}} \epsilon_j \frac{\sigma_j^2}{1-\rho_j^2}.$$

Notice that given the simplicity of the model we can obtain the elasticity of the effectiveness in its analytical form simply by computing

$$\epsilon_j^L = \epsilon_j \frac{\phi_\pi}{\sigma_\pi^2}, \text{ with } j = \{a, v, d\}.$$

We can then visualize the analytical relationship between the effectiveness elasticity specific to

Figure 2 – Elasticity of Shock-Specific Effectiveness of Monetary Policy



Note: The figure displays the elasticity of monetary policy effectiveness in stabilizing inflation variations as a function of the persistence of labor market shock, ρ_d, and the monetary policy parameter ϕ_π. The model considered is the New Keynesian model as in Galí (2009) augmented with the labor market shock.

the labor supply shock, ϵ_d^L, the response of monetary policy to inflation, ϕ_π, and the persistence of this shock, ρ_d. This relationship, as displayed in Figure 2, is highly non-monotone, implying that the effectiveness of monetary policy in reducing inflation variance is dependent on the value of the persistence of the labor supply shock. Also, the effectiveness of monetary policy is the highest when the persistence of labor supply shock is high, and similar to the estimated value in our fully-fledged DSGE model.

6 Conclusion

The U.S. macroeconomic volatility significantly declined after the early 1980s. While some authors attributed this reduction to the less volatile macroeconomic shocks or better inventories management, others claimed that monetary policy became more effective. In this paper we investigated whether monetary policy has maintained that same effectiveness. In other words, we investigated if monetary policy could stabilize inflation as effectively as it did when it adopted a hawkish stance during Volcker's appointment as FED Chairman.

In order to answer this question, we estimated a DSGE model in the two subsamples, pre-1980 sample period (1955-1979) and post-1980 sample period (1984-2012), by using Bayesian techniques. The estimated model revealed that the effectiveness of monetary policy in stabilizing inflation has drastically declined, from -1.53 in the first subsample to -0.06 in the second subsample. Also, the elasticity of the effectiveness largely declined, from -1.89 in the first subsample to -0.35 in the second subsample. This finding revealed that although monetary policy was very effective in accommodating adverse shocks in the early 1980s, this task might be much harder now because of the changed economic environment. A lesson to learn from this paper is, then, that if the economy were to be hit by some large unexpected shocks, the stabilization effect of monetary policy interventions through conventional Taylor rule parameter manipulations might be weaker than in the past.

After investigating all the factors that could have explained this result, we showed that the behavior of the wage markup shock after 1980s played a crucial role. In particular, unlike with all the other shocks in the model, variance of this shock doubled while its persistence decreased over the second subsample. Therefore, we showed that the changed behavior on the labor market has played the most important role in driving down potential effectiveness of monetary policy. This finding can be linked to the one in Chari, Kehoe, and McGrattan (2007), which recognize the importance of labor market wedges in explaining macroeconomic dynamics.

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A Appendix: Analytical Solution of the Model

Using the method of undetermined coefficients, it is straightforward to derive the coefficients of the analytical solution of the model. They are as follows:

$$
\begin{aligned}
\Lambda_{yv} &= -\frac{1-\beta\rho_v}{(1-\beta\rho_v)(\sigma(1-\rho_v)+\phi_y)+\kappa(\phi_\pi-\rho_v)}; \\
\Lambda_{\pi v} &= -\frac{\kappa}{(1-\beta\rho_v)(\sigma(1-\rho_v)+\phi_y)+\kappa(\phi_\pi-\rho_v)}; \\
\Lambda_{ya} &= -\frac{\sigma\psi_{ya}(1-\rho_a)(1-\beta\rho_a)}{(1-\beta\rho_a)(\sigma(1-\rho_a)+\phi_y)+\kappa(\phi_\pi-\rho_a)}; \\
\Lambda_{\pi a} &= -\frac{\kappa\sigma\psi_{ya}(1-\rho_a)}{(1-\beta\rho_a)(\sigma(1-\rho_a)+\phi_y)+\kappa(\phi_\pi-\rho_a)}; \\
\Lambda_{yd} &= \frac{\sigma\tilde{\psi}(1-\rho_d)(1-\beta\rho_d)}{(1-\beta\rho_d)(\sigma(1-\rho_d)+\phi_y)+\kappa(\phi_\pi-\rho_d)}; \\
\Lambda_{\pi d} &= \frac{\kappa\sigma\tilde{\psi}(1-\rho_d)}{(1-\beta\rho_d))(\sigma(1-\rho_d)+\phi_y)+\kappa(\phi_\pi-\rho_d)}.
\end{aligned}
$$