What's News in News? A Cautionary Note on Using a Variance Decomposition to Assess the Quantitative Importance of News Shocks

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Abstract

This paper points out a conceptual difficulty in using a variance decomposition to assess the quantitative importance of news shocks. A variance decomposition will attribute to news shocks movements in endogenous variables driven both by news about future exogenous fundamentals that has yet to materialize (what I call "pure news") as well as movements driven by realized changes in fundamentals that were anticipated in the past (what I call "realized news"). I present a stylized model in which news about yet unrealized changes in fundamentals is irrelevant for output dynamics, but in which a variance decomposition may nevertheless attribute a large share of the variance of output to news shocks. I then revisit the quantitative importance of news in the model of Schmitt-Grohe and Uribe (2012). In their model news shocks account for 40 percent of the variance of output growth, but this is mostly driven by realized news.

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1 Introduction

In macroeconomics, the term "news shock" refers to a shock to an exogenous variable which agents observe in advance of that variable changing. A large literature has emerged in recent years which explores the empirical and theoretical implications of news shocks and seeks to asses their relevance for understanding business cycles.[1]

In this paper I highlight a conceptual difficulty in the use of a variance decomposition to study the quantitative importance of news shocks. A forecast error variance decomposition is an alternative way to represent impulse response functions. In a linear model with multiple exogenous driving forces, the fraction of the forecast error variance of an endogenous variable due to a particular shock equals the sum of squared impulse response functions to that shock up to a given forecast horizon divided by the sum of squared impulse response functions to all shocks up to the same forecast horizon. As the forecast horizon tends towards infinity, the variance decomposition is often said to be "unconditional" in that it shows the fraction of the unconditional variance of an endogenous variable attributable to each shock. Variance decompositions are frequently employed to asses the relative importance of different exogenous shocks in accounting for business cycles – recent well-cited examples include Smets and Wouters (2007) in a model without news shocks and Schmitt-Grohe and Uribe (2012) in a DSGE model with news shocks.[2]

The impulse response functions of endogenous variables to a news shock can be broken into conceptually distinct components, what I call "pure news" and "realized news." Suppose that agents in an economy observe a shock to an exogenous variable l periods prior to the exogenous variable actually being affected, where I refer to l as the "anticipation horizon." The "pure news" component is the first l forecast horizons of the impulse response function, capturing movements in an endogenous variable in response to an anticipated change in an exogenous variable that is yet to occur. The "realized news" portion measures the impulse response function at horizons after l, when (in expectation) the exogenous variable has in fact changed. An unconditional forecast error variance decomposition (or more generally a variance decomposition at forecast horizons well beyond the anticipation horizon of a news shock) is likely to overstate the quantitative importance

[1] Most of this literature focuses on news shocks about neutral productivity, although the concept of a news shock may apply to any exogenous driving force. One part of this literature is empirical and relies on reduced form time series techniques. Beaudry and Portier (2006) is one of the earliest papers empirically exploring the economic effects of news shocks in a multivariate time series model; a non-exhaustive list of subsequent contributions includes Beaudry and Lucke (2010), Barsky and Sims (2011), Kurmann and Otrok (2013), Forni, Gambetti, and Sala (2014), and Barsky, Basu, and Lee (2015). Another strand of the literature is theoretical and seeks to elucidate mechanisms capable of generating "business cycle-like" co-movements in response to news shocks. A leading example of this literature is Jaimovich and Rebelo (2009). Finally, a third strand of the literature structurally estimates DSGE models to study the role of news shocks. Papers in this literature include Fujiwara, Hirose, and Shintani (2011), Schmitt-Grohe and Uribe (2012), and Kahn and Tsoukalas (2012).

[2] Other well-cited examples in models without news shocks include Ireland (2004), who presents variance decompositions conditional on forecast horizons; and Justiniano, Primiceri, and Tambalotti (2010) and Christiano, Motto, and Rostagno (2014), who present variance decompositions at business cycle frequencies. Fujiwara, Hirose, and Shintani (2011) and Kahn and Tsoukalas (2012) study models with news shocks, and like Schmitt-Grohe and Uribe (2012), focus on an unconditional variance decomposition. Jurado (2015) studies a model with news shocks and distorted beliefs and also uses an unconditional variance decomposition to asses the relative importance of different classes of shocks.

of actual news about yet unrealized changes in exogenous variables by mixing the "pure news" component of a news shock with the movements in endogenous variables which occur subsequent to the news being realized.

The distinction between pure and realized news is important because one of the promises of the news-driven business cycle literature is to generate "boom-bust" cycles without any observable change in fundamentals ex-post. In particular, if good news about some exogenous fundamental generates an expansion but that exogenous fundamental does not change ex-post, then one might observe business cycle dynamics (i.e. output expanding and then contracting) with no observable change in fundamentals. For understanding whether such "boom-bust" dynamics are quantitatively important it is critical to differentiate between effects of news shocks driven by actual news versus movements in endogenous variables caused by realized changes in fundamentals. A traditional variance decomposition does not make this distinction.

Section 2 presents a highly stylized model where the potential problem with using a variance decomposition to study the quantitative importance of news shocks is particularly clear. The model is a frictionless real business cycle model in which output is produced according to a linear production technology with labor as the only factor of production. There is an exogenous productivity variable which obeys a stationary stochastic process driven by both a traditional unanticipated shock and a news shock which agents observe four quarters in advance. With no capital accumulation and no other endogenous state variable, in equilibrium output is simply proportional to the current value of exogenous productivity. This means that output does not respond to news in advance of that news being realized, and once the news is realized output reacts in exactly the same way it would if the shock were unanticipated. Nevertheless, an unconditional forecast error variance decomposition can attribute an arbitrarily large share of the variance of output to the news shock, and a forecast error variance decomposition at finite horizons beyond the anticipation horizon of news may suggest that the news shock is a major driver of output. This is in spite of the fact that actual news is completely irrelevant for output dynamics in the model.

The model of Section 2 is useful for highlighting the conceptual problem with a variance decomposition in a model with news shocks but cannot address how important the problem may be in practice – the model is far too simple, as it lacks any means by which output can react to news prior to its realization. I therefore consider in Section 3 the rich model developed and estimated in Schmitt-Grohe and Uribe (2012). The model has several features which can help produce significant amplification in response to news shocks even before their realization. These features include preferences with a weak wealth effect on labor supply, investment adjustment costs, internal habit formation in consumption, and variable capital utilization. The model features seven exogenous stochastic variables, each of which are impacted by three shocks – one conventional unanticipated shock, and two news shocks which differ by anticipation horizon. The model is estimated using Bayesian and classical maximum likelihood methods on postwar US data. The principal conclusion of the paper is that news shocks quantitatively matter – the combined contribution of the fourteen news shocks in the model to the unconditional forecast error variance of output growth is 40 percent.

While the unconditional variance decomposition in the estimated model suggests that news shocks combine to be a major driving force of aggregate variables, the variance decomposition focusing on forecast horizons different than infinity paints a more nuanced picture. In particular, news shocks combine to explain 10 percent or less of the forecast error variances of output and other aggregate variables prior to the horizons at which news shocks are actually realized. Furthermore, the variance decomposition of output and other aggregate variables displays large discreet jumps at the horizons corresponding to the realization of news shocks (horizons four and eight). These patterns are suggestive that much of the overall 40 percent contribution of news shocks to the unconditional variance of output growth is driven by realized news, not news about future changes in exogenous variables that have not yet occurred.

I propose a simple way to decompose the contributions of "pure news" and "realized news" in the variance decomposition. I define auxiliary impulse response functions and then use those to compute an alternative variance decomposition. The impulse response function to "pure news" equals the impulse response function prior to the realization of that news and equals zero at horizons thereafter. The impulse response function to "realized news" equals zero at horizons prior to the realization of news, and takes on the value of the impulse response function to a news shock at horizons subsequent to that. I then use these auxiliary impulse response functions to compute the alternative variance decomposition; by construction, the sum of the variance shares due to "pure news" and "realized news" equals the the overall news shock share from the traditional variance decomposition. This exercise reveals that the majority of the overall news shock share in Schmitt-Grohe and Uribe's (2012) model is indeed driven by realized news – "pure news" accounts for about 10 percent of the unconditional variance of output growth, whereas "realized news" makes up the other 30 percent.

A potential drawback of my decomposition into "pure news" and "realized news" is that it attributes all of the movements in endogenous variables subsequent to the anticipation horizon to the realization of an anticipated change in an exogenous variable. Given that Schmitt-Grohe and Uribe's (2012) features endogenous state variables, unlike the simple model in Section 2, this will tend to understate the contribution of pure news. I therefore consider an alternative way to disentangle the roles of pure and realized news based on the counterfactual thought experiment proposed in Barsky, Basu, and Lee (2015), who study news shocks about productivity in a VAR model.[3] In particular, I compute impulse response functions to "unrealized" news shocks by counteracting the impulse response to a news shock with an offsetting unanticipated shock in the period of realization so as to leave the relevant exogenous variable unchanged. One can interpret the difference between the news shock impulse response and the unrealized news shock impulse response as attributable to the realization of an anticipated change in an exogenous variable. I then use the counterfactual im-

[3]Barsky, Basu, and Lee (2015) are among the first authors to make the point that one ought to differentiate "pure news" from effects driven by realized changes in fundamentals. There are some conceptual difficulties in the implementation of their counterfactual thought experiment because of the lack of a structural model, they focus solely on news shocks about productivity, and they do not attempt to decompose a variance decomposition into pure and realized news. Overall, however, the approach and message of the present paper is very much complementary to theirs.

pulse response function to an unrealized news shock (interpreted as "pure news") and the difference between the actual impulse response to news and the counterfactual response to an unrealized news shock (interpreted as "realized news") to form a variance decomposition. This approach has the drawback that the variance shares due to pure and realized news will not sum to the overall news shock share, unlike my baseline approach. This is because the counterfactual impulse responses to an unrealized news shock should not happen on average, and hence do not map cleanly into the traditional definition of a forecast error. This caveat aside, the results from this alternative exercise are very much in line with my baseline exercise – most of the contribution of news shocks in the Schmitt-Grohe and Uribe (2012) model comes from the realization of anticipated changes in exogenous variables, not news about yet unrealized changes in those variables.

While the model in Schmitt-Grohe and Uribe (2012) is particularly suitable for illustrating the main point of this paper, the lesson here is a broader one. It is now common practice to use a variance decomposition to assess the quantitative importance of different shocks in DSGE models. News shocks present a challenge for a traditional variance decomposition (either conditional on a forecast horizon or unconditional) because the timing of these shocks matters for their interpretation in a way that is not true for unanticipated shocks. News shocks are most interesting prior to their realization. Quantitative assessments of the role of these shocks should distinguish between the effects of news about yet unrealized changes in economic fundamentals from the effects driven by the realization of changes in fundamentals that were anticipated in the past. By confounding these two conceptually distinct components of a news shock, a traditional variance decomposition is likely to overstate the quantitative importance of genuine news that has yet to be realized.[4]

The remainder of the paper is organized as follows. Section 2 presents an illustrative model to cleanly make the case that a variance decomposition may give a misleading sense of the importance of genuine news. Section 3 briefly sketches the Schmitt-Grohe and Uribe (2012) model, replicates their variance decompositions, and decomposes these variance decompositions into "pure news" and "realized news" components. The final section offers some concluding thoughts. Details of the model as well as some additional results are relegated to an Appendix.

2 An Illustrative Model

This section considers a stylized model with both news and unanticipated shocks to productivity. The environment is a frictionless real model with a representative household and firm and no capital accumulation.

[4] As noted in Footnote 1, much of the news shock literature focuses on news about exogenous productivity. News shocks can also be applied to policy variables, as in House and Shapiro (2006) with tax cuts, Ramey (2011) with government spending shocks, or Milani and Treadwell (2012) with monetary policy shocks. The objective of the present paper is simply to point out that a distinction ought to be made between "pure news" and the effects of realized changes in variables that were anticipated in the past. That I find that "pure news" is quantitatively unimportant in Schmitt-Grohe and Uribe's (2012) model does not necessarily apply to other settings, such as the nascent literature studying the so-called "forward guidance puzzle." Milani and Treadwell (2012), in an estimated New Keynesian DSGE model, find that news shocks about monetary policy (anticipated innovations to a Taylor rule) are quantitatively more important than conventional surprise monetary policy shocks. Del Negro and Giannoni (2015) find that the anticipation of extended periods of low interest rates can be wildly expansionary.

A representative household picks a sequence of consumption, C_t, bond holdings, B_{t+1}, and labor supply, h_t, to maximize the present discounted value of utility subject to a standard flow budget constraint:

$$\max_{C_t, h_t, B_{t+1}} \quad E_0 \sum_{t=0}^{\infty} \beta^t \left(\ln C_t - \psi \frac{h_t^{1+\theta}}{1+\theta} \right)$$

s.t.

$$C_t + B_{t+1} - B_t \leq w_t h_t + \Pi_t + r_{t-1} B_t$$

The discount factor is given by $0 < \beta < 1$, ψ is a scaling parameter, and θ is the inverse Frisch labor supply elasticity. B_{t+1} is a stock of one period riskless bonds that pay out r_t units of consumption in $t+1$. w_t is the real wage and Π_t denotes lump sum distributed profit which the household takes as given. The first order optimality conditions are a standard intratemporal labor supply condition and an Euler equation for bonds:

$$\psi h_t^{\theta} = \frac{1}{C_t} w_t \tag{1}$$

$$\frac{1}{C_t} = \beta (1 + r_t) E_t \frac{1}{C_{t+1}} \tag{2}$$

A representative firm produces output according to a linear technology in labor input:

$$Y_t = Z_t h_t \tag{3}$$

The exogenous variable Z_t measures productivity. The firm's optimality condition requires that the wage equal the marginal product:

$$w_t = Z_t \tag{4}$$

The productivity variable follows a mean zero stationary AR(1) in the log, subject to two stochastic shocks: ε_t^0, a conventional surprise productivity shock, and ε_t^4, which is a news shock that agents observe four periods in advance of it impacting productivity. The choice of a four period anticipation horizon is arbitrary and none of the insights from the simple model depend upon the anticipation horizon. These shocks are both drawn from standard normal distributions; the shocks are then scaled by σ_0 and σ_4, which measure their standard deviations:

$$\ln Z_t = \rho_z \ln Z_{t-1} + \sigma_0 \varepsilon_t^0 + \sigma_4 \varepsilon_{t-4}^4, \quad 0 < \rho_z < 1 \tag{5}$$

In the competitive equilibrium bond holdings are zero at all times, $B_t = 0$, and output equals consumption, $Y_t = C_t$. Given the absence of an endogenous state variable, equations (1), (3), and (4), plus the market-clearing condition, uniquely determine Y_t, C_t, h_t, and w_t as functions of the current value of Z_t alone. The Euler equation, (2), prices the bond, which is in zero net supply in equilibrium. In logs, we can express output as:

$$\ln Y_t = -\frac{1}{1+\theta}\ln\psi + \ln Z_t \tag{6}$$

Since it depends only on the current level of productivity, output will not respond to a news shock until that shock actually impacts the level of Z_t. Furthermore, once the news shock materializes four periods after agents observe it, output will respond in exactly the same way as if the shock were unanticipated.

Define impulse response functions of output in the model as the displacement of future forecasts of output conditional on the realization of a one standard deviation shock to one of the shocks.[5] The impulse response function is defined over forecast horizons and there is a separate response function for each shock. Let H denote the forecast horizon and j index the shock:

$$\text{IRF}_j(H) = E_t Y_{t+H} - E_{t-1} Y_{t+H} \mid \varepsilon_t^j = 1, \quad \text{for } j = \{0, 4\}, \;\; H \geq 0 \tag{7}$$

Given the simple structure of the model, the impulse response functions to the unanticipated and news shocks are:

$$\text{IRF}_0(H) = \rho_z^H \sigma_0 \tag{8}$$

$$\text{IRF}_4(H) = \begin{cases} 0 & \text{if } H < 4 \\ \rho_z^{H-4}\sigma_4 & \text{otherwise} \end{cases} \tag{9}$$

Define the mean squared error (MSE) as the square of the forecast error at horizon $t+H$, conditional on information available at time $t-1$, $u_{t+H|t-1} = Y_{t+H} - E_{t-1}Y_{t+H}$:

$$\text{MSE}(u_{t+H|t-1}) = E\big[Y_{t+H} - E_{t-1}Y_{t+H}\big]^2, \quad H \geq 0 \tag{10}$$

Given the structure of the model, the expression for the MSE works out to:

$$\text{MSE}(u_{t+H|t-1}) = \begin{cases} \sigma_0^2 \sum_{j=0}^{H} \rho_z^{2j} & \text{if } H < 4 \\ \sigma_0^2 \sum_{j=0}^{H} \rho_z^{2j} + \sigma_4^2 \sum_{j=4}^{H} \rho_z^{2(H-j)} & \text{otherwise} \end{cases} \tag{11}$$

From (11), one observes that the MSE at horizon H is simply the sum, across both shocks, of the sum of squared impulse response functions from horizons 0 up to H. The forecast error variance decomposition shows the fraction of the total forecast error variance attributable to each shock at different forecast horizons. This can be computed by constructing a mean squared error conditional on each shock and computing the ratio to the total MSE. As $H \to \infty$, the forecast error variance decomposition is sometimes called an unconditional variance decomposition. For

[5] In principle, the impulse response function can be defined for any size (or sign) shock. So as to facilitate the comparison between the impulse response function and the forecast error variance decomposition, I define impulse response functions in terms of one standard deviation shocks.

this model, the total unconditional variance of log output and the unconditional variance shares due to the unanticipated and news shocks can be expressed as:

$$\text{var}(\ln Y_t) = \frac{\sigma_0^2 + \sigma_4^2}{1 - \rho_z^2} \tag{12}$$

$$\text{var}\left(\ln Y_t \mid \varepsilon_t^0\right) = \frac{\sigma_0^2}{\sigma_0^2 + \sigma_4^2} \qquad \text{var}\left(\ln Y_t \mid \varepsilon_t^4\right) = \frac{\sigma_4^2}{\sigma_0^2 + \sigma_4^2} \tag{13}$$

The unconditional variance decomposition in this model depends only on the relative variances of the two shocks. As σ_4 gets large relative to σ_0, the unconditional variance decomposition will attribute an increasingly large share of the variance of output to the news shock. In the limiting case as $\frac{\sigma_4}{\sigma_0} \to \infty$, the unconditional decomposition will attribute all of the variance of output to the news shock. This is in spite of the fact that news about yet unrealized changes in productivity is irrelevant for the evolution of output in the model.

This interpretative problem is not unique to an unconditional variance decomposition but also arises in a decomposition conditional on forecast horizons. To make this point cleanly, Table 1 shows the forecast error variance decomposition for log output at various different forecast horizons. This table is generated assuming that the unanticipated and news shocks have the same variance, i.e. $\sigma_0 = \sigma_4 = 1$, and $\rho_z = 0.90$. Given that I have assumed equal shock variances, at horizon ∞ each shock accounts for 50 percent of the forecast error variance of log output. From forecast horizons zero through three, the news shock explains none of the forecast error variance of output. Only once the news shock affects $\ln Z_t$ at horizons four or later does the news shock begin to account for any movements in log output. In terms of assessing the quantitative importance of news, the forecast error variance decomposition conditional on forecast horizon represents an improvement over the unconditional variance decomposition in that the pattern of the decomposition strongly suggests that realized news is driving the overall contribution of the new shock, but it is nevertheless still potentially misleading. At horizons 8 through 32, for example, the forecast error variance decomposition attributes between 43 and 50 percent of the variance of log output to the news shock, even though actual news about yet unrealized changes in productivity does not affect output.[6]

[Table 1 about here]

The simple model in this section is highly stylized – it has no internal propagation mechanism and therefore no means by which agents can react to news shocks. But it is nevertheless useful in making the point that a variance decomposition may be a misleading way to assess the quantitative importance of news shocks. Even though actual news is irrelevant for output in the model, a traditional variance decomposition (either unconditional or at forecast horizons beyond the anticipation horizon of news) may suggest that news is a major driver of output.

[6] The assumed value of ρ_z has an impact on the relative contributions of the surprise and news shocks at different forecast horizons. As can be seen in (11), the contribution of the news shock will be larger (at horizons beyond the anticipation horizon) for smaller values of ρ_z. Put differently, the lower is ρ_z, the more quickly the variance shares due to the surprise and news shocks converge to one another.

In closing, it should be noted that there is nothing "incorrect" about a traditional variance decomposition applied to a model with news shocks. Rather, the point is that care must be taken when using a variance decomposition as a tool to assess the quantitative importance of news shocks, as these shocks have come to be defined in the literature. In particular, most of the existing literature does not distinguish between the effects of anticipated but unrealized changes in exogenous variables and the effects of realized but anticipated changes in those variables. Defining a news shock as is done in the literature without making this distinction and performing a variance decomposition may give a misleading sense of the role of actual news.

3 News Shocks in the Schmitt-Grohe and Uribe (2012) Model

This section reconsiders the quantitative importance of news shocks in the DSGE model of Schmitt-Grohe and Uribe (2012). This model features a number of shocks and frictions, and, unlike the simple model from the previous section, has built-in features that allow endogenous variables to react to news shocks in anticipation of their realization. After estimating the model via Bayesian and classical methods, Schmitt-Grohe and Uribe (2012) conclude, on the basis of an unconditional variance decomposition of output growth, that news shocks account for about half of the variance of output.

I briefly sketch the key ingredients of the model in the text; a full description of the model is left to the Appendix. The model has as a backbone a basic real business cycle model structure with endogenous capital accumulation. Relative to a standard RBC model, it is augmented with preferences with a weak wealth effect on labor supply, investment adjustment costs, variable capital utilization, habit formation in consumption, and a production technology with decreasing returns in capital and labor. Flow utility of a representative household is given by:

$$U(V_t) = \frac{V_t^{1-\sigma} - 1}{1-\sigma} \tag{14}$$

Where:

$$V_t = C_t - bC_{t-1} - \psi h_t^{\theta} S_t \tag{15}$$

$$S_t = (C_t - bC_{t-1})^{\gamma} S_{t-1}^{1-\gamma} \tag{16}$$

These preferences are based on Jaimovich and Rebelo (2009), whose preferences are in turn an adaptation of Greenwood, Hercowitz, and Huffman (1988). The parameter $\gamma \in (0, 1]$ governs the income effect on labor supply; as $\gamma \to 0$, these preferences are isomorphic to GHH preferences augmented to include internal habit formation (measured by the parameter $b \in [0, 1)$), whereas when $\gamma \to 1$, these preferences feature exact cancellation of substitution and income effects on labor supply in the long run, as in King, Plosser, and Rebelo (1988). The household discounts future flow utility by $0 < \beta < 1$, with an exogenous shock ζ_t resulting in time-variation in the discount factor.

Capital accumulates according to the following law of motion:

$$K_{t+1} = z_t^I \left[1 - \frac{\kappa}{2} \left(\frac{I_t}{I_{t-1}} - \mu^I \right)^2 \right] I_t + (1 - \delta(u_t)) K_t \tag{17}$$

Here I_t denotes investment and K_t physical capital. The exogenous variable z_t^I is an investment shock which affects the transformation of investment into physical capital; it obeys a stationary stochastic process. The parameter $\kappa \geq 0$ governs the convexity of an investment adjustment cost based on the specification in Christiano, Eichenbaum, and Evans (2005), where μ^I is the steady state gross growth rate of investment. The depreciation rate of capital, $\delta(u_t)$, is a function of utilization, u_t:

$$\delta(u_t) = \delta_0 + \delta_1(u_t - 1) + \frac{\delta_2}{2}(u_t - 1)^2 \tag{18}$$

The production function is given by:

$$Y_t = z_t \left(u_t K_t\right)^{\alpha_k} \left(X_t h_t\right)^{\alpha_h} \left(X_t L\right)^{1-\alpha_k-\alpha_h} \tag{19}$$

Y_t is output and z_t is an exogenous variable measuring neutral productivity which follows a stationary stochastic process. X_t is a non-stationary labor-augmenting productivity shock. L is some fixed factor such as land, which generates decreasing returns in the two variable factors of capital and labor.

The aggregate resource constraint is given by:

$$Y_t = C_t + A_t I_t + G_t \tag{20}$$

Here G_t is government spending and A_t is an exogenous shock to investment-specific technology (IST). This shock affects the transformation of consumption goods into investment goods.[7] It is assumed to follow a non-stationary stochastic process with trend growth to account for the observed downward trend in the relative price of investment goods. Government spending has both an exogenous component and a component which reacts (with a lag) to changes in the trend growth rate of output, which is necessary for the model to exhibit a balanced growth path.

A final twist in the model is that the household has some market-power in wage-setting. The household supplies labor to monopolistically competitive labor unions which then sell differentiated labor to the goods producing firm. The elasticity of substitution between differentiated labor inputs is time-varying, with the time-varying wage markup denoted by μ_t. In equilibrium this shock has the effect of driving a wedge between the marginal product of labor and the marginal rate of substitution, in a way isomorphic to how a preference shock to the disutility from labor would enter

[7]This shock is conceptually distinct from the investment shock, z_t^I, in that the investment shock affects the transformation of investment goods into new capital, whereas the investment-specific technology shock impacts the transformation of consumption goods into investment goods. The latter is associated with the relative price of investment goods, which shows a strong downward trend in the data, whereas the former is not. For further discussion see Justiniano, Primiceri, and Tambalotti (2011).

a standard intratemporal first order condition for labor supply when preferences are separable.

The model features two sources of non-stationarity: growth in labor augmenting productivity, X_t, and growth in investment-specific technology, A_t. Let the growth rates of these variables be denoted by $\mu_t^x = X_t/X_{t-1}$ and $\mu_t^a = A_t/A_{t-1}$. In addition to these growth rates, the other exogenous variables are the aforementioned neutral productivity shock, z_t; the investment shock, z_t^I; a shock to the exogenous component of government spending, g_t; the preference shock to the discount factor, ζ_t; and the wage markup shock, μ_t. This is seven shocks in total. All of these exogenous shocks obey stationary AR(1) processes and are affected by an unanticipated shock and two news shocks of different anticipation horizons. In particular, for $x = \left\{z, z^I, \mu^x, \mu^a, g, \zeta, \mu\right\}$, it is assumed that:

$$\ln\left(x_t/x\right) = \rho_x \ln\left(x_{t-1}/x\right) + \varepsilon_{x,t} \tag{21}$$

$$\varepsilon_{x,t} = \varepsilon_{x,t}^0 + \varepsilon_{x,t-4}^4 + \varepsilon_{x,t-8}^8 \tag{22}$$

In these specifications x denotes the non-stochastic steady state value of a variable. The innovations $\varepsilon_{x,t}^j$, for $j = 0, 4, 8$ are assumed to be iid normal with standard deviation σ_x^j. As in the simpler model of Section 2, the superscript 0 innovation is an unanticipated shock and the superscript 4 innovation is seen by agents four periods prior to impacting the exogenous variable. This specification augments that to include an eight period ahead news shock as well. Since there are seven exogenous variables buffeted by three innovations each, the model features a total of 21 shocks.

The model is parameterized as in Schmitt-Grohe and Uribe (2012). These parameter values are shown in Table 2. The unit of time is taken to be a quarter. In their paper the parameters $\{\beta, \sigma, \alpha_k, \alpha_h, \mu^x, \mu^a, g, \delta_0\}$ are calibrated using standard values or to match long run moments of the data. Steady state utilization and labor hours are normalized to 1 and 0.2, respectively, implying values of δ_1 and ψ. The fixed factor of production, L, is normalized to one. The remaining parameters are estimated via Bayesian maximum likelihood. Table 2 shows the mean value of these parameters from their posterior distributions. These parameter values were downloaded from the replication website for *Econometrica*.

[Table 2 about here]

3.1 Variance Decomposition

The model is solved via a log-linear approximation about the non-stochastic steady state. The solution to the model can be expressed in the familiar state space form:

$$\mathbf{S}_t = \mathbf{A}\mathbf{S}_{t-1} + \mathbf{B}\epsilon_t \tag{23}$$

$$\mathbf{X}_t = \mathbf{C}\mathbf{S}_t \tag{24}$$

$\mathbf{S}_t$ is a $s \times 1$ vector of state variables, $\mathbf{X}_t$ is a $n \times 1$ vector of observed variables (some of which could be states), and ϵ_t is a $k \times 1$ vector of shocks observed by agents at date t. The anticipated nature of several of the shocks means that the state vector includes lagged values of these shocks. The coefficient matrixes $\mathbf{A}$, $\mathbf{B}$, and $\mathbf{C}$ are of dimension $s \times s$, $s \times k$, and $n \times s$, respectively. The variance-covariance matrix of shocks, $\Sigma_\epsilon = E(\epsilon_t \epsilon_t')$, is diagonal. It can be normalized to have diagonal elements all equal to unity, which then loads the variance of each shock in to the coefficient matrix $\mathbf{B}$. The impulse response function of variable i to the j^{th} shock at horizon H is given by:

$$\text{IRF}_{i,j}(H) = \mathbf{Q}_i' \mathbf{C} \mathbf{A}^H \mathbf{B} \mathbf{D}_j \tag{25}$$

Here, $\mathbf{Q}_i$ is a $n \times 1$ selection vector with a value of unity in the i^{th} position and zeros elsewhere, while $\mathbf{D}_j$ is a $k \times 1$ selection vector with a value of unity in the j^{th} position. The forecast error for the i^{th} variable at horizon H is the realized value at a lead of H periods less the $t-1$ conditional expectation: $u_{i,t+H|t-1} = \mathbf{X}_{i,t+H} - E_{t-1}\mathbf{X}_{i,t+H}$. The MSE is the squared forecast error:

$$\text{MSE}(u_{i,t+H|t-1}) = \left(\mathbf{X}_{i,t+H} - E_{t-1}\mathbf{X}_{i,t+H}\right)^2 \tag{26}$$

In terms of the coefficients of the state space representation, the MSE for the i^{th} variable can be written:

$$\text{MSE}(u_{i,t+H|t-1}) = \sum_{h=0}^{H} \mathbf{Q}_i' \mathbf{C} \mathbf{A}^h \mathbf{B} \mathbf{B}' \mathbf{A}^{h\prime} \mathbf{C}' \mathbf{Q}_i \tag{27}$$

The forecast error variance decomposition for each variable in $\mathbf{X}_t$ is defined as the ratio of the MSE conditional on each shock to the total MSE for that variable:

$$\Omega_{i,j}(H) = \frac{\sum_{h=0}^{H} \mathbf{Q}_i' \mathbf{C} \mathbf{A}^h \mathbf{B} \mathbf{D}_j \mathbf{D}_j' \mathbf{B}' \mathbf{A}^{h\prime} \mathbf{C}' \mathbf{Q}_i}{\sum_{h=0}^{H} \mathbf{Q}_i' \mathbf{C} \mathbf{A}^h \mathbf{B} \mathbf{B}' \mathbf{A}^{h\prime} \mathbf{C}' \mathbf{Q}_i} \tag{28}$$

The numerator in (28) is sum of squared impulse responses to shock j from horizons 0 up to H. The denominator is the MSE, which is equal to the sum of squared impulse responses from horizons 0 up to H, summed across all of the k shocks. In other words:

$$\Omega_{i,j}(H) = \frac{\sum_{h=0}^{H} \text{IRF}_{i,j}(h)^2}{\sum_{q=1}^{k} \sum_{h=0}^{H} \text{IRF}_{i,q}(h)^2} \tag{29}$$

I use these expressions to compute a variance decomposition of output growth, consumption growth, investment growth, and the growth rate of labor hours using the parameter values described in Table 2. This variance decomposition is shown in Table 3. As in Schmitt-Grohe and Uribe (2012), I collapse the variance decomposition into the variance share due to "non-news" shocks and news shocks – i.e. the "non-news share" sums the contributions to the forecast error variance for the seven unanticipated shocks, while the "news share" sums up the the variance shares due to the fourteen news shocks. Differently than Schmitt-Grohe and Uribe (2012), I show the variance decomposition at several different forecast horizons.

Focus first on the column of Table 3 labeled "∞," corresponding to the unconditional forecast error variance decomposition, which is the principal object of interest in Schmitt-Grohe and Uribe (2012). News shocks account for about 40 percent of the unconditional variance of output growth, while non-news shocks make up the remaining 60 percent. News shocks are slightly more important in accounting for consumption growth (48 percent unconditional variance share) and much more important for hours growth (76 percent), and somewhat less important for investment growth (33 percent). These numbers form the basis of Schmitt-Grohe and Uribe's (2012) conclusion that news shocks are a quantitatively important driver of the business cycle. Table A1 in the Appendix shows the unconditional variance share of these variables to each of the 21 shocks, rather than just summing up variance shares across different "classes" of shocks (e.g. non-news and news). The most important news shock is the four period anticipated wage markup shock, accounting for 17 percent of the unconditional variance share of output growth and 66 percent of the variance share of the growth rate of hours. The eight period anticipated investment shock is the next most important news shock, accounting for about 6 percent of the unconditional variance of output growth. News about government spending and the preference shock to the discount factor have mild quantitative contributions to output growth. News about neutral or investment-specific productivity account for essentially no variation in output growth.

[Table 3 about here]

Next, turn attention to the forecast horizon labeled "zero," which can be interpreted as the variance share "on impact" of shocks being realized. Here one sees that news shocks account for only 3 percent of the variance share of output growth. This variance share grows for several periods, reaching 11 percent at forecast horizon three. At forecast horizon four (shaded gray in the Table), the variance share of output growth due to news shocks jumps up by 13 percentage points to 24 percent. One observes a similar pattern for the other endogenous variables in the Table, with the jump for hours growth particularly dramatic (the variance share due to news shocks jumps from 10 percent at horizon three to 75 percent at horizon four). The variance share of output growth attributable to news shocks continues to grow at a modest pace from horizons five through seven, but again discreetly jumps up from 31 percent to 36 percent at forecast horizon eight (like the column for forecast horizon four, the column corresponding to horizon eight is also shaded gray in the Table). The variance shares are fairly stable after horizon eight, quickly settling down to the unconditional shares shown at horizon ∞.

Forecast horizons four and eight are special in this model (and therefore shaded gray) because these are the horizons in which the four and eight period ahead news shocks become "realized" in the sense of (in expectation) actually impacting the exogenous variables. The discreet jumps in the variance shares at these horizons suggests that the realization of news shocks likely plays a more important role in driving the endogenous variables than does "pure news" about future changes in exogenous variables.

3.2 Disentangling the Roles of "Pure" and "Realized" News

The forecast error variance decomposition conditional on forecast horizons presented in Table 3 is suggestive that the realization of news shocks might be driving most of the unconditional variance share attributable to news shocks in Schmitt-Grohe and Uribe (2012). In this subsection I propose a simple way to disentangle the role of "realized news" versus what I call "pure news" in constructing an alternative variance decomposition.

As noted above and shown in (29), the forecast error variance decomposition is based on impulse response functions. As such, I propose disentangling the roles of "pure" and "realized" news by defining auxiliary impulse response functions and using those to compute an alternative variance decomposition. In particular, I define the impulse response of an endogenous variable to "pure news" as being equal to the impulse response to a news shock at horizons prior to the realization of that news, and zero at horizons thereafter. In contrast, the "realized news" impulse response function takes on values of zero prior to the realization of the shock, and takes on the values of the impulse response to a news shock at horizons thereafter. Formally, suppose that shock j is a news shock with an anticipation horizon of m quarters. The auxiliary impulse response functions, $\text{IRF}^p_{i,j}(H)$ and $\text{IRF}^r_{i,j}(H)$ for pure and realized news, respectively, are:

$$\text{IRF}^p_{i,j}(H) = \begin{cases} \text{IRF}_{i,j}(H) & \text{if } H < m \\ 0 & H \geq m \end{cases}, \qquad \text{IRF}^r_{i,j}(H) = \begin{cases} 0 & \text{if } H < m \\ \text{IRF}_{i,j}(H) & \text{if } H \geq m \end{cases} \tag{30}$$

The auxiliary impulse response functions sum to the actual impulse response functions at all forecast horizons: $\text{IRF}^p_{i,j}(H) + \text{IRF}^r_{i,j}(H) = \text{IRF}_{i,j}(H)$. Because one of the auxiliary impulse responses is equal to zero at all horizons, it is also the case that the sum of squared auxiliary responses equals the squared actual impulse response at all forecast horizons: $\text{IRF}^p_{i,j}(H)^2 + \text{IRF}^r_{i,j}(H)^2 = \text{IRF}_{i,j}(H)^2$. Because of this fact, the MSE of a variable is unaffected whether one computes it using the actual or auxiliary impulse response functions. Using the auxiliary impulse response functions, I can then modify (29) to partition the variance share due to pure and realized news as:

$$\Omega^p_{i,j}(H) = \frac{\sum_{h=0}^{H} \text{IRF}^p_{i,j}(h)^2}{\sum_{q=1}^{k}\sum_{h=0}^{H} \text{IRF}_{i,q}(h)^2} \qquad \Omega^r_{i,j}(H) = \frac{\sum_{h=0}^{H} \text{IRF}^r_{i,j}(h)^2}{\sum_{q=1}^{k}\sum_{h=0}^{H} \text{IRF}_{i,q}(h)^2} \tag{31}$$

From (30) and (31), it is the case that the variance shares due to pure and realized news sum up to the variance share to the news shock at all forecast horizons: $\Omega^p_{i,j}(H) + \Omega^r_{i,j}(H) = \Omega_{i,j}(H)$. Table 4 shows the variance decomposition by forecast horizon, partitioning the decomposition into pure and realized news.[8] The Table is structured similarly to Table 3, but splits the news shock share into "pure news" and "realized news." In an unconditional sense (i.e. at horizon ∞), the "pure news" component of news shocks accounts for only 10 percent of the variance share of output, with "realized news" accounting for the remaining 30 percent. In other words, "realized news" is three times more important than "pure news" in accounting for movements in output growth. For consumption and hours growth, the "pure news" contribution is even weaker, with "pure news" only accounting for 3 percent of the unconditional variance shares of each (in contrast, 45 and 73 percent of the variance shares of consumption and hours, respectively, are driven by realized news). Interestingly, the endogenous variable for which "pure news" is unconditionally most important is investment, which is the variable with the smallest variance share driven by news shocks in Table 3. Focusing on forecast horizons other than ∞ reveals that "pure news" never accounts for more than 12 percent of the variance share of output and suggests that the discreet jumps in the variance shares due to news at horizons four and eight highlighted in Table 3 are driven by the realization of news.[9]

[Table 4 about here]

It is also possible to construct a variance decomposition for the log level of output as opposed to its growth rate; this is done by cumulating the growth rate impulse responses into levels and proceeding with the forecast error variance decomposition in the usual way. Given the non-stationarity in the model, some care must be taken in interpreting the variance decomposition in levels, in particular as the forecast horizon tends to infinity. This is because only shocks which have permanent effects can account for any of the unconditional variance of the level of output in the very long run. Table 5 shows the fraction of the overall forecast error variance of the level of output attributable to news shocks by forecast horizon, along with the same decomposition into "pure news" and "realized news." At business cycle frequencies (i.e. at forecast horizons between 8 and 32 quarters) news shocks account for about 40 percent of the variance of the level of output, very much in line with the decomposition of output growth in Table 3. "Pure news" only explains between 1 and 5 percentage points of the total news shock share at these frequencies, with "realized news" accounting for the bulk of the overall news shock share.[10]

[8] In Table 4, sometimes the shares due to "pure" and "realized" news do not add up to the overall news share due to rounding to the nearest integer.

[9] Table A2 in the Appendix shows the decomposition into "pure news" and "realized news" by type of exogenous variable being shocked. "Pure news" accounts for about half of the unconditional variance share due to investment news shocks and about one-third of the unconditional variance share due to wage markup news shocks. "Pure news" is irrelevant for the other exogenous driving forces. Table A3 breaks down the contributions due to pure and realized news shocks across four and eight period anticipated shocks, rather than bunching the different anticipation horizons together. There is not much difference in terms of the contributions of "pure" and "realized" news across the four and eight period anticipation horizons.

[10] The fraction of the unconditional variance share of the level of output (i.e. at $H \to \infty$) attributable to news shocks is only 17 percent, which is considerably smaller than the unconditional news share in Table 3. This is because the only two news shocks which can account for any of the long run variance of the level of output are the shocks which have permanent effects – news shocks to non-stationary neutral productivity and investment-specific technology. These shocks are not estimated to be particularly important, as can be seen in Table A1 of the Appendix.

[Table 5 about here]

3.3 Alternative Approach to Disentangling "Pure" and "Realized" News

The approach outlined above to disentangling the roles of "pure" and "realized" news is conceptually straightforward and fits well within the traditional definition of a forecast error variance decomposition. A potential drawback of this approach, however, is that it implicitly attributes all of the movements in endogenous variables subsequent to the anticipation horizon to the realization of the exogenous variable. Because Schmitt-Grohe and Uribe's (2012) model features endogenous state variables, the responses of endogenous variables after the anticipation horizon will not be identical to the responses to an unanticipated shock of the same magnitude, which is different than the simple model laid out in Section 2. For this reason my approach to decomposing the effects of news shocks into "pure" and "realized" news may understate the contribution of pure news.

In this subsection I consider an alternative way to disentangle the importance of "pure" and "realized" news that is similar to a counterfactual thought experiment considered in Barsky, Basu, and Lee (2015). I compute impulse responses to "unrealized" news shocks and compare those to the responses to a news shock, where I interpret the difference between these responses as attributable to the realization of an anticipated change in an exogenous variable. In particular, I counteract the news shock with an unanticipated shock at the anticipation horizon so as to leave the relevant exogenous variable unchanged.[11] Offsetting an anticipated change in an exogenous variable with an unanticipated shock at the anticipation horizon is also the same thought experiment considered in the "boom-bust" exercises in Christiano, Ilut, Motto, and Rostagno (2008).

Formally, suppose that the news shock is indexed by j. Let the corresponding unanticipated shock be indexed by f and the relevant exogenous variable be indexed by b. The impulse response function of variable i to an unrealized news shock is then defined as:

$$\mathrm{IRF}^{ur}_{i,j}(H) = \begin{cases} \mathrm{IRF}_{i,j}(H) & \text{if } H < m \\ \mathrm{IRF}_{i,j}(H) + \mathrm{IRF}_{i,f}(H-m) & H \geq m \end{cases} \tag{32}$$

The magnitude of the unanticipated shock is chosen such that $\mathrm{IRF}_{b,j}(H) + \mathrm{IRF}_{b,f}(H-m) = 0$ for $H \geq m$ – in other words, such that the relevant exogenous variable does not change ex-post. Importantly, in this thought experiment that the relevant exogenous variable does not change ex-post is not expected by agents ex-ante. One could model unrealized news shocks formally as noise shocks, as in Barsky and Sims (2012) or Blanchard, L'Hullier, and Lorenzoni (2013). In such a setup, agents observe noisy signals about the future value of some relevant exogenous variable. They are unable, ex-ante, to distinguish between noise and actual news. One could envision isolating the role of "pure news" by focusing on the contribution of noise shocks to the evolution of macroeconomic

[11] This is admittedly somewhat arbitrary, as there is in general no unique way to construct the impulse response function to an unrealized news shock because there are multiple different ways for a news shock to go unrealized. For example, an eight period news shock could go unrealized because of an offsetting unanticipated shock in the period where the news shock was to be realized or an offsetting four period news shock four periods subsequent to agents observing the eight period news shock.

variables. This would entail a quite different setup than the model laid out in Schmitt-Grohe and Uribe (2012) and much of the existing news shock literature. In particular, agents' responses to signals in a noise shock setup are affected by the variance of noise relative to the variance of news.

Continuing with the setup where the offsetting level shock at the anticipation horizon is fully unanticipated by agents, the impulse response function due to the realization of a change in the relevant exogenous variable can be defined as:

$$\mathrm{IRF}^{re}_{i,j}(H) = \mathrm{IRF}_{i,j}(H) - \mathrm{IRF}^{ur}_{i,j}(H) \tag{33}$$

Combining (33) with (32), the impulse response due to the realization of a news shock is then:

$$\mathrm{IRF}^{re}_{i,j}(H) = \begin{cases} 0 & \text{if } H < m \\ -\mathrm{IRF}_{i,f}(H-m) & H \geq m \end{cases} \tag{34}$$

In other words, the impulse response to a realized news shock is equal to zero up until the anticipation horizon, and equals the negative of the impulse response to an unanticipated level shock thereafter. Figures 1 and 2 plot impulse responses of the level of output to either 4 or 8 period news shocks in the solid lines, and to unrealized news shocks in the dashed lines. By construction, the impulse response functions are identical up until the anticipation horizon (either horizon 4 or 8). The dashed lines plot the hypothetical path of output if an unanticipated shock were to completely counteract the news shock at the anticipation horizon so that the exogenous variable in question would remain unchanged. Though I focus on the growth rate of output in most of this paper so to facilitate comparison with Schmitt-Grohe and Uribe (2012), this alternative counterfactual decomposition based on Barsky, Basu, and Lee (2015) is much more natural in levels, and so I focus on output levels in this part of the paper.[12]

[Figure 1 about here]

[Figure 2 about here]

Unlike the decomposition described in Section 3.2, it is not straightforward to use the impulse responses to unrealized and realized news shocks to decompose the variance decomposition into shares due to pure and realized news. While it is the case the auxiliary impulse response functions to realized and unrealized news sum to the conventional impulse response function – i.e. that $\mathrm{IRF}^{re}_{i,j}(H) + \mathrm{IRF}^{ur}_{i,j}(H) = \mathrm{IRF}_{i,j}(H)$ – the sum of squared auxiliary impulse responses does not sum to the square of the conventional response to a news shock, i.e. $\mathrm{IRF}^{re}_{i,j}(H)^2 + \mathrm{IRF}^{ur}_{i,j}(H)^2 \neq$

[12] The reason why the decomposition in growth rates is potentially misleading is because the output growth responses to unrealized news shocks often display large discreet "sign flips" in the period of anticipation (e.g. the output growth response to an unrealized news shock about productivity flips from positive to sharply negative at the anticipation horizon as the level of output reverts back to zero following the non-realization of the anticipated change in productivity). This can be clearly seen in the growth rate impulse response figures shown in the Appendix, Figures A1 and A2. Because a variance decomposition is based on squared impulse responses, it will not account for this "sign flip" and will tend to attribute significant volatility to unrealized news shocks in the period of anticipation.

$\mathrm{IRF}_{i,j}(H)^2$. This is different than the decomposition proposed in Section 3.2, and arises because the unrealized response will not, in general, equal zero after the anticipation horizon.

This caveat aside, I nevertheless proceed with forming an alternative variance decomposition based on the auxiliary impulse responses to unrealized and realized news shocks. In particular, define:

$$\Omega_{i,j}^{ur}(H) = \frac{\sum_{h=0}^{H} \mathrm{IRF}_{i,j}^{ur}(h)^2}{\sum_{q=1}^{k}\sum_{h=0}^{H} \mathrm{IRF}_{i,q}(h)^2} \qquad \Omega_{i,j}^{re}(H) = \frac{\sum_{h=0}^{H} \mathrm{IRF}_{i,j}^{re}(h)^2}{\sum_{q=1}^{k}\sum_{h=0}^{H} \mathrm{IRF}_{i,q}(h)^2} \tag{35}$$

In words, the variance share attributed to unrealized news is defined as the ratio of the sum of squares of the responses to an unrealized news shock divided by the total mean squared error, while the variance share due to the realization of news is defined as the ratio of the sum of squares of the responses to a realized news shock divided by the total mean squared error. While it is straightforward to compute the expressions in (35), there does not exist a clear mapping back into a conventional variance decomposition. Because the squared auxiliary impulse responses functions do not sum to the squared conventional impulse response, the variance shares due to unrealized and realized news shocks will not sum to the total news shock share, as was the case using the decomposition in the previous section.

[Table 6 about here]

Table 6 decomposes the variance decomposition of the level of output due to news shocks into unrealized and realized news using (35). The row labeled "Unrealized News" shows the total variance of the level of output due to unrealized news shocks by horizon; the row labeled "Realized News" shows the total variance of the level of output attributable to the realization of anticipated changes in exogenous variables. The top row, labeled "News," shows the variance share of output accounted for by all news shocks in the conventional variance decomposition. As noted above, the variance shares due to unrealized and realized news do not sum up to the total news shock share here. Nevertheless, this decomposition conveys a similar message to what is shown in Table 5 using the decomposition into pure and realized news from the previous section. Unrealized news explains between 2 and 9 percent of the variance of output at business cycle frequencies (i.e. horizons between 8 and 32 quarters), whereas realized news accounts for between 20 and 40 percent of the variance of the level of output. The maximum variance share of output due to unrealized news is 12 percent at forecast horizon four. While the contribution of pure news is naturally higher under this alternative approach than in my baseline exercises, the bottom line is the same: the large majority of the movements in output due to news shocks comes from the realization of news, not news about yet unrealized changes in exogenous variables.

4 Concluding Thoughts

The objective of this paper has been to point out a conceptual difficulty in the use of a conventional forecast error variance decomposition to asses the quantitative importance of news shocks. I present a simple model in which news about future changes in exogenous productivity is irrelevant for understanding output dynamics, but in which a traditional unconditional variance decomposition (or more generally a variance decomposition at long forecast horizons) may nevertheless attribute a large share of output movements to news shocks. I then study the quantitative relevance of news shocks in the model of Schmitt-Grohe and Uribe (2012). While an unconditional variance decomposition suggests that news shocks account for 40 percent of the variance of output growth, I show that the majority of this is driven by realized news, not news about yet unrealized changes in fundamentals. News about changes in exogenous variables that have not yet occurred only explains about 10 percent of the unconditional variance of output growth.

The purpose of this paper is nevertheless not to cast doubt on the quantitative relevance of news shocks per se, but rather to point out that researchers must be careful in interpreting a variance decomposition in a model with news shocks. News is really only news prior to the expected realization of that news, after which point a news shock is not conceptually all that different from a traditional unanticipated shock. In a DSGE model where the anticipation horizon of news shocks is known, the decomposition into "pure news" and "realized news" is a simple way to isolate the role of genuine news about future fundamentals that has yet to materialize. When the anticipation horizon of a news shock is not known or is difficult to pinpoint (such as would be the case when identifying news shocks in a VAR, for example), a forecast error variance decomposition that is conditional on forecast horizons is likely to be much more informative of the role of actual news than is an unconditional variance decomposition.

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Table 1: Forecast Error Variance Decomposition of log Output in Simple Model

	Forecast Horizon											
	0	1	2	3	4	5	6	7	8	16	32	∞
Unanticipated Shock	100	100	100	100	77	68	62	59	57	51	50	50
News Shock	0	0	0	0	23	32	38	41	43	49	50	50

Note: This table shows the forecast error variance decomposition of log output in the simple model of Section 2 by forecast horizon, where the forecast error is defined as $\ln Y_{t+H} - E_{t-1} \ln Y_{t+H}$, for $H \geq 0$. The numbers in the table are expressed as percentages of the total forecast error variance of log output and are rounded to the nearest integer. These numbers are generated assuming that $\sigma_0 = \sigma_4 = 1$ and $\rho_z = 0.90$. The column corresponding to forecast horizon 4 is shaded gray; this horizon corresponds to the period in which the news shock becomes realized.

Table 2: Parameter Values for Schmitt-Grohe and Uribe (2012) Model

Parameter	Value	Description
β	0.99	Discount factor
σ	1	Elasticity of intertemporal substitution
α_k	0.225	Capital share
α_h	0.675	Labor share
μ^x	1.0032	SS growth neutral prod
μ^a	0.9957	SS growth relative price of investment
g	0.20	SS government spending share
μ	0.15	SS wage markup
u	1	SS utilization
h	0.20	SS labor
L	1	Fixed factor of production
δ_0	0.025	SS depreciation
δ_2	0.0154	Utilization elasticity
θ	4.78	Labor utility curvature
b	0.90	Consumption habit
γ	0.0025	Utility curvature
κ	9.11	Investment adjustment cost
ρ_{xg}	0.69	AR government spending trend
ρ_{μ^x}	0.35	AR non-stationary neutral productivity
ρ_{μ^a}	0.47	AR non-stationary investment-specific productivity
ρ_z	0.90	AR stationary neutral productivity
ρ_{z^I}	0.45	AR stationary investment
ρ_g	0.95	AR government spending
ρ_μ	0.96	AR wage markup
ρ_ζ	0.18	AR preference shock
$\sigma^0_{\mu^x}, \sigma^4_{\mu^x}, \sigma^8_{\mu^x}$	0.39, 0.10, 0.11	SD non-stationary neutral productivity shocks
$\sigma^0_{\mu^a}, \sigma^4_{\mu^a}, \sigma^8_{\mu^a}$	0.20, 0.16, 0.16	SD non-stationary investment-specific productivity shocks
$\sigma^0_z, \sigma^4_z, \sigma^8_z$	0.65, 0.13, 0.11	SD stationary neutral productivity shocks
$\sigma^0_{z^I}, \sigma^4_{z^I}, \sigma^8_{z^I}$	11.72, 2.45, 5.69	SD stationary investment shocks
$\sigma^0_\zeta, \sigma^4_\zeta, \sigma^8_\zeta$	3.85, 2.15, 2.28	SD preference shocks
$\sigma^0_g, \sigma^4_g, \sigma^8_g$	0.59, 0.56, 0.43	SD government spending shocks
$\sigma^0_\mu, \sigma^4_\mu, \sigma^8_\mu$	0.55, 4.65, 0.81	SD wage markup shocks

Note: This table shows the parameter values used in the quantitative simulations of Schmitt-Grohe and Uribe's (2012) model. The right hand column provides descriptions of the parameters. These are taken directly from Schmitt-Grohe and Uribe (2012). Calibrated parameters include β, σ, α_k, α_h, μ^x, μ^a, g, and δ_0. Steady state utilization and labor hours, u and h, are calibrated to 1 and 0.2, respectively, implying values of δ_1 and ψ. The value of the fixed factor of production, L, is set to 1. The parameters δ_2, θ, b, γ, κ, as well the parameters related to the stochastic processes of the shocks, are the mean values of the posterior distribution (downloaded from the *Econometrica* website). The rows labeled $\sigma^0_x, \sigma^4_x, \sigma^8_x$ show, respectively, the standard deviations of the unanticipated, 4 period news, and 8 period news shocks for exogenous processes $x = \{\mu^x, \mu^a, z, z^I, \zeta, g, \mu\}$. The estimated model from the Schmitt-Grohe and Uribe (2012) paper also includes a measurement error shock for observed output growth, but this is not relevant for the construction of the variance decompositions or impulse response functions.

Table 3: Variance Share due to News and Non-News Shocks by Forecast Horizon

		Forecast Horizon											
Variable		0	1	2	3	4	5	6	7	8	16	32	∞
dY													
	Non-News	97	95	92	89	76	73	71	69	64	62	61	61
	News	3	5	8	11	24	27	29	31	36	38	39	39
dC													
	Non-News	98	97	96	94	71	68	66	64	54	53	53	52
	News	2	3	4	6	29	32	34	36	46	47	47	48
dI													
	Non-News	97	95	92	88	84	81	80	77	74	69	67	67
	News	3	5	8	12	16	19	20	23	26	31	33	33
dh													
	Non-News	96	95	93	90	25	26	26	26	24	24	24	24
	News	4	5	7	10	75	74	74	74	76	76	76	76

Note: This table shows the fraction of the forecast error variance due to non-news shocks and news shocks at different forecast horizons for output growth, consumption growth, investment growth, and hours growth in the Schmitt-Grohe and Uribe (2012) model. Rows labeled "Non-News" sum the variance shares due to each of the seven unanticipated shocks, while rows labeled "News" sum the variance shares due to the 14 news shocks. Numbers are rounded to the nearest integer. The column labeled "∞" corresponds to the unconditional variance share. Columns corresponding to forecast horizons 4 and 8 are shaded gray; these horizons correspond to the periods in which the 4 and 8 period news shocks become realized, respectively.

Table 4: Variance Share due to News, Pure News, and Realized News by Horizon

Variable		Forecast Horizon 0	1	2	3	4	5	6	7	8	16	32	∞
dY													
	News	3	5	8	11	24	27	29	31	36	38	39	39
	Pure News	3	5	8	11	10	10	10	12	11	10	10	10
	Realized News	0	0	0	0	15	17	19	19	26	28	29	29
dC													
	News	1	3	4	6	29	32	34	36	46	47	47	48
	Pure News	1	3	4	6	5	5	5	5	4	4	4	3
	Realized News	0	0	0	0	25	28	30	31	42	43	44	45
dI													
	News	3	5	8	12	16	19	20	23	26	31	33	33
	Pure News	3	5	8	12	12	13	14	17	16	14	14	13
	Realized News	0	0	0	0	5	6	6	6	10	17	19	19
dh													
	News	4	5	7	10	75	74	74	74	76	76	76	76
	Pure News	4	5	7	10	3	3	3	4	4	3	3	3
	Realized News	0	0	0	0	72	71	71	71	72	72	73	73

Note: This table shows the fraction of the total forecast error variance due to news shocks in the Schmitt-Grohe and Uribe (2012) model, along with the decomposition into the variance shares due to "pure news" and "realized news," respectively. Numbers are rounded to the nearest integer; the "pure news" and "realized news" shares should sum to the total news share, but in some cases may not due to rounding. The column labeled "∞" corresponds to the unconditional variance share. Columns corresponding to forecast horizons 4 and 8 are shaded gray; these horizons correspond to the periods in which the 4 and 8 period news shocks become realized, respectively.

Table 5: Variance Share of Level of Output due to News, Pure News, and Realized News by Horizon

		Forecast Horizon 0	1	2	3	4	5	6	7	8	16	32	∞
Output Level													
	News	3	5	8	12	19	24	29	33	37	46	43	17
	Pure News	3	5	8	12	9	7	6	6	5	2	1	0
	Realized News	0	0	0	0	10	17	23	27	31	44	42	17

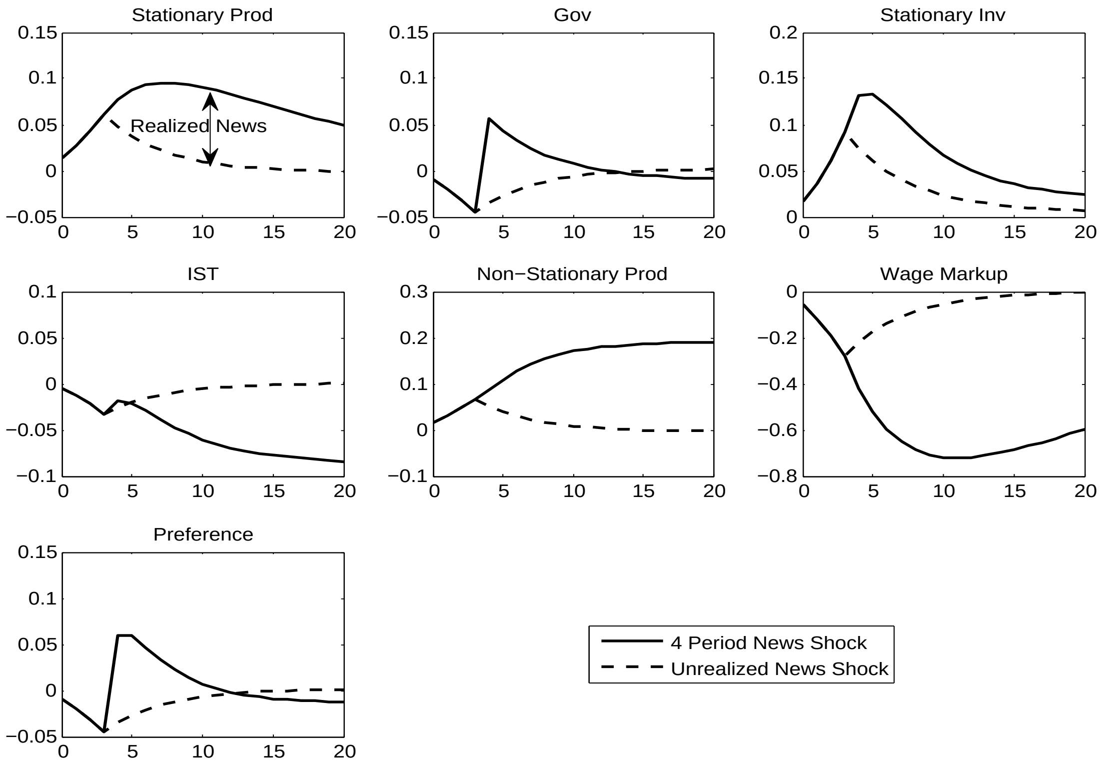
Note: This table shows the fraction of the total forecast error variance of the log level of output due to news shocks in the Schmitt-Grohe and Uribe (2012) model, along with the decomposition into the variance shares due to "pure news" and "realized news," respectively. Numbers are rounded to the nearest integer; the "pure news" and "realized news" shares should sum to the total news share, but in some cases may not due to rounding. The column labeled "∞" corresponds to the unconditional variance share. Columns corresponding to forecast horizons 4 and 8 are shaded gray; these horizons correspond to the periods in which the 4 and 8 period news shocks become realized, respectively.

Table 6: Variance Share of Level of Output due to News, Pure News, and Realized News by Horizon, Alternative Decomposition

		Forecast Horizon											
		0	1	2	3	4	5	6	7	8	16	32	∞
Output Level													
	News	3	5	8	12	19	24	29	33	37	46	43	17
	Unrealized News	3	5	8	12	12	11	10	10	9	4	2	0
	Realized News	0	0	0	0	3	7	12	16	20	37	39	17

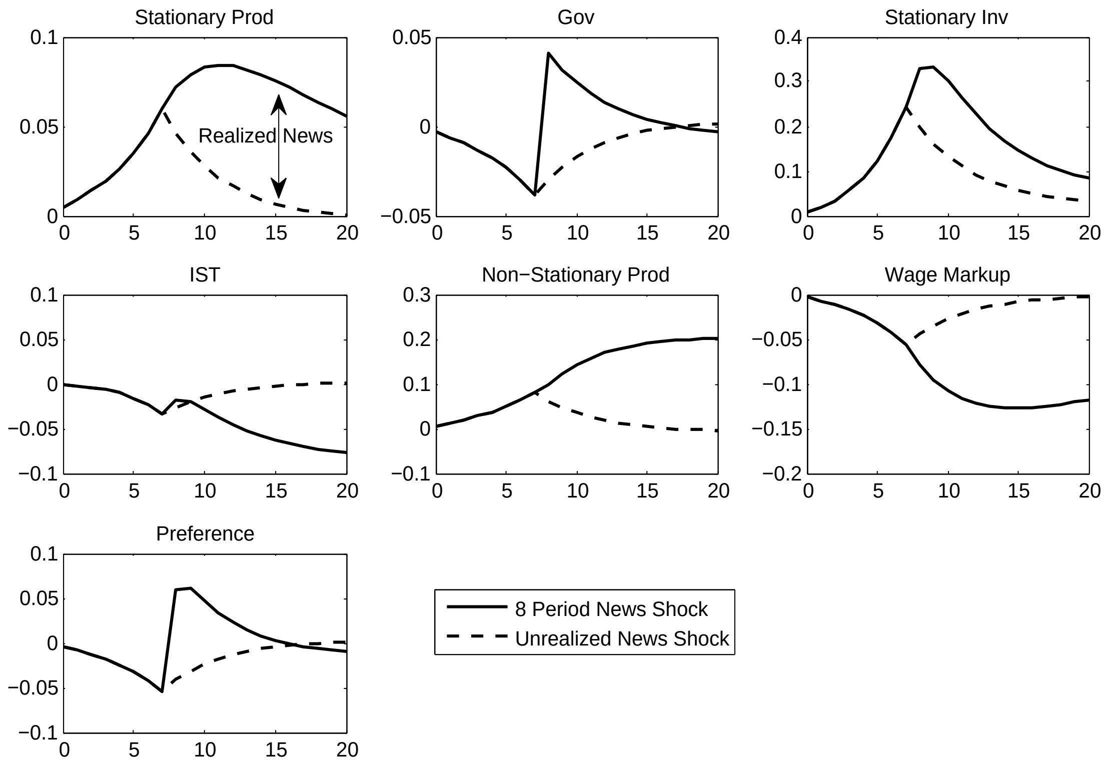
Note: This table shows the fraction of the total forecast error variance of the log level of output due to news shocks in the Schmitt-Grohe and Uribe (2012) model, along with the decomposition into the variance shares due to "pure news" and "realized news," respectively, using the alternative decomposition outlined in Section 3.3. In particular, the "pure news" share is based on the impulse responses to unrealized news shocks, while the "realized news" share is based on the difference between the impulse responses to a news shock and the impulse response to an unrealized news shock. Numbers are rounded to the nearest integer. As discussed in the text, the variance share due to pure and realized news will in general not sum to the overall news share in this exercise. The column labeled "∞" corresponds to the unconditional variance share. Columns corresponding to forecast horizons 4 and 8 are shaded gray; these horizons correspond to the periods in which the 4 and 8 period news shocks become realized, respectively.

Figure 1: Output Level Responses to 4 Period News Shocks, SGU (2012) Model



Note: These figures plot the impulse responses of the log level of output to each of the seven four period news shocks (solid lines) in the Schmitt-Grohe and Uribe (2012) model, along with hypothetical impulse response functions to "unrealized news shocks" (dashed lines). The unrealized news shocks are constructed by counteracting the news shock in the period of its realization with an offsetting unanticipated shock so as to leave the exogenous variable in question unchanged. The vertical difference between the solid and dashed lines can be interpreted as the portion of the news shock impulse response attributable to the realization of a change in the relevant exogenous variable.

Figure 2: Output Level Responses to 8 Period News Shocks, SGU (2012) Model



Note: These figures plot the impulse responses of the log level of output to each of the seven eight period news shocks (solid lines) in the Schmitt-Grohe and Uribe (2012) model, along with hypothetical impulse response functions to "unrealized news shocks" (dashed lines). The unrealized news shocks are constructed by counteracting the news shock in the period of its realization with an offsetting unanticipated shock so as to leave the exogenous variable in question unchanged. The vertical difference between the solid and dashed lines can be interpreted as the portion of the news shock impulse response attributable to the realization of a change in the relevant exogenous variable.

A Appendix

This Appendix provides some more detail on the Schmitt-Grohe and Uribe (2012) model. The full set of equilibrium conditions for the endogenous variables can be written:

$$V_t = C_t - bC_{t-1} - \psi h_t^{\theta} S_t \tag{A.1}$$

$$S_t = (C_t - bC_{t-1})^{\gamma} S_{t-1}^{1-\gamma} \tag{A.2}$$

$$\Lambda_t = \zeta_t V_t^{-\sigma} - \gamma \Pi_t \frac{S_t}{C_t - bC_{t-1}} - b\beta E_t \left[\zeta_{t+1} V_{t+1}^{-\sigma} - \gamma \Pi_{t+1} \frac{S_{t+1}}{C_{t+1} - bC_t} \right] \tag{A.3}$$

$$\Pi_t = \zeta_t V_t^{-\sigma} \psi h_t^{\theta} + \beta(1-\gamma) E_t \Pi_{t+1} \frac{S_{t+1}}{S_t} \tag{A.4}$$

$$\theta \psi \zeta_t V_t^{-\sigma} h_t^{\theta-1} S_t = \Lambda_t \frac{W_t}{1+\mu_t} \tag{A.5}$$

$$R_t = Q_t \delta'(u_t) \tag{A.6}$$

$$Q_t \Lambda_t = \beta E_t \Lambda_{t+1} \left[R_{t+1} u_{t+1} + Q_{t+1}(1 - \delta(u_{t+1})) \right] \tag{A.7}$$

$$\begin{aligned} A_t \Lambda_t = Q_t \Lambda_t z_t^I & \left[1 - \frac{\kappa}{2} \left(\frac{I_t}{I_{t-1}} - \mu^I \right)^2 - \kappa \left(\frac{I_t}{I_{t-1}} - \mu^I \right) \frac{I_t}{I_{t-1}} \right] \\ & + \beta E_t Q_{t+1} \Lambda_{t+1} z_{t+1}^I \kappa \left(\frac{I_{t+1}}{I_t} - \mu^I \right) \left(\frac{I_{t+1}}{I_t} \right)^2 \end{aligned} \tag{A.8}$$

$$W_t = \alpha_h z_t \left(u_t K_t \right)^{\alpha_k} X_t^{\alpha_h} \left(X_t L \right)^{1-\alpha_k-\alpha_h} h_t^{\alpha_h - 1} \tag{A.9}$$

$$R_t = \alpha_k z_t \left(u_t K_t \right)^{\alpha_k - 1} \left(X_t h_t \right)^{\alpha_h} \left(X_t L \right)^{1-\alpha_k-\alpha_h} \tag{A.10}$$

$$Y_t = z_t \left(u_t K_t \right)^{\alpha_k} \left(X_t h_t \right)^{\alpha_h} \left(X_t L \right)^{1-\alpha_k-\alpha_h} \tag{A.11}$$

$$K_{t+1} = z_t^I I_t \left[1 - \frac{\kappa}{2} \left(\frac{I_t}{I_{t-1}} - \mu^I \right)^2 \right] + (1 - \delta(u_t)) K_t \tag{A.12}$$

$$C_t + A_t I_t + G_t = Y_t \tag{A.13}$$

$$\delta(u_t) = \delta_0 + \delta_1(u_t - 1) + \frac{\delta_2}{2}(u_t - 1)^2 \tag{A.14}$$

The variables have the following interpretations. V_t measures flow utility, C_t is consumption, h_t is labor hours, and S_t is an auxiliary state variable that allows for differential wealth effects on labor supply. Λ_t is the Lagrange multiplier on the household's flow budget constraint, Π_t is the multiplier on the law of motion for S_t, and $Q_t\Lambda_t$ is the multiplier on the accumulation equation (so that Q_t has the interpretation as the marginal value of an additional unit of installed capital expressed in consumption units). W_t is the wage and r_t the rental rate on capital services. The exogenous variable μ_t is an exogenous time-varying wage markup and ζ_t is a shock to the rate of time preference. u_t the level of capital utilization, normalized to equal one in the non-stochastic steady state. I_t is investment, A_t is an investment-specific productivity shock, and z_t^I is an exogenous shock to the marginal efficiency of investment. Y_t is output, K_t physical capital, and G_t government spending. The depreciation rate on capital is a time-varying function of utilization, $\delta(u_t)$. X_t is a non-stationary neutral productivity shock and z_t is a stationary neutral productivity shock. There are fourteen equations in fourteen endogenous variables – $\{\Lambda_t, \Pi_t, Q_t, V_t, S_t, C_t, h_t, I_t, u_t, K_t, Y_t, w_t, r_t, \delta(u_t)\}$. The current level of capital is predetermined. The exogenous variables are $\left\{A_t, X_t, z_t, z_t^I, \zeta_t, \mu_t, G_t\right\}$.

The equilibrium conditions have the following interpretations. (A.1) defines V_t, which is the argument in the flow utility function $U(V_t) = \frac{V_t^{1-\sigma}-1}{1-\sigma}$. Equation (A.2) defines an auxiliary state variable, S_t, which enters the argument of flow utility. (A.3) is the first order condition of the household problem with respect to C_t, while (A.4) is the first order condition with respect to S_t. The optimality condition with respect to labor is given by (A.5), and (A.6) is the first order condition with respect to utilization. (A.7) is the optimality condition associated with the choice of one period ahead capital, K_{t+1}, and defines a forward-looking difference equation in Q_t, the marginal value of an extra unit of installed capital denominated in units of current consumption. The first order condition with respect to investment is given by (A.8). Expressions (A.9) and (A.10) implicitly define demand curves for labor and capital services from the firm, respectively. The production function is given by (A.11). (A.12) is the law of motion for physical capital and (A.13) is the aggregate resource constraint. The expression for the time-varying depreciation rate on physical capital is given by (A.14).

The model features two sources of non-stationary: growth in labor-augmenting productivity, X_t, and growth in investment-specific productivity, A_t. Let $\mu_t^x = \frac{X_t}{X_{t-1}}$ and $\mu_t^a = \frac{A_t}{A_{t-1}}$ be the gross growth rates of these two variables, both assumed stationary. Most of the other endogenous variables must be transformed to be stationary. Assume that $\sigma = 1$. Let $X_t^Y = X_t A_t^{\frac{\alpha_k}{\alpha_k - 1}}$, $X_t^K = X_t A_t^{\frac{1}{\alpha_k - 1}}$, and $X_t^G = \left(X_{t-1}^G\right)^{\rho_{xg}} \left(X_{t-1}^Y\right)^{1-\rho_{xg}}$. The following variables are stationary: $y_t = \frac{Y_t}{X_t^Y}$, $c_t = \frac{C_t}{X_t^Y}$, $w_t = \frac{W_t}{X_t^Y}$, $s_t = \frac{S_t}{X_t^Y}$, $v_t = \frac{V_t}{X_t^Y}$, $r_t = \frac{R_t}{A_t}$, $k_t = \frac{K_t}{X_{t-1}^K}$, $i_t = \frac{I_t}{X_t^K}$, $\lambda_t = X_t^Y \Lambda_t$, $q_t = \frac{Q_t}{A_t}$, and $g_t = \frac{G_t}{X_t^G}$. Capital utilization, u_t, and hours, h_t, are stationary without need for transformation. The stationarity-inducing transformation for G_t is written in such a way as to be consistent with balanced growth (i.e. in the steady state government spending and output grow at the same rate), but the parameter $0 < \rho_{xg} < 1$ governs the speed at which government spending changes in response to shocks to the trend growth rate of output. The transformed variable, g_t, can be thought of as representing an exogenous but stationary deviation from the common trend between output and government spending.

The equilibrium conditions above can be transformed so that the model conditions are stationary. The objects of interest in the variance decompositions are not stationary transformations of the endogenous variables but rather growth rates of the endogenous variables. These can be constructed by manipulating the stationary transformations of the relevant variables. For output, for example, we would have $\mu_t^y = \frac{Y_t}{Y_{t-1}} = \frac{y_t}{y_{t-1}} \frac{X_t^Y}{X_{t-1}^Y} = \frac{y_t}{y_{t-1}} \mu_t^x \left(\mu_t^a\right)^{\frac{\alpha_k}{\alpha_k - 1}}$. The exogenous processes can be written as:

$$\ln\left(\mu_t^x/\mu^x\right) = \rho_{\mu^x}\ln\left(\mu_t^x/\mu^x\right) + \varepsilon_{\mu^x,t} \tag{A.15}$$

$$\ln\left(\mu_t^a/\mu^a\right) = \rho_{\mu^a}\ln\left(\mu_t^a/\mu^a\right) + \varepsilon_{\mu^a,t} \tag{A.16}$$

$$\ln\left(z_t/z\right) = \rho_z\ln\left(z_t/z\right) + \varepsilon_{z,t} \tag{A.17}$$

$$\ln\left(z_t^I/z^I\right) = \rho_{z^I}\ln\left(z_t^I/z^I\right) + \varepsilon_{z^I,t} \tag{A.18}$$

$$\ln\left(\mu_t/\mu\right) = \rho_\mu\ln\left(\mu_t/\mu\right) + \varepsilon_{\mu,t} \tag{A.19}$$

$$\ln\left(\zeta_t/\zeta\right) = \rho_\zeta\ln\left(\zeta_t/\zeta\right) + \varepsilon_{\zeta,t} \tag{A.20}$$

$$\ln\left(g_t/g\right) = \rho_g\ln\left(g_t/g\right) + \varepsilon_{g,t} \tag{A.21}$$

Variables without time subscripts denote non-stochastic steady state values. In the quantitative applications, the non-stochastic steady state values of stationary neutral productivity, the investment shock, and the discount factor shock are normalized to unity; i.e. $z = z^I = \zeta = 1$. Each of the innovations in these exogenous processes follows (22) from the main text, with an unanticipated shock, a four period news shock, and an eight period news shock. This leaves a total of 21 shocks.

Table A1 presents an unconditional variance decomposition (i.e. as the forecast horizon $H \to \infty$) for several endogenous variables for each of the 21 shocks. Rows labeled "0," "4," and "8" refer to the unanticipated, 4 period news, and 8 period news shocks, respectively. Summing the variance shares by endogenous variable across shocks in rows labeled "0" re-produces the "non-news" share in Table 3; summing variance shares by endogenous variable across shocks in rows labeled "4" and "8" reproduces the "news share" in Table 3. For example, the unanticipated stationary productivity, non-stationary productivity, investment, investment-specific productivity (IST), government spending, preference, and wage markup shocks account for 12, 15, 22, 3, 8, and 0 percent of the total variance share of output growth, the sum of which is 60 (this differs slightly from the 61 in Table 3 due to rounding). The four and eight period news shocks for productivity, non-stationary productivity, investment, investment-specific productivity (IST), government spending, preference, and wage markup account for, respectively, 0 and 0, 1 and 1, 1 and 6, 0 and 0, 3 and 2, 3 and 3, and 17 and 0 percent of the variance share of output growth, the sum of which is 37 percent (again differing slightly from the 39 percent shown in Table 3 because of rounding to the nearest integer).

Table A1: Unconditional Variance Shares for All Shocks

	dY	dC	dI	dh	dG	$dTFP$	dA
Stationary Prod							
0	12	3	14	14	0	75	0
4	0	0	0	1	0	3	0
8	0	0	0	1	0	2	0
Non-Stationary Prod							
0	15	10	7	2	5	17	0
4	1	1	0	0	0	1	0
8	1	1	0	0	0	2	0
Investment							
0	22	1	45	3	0	0	0
4	1	0	3	0	0	0	0
8	6	1	16	2	0	0	0
IST							
0	0	0	1	0	0	0	43
4	0	0	0	0	0	0	28
8	0	0	0	0	0	0	29
Gov. Spending							
0	3	0	0	1	38	0	0
4	3	0	0	1	35	0	0
8	2	0	0	0	20	0	0
Pref. Shock							
0	8	37	1	2	0	0	0
4	3	12	0	1	0	0	0
8	3	14	0	1	0	0	0
Wage Markup							
0	0	0	0	1	0	0	0
4	17	19	11	66	0	0	0
8	0	1	0	2	0	0	0

Note: This table is a replication of Table 6 from the published Schmitt-Grohe and Uribe (2012) paper. It shows the unconditional variance share (i.e. the forecast error variance decomposition as $H \to \infty$) attributable to each of the 21 shocks for output growth, consumption growth, investment growth, hours growth, government spending growth, the growth rate of measured TFP, and the growth rate of the relative price of investment. The exogenous shocks are described in the far left column, with the rows labeled "0," "4," and "8" referring to the period of anticipation for each shock. Variance shares are rounded to the nearest integer. There are very small discrepancies between the numbers presented here and the numbers in the published paper due to the different nature of the exercises. In particular, these numbers are generated for one draw of the parameters (at the mean of the posterior distribution), whereas the numbers in the published paper are averages from 500,000 draws of the parameters from the posterior distributions.

Table 4 in the main text breaks down the contributions of pure and realized news shocks for the variance share of output growth and other variables by horizon, but it lumps all sources of news shocks together. Table A2 presents the contributions of "pure" and "realized" news to the variance share of output growth, broken down for each of the seven exogenous variables which are subject to news shocks. In this table, the 4 and 8 period news shocks are lumped together when computing the different news shares.

Table A2: Variance Share of Output Growth due to News, Pure News, and Realized News by Horizon
Shock-Specific

		Forecast Horizon											
Variable		0	1	2	3	4	5	6	7	8	16	32	∞
Stationary Prod													
	News	0	0	0	0	0	0	1	1	1	1	1	1
	Pure News	0	0	0	0	0	0	0	0	0	0	0	0
	Realized News	0	0	0	0	0	0	0	0	0	0	0	0
Non-Stationary Prod													
	News	0	0	0	1	1	1	1	1	1	1	1	1
	Pure News	0	0	0	1	0	0	1	1	1	1	1	1
	Realized News	0	0	0	0	0	0	0	0	1	1	1	1
Investment													
	News	0	0	1	1	2	2	3	4	6	8	8	8
	Pure News	0	0	1	1	1	2	3	4	3	3	3	3
	Realized News	0	0	0	0	1	0	1	1	3	4	4	4
IST													
	News	0	0	0	0	0	0	0	0	0	0	0	0
	Pure News	0	0	0	0	0	0	0	0	0	0	0	0
	Realized News	0	0	0	0	0	0	0	0	0	0	0	0
Gov. Spending													
	News	0	0	0	0	4	4	3	3	5	5	5	5
	Pure News	0	0	0	0	0	0	0	0	0	0	0	0
	Realized News	0	0	0	0	4	3	3	3	5	5	4	4
Preference Shock													
	News	0	0	0	0	4	4	4	4	7	7	7	7
	Pure News	0	0	0	0	0	0	0	0	0	0	0	0
	Realized News	0	0	0	0	4	3	3	3	7	3	6	6
Wage Markup													
	News	2	4	6	8	13	16	17	17	16	16	17	18
	Pure News	2	4	6	8	7	6	6	6	6	5	5	5
	Realized News	0	0	0	0	7	10	11	11	11	11	12	13

Note: This table shows the contributions to the forecast error variance of output growth by horizon, separated out by the exogenous variable which is being shocked. For each exogenous variable, the news share is the sum of the variance shares due to the 4 and 8 period news shocks. Similarly, the pure news and realized news rows the are sum of the pure and realized news shares for each type of exogenous variable, summed across the 4 and 8 period news shocks.

Table 4 in the main text breaks down the total news shock share into the part due to "pure" and "realized" news. In doing so, it treats 4 and 8 period anticipated news shocks the same. Table A3 breaks these contributions down by the length of anticipation. The upper panel shows the contribution to the forecast error variance by horizon for several variables due to the seven different 4 period anticipated news shocks. The bottom panel does the same for the seven news shocks with 8 period anticipation horizons.

Table A3: Variance Share due to News, Pure News, and Realized News by Horizon Broken Down by Anticipation Horizon

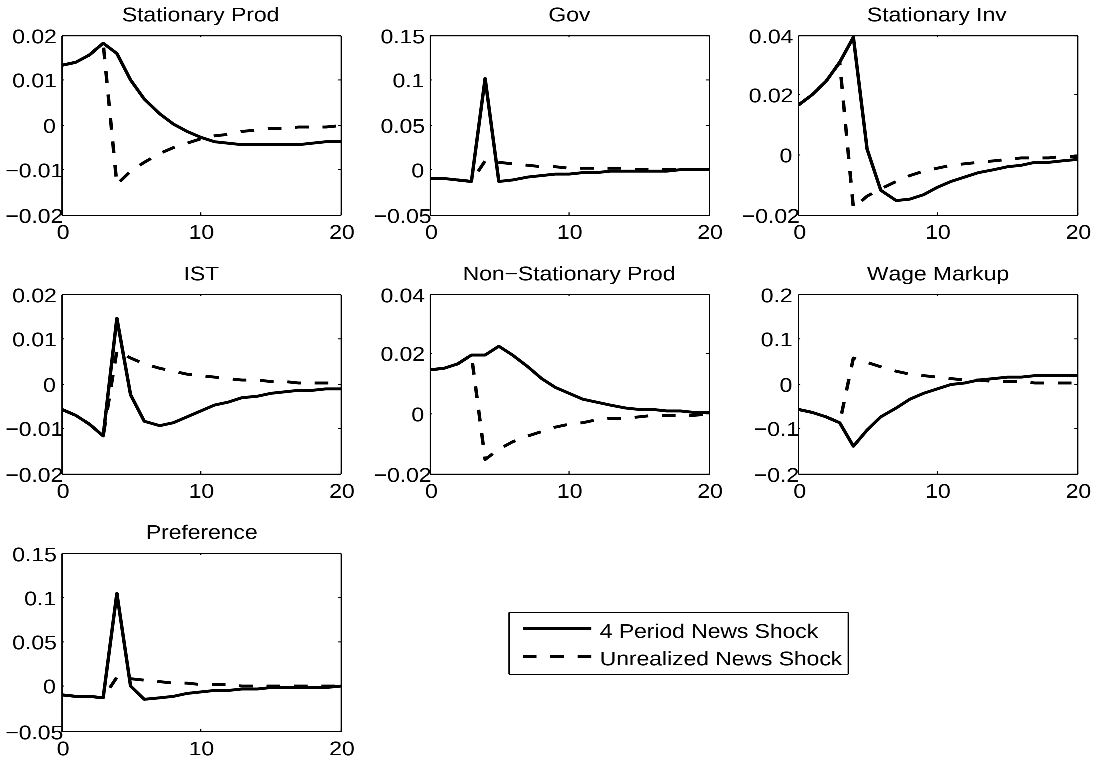
		4 Period Anticipation											
		Forecast Horizon											
Variable		0	1	2	3	4	5	6	7	8	16	32	∞
dY													
	News	3	5	7	10	23	26	27	27	25	25	25	26
	Pure News	3	5	7	10	9	8	8	8	7	7	7	6
	Realized News	0	0	0	0	15	17	19	19	18	18	19	19
dC													
	News	1	2	3	5	28	31	33	34	30	30	31	32
	Pure News	1	2	3	5	4	3	3	3	3	2	2	2
	Realized News	0	0	0	0	25	28	30	31	27	28	28	30
dI													
	News	3	5	7	10	14	15	15	15	14	14	15	15
	Pure News	3	5	7	10	9	9	9	8	8	7	7	7
	Realized News	0	0	0	0	5	6	6	6	6	7	9	9
dh													
	News	3	4	6	9	74	74	74	73	69	69	70	70
	Pure News	3	4	6	9	3	2	2	2	2	2	2	2
	Realized News	0	0	0	0	72	71	71	71	67	67	67	67

		8 Period Anticipation											
		Forecast Horizon											
Variable		0	1	2	3	4	5	6	7	8	16	32	∞
dY													
	News	0	0	0	1	1	1	2	4	11	13	13	13
	Pure News	0	0	0	1	1	1	2	4	4	3	3	3
	Realized News	0	0	0	0	1	0	1	1	6	10	10	10
dC													
	News	0	1	1	1	1	1	1	2	16	17	17	16
	Pure News	0	1	1	1	1	1	1	2	1	1	1	1
	Realized News	0	0	0	0	0	0	0	0	15	15	16	15
dI													
	News	0	1	1	2	3	4	6	8	12	17	17	17
	Pure News	0	1	1	2	3	4	6	8	8	7	7	7
	Realized News	0	0	0	0	1	1	1	1	2	10	10	10
dh													
	News	1	1	1	1	0	1	1	1	6	7	7	7
	Pure News	1	1	1	1	0	1	1	1	1	1	1	1
	Realized News	0	0	0	0	0	0	0	0	5	5	5	5

Note: This table shows the fraction of the total forecast error variance due to news shocks in the Schmitt-Grohe and Uribe (2012) model, along with the decomposition into the variance shares due to "pure news" and "realized news," respectively. This is broken down by news shocks according to the anticipation horizon of 4 or 8 quarters. Numbers are rounded to the nearest integer; the "pure news" and "realized news" shares should sum to the total news share, but in some cases may not due to rounding. The column labeled "∞" corresponds to the unconditional variance share. Numbers from the 4 and 8 period anticipation panels should sum to the corresponding rows in Table 4, but may not exactly due to rounding.

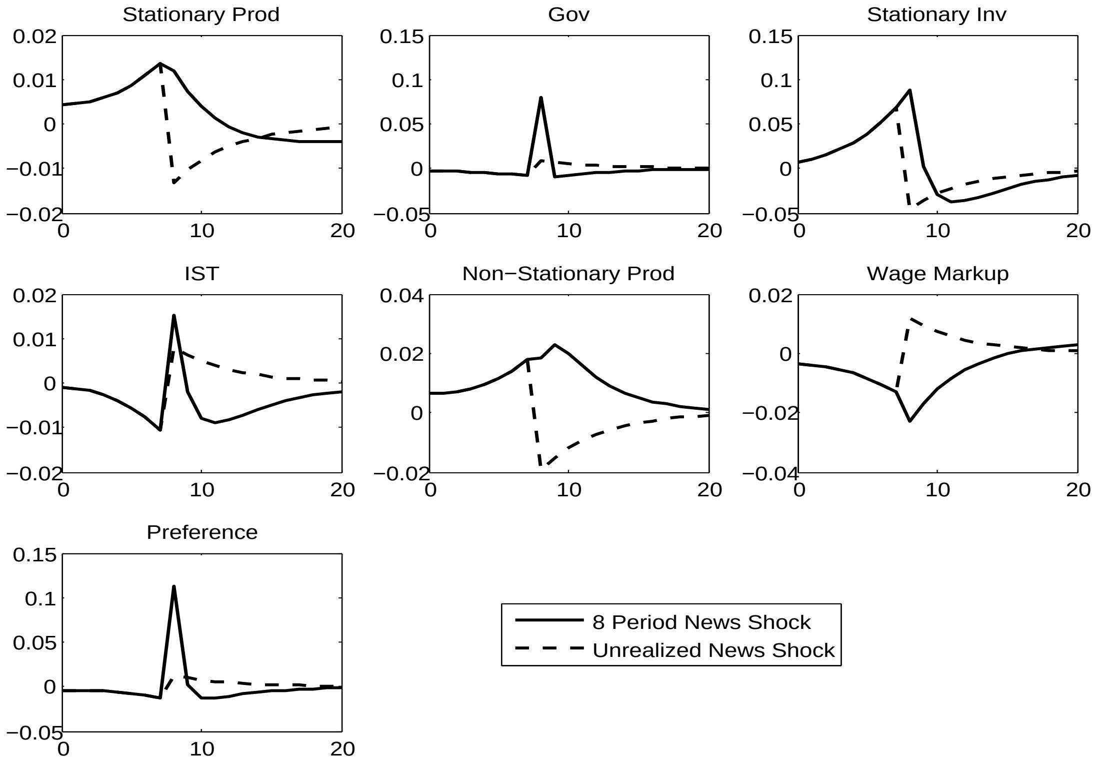
The next two figures show the impulse responses of output growth to news shocks (solid lines), along with the counterfactual impulse responses of output growth to unrealized news shocks (dashed lines). As discussed in the text of Section 3.3 and further in Footnote 12, the construction of impulse responses to unrealized news shocks, and then using those to compute an alternative variance decomposition, is much more natural in levels than in growth rates. The impulse response functions below make this clear. In the anticipation period (either horizon 4 or 8), output growth typically either sharply contracts (flipping from positive to negative) or expands (flipping from negative to positive). This occurs as the level of output starts to revert in response to the non-realization of the anticipated change in the relevant exogenous variable. Because a variance decomposition is based on squared impulse response functions, these large discrete "sign flips" are not factored into a variance decomposition, giving the appearance that unrealized news shocks induce large swings in volatility in the period of anticipation. A variance decomposition in growth rates would tend to therefore sharply overstate the role of unrealized news. The levels responses give a much clearer picture of the roles of unrealized news shocks and realized news, and the variance decomposition using the levels conveys information that is much more consistent with my baseline approach to disentangling the roles of pure news and realized news, although this alternative approach (naturally) attributes a somewhat larger role to pure news than does my baseline approach.

Figure A1: Output Growth Responses to 4 Period News Shocks, SGU (2012) Model, Alternative Decomposition



Note: These figures plot the impulse responses of output growth to each of the seven eight period news shocks (solid lines) in the Schmitt-Grohe and Uribe (2012) model, along with hypothetical impulse response functions to "unrealized news shocks" (dashed lines). The unrealized news shocks are constructed by counteracting the news shock in the period of its realization with an offsetting unanticipated shock so as to leave the exogenous variable in question unchanged. The vertical difference between the solid and dashed lines can be interpreted as the portion of the news shock impulse response attributable to the realization of a change in the relevant exogenous variable.

Figure A2: Output Growth Responses to 8 Period News Shocks, SGU (2012) Model, Alternative Decomposition



Note: These figures plot the impulse responses of output growth to each of the seven eight period news shocks (solid lines) in the Schmitt-Grohe and Uribe (2012) model, along with hypothetical impulse response functions to "unrealized news shocks" (dashed lines). The unrealized news shocks are constructed by counteracting the news shock in the period of its realization with an offsetting unanticipated shock so as to leave the exogenous variable in question unchanged. The vertical difference between the solid and dashed lines can be interpreted as the portion of the news shock impulse response attributable to the realization of a change in the relevant exogenous variable.