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Are Uncertainty Shocks Aggregate Demand Shocks?

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Are Uncertainty Shocks Aggregate Demand Shocks?

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Abstract

This note considers the Leduc and Liu (JME, 2016) model and studies the effects of their uncertainty shock under different Taylor-types rules. It shows that both the responses of real and nominal variables highly depend on the Taylor rule considered. Remarkably, inflation reacts positively so that uncertainty shocks look more like supply shocks, once an empirically plausible degree of interest rate smoothness is taken into account. This result is reinforced with less reactive monetary rules. Overall, these rules bring about a less severe recession.

Keywords: Uncertainty Shocks; DSGE Model; Search and Matching frictions; Taylor rules; Inflation Dynamics.

JEL codes: E12, E21, E22, E24, E31, C32

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Introduction

This note contributes to the literature on the macroeconomic effects of uncertainty shocks, by testing the robustness of the Leduc and Liu (2016) model - LL henceforth - to different Taylor-type rules.

The two authors were the first to claim that real uncertainty shocks look like negative aggregate demand shocks. First, using two different proxies for macroeconomic real uncertainty, they show that a linear BVAR implies that output, unemployment, inflation and nominal interest rate all reduce in response to an increase in uncertainty. Then, building up a NK-DSGE model with search and matching frictions they show theoretical responses to a model equivalent uncertainty shock in line with the empirical ones. They conclude that uncertainty shocks are aggregate demand shocks. This note shows that, their theoretical result on inflation is however based on an interest rate rule which responds to output and inflation, without any interest rate smoothness. When the Central Bank does smooth the interest rate, the LL model cannot replicate the decline in inflation in response to a real uncertainty shock. In fact, with an interest rate smoothing above zero, namely at 0.8 as the empirical evidence suggests, inflation reacts positively at impact and stays above the long-run level for almost six periods before going back to its steady state.[1] Due to the concavity of the profit function, firms prefer to set their prices at an higher level when the uncertainty about future outcomes is elevated. If the Central Bank does not react immediately to offset the increasing prices, the shock results inflationary instead of being deflationary. Thus, with a less active but more realistic Taylor rule, uncertainty shocks look more like aggregate supply shocks rather than demand shocks. Remarkably, this result is reinforced when the monetary authority is less reactive in responding to inflation and output. Overall, less reactive rules also imply less severe recession.

The finding of a positive response of inflation to uncertainty shocks is not new in the literature. Using different models, both Born and Pfeifer (2014) and Fernández-Villaverde et al. (2015) argue that firms desire to increase prices in response to an higher uncertainty on future marginal costs.[2] Differently from these authors, this note tests the robustness of the LL model under different Taylor-type rules, and stresses on the importance of the reactiveness of monetary policy as a leading element for inflation dynamics.

Annichiarico et al. (2011) and Annichiarico and Rossi (2015), were the first to investigate the relationship between economic uncertainty and monetary policy rules. They find a non-negligible relationship between uncertainty and long-run growth, which

[1] Among many others, Clarida et al. (1999) estimates the smoothing parameter of the Taylor rule at 0.79, Smets and Wouters (2003) at 0,95, Smets and Wouters (2007) at 0,81, Benati and Surico (2008) at 0.81, Benati and Surico (2009) at 0.74, Justiniano et al. (2010) at 0,82.

[2] Bonciani and van Roye, (2016) give a similar intuition.

depends on the Taylor rule considered, particularly on the smoothing parameter of the Taylor rule. Using a medium-scale AK-model with endogenous growth, they focus, however, on the long-run relationship between economic uncertainty and growth, without investigating the short-run dynamics.

The rest of the paper proceeds as follows. Section 2 briefly discusses the model economy of the LL model. Section 3 presents the model solution and calibration and shows the dynamics of the model in response to an uncertainty shock under five different Taylor-type rules.

The Leduc and Liu (2016) Model

The model considered is identical to that of LL. Thus, we now present a very brief description of their model, underlying the way in which uncertainty shock is introduced in LL and the interest rate rule implemented by the monetary authority.[3]

The economy is populated by households, firms and a monetary policy authority. Households consist of a continuum of worker members. They consume a basket of differentiated retail-goods and their consumption is characterized by internal habits formations. They own a continuum of firms, each of which uses one worker to produce an intermediate-good under monopolistic competition and flexible prices. The production function of the intermediate-goods' producing firm is then,

$$x_t = Z_t, \tag{1}$$

with x_t denoting output and Z_t an aggregate technology shock given by,

$$\ln(Z_t) = \rho_z \ln(Z_{t.1}) + \sigma_{z,t}\varepsilon_{z,t}, \tag{2}$$

ρ_z measures its persistence and $\varepsilon_{z,t}$ is an i.i.d. innovation with a standard normal process. $\sigma_{z,t}$ is a time-varying standard deviation of the innovation, interpreted as an uncertainty shock, which follows an AR(1) process:

$$\ln(\sigma_{z,t}) = (1 - \rho_{\sigma z})\,\sigma_{zt} + \rho_{\sigma z}\ln(\sigma_{z,t-1}) + \sigma_{\sigma z}\varepsilon_{\sigma z,t} \tag{3}$$

$\rho_{\sigma z}$ measures its persistence and $\varepsilon_{\sigma z,t}$ is an i.i.d. standard normal process. $\sigma_{\sigma z}$ is the standard deviation of the innovation to technology uncertainty.

The labor market is characterized by search and matching frictions. In each period, a fraction of workers is unemployed and searches for jobs. Firms post vacancies at a fixed cost. The number of successful matches is produced with a Cobb-Douglas matching technology. Real wages are determined by Nash bargaining between firms and workers. Further, real wages are sticky and adjust slowly to their Nash optimal

[3]For a more detailed description see Leduc and Liu (2016).

value. The government finances workers' unemployment benefits through lump-sum taxes. Retail sector firms compete under monopolistic competition and set their prices under quadratic Rotemberg (1982) adjusting costs.

Finally, the monetary policy is described by the following standard Taylor rule,

$$\log\left(\frac{R_t}{R}\right) = \rho_R \log\left(\frac{R_{t-1}}{R}\right) + (1-\rho_R)\left[\rho_\Pi\left(\frac{\Pi_t}{\Pi}\right) + \rho_Y\left(\frac{Y_t}{Y}\right)\right], \tag{4}$$

where the nominal interest rate responds to deviations of inflation and output from their long-run target. Importantly, differently from LL, and as standard in the literature, we allow the Central Bank to smooth the interest rate. All the equations characterizing the equilibrium of the economy are reported in Table 1.

Model Calibration and Dynamics

As in LL we follow Fernández-Villaverde et al. (2011) to compute the impulse response functions (IRFs). The model calibration -reported in Table 2- follows LL paper. Differently from the authors, we consider five different interest rate rules: (i) the LL Rule (LLR), where $\phi_\pi = 1.5$, $\phi_y = 0.2$ and $\phi_r = 0$; (ii) the LLR with Smoothing (LLRS), where $\phi_\pi = 1.5$, $\phi_y = 0.2$, and $\phi_r = 0.8$, which is a rather standard - and empirically plausible - Taylor rule; (iii) the LLRS with a Muted response to output (LLRSMY), where $\phi_\pi = 1.5$, $\phi_y = 0$, and $\phi_r = 0.8$, (iv) a Strong Inflation Targeting Rule (SITR), where $\phi_\pi = 5$, and $\phi_y = \phi_r = 0$; (v) a Weak Inflation Targeting Rule (WITR), where $\phi_\pi = 1.2$, and $\phi_y = \phi_r = 0$.

Impulse Response Functions

Figures 1 and 2 report the IRFs of the model to real uncertainty shocks under the five Taylor rules described above.

First, notice that the responses of real variables do not change qualitatively under the different Taylor rules. Consumption, output and real marginal costs fall in response to an increase in uncertainty, while the unemployment rate increases. Both the option-value channel associated with search frictions and the aggregate demand channel stemming from nominal rigidities are important for amplifying the negative effect of the uncertainty shock. The persistent decline in consumption, due to habits formation, further amplifies the effect of the option-value channel, generating an additional rise in the unemployment rate in response to the shock. Firms refrain from hiring, the fall in real wage is higher and the shock is more recessionary, than in a model without habits. LL, conclude that "*overall, incorporating habit formation brings the magnitude of the peak unemployment response much closer to that estimated from the VAR model*". This is true for the LLR that makes the recession more severe and deflationary. The response of the inflation is instead different when an empirical plausible degree of interest rate smoothing is attached to the LLR. In fact with the LLRS, the reaction of inflation is positive at impact and takes almost six periods to go back to its steady state. Thus, with a more realist Taylor rule the inflation response is not in accordance with a negative demand shock and the uncertainty shock looks more like a supply shock. The intuition behind this result is the following. The concavity of the profit function implies an upward pricing bias for firms in response to an increase in uncertainty. Using a Taylor rule which reacts immediately to changes in output and inflation, the monetary authority is able to offset firms inflation bias and to reduce inflation expectations. This worsens the precautionary saving effect, which strongly reduces consumption. In a demand driven economy, the reduction in consumption translates into a negative *demand effect* that results deflationary. If instead the monetary authority reacts slowly, by smoothing the interest rate, a *supply effect* due to the inflation bias prevails. Both actual and expected inflation increase, inducing a lower reduction in consumption that makes the recession less severe both in terms of output and unemployment. This result is confirmed when we consider the same rule, but with a muted response to output, that is with the LLRSMY. In this case the increase in inflation is even stronger since the Central Bank is less active with respect to the LLRS.

Finally, Figure 2 compares a WITR with a SITR. It shows that the WITR is similar to the LLRS and to the LLRSMY, though the lower coefficient on inflation generates an extra inflation bias and a lower recession. Not surprisingly, a SITR is able to stabilize the economy by generating a negligible effect on inflation, which remains close to zero. The welfare analysis of the model is however beyond the scope of this note.

To sum up, this note aims at clarifying that an uncertainty shock is not necessarily an aggregate demand shock and its effect remarkably depends on the Taylor rule adopted. Overall, with a less reactive Taylor rule the effects of the shock are inflationary instead of being deflationary. The estimation of an NK-DSGE medium-scale model with search and matching frictions is in our future research agenda.

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Tables

Table 1: Benchmark Model

Description	Equations
Marg. Utility of Consumption	$\Lambda_t = \frac{1}{C_t - hC_{t-1}} - \beta E_t \frac{h}{C_{t+1} - hC_t}$,
Euler Equation	$\frac{1}{R_t} = \beta E_t \left[\frac{\Lambda_{t+1}}{\Lambda_t} \frac{1}{\Pi_{t+1}} \right]$,
Nash Bargaining. Real Wage	$w_t^N = b \left(q_t Z_t + (1-\rho) \beta E_t \frac{\Lambda_{t+1}}{\Lambda_t} \frac{\kappa v_{t+1}}{u_{t+1}} \right) + (1-b) \left(\frac{\chi}{\Lambda_t} + \phi \right)$,
Actual Real Wage	$w_t = (w_{t-1})^{\gamma} \left(w_t^N \right)^{1-\gamma}$,
Production Function	$Y_t = Z_t N_t$,
Resource Constraint	$\left(1 - \frac{\Omega_p}{2} (\pi_t - 1) \right)^2 Y_t = C_t + \kappa v_t$,
Phillips Curve	$q_t = \frac{\eta - 1}{\eta} + \frac{\Omega_p}{\eta} \left(\frac{\pi_t}{\pi} - 1 \right) \pi_t - \frac{\Omega_p}{\eta} \beta E_t \left[\frac{\Lambda_{t+1}}{\Lambda_t} \frac{Y_{t+1}}{Y_t} \left(\frac{\pi_{t+1}}{\pi} - 1 \right) \pi_{t+1} \right]$,
Job Creation Condition	$\frac{\kappa}{q_t^v} = q_t Z_t - w_t + (1-\rho) \beta E_t \left\{ \left(\frac{\Lambda_{t+1}}{\Lambda_t} \right) \frac{\kappa}{q_{t+1}^v} \right\}$,
Matching Function	$m_t = \mu u_t^{\alpha} v_t^{1-\alpha}$,
Job Finding Probability	$q_t^u = \frac{m_t}{u_t}$,
Vacancy Filling Probability	$q_t^v = \frac{m_t}{v_t}$,
Employment. Law Motion	$N_t = (1-\rho) N_{t-1} + m_t$,
Unemployment Rate	$U_t = 1 - N_t$,
Job searcher	$u_t = 1 - (1-\rho) N_{t-1}$,
Productivity Shock	$\log \left(\frac{Z_t}{Z} \right) = \rho_Z \log \left(\frac{Z_{t-1}}{Z} \right) + \sigma_{Z,t} \varepsilon_t^Z$,
Uncertainty Shock	$\log \left(\frac{\sigma_{Z,t}}{\sigma_Z} \right) = \rho_{\sigma_Z} \log \left(\frac{\sigma_{Z,t-1}}{\sigma_Z} \right) + \sigma_{\sigma_Z} \varepsilon_t^{\sigma^Z}$,
Government BC	$(1 - N_t) \phi = T_t$,
Taylor Rule	$\log \left(\frac{R_t}{R} \right) = \rho_R \log \left(\frac{R_{t-1}}{R} \right) + (1-\rho_R) \left(\rho_{\Pi} \left(\frac{\Pi_t}{\Pi} \right) + \rho_Y \left(\frac{Y_t}{Y} \right) \right)$,

Table 2: Benchmark Calibration

Parameters	Description	Value
	Structural Parameters	
β	preference discount factor	0.99
θ	intertemporal elasticity of substitution	1
h	benchmark habits persistence	0.6
U	steady state unemployment rate	0.064
q^v	vacancy filling probability	0.7
α	elasticity parameter in matching function	0.5
b	Nash Bargaining weight	0.5
γ	degree of real wage rigidity	0.8
ρ	separation rate	0.1
κ	vacancy posting costs	$0.02\left(\frac{Y}{v}\right) = 0.14$
ϕ	unemployment benefit	0.25
η	elasticity of substitution among varieties	10
Ω_p	price adjustment cost parameter	112
Π	steady state gross inflation rate	1.005
Z	steady state TFP level	1
ρ_R	Taylor rule smoothness parameter	0; 0.8
ρ_Π	Taylor rule inflation weight parameter	1.5; 1.2; 5
ρ_Y	Taylor rule output weight parameter	0.2; 0
	Shocks Parameters	
σ_Z	steady state st.dev of TFP level	0.01
ρ_Z	persistence degree of TFP level	0.90
σ_Z	steady state st.dev of TFP level	0.01
ρ_{σ_Z}	persistence of TFP uncertainty shock	0.76
σ_{σ_Z}	st.dev of TFP uncertainty shock	0.392

Figures

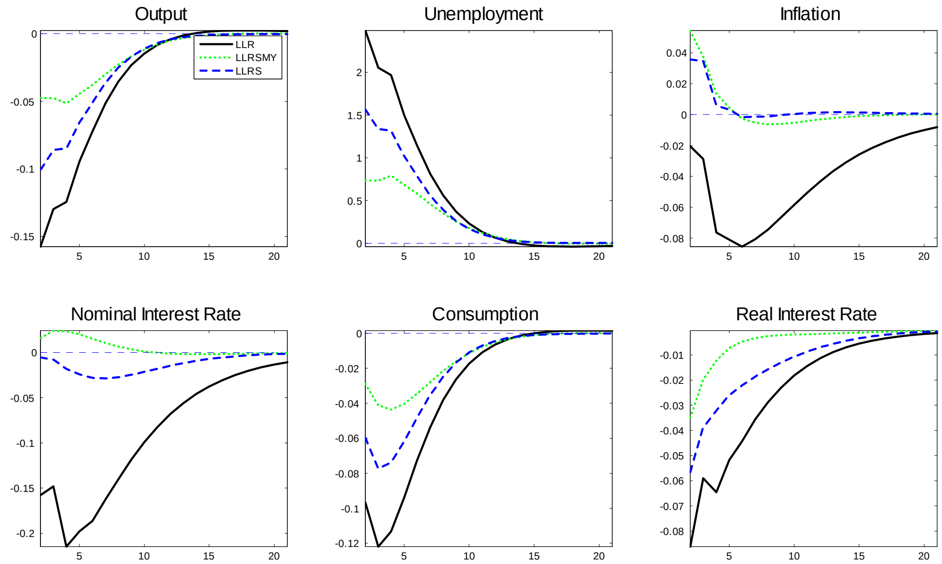

Figure 1. IRFs to an uncertainty shock: LLR (black solid line), LLRS (blue dashed line) and LLRSMY (green dotted line).

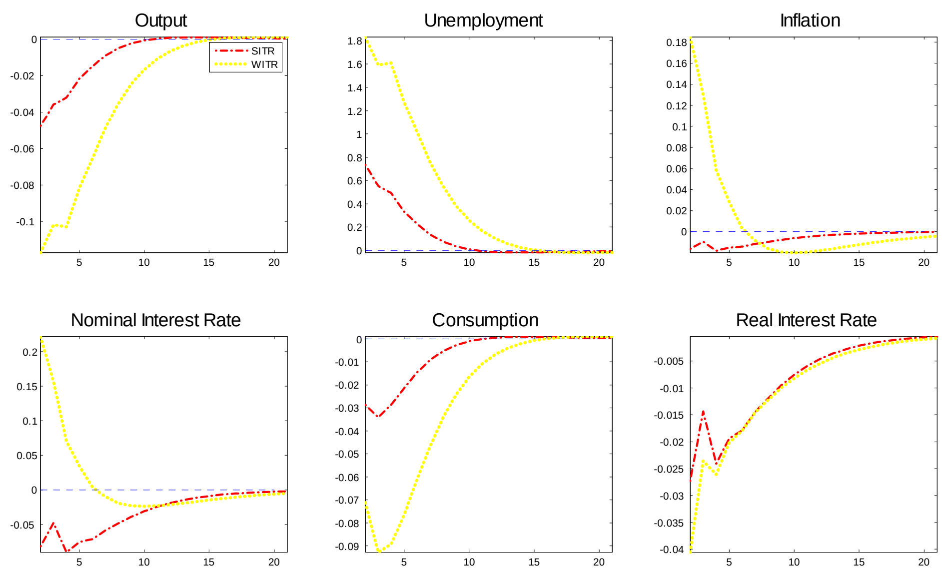

Figure 2. IRFs to an uncertainty shock: SITR (red dashed-dotted line) and WITR (yellow dotted line).