Uncertainty and monetary policy in good and bad times: A Replication of the VAR investigation by Bloom (2009)*

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Abstract

This paper revisits the well-known VAR evidence on the real effects of uncertainty shocks by Bloom (Econometrica 2009(3): 623-685. doi: 10.3982/ECTA6248). We replicate the results in a narrow sense using Eviews and Matlab. In a wide sense, we extend his study by working with a smooth transition-VAR framework that allows for business cycle-dependent macroeconomic responses to an uncertainty shock. We find a significantly stronger response of real activity in recessions. Counterfactual simulations point to a greater effectiveness of systematic monetary policy in stabilizing real activity in expansions.

Keywords: Uncertainty shocks, nonlinear Smooth Transition Vector AutoRegressions, Generalized Impulse Response Functions, systematic monetary policy.

JEL codes: C32, E32.

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1 Introduction

This paper replicates, as well as extends, the VAR analysis conducted by Bloom (2009) on the real effects of uncertainty shocks.[1] Bloom provides codes in Stata and R to produce his VAR results. To replicate them in a narrow sense, we used Eviews. We then extended, in a wide sense, Bloom's work to allow for nonlinear real effects of uncertainty shocks. We did so by estimating a Smooth Transition-VAR model via the Markov-Chain Monte Carlo simulation method proposed by Chernozhukov and Hong (2003). We employed the Matlab code set up by Auerbach and Gorodnichenko (2012), which we extended to allow for fully nonlinear impulse response functions.

A nonlinear replication of Bloom's (2009) findings is interesting in light of the recent COVID-19 outbreak. The COVID-19 shock has taken the world by storm, and some indicators of uncertainty - in particular, financial uncertainty - have recorded heights comparable to those realized in 1987 and 2008. More than ever, it is therefore crucial to rely on solid empirical facts to understand the real effects of uncertainty shocks. Bloom (2009) proposes a partial equilibrium model featuring nonconvex adjustment costs on the labor and capital markets that is able to replicate his VAR facts. Such model represents a key reference for the construction of more complex, general equilibrium frameworks (e.g., Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2018), Lanteri (2018), Dibiasi (2018)). At the same time, the empirical literature, typically using small-scale VARs, has found that the real effects of uncertainty shocks are particularly acute in recessions (see Caggiano, Castelnuovo, and Groshenny (2014), Nodari (2014), Caggiano, Castelnuovo, and Pellegrino (2017), Caggiano, Castelnuovo, and Figueres (2017), Ferrara and Guérin (2018), and Chatterjee (2019)). Our paper, which deals with Bloom's (2009) medium-scale VAR, shows that Bloom's (2009) results are: i) replicable; ii) robust to working with nonlinear frameworks. Finally, our paper shows that systematic monetary policy is less effective as a stabilization tool during a recession. This last result can easily be interpreted in light of the "wait-and-see" transmission channel studied by Bloom (2009), Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2018), Lanteri (2018), Dibiasi (2018). This last analysis complements the ones on the effects of monetary policy shocks in high/low uncertainty regimes by Pellegrino (2018, 2020) and Castelnuovo and Pellegrino (2018), and those on the "risk-management" approach undertaken by the Federal Reserve when tackling un-

[1] The data used in this study are available at Nicholas Bloom's webpage: https://nbloom.people.stanford.edu/sites/g/files/sbiybj4746/f/replication.zip.

certainty shocks (Evans, Fisher, Gourio, and Krane (2015) and Caggiano, Castelnuovo, and Nodari (2018)).

The remainder of the paper is structured as follows. In Section 2, we document the data used in Bloom's study. Section 3 presents details for the replication in a narrow sense. Section 4 extends Bloom's (2009) VAR analysis to allow for nonlinear macroeconomic responses to an uncertainty shock, and it runs a counterfactual analysis to investigate if systematic monetary policy is differently powerful in good and bad times. Section 5 concludes.

2 Data description

We use the same data and sample investigated by Bloom (2009) to estimate a linear VAR with a constant and 12 lags (as Bloom's). The vector X_t of endogenous variables we model features (from the top to the bottom) the S&P500 stock market index, an uncertainty dummy based on the VXO, the federal funds rate, a measure of average hourly earnings, the consumer price index, hours, employment, and industrial production. We use monthly data covering the period July 1962-June 2008. The realized volatility of the returns of the S&P500 index is used before 1986 due to the unavailability of the VXO. The uncertainty dummy takes the value of 1 when the HP-detrended VXO level rises over 1.65 standard deviations above the mean, and 0 otherwise. Variables are in logs, except the uncertainty dummy, the policy rate, and hours.[2]

3 Replication of Bloom's (2009) results

Figure 1 plots the impulse responses of industrial production and employment to a unit uncertainty shock. These responses are exactly the ones documented by Bloom in his Figures 2 (industrial production) and 3 (employment). Industrial production displays a quick drop of around 1% within 4 months, with a subsequent recovery and rebound from 7 months after the shock. The drop and rebound pattern is statistically significant. Employment displays a similar pattern.[3]

[2] Following Bloom (2009), we Hodrick-Prescott filter these variables (other than the VXO). Bloom (2009) shows that his results are robust to not pre-filtering the variables in his VAR. When turning to our non-linear analysis, we work with non-filtered variables to avoid inducing spurious cyclical fluctuations which could bias our results (Cogley and Nason (1995), Wong and Wiriyawit (2016)).

[3] Figures 2 and 3 in Bloom (2009) also display the response of industrial production and employment to a 1% impulse to the federal funds rate. Given that our focus is on uncertainty shocks, we decided to omit the evidence on the effects of monetary policy shocks. Such evidence (which replicates exactly

4 Nonlinear analysis

STVAR framework. The vector of endogenous variables $\boldsymbol{X}_t$ is modeled with the following STVAR (for a detailed presentation, see Teräsvirta, Tjøstheim, and Granger, 2010):

$$\begin{aligned} \boldsymbol{X}_t &= F(z_{t-1})\boldsymbol{\Pi}_R(L)\boldsymbol{X}_t + (1 - F(z_{t-1}))\boldsymbol{\Pi}_E(L)\boldsymbol{X}_t + \boldsymbol{\varepsilon}_t, && (1) \\ \boldsymbol{\varepsilon}_t &\sim N(0, \boldsymbol{\Omega}_t), && (2) \\ \boldsymbol{\Omega}_t &= F(z_{t-1})\boldsymbol{\Omega}_R + (1 - F(z_{t-1}))\boldsymbol{\Omega}_E, && (3) \\ F(z_t) &= \exp(-\gamma z_t)/(1 + \exp(-\gamma z_t)), \gamma > 0, z_t \sim d(0, 1). && (4) \end{aligned}$$

$F(z_{t-1})$ is a logistic transition function that captures the probability of being in a recession, γ is the smoothness parameter, z_t is a business cycle indicator (whose generic distribution d is not necessarily Gaussian), $\boldsymbol{\Pi}_R$ and $\boldsymbol{\Pi}_E$ are the VAR coefficients capturing the dynamics of the system in recessions and expansions respectively, $\boldsymbol{\varepsilon}_t$ is the vector of reduced-form residuals with zero-mean and time-varying, state-contingent variance-covariance matrix $\boldsymbol{\Omega}_t$, and $\boldsymbol{\Omega}_R$ and $\boldsymbol{\Omega}_E$ are the state-dependent covariance matrices of the reduced-form residuals. The transition variable z_t in eq. (4) is the standardized zero mean-unit standard deviation backward-looking moving average of the yearly growth rate of industrial production. The smoothness parameter γ is notoriously difficult to estimate because of well-known identification issues (see the discussion in Teräsvirta, Tjøstheim, and Granger (2010)). We calibrate $\gamma = 1.8$ to match the frequency of the U.S. recessions, which amounts to 14% in our sample. The implied model-probability of being in a recession $F(z_t)$ tracks remarkably well the dating of the NBER recessions. Model (1)-(4) is estimated via the Markov-Chain Monte Carlo simulation method proposed by Chernozhukov and Hong (2003). Statistical support to our nonlinear model (against the alternative of a linear VAR) is offered by the test designed by Teräsvirta and Yang (2014). The estimated model is then employed to compute generalized impulse response functions (GIRFs), which take into account the endogeneity of the transition indicator z_t. For brevity, information on the match between the recession probability implied by our logistic function and the NBER recessions, the statistical test offering support to our nonlinear framework, and the algorithm we use to compute GIRFs is provided in the working paper version of this document.[4]

Bloom's) is available upon request.

[4] The working paper version is available at https://sites.google.com/site/efremcastelnuovo/home/

Results. Figure 2 (first and second rows) plots the estimated nonlinear dynamic responses of industrial production and employment to an uncertainty shock of the same size as Bloom's. These variables react negatively and significantly no matter what phase of the business cycle the economy is in. However, in recessions, the peak short-run response of industrial production is about -2.5%, while that of employment is about -1.5%. The same values in expansions read, respectively, -1.5% and -0.9. Hence, we find evidence in favor of an asymmetric response of real activity to uncertainty shocks along the business cycle. Turning to monetary policy, Figure 2 (third and fourth rows) shows the effect of an uncertainty shock on aggregate prices and the federal funds rate. An uncertainty shock triggers a temporary fall in prices, which is statistically significant in recessions only. The federal funds rate falls significantly more in recessions - the peak response is about 2 percentage points, compared to 0.8 percentage points in expansions. In the working paper version of this document, we show that industrial production, employment, and the federal funds rate react significantly more in recessions to uncertainty shocks.

Effectiveness of systematic monetary policy. What would have happened if the Federal Reserve had not reacted to the macroeconomic fluctuations induced by uncertainty shocks? We address this question by running a counterfactual exercise that assumes the central bank to stay still after an uncertainty shock, i.e., we shut down the systematic response of the federal funds rate to movements in the economic system due to uncertainty shocks by zeroing the coefficients of the federal funds rate equation in our VAR. We run this exercise with the aim of identifying the effectiveness of the estimated (factual) systematic monetary policy response by contrasting the factual and the counterfactual scenarios.

Figure 3 contrasts the responses of real activity and prices conditional on the absence of the systematic policy response with the baseline results. Focusing on real activity, the differences between the factual and counterfactual responses point to a dramatically lower monetary policy effectiveness in recessions. The recession is estimated to be almost as severe as the one which occurs when policymakers are allowed to lower the policy rate. A different picture emerges when our counterfactual monetary policy is implemented in good times. When the policy rate is kept fixed, industrial production falls markedly (about -2.5% at its peak) and persistently, remaining statistically below zero for a prolonged period of time. The same holds when looking at the response of employment, i.e., the gap between the baseline response and the one associated with our counterfactual exercise is quantitatively substantial. Interestingly, prices display a more persistent departure from their trend in both states. Importantly, the relatively lower effectiveness of systematic monetary policy in recessions can be interpreted in the light of models formalizing the "wait-and-see" behavior by firms which, under uncertainty, optimally cut on their capital and labor demand and wait until uncertainty vanishes before resuming their normal level of production (Bloom (2009), Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2018)), and of models that allow for state-dependent non convex adjustment costs (Lanteri (2018), Dibiasi (2018)).

5 Conclusions

A replication exercise of Bloom's (2009) VAR results on the real effects of uncertainty shocks in a narrow sense was performed by using Eviews. We obtained exactly the same results documented in the original paper. We then relaxed the assumption of linearity and verified, with a Smooth Transition-VAR framework, the stronger real effects of uncertainty shocks in recessions. Counterfactual simulations revealed that systematic monetary policy exerts stronger effects on real activity in expansions. These results: i) offer support to models featuring "wait-and-see" effects (e.g„ Bloom (2009), Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2018), Lanteri (2018), Dibiasi (2018)); ii) justify the rapid and massive monetary policy interventions by the Federal Reserve in response to the COVID-19 uncertainty shock.

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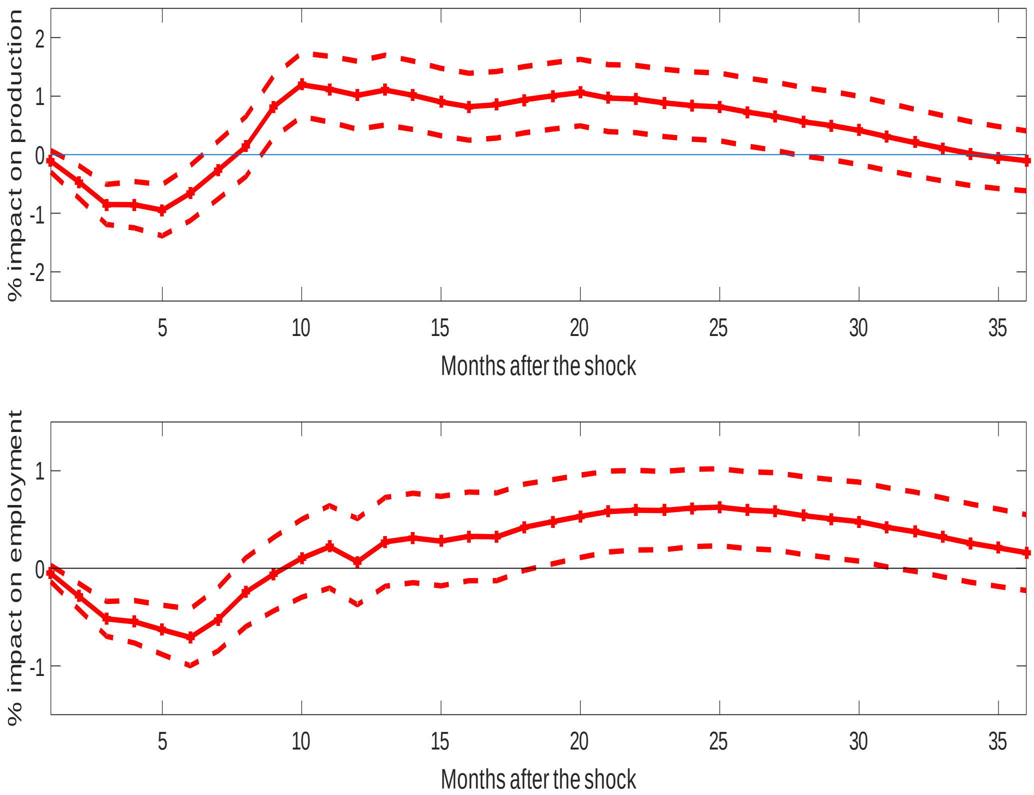

Figure 1: **VAR estimation of the impact of an uncertainty shock on industrial production and employment as in Bloom (2009).** Impulse responses (point estimates) to an uncertainty shock inducing an on-impact reaction of uncertainty equal to one as in Bloom (2009). Solid lines with crosses: Point estimates. Dashed lines: 68% confidence bands.

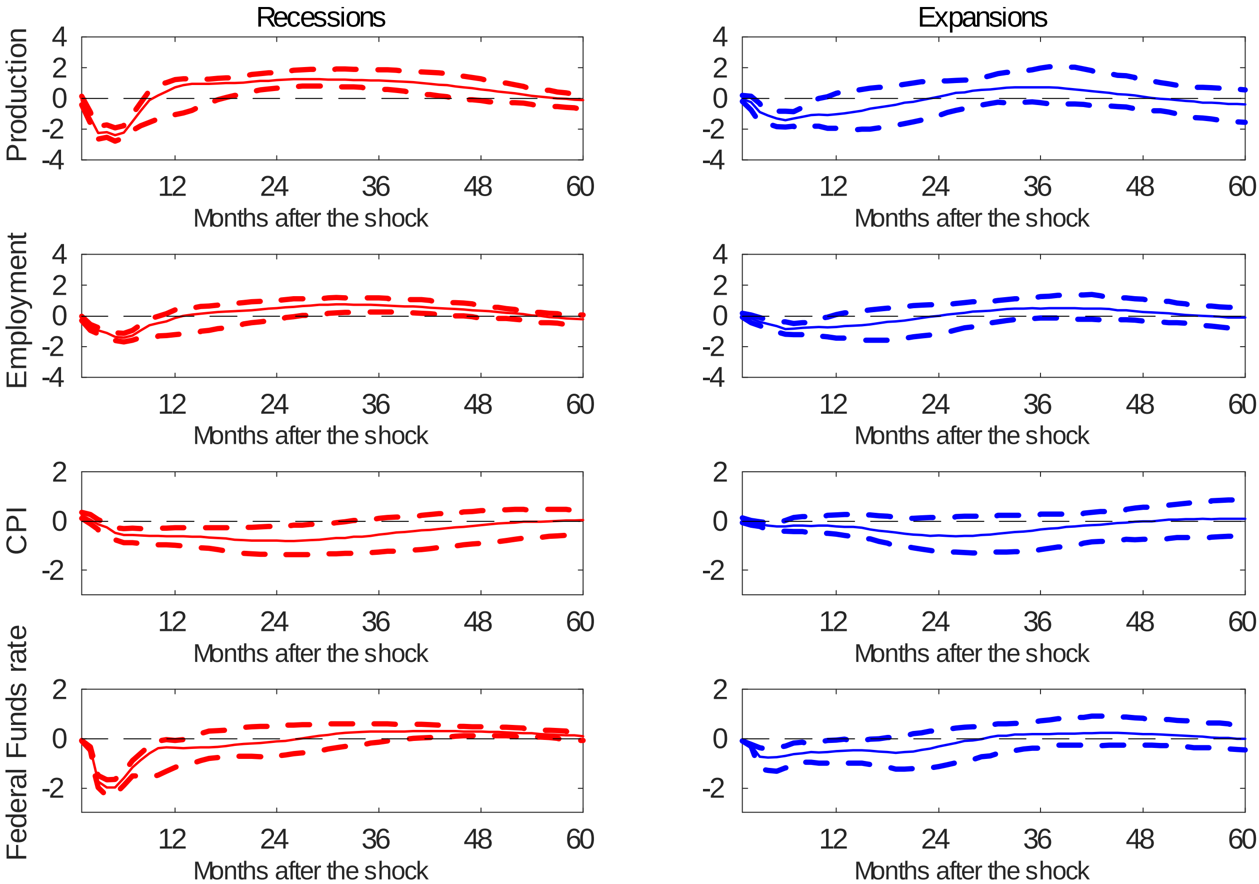

Figure 2: **Macroeconomic Effects of Uncertainty Shocks: Good and Bad Times.** Impulse responses (median values) to an uncertainty shock inducing an on-impact reaction of uncertainty equal to one as in Bloom (2009). Red (blue) lines: Responses computed with the Smooth-Transition VAR and conditional on recessions (expansions). Dashed lines: 68% confidence bands.

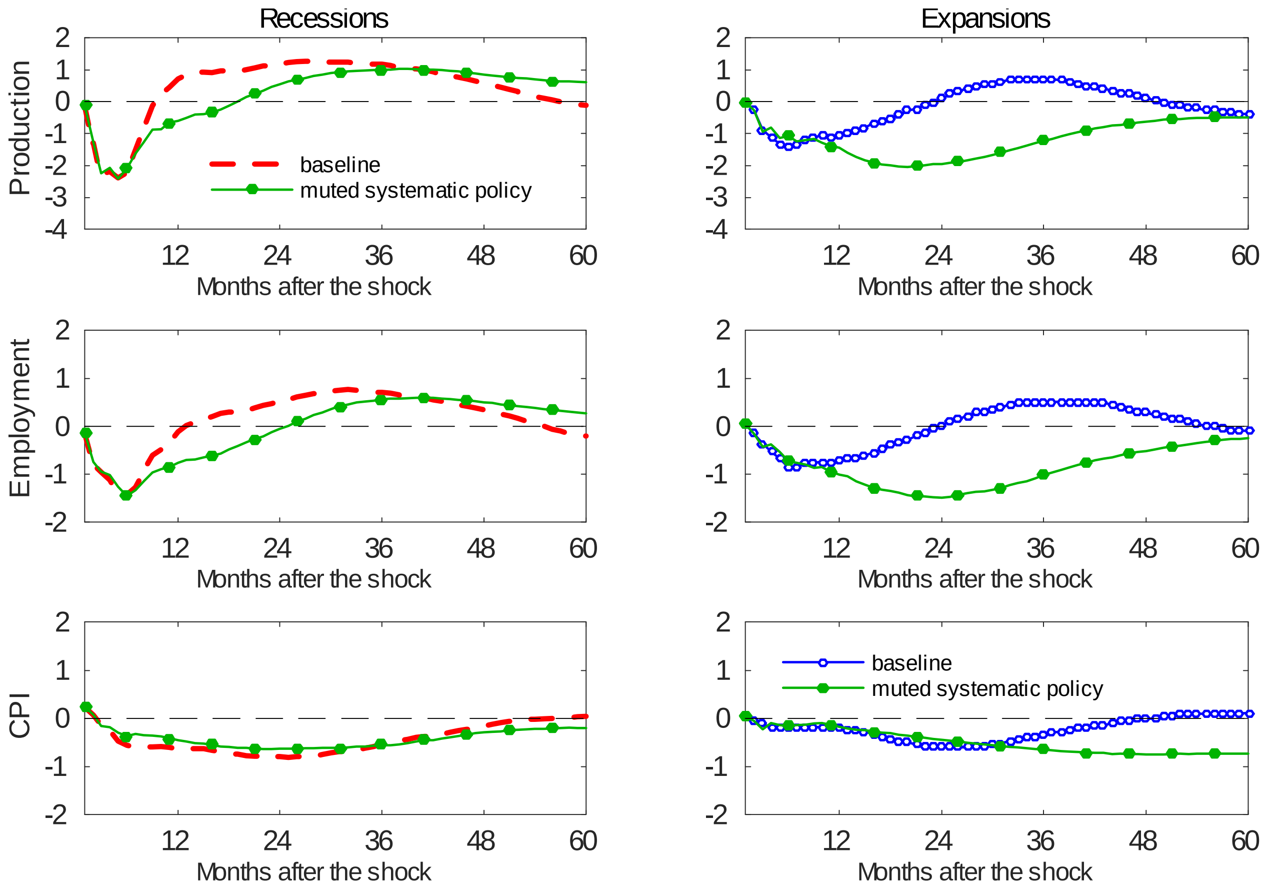

Figure 3: **Real Effects of Uncertainty Shocks: Role of Systematic Monetary Policy.** Impulse responses (median values) to an uncertainty shock inducing an on-impact reaction of uncertainty equal to one as in Bloom (2009). Responses conditional on unconstrained/constrained monetary policy. Red dashed (blue circled) lines: Responses computed with the Smooth-Transition VAR and conditional on recessions (non-recessionary phases). Counterfactual responses computed conditional on a muted systematic policy (fixed federal funds rate) in green circled lines.