

Assessing Different Drivers of the Great Moderation in the U.S.*

Efrem Castelnuovo
University of Padua

January 2007

Abstract

This paper performs counterfactual simulations with a calibrated new-Keynesian model to assess the relative importance of two different drivers of the U.S. Great Moderation, namely 'good policy' and 'good luck'. Our simulations suggest that systematic monetary policy is the main responsible of the inflation volatility drop observed in the '80s and '90s. By contrast, more benign macroeconomic shocks appear to have been the main driver of the dampened business cycle fluctuations.

JEL classification: E30, E52.

Keywords: Great Moderation, indeterminacy, good policy, good luck, counterfactual simulations.

*First version: June 2006. We thank Giovanni Di Bartolomeo, Margherita Fort, Francesco Lisi, Giovanni Lombardo, Thomas Lubik, Fabio Milani, Michael Reiter, Paolo Surico, and seminar participants at the Society for Computational Economics 2006 (Limassol), the Far Eastern Meeting of the Econometric Society 2006 (Beijing), and the First Piero Moncasca Money-Macro Workshop 2006 (Pavia) for helpful suggestions and discussions. All remaining errors are ours. Financial support by the Italian Ministry of University and Research is gratefully acknowledged (PRIN 2005-N. 2005132539). Address for correspondence: Efrem Castelnuovo, Department of Economics, University of Padua, Via del Santo 33, I-35123 Padova (PD). Phone: +39 049 8274257; Fax: +39 049 8274211. E-mail: efrem.castelnuovo@unipd.it.

1 Introduction

The standard deviation of the U.S. inflation rate dropped from 2.80 (sample: 1960Q1-1983Q4) to 0.98 (sample: 1984Q1-2005Q4), and that of the U.S. output fell from 3.16 to 1.59.¹ Recent empirical studies confirm the statistical relevance of what Bernanke (2004) labeled as the 'Great Moderation'.² But which is the (main) source of the Great Moderation? Some researchers support the 'good policy' hypothesis, i.e. the improved ability of the U.S. monetary policymakers to stabilize the economy (e.g. Clarida, Galí, and Gertler (2000), Lubik and Schorfheide (2004), Boivin and Giannoni (2005), Cogley and Sargent (2005)). By contrast, other researchers point towards the 'good luck' hypothesis, i.e. more benign macroeconomic shocks hitting the U.S. economy in the last two decades (e.g. Stock and Watson (2003), Primiceri (2005), Canova, Gambetti, and Pappa (2006), Sims and Zha (2006), Justiniano and Primiceri (2006)). Evidently, while an aggressive systematic monetary policy can be replicated over time so to maintain the volatility of the U.S. economy under control, policymakers cannot influence the magnitude of exogenous macroeconomic shocks.

Interestingly, Lubik and Schorfheide (2004) and Boivin and Giannoni (2005)'s investigations provide evidence in favor of indeterminacy in the pre-Volcker era. Unfortunately, such an ingredient is not considered in the studies cited above.³ To fill this gap, we perform counterfactual simulations with a calibrated new-Keynesian model allowing for indeterminacy when the Taylor principle is not met.⁴ Our simulations suggest that systematic monetary policy may be seen as the main responsible of the drop in inflation volatility, but can hardly explain the reduction in the business cycle volatility.

This note is structured as follows. Section 2 describes the model we employ for our simulations as well as the different simulated scenarios, and presents our results.

¹We focus on the annualized quarterly growth rate of the GDP chain-weighted price index, and on a measure of the output gap computed as percentualized log-deviation of the real GDP with respect to the potential output (as measured by the Congressional Budget Office). Data downloaded from the Federal Reserve Bank of St. Louis' web-site, i.e. <http://research.stlouisfed.org/fred2/>.

²See e.g. Kim and Nelson (1999), McConnell and Perez-Quiros (2000), Blanchard and Simon (2001), Stock and Watson (2003), and Kim, Nelson, and Piger (2004) for output; Mumtaz and Surico (2006) for the inflation rate.

³Boivin and Giannoni (2005) allow for indeterminacy in their simulations but miss to assess the role played by 'good luck'.

⁴When this project was already on-going, we became aware of a similar effort by Lubik and Surico (2006). They perform factual and counterfactual simulations to compare the implications of 'good policy' vs. 'good luck' with respect to volatilities and persistences of inflation, output, and the interest rate. Our results line up with theirs on the importance of systematic monetary policy shifts for explaining the drop in inflation volatility observed in the U.S. since the beginning of the '80s.

Section 3 concludes.

2 'Good policy' or 'good luck'? Factual and counterfactual simulations

We employ a calibrated version of the textbook new-Keynesian model (Woodford (2003)). The model reads as follows:

$$\pi_t = \beta E_t \pi_{t+1} + \kappa(x_t - z_t) \quad (1)$$

$$x_t = E_t x_{t+1} - \tau(R_t - E_t \pi_{t+1}) + g_t \quad (2)$$

$$R_t = (1 - \rho)[\rho_\pi \pi_t + \rho_x(x_t - z_t)] + \rho R_{t-1} + \varepsilon_t^{MP} \quad (3)$$

$$z_t = \rho_z z_{t-1} + \varepsilon_t^z, g_t = \rho_g g_{t-1} + \varepsilon_t^g \quad (4)$$

where x stands for real output, π represents inflation, R is the short term nominal interest rate, z captures exogenous shifts of the marginal costs of production, g is a demand disturbance, and ε^{MP} is a monetary policy shock.⁵ The random variables z and g follow AR(1) processes whose roots are - respectively - ρ_z and ρ_g . The shocks ε^z , ε^g , and ε^{MP} are white noise, and their variance is, respectively, $\sigma_{\varepsilon^z}^2$, $\sigma_{\varepsilon^g}^2$, and $\sigma_{\varepsilon^{MP}}^2$. The model is calibrated as follows: $\beta = 0.99$, $\kappa = 1$, $\tau = .7$, $\rho_z = 0.95$, $\rho_g = 0.9$ (both subsamples), $\rho_\pi = 0.83$, $\rho_x = 0.27$, $\rho = 0.68$, $\sigma_{\varepsilon^z} = 1.13$, $\sigma_{\varepsilon^g} = 0.27$, $\sigma_{\varepsilon^{MP}} = 0.23$ (first subsample, i.e. '60s and '70s), $\rho_\pi = 1.5$, $\rho_x = 0.50$, $\rho = 0.80$, $\sigma_{\varepsilon^z} = 0.64$, $\sigma_{\varepsilon^g} = 0.18$, $\sigma_{\varepsilon^{MP}} = 0.18$ (second subsample, i.e. '80s and '90s).⁶

This model can be associated to a unique solution if the Taylor principle is satisfied (i.e. if the condition $\rho_\pi > 1 - \frac{(1-\beta)}{\kappa} \rho_x$ holds, see Woodford (2003), Lubik and Marzo (2006)). If the Taylor principle is not met, multiple equilibria arise, and distortions in the transmission mechanism going from the structural shocks to the endogenous variables of the system take place. Formally, $\eta_t = \begin{bmatrix} x_t - E_{t-1} x_t \\ \pi_t - E_{t-1} \pi_t \end{bmatrix} = (A + B\widetilde{M})\varepsilon_t$ is the vector of the endogenous forecast errors, where A and B are (respectively) (1×3) and (2×3) matrixes obtained by computing the generalized Schur decomposition. Under

⁵The variables of the model are expressed in percentage deviation with respect to their steady state values, or in the case of output from a trend path.

⁶We borrowed the parameter values for the policy rules mainly from Clarida et al (2000), and those of the macroeconomic shocks from Lubik and Schorfheide (2004). As regards $\kappa, \tau, \rho_z, \rho_g$ we pinned down the values that minimize the penalty function $L_j = (\sigma_{\pi,j}^{simul} - \sigma_{\pi,j}^{actual})^2 + (\sigma_{x,j}^{simul} - \sigma_{x,j}^{actual})^2$, $j \in \{1, 2\}$ (with j indexing the subsample of interest). We then computed (for each parameter) the simple average across the two subsamples.

indeterminacy the vector B is featured by non-zero elements, and the (1×3) vector \widetilde{M} influences the transmission mechanism. Following Lubik and Schorfheide (2003,2004), for every vector of parameters θ belonging to the indeterminacy region we construct a vector $\widetilde{\theta}$ that lies on the boundary of the determinacy region. Then, we choose \widetilde{M} such that the response of s_t to ε_t conditional on θ mimics the one conditional on $\widetilde{\theta}$.⁷ Once pinned down the vector \widetilde{M} , we simulate the model under indeterminacy. Under uniqueness, $B = [0 \ 0 \ 0]'$ and the transmission mechanism falls back to the standard one.

Simulated scenarios

We simulate a factual scenario (by employing the previously presented model calibration), and four different counterfactual scenarios: i) 'Good Policy', implemented by 'planting' the Volcker-Greenspan monetary policy conduct in the '60s and '70s; ii) 'Good Luck', featured by the presence of the more benign shocks of the '80s and '90s also in the two earlier decades; iii) 'Bad Policy', characterized by a 'passive' monetary policy in both the simulated subsamples; and iv) 'Bad Luck', a scenario in which the economy is hit by highly volatile shocks all time long. Our counterfactuals aim at isolating the effect of a change in 'policy' / 'luck' on the macroeconomic volatilities of interest.

For all the model simulations we consider, we produce 10,000 pseudo-subsamples of a length comparable to that of the two subsamples 1960Q1-1983Q4 / 1984Q1-2005Q4, i.e. 96 observations for the former and 88 for the latter. In each period, we load the model with independent draws from the zero-mean normally distributed shocks $\varepsilon^{MP}, \varepsilon^z, \varepsilon^g$ (whose variances were previously indicated.) The model simulations are stochastically initialized with 100 pseudo-observations, which are then discarded.

Figure 1 displays the factual and counterfactual distributions of inflation and output. The factual distributions nicely reproduce the Great Moderation. In fact, the simulated drop in the inflation volatility is 71% (drop in the actual data: 65%), while the simulated decrease in the output gap volatility is 44% (actual: 50%). As regards our counterfactuals, the distributions of the inflation volatility under both 'good policy' and 'good luck' suggest that both these drivers would have delivered a much more stable inflation in the '60s and '70s, with a possibly larger impact played by systematic monetary policy. Interestingly, a very different picture emerges when output is considered. Our counterfactuals suggest that while less volatile shocks would have implied a much

⁷Lubik and Schorfheide (2003) label this choice as 'continuity'.

more stable business cycle (in the first subsample), the latter would have hardly been influenced by a tighter monetary policy.

[insert Figure 1 here]

Robustness checks

Our results are robust to several perturbations of the benchmark parameterization, including a lower intertemporal elasticity of substitution, a lower slope of the Phillips curve, the presence of a sunspot shock, and different parameterizations of the monetary policies as well as the macroeconomic shocks' volatilities. They are also robust to the employment of different vectors \widetilde{M} . The results of our robustness checks are available upon request.

3 Conclusions

We performed counterfactual simulations with a calibrated new-Keynesian model to understand the relative role played by 'good policy' and 'good luck' in explaining the U.S. Great Moderation. According to our simulations, systematic monetary policy has mainly affected inflation fluctuations, while more benign macroeconomic shocks are likely to have been the driver of the observed drop in the business cycle volatility.

References

- Blanchard, O., and J. Simon, 2001, The Long and Large Decline in U.S. Output Volatility, *Brookings Papers on Economic Activity*, 1, 135-174.
- Bernanke, B., 2004, The Great Moderation, Remarks at the meetings of the Eastern Economic Association, Washington, DC, February 20.
- Boivin, J., and M. Giannoni, 2005, Has Monetary Policy Become More Effective?, *The Review of Economics and Statistics*, forthcoming.
- Canova, F., L. Gambetti, and E. Pappa, 2006, The Structural Dynamics of the U.S. Output and Inflation: What Explains the Changes?, *Journal of Money, Credit, and Banking*, forthcoming.
- Clarida, R., J. Galí, and M. Gertler, 2000, Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory, *The Quarterly Journal of Economics*, 115(1), 147-180.
- Cogley, T., and T. J. Sargent, 2005, Drift and Volatilities: Monetary Policies and Outcomes in the Post WWII US, *Review of Economic Dynamics*, 8(2), 262-302, April.

- Justiniano, A., and G. Primiceri, 2006, The Time Varying Volatility of Macroeconomic Fluctuations, mimeo.
- Kim, C., and C. Nelson, 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., C. Nelson, and J. Piger, 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.
- Lubik, T.A., and F. Schorfheide, 2003, Computing Sunspot Equilibria in Linear Rational Expectations Models, *Journal of Economic Dynamics and Control*, 28(2), 273-285.
- Lubik, T.A., and F. Schorfheide, 2004, Testing for Indeterminacy: An Application to US Monetary Policy, *The American Economic Review*, 94(1), 190-217.
- Lubik, T.A., and M. Marzo, 2006, An Inventory of Simple Monetary Policy Rules in a New Keynesian Macroeconomic Model, *International Review of Economics and Finance*, forthcoming.
- Lubik, T.A., and P. Surico, 2006, The Lucas Critique and the Stability of Empirical Models, Federal Reserve Bank of Richmond, Working Paper No. 06-05.
- McConnell, M., and G. Perez-Quiros, 2000, Output fluctuations in the United States: What has changed since the early 1980's?, *The American Economic Review*, 90(5), 1464-1476.
- Mumtaz, H., and P. Surico, 2006, Evolving International Inflation Dynamics: World and Country Specific Factors, mimeo.
- Primiceri, G., 2005, Time Varying Structural Vector Autoregressions and Monetary Policy, *The Review of Economic Studies*, 72, 821-852, July.
- Sims, C.A., and T. Zha, 2006, Were there regime switches in US monetary policy?, *The American Economic Review*, 96(1), 54-80, March.
- Stock, J.H., and M.W. Watson, 2003, Has the Business Cycle Changed? Evidence and Explanations, Federal Reserve Bank of Kansas City, Proceedings of the Symposium on "Monetary Policy and Uncertainty", Jackson Hole, Wyoming, August 28-30, 2003.
- Woodford, M., 2003, *Interest and Prices: Foundation of a Theory of Monetary Policy*, Princeton University Press.

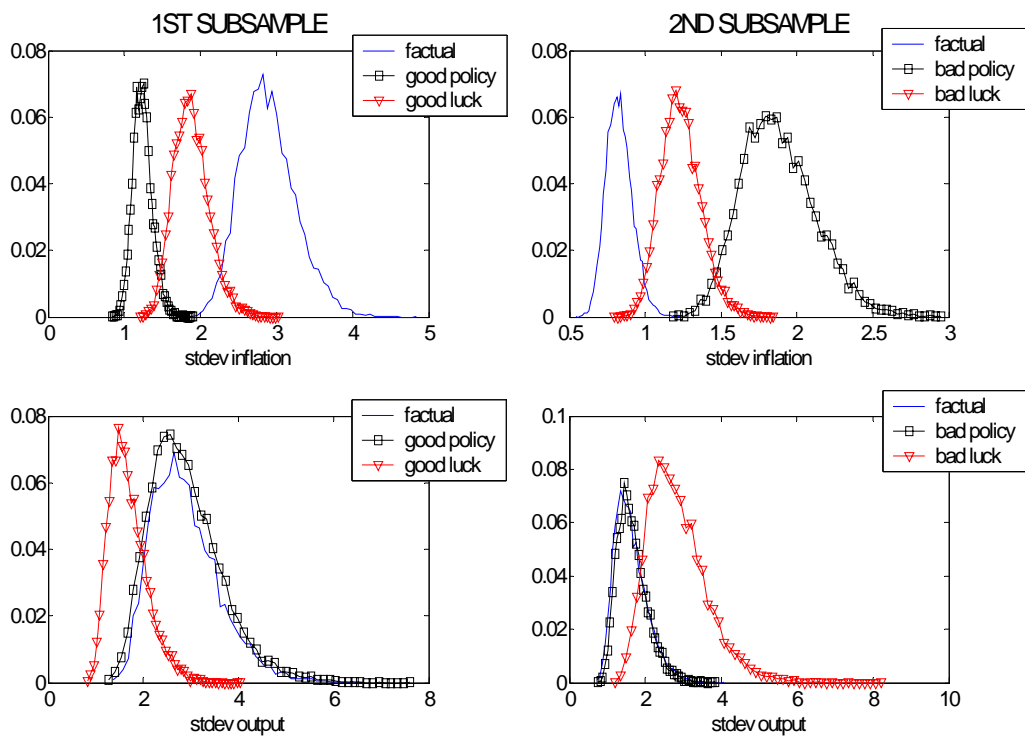


Figure 1: STANDARD DEVIATIONS OF INFLATION AND OUTPUT: SIMULATED DISTRIBUTIONS.

4 Robustness checks

We present here some of the robustness checks performed.

4.1 Low intertemporal elasticity of substitution

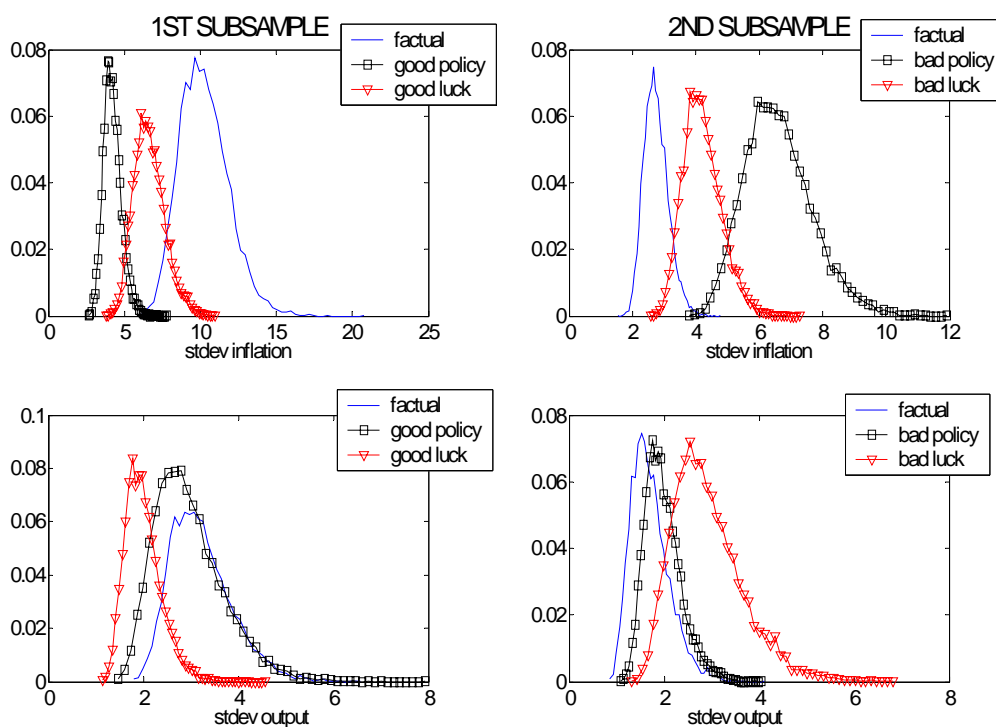


Figure 2: STANDARD DEVIATIONS OF INFLATION AND OUTPUT: SIMULATED DISTRIBUTIONS. $\tau = 0.15$ as in G.D. Rudebusch (2002), Assessing Nominal Income Rules for Monetary Policy with Model and Data Uncertainty, *The Economic Journal*, 112, 402-432, April.

4.2 Low slope of the Phillips curve

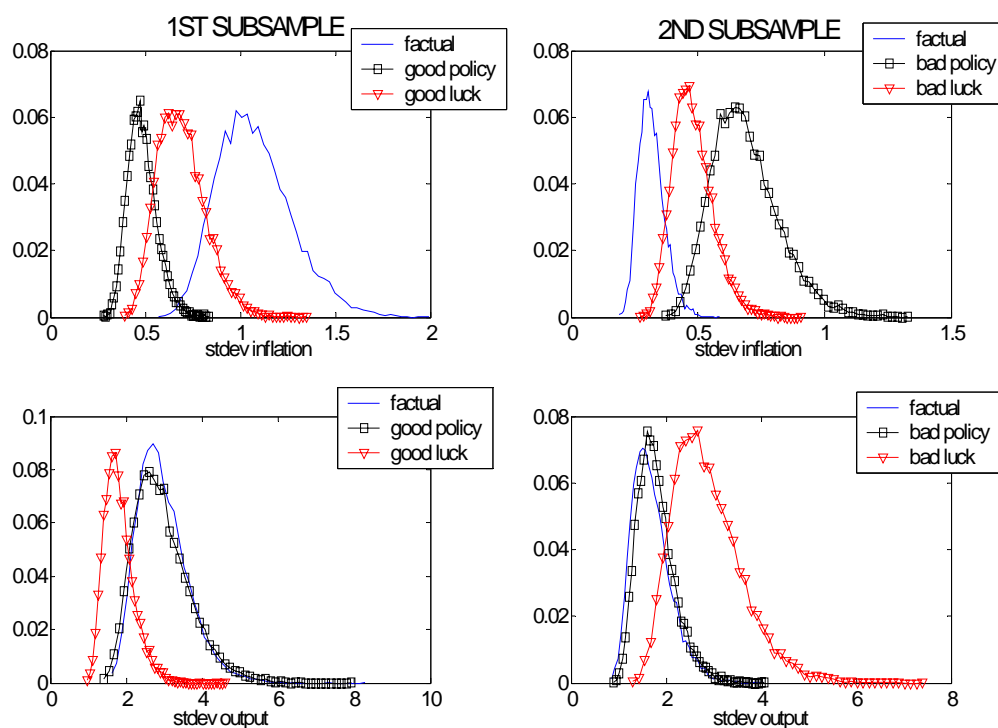


Figure 3: STANDARD DEVIATIONS OF INFLATION AND OUTPUT: SIMULATED DISTRIBUTIONS. $\kappa = 0.10$ as in P. Ireland (2004), Technology Shocks in the New Keynesian Model, *The Review of Economics and Statistics*, 86(4), 923-936.

4.3 Presence of the sunspot shock

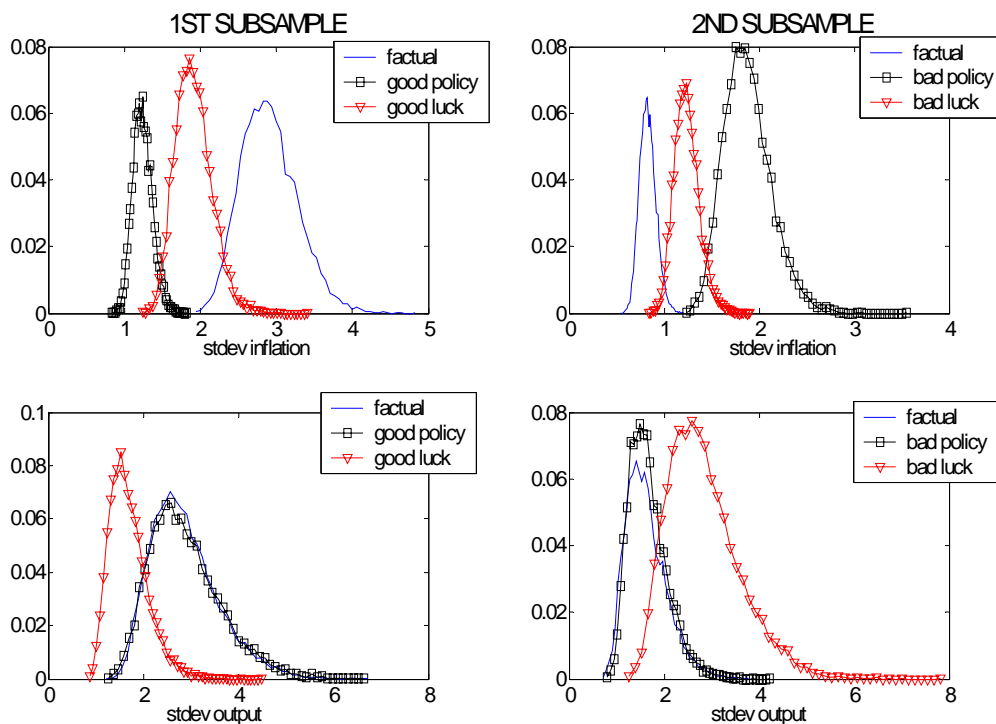


Figure 4: INFLATION AND OUTPUT: SIMULATED DISTRIBUTIONS. The sunspot shock ζ_t enters the system by influencing the endogenous forecast errors as in Lubik and Schorfheide (2003,2004), i.e. $\eta_t = (A + B\widetilde{M})\varepsilon_t + B\zeta_t$. The standard deviation of the zero-mean sunspot shock is 0.20 (posterior median as reported by Lubik and Schorfheide (2004)).

4.4 Different macroeconomic shocks

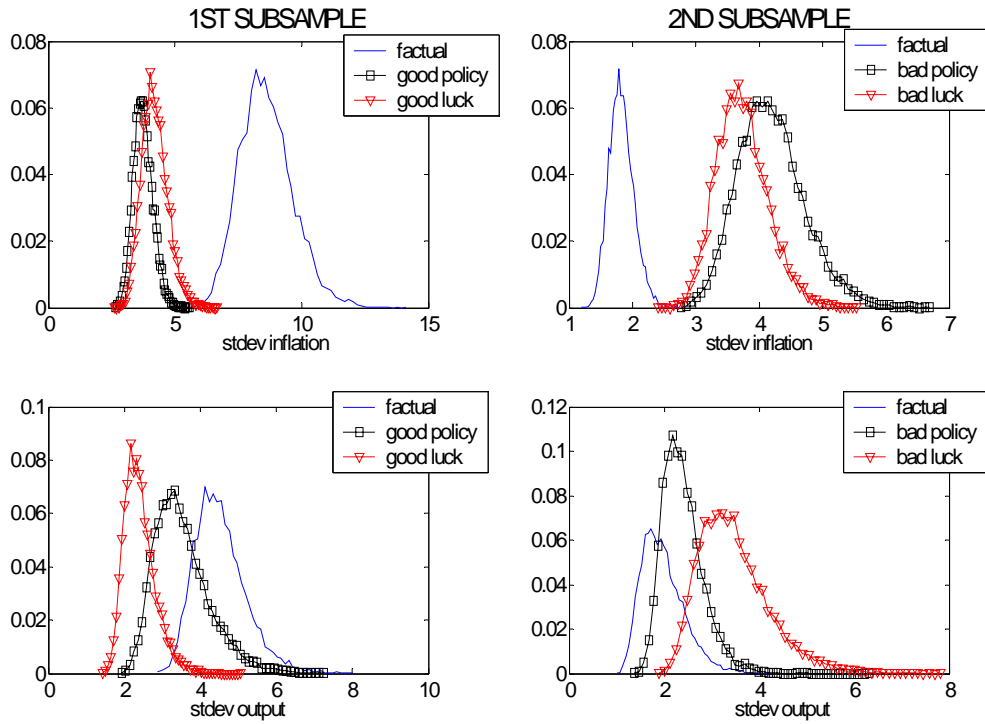


Figure 5: Macroeconomic shocks' standard deviations: $\widehat{\sigma}_{\varepsilon\pi} = 1.18$, $\widehat{\sigma}_{\varepsilon x} = 0.89$ for the first sample, and $\widehat{\sigma}_{\varepsilon\pi} = 0.71$, $\widehat{\sigma}_{\varepsilon x} = 0.43$ for the second one. Values obtained by estimating the IS-Phillips curve model a la G.D. Rudebusch and L.E.O. Svensson (1999), in John B. Taylor (ed.), Monetary Policy Rules, University of Chicago Press.

4.5 \widetilde{M} as estimated Lubik and Schorfheide (2004)

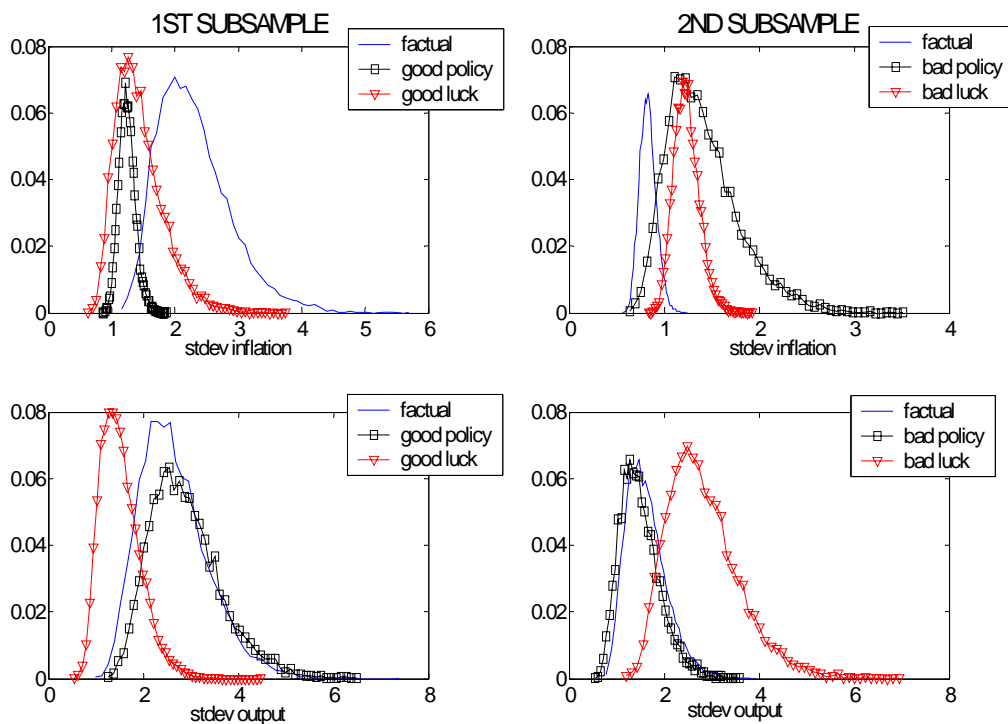


Figure 6: INFLATION AND OUTPUT: SIMULATED DISTRIBUTIONS. $\widetilde{M} = [-0.68 \ 1.74 \ -.69]$, as estimated by Lubik and Schorfheide (2004).

4.6 \widetilde{M} as in the 'orthogonality' case

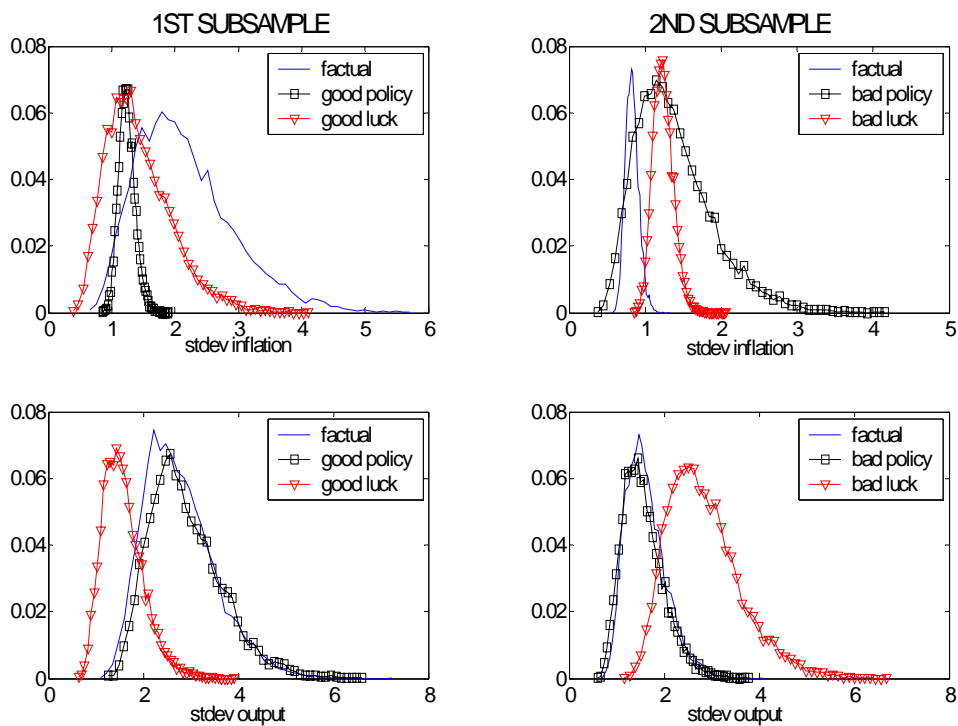


Figure 7: INFLATION AND OUTPUT: SIMULATED DISTRIBUTIONS. $\widetilde{M} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$, a case labeled as 'orthogonality' by Lubik and Schorfheide (2003).

4.7 Policy rules as in Lubik and Schorfheide (2004)

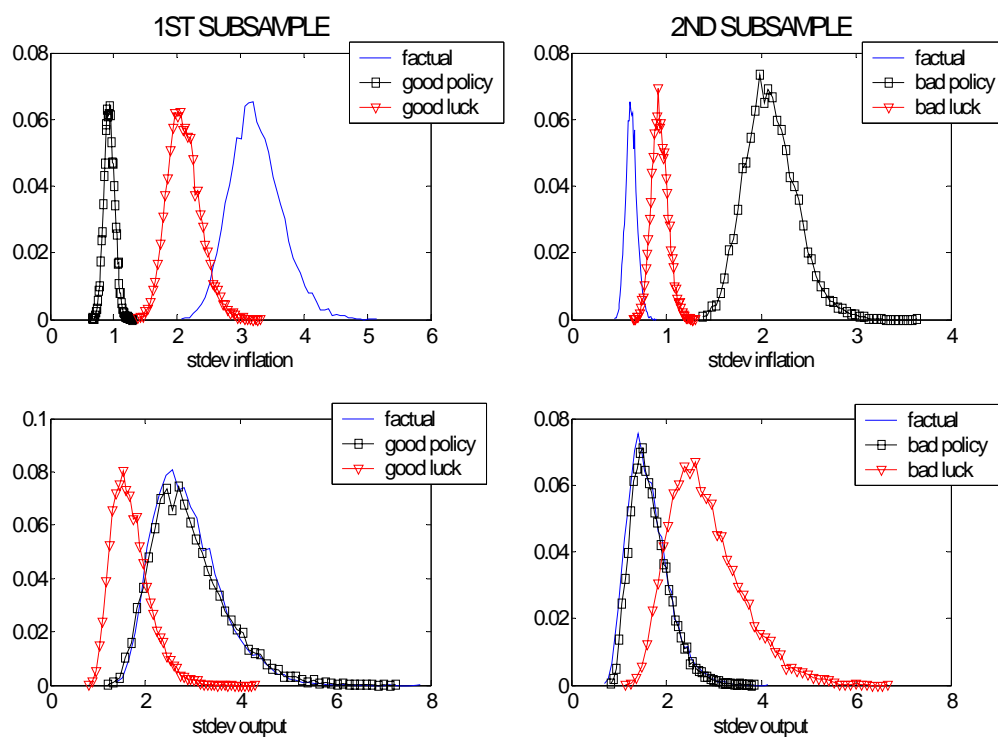


Figure 8: INFLATION AND OUTPUT: SIMULATED DISTRIBUTIONS. Policy rules as estimated by Lubik and Schorfheide (2004).