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UNCERTAINTY SHOCKS IN A MODEL OF EFFECTIVE DEMAND: REPLY

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de Groot, Richter, and Throckmorton (2018) argue that the model in Basu and Bundick (2017) can match the empirical evidence only because the model assumes an asymptote in the economy's response to an uncertainty shock. In this Reply, we provide new results showing that our model's ability to match the data does not rely either on assuming preferences that imply an asymptote nor on a particular value of the intertemporal elasticity of substitution. We demonstrate that shifting to preferences that are not vulnerable to the Comment's critique does not change our previous conclusions about the propagation of uncertainty shocks to macroeconomic outcomes.

KEYWORDS: Uncertainty shocks, monetary policy, sticky-price models.

IN *Uncertainty Shocks in a Model of Effective Demand*, WE EXAMINE the macroeconomic effects of changes in uncertainty about the future. Figure 1 of this Reply summarizes some of the key findings of our work. In the data, an identified uncertainty shock causes statistically significant declines in output, consumption, investment, and hours worked. We argue that this comovement between output and its components is a key empirical feature of the economy's response to an uncertainty shock. Then, we examine whether a general-equilibrium model can reproduce this empirical evidence. If prices adjust slowly to changing economic conditions, we show that a relatively simple theoretical model can match the actual economy's response to an increase in uncertainty. Moreover, Table I illustrates that the model can match this empirical evidence while remaining consistent with the observed unconditional and stochastic volatility in key macroeconomic aggregates.

In our paper, we model uncertainty shocks as changes in the second moment of household discount rate shocks, which we interpret as changes in the ex ante uncertainty about future demand. To help the model match both macroeconomic and financial market data, we incorporate these discount factor shocks into a setting in which the representative household has Epstein–Zin preferences over consumption C_t and leisure $1 - N_t$. Specifically, we assume that household's value function V_t^{BB} takes the following form:

$$V_t^{\mathrm{BB}} = \max\Big[a_t(1-\beta)\big(C_t^{\eta}(1-N_t)^{1-\eta}\big)^{\frac{1-\sigma}{\theta_V}} + \beta\big(\mathbb{E}_t\big(V_{t+1}^{\mathrm{BB}}\big)^{1-\sigma}\big)^{\frac{1}{\theta_V}}\Big]^{\frac{\theta_V}{1-\sigma}}, \tag{1}$$

where σ controls risk aversion over the consumption-leisure basket, ψ denotes the intertemporal elasticity of substitution (IES), η affects the elasticity of labor supply, and the parameter $\theta_V \triangleq (1-\sigma)(1-1/\psi)^{-1}$ controls the household's preference for the resolution of uncertainty. a_t is the exogenous demand shock process, which has a steady-state value of 1 and features time-varying first and second moments.

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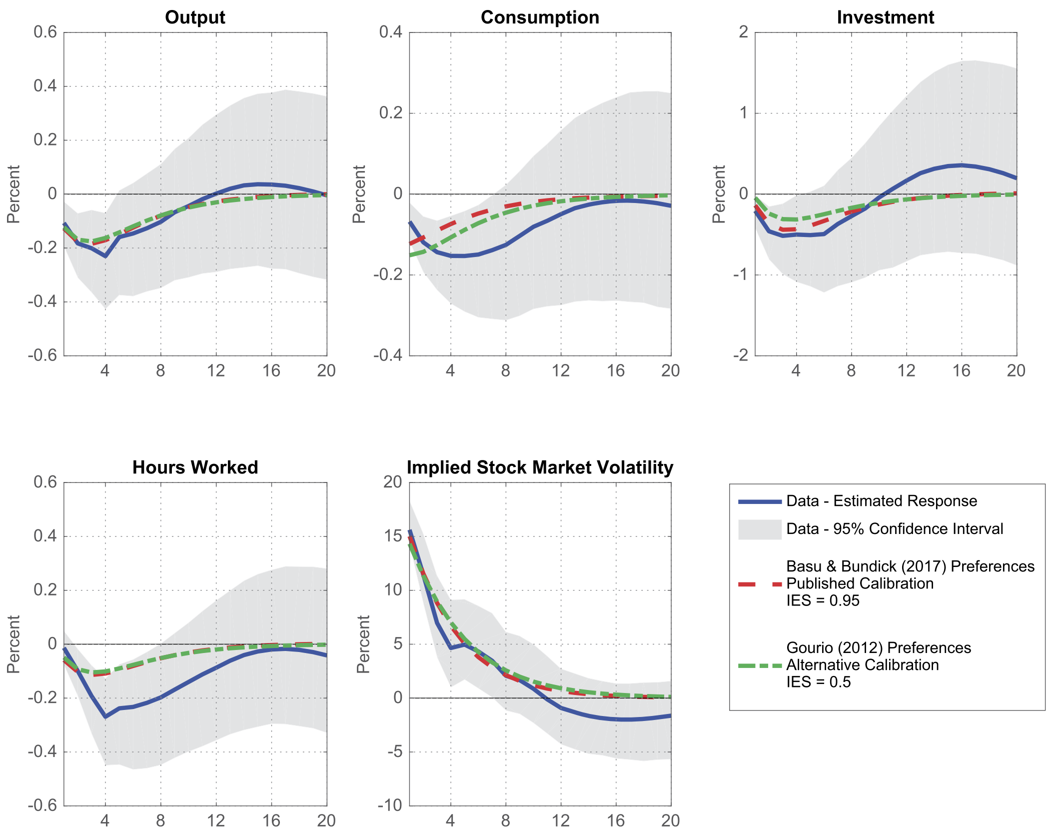

FIGURE 1.—Empirical and model-implied responses to an uncertainty shock.

de Groot, Richter, and Throckmorton (2018) challenge the robustness of the claim that our model can reproduce the actual economy's response to an uncertainty shock. Specifically, they argue that the ability of our model to match the data rests on an asymptote in the economy's response to an uncertainty shock with respect to the IES. Since a_t fluctuates over time, the distributional weights in our utility function specification do not always sum to 1. When the IES is less than 1, they show that, all else equal, increasing the IES produces larger declines in output and its components. As the IES approaches 1 from below, they point out that the economy's response to an uncertainty shock becomes significantly larger and features an asymptote when the IES equals 1. When, instead, the IES approaches 1 from above, the effect of an uncertainty shock on economic activity is reversed. As the published version of our model set to IES = 0.95, they argue that this asymptote at the unitary IES is necessary for our model to reproduce our key findings. The Comment then proposes an alternative set of preferences which removes this asymptote with respect to the unitary IES:

$$V_t^{\mathrm{ALT}} = \max\Big[(1 - a_t\beta)\big(C_t^{\eta}(1 - N_t)^{1-\eta}\big)^{\frac{1-\sigma}{\theta_V}} + a_t\beta\Big(\mathbb{E}_t\big(V_{t+1}^{\mathrm{ALT}}\big)^{1-\sigma}\Big)^{\frac{1}{\theta_V}}\Big]^{\frac{\theta_V}{1-\sigma}}. \tag{2}$$

Under these alternative preferences, they show that our theoretical model generates much smaller responses to an uncertainty shock and fails to generate macroeconomic comovement between output, consumption, and investment.

TABLE I

EMPIRICAL AND MODEL-IMPLIED UNCONDITIONAL MOMENTS[a]

Moment	Data	Model BB Preferences Published Calibration	Model Gourio Preferences Alternative Calibration
Unconditional Volatility			
Output	1.1	1.0	0.9
Consumption	0.7	0.8	0.7
Investment	3.8	4.7	4.7
Hours Worked	1.4	0.8	1.4
Stochastic Volatility			
Output	0.4	0.2	0.2
Consumption	0.2	0.2	0.1
Investment	1.6	1.2	1.0
Hours Worked	0.5	0.2	0.2
Distance Criterion J		227.8	177.0

[a]Note: Unconditional volatility is measured with the sample standard deviation. We measure stochastic volatility using the standard deviation of the time-series estimate for the 5-year rolling standard deviation. The empirical sample period is 1986–2014. The published version of the Basu–Bundick (BB) model uses the preference specification in Equation (1), while the model with Gourio preferences uses the preference specification in Equation (3). The distance criterion J measures the distance between the model-implied impulse responses and unconditional moments from their empirical counterparts. See Equation (11) of Basu and Bundick (2017) for a formal definition of the distance criterion.

ALTERNATIVE ESTIMATION USING GOURIO (2012) PREFERENCES AND AN IES = 0.5

We believe the Comment contributes to a better understanding of the properties of Epstein–Zin utility functions with preference shocks, and we have learned from it. However, the ability of our model to match the empirical evidence does *not* rely on assuming preferences that contain an asymptote nor on a particular value of the IES. In Section 5.2 of the Comment, the authors suggest another set of preferences, based on the analysis in Gourio (2012), which also removes the asymptote with respect to the IES:

$$V_t^G = \max\Big[(1-\beta)\big(a_t C_t^{\eta}(1-N_t)^{1-\eta}\big)^{\frac{1-\sigma}{\theta_V}} + \beta\big(\mathbb{E}_t\big(V_{t+1}^G\big)^{1-\sigma}\big)^{\frac{1}{\theta_V}}\Big]^{\frac{\theta_V}{1-\sigma}}. \tag{3}$$

Figure 1 of this Reply illustrates the model-implied impulse responses if we re-estimate our baseline model using these alternative preferences and set the IES equal to the commonly-cited value of 0.5. In terms of the visual fit, especially of the impulse response of output, this alternative specification produces impulse responses that are nearly as good as our published results. Moreover, Table I shows that this ability to fit the empirical impulse responses with the Gourio preferences and an IES of 0.5 does not lead the model to over-predict either the unconditional or stochastic volatility in output and its components. Our estimates for these moments are quite close to those in our original paper, and remain consistent with their empirical counterparts. The overall distance criterion J, which measures the distance between the model-implied impulse responses and unconditional moments from their empirical counterparts, is also significantly lower under this alternative estimation, suggesting that the data actually prefer these alternative preferences and a lower value of the IES.

Table II shows the calibrated and estimated model parameters for both the published version of our model and this re-estimation exercise. To reproduce our previously pub-

TABLE II

MODEL PARAMETERS[a]

Parameter	BB Preferences Published Calibration	Gourio Preferences Alternative Calibration
IES ψ	0.95	0.50
Risk Aversion σ	80	100
Nominal Price Rigidity ϕ_P	100	240
Capital Adjustment Costs $\boldsymbol{\phi_K}$	**2.09**	**3.92**
Unconditional Shock Volatility $\boldsymbol{\sigma^a}$	**0.003**	**0.005**
First-Moment Shock Persistence $\boldsymbol{\rho_a}$	**0.94**	**0.98**
Uncertainty Shock Size $\boldsymbol{\sigma^{\sigma^a}}$	**0.003**	**0.004**
Uncertainty Shock Persistence $\boldsymbol{\rho_{\sigma^a}}$	**0.74**	**0.77**

[a]Note: Parameters listed in bold are estimated via impulse response and moment matching. See Section 4 of Basu and Bundick (2017) for additional information about the model and its parameters.

lished results under these preferences, we slightly increased risk aversion from $\sigma = 80$ to $\sigma = 100$ and increased the degree of nominal price rigidity from $\Phi_P = 100$ to $\Phi_P = 240$. However, both of these alternative parameterizations are well within the range of estimates from the literature.[1]

This exercise shows that alternative preferences and calibrations may affect the exact degree of nominal rigidities and risk aversion needed to reproduce the VAR evidence while remaining consistent with the observed volatility in macro aggregates. Importantly, these results show that our model need not rely on the presence of an asymptote nor a particular value of the IES to reproduce the actual economy's response to an uncertainty shock.[2]

We have shown that we can reproduce our key findings using the Gourio (2012) preferences, which do not have an asymptote at the unitary IES. The presence of this asymptote in our published paper is the Comment's objection to our previous work. The new results we present in this Reply show that shifting to preferences that are not vulnerable to this critique does not change our core qualitative or quantitative conclusions. While the Comment makes a useful contribution to the literature, it does not change the basic message of our paper regarding the propagation of uncertainty shocks to macroeconomic outcomes.

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[1]For example, Ireland (2003) estimated a point estimate of $\Phi_P = 162$ with a standard error of 79. Our alternative calibration for the degree of nominal price rigidity implies a Phillips curve slope with respect to marginal costs of 0.02, which is within the range of empirical estimates surveyed in Schorfheide (2008). van Binsbergen, Fernàndez-Villaverde, Koijen, and Rubio-Ramìrez (2012) and Rudebusch and Swanson (2012) found that high risk aversion parameters, ranging from 40 to 110 across different specifications, help their models match macro and bond market data.

[2]Using an IES very close to zero, de Groot, Richter, and Throckmorton (2018) also showed that the model can also match the data using higher risk aversion and larger nominal rigidities.

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