Analyzing fiscal policy news from a cross-country perspective*

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Abstract

Economic agents' expectations about future tax policy are not constant over time. News about changes in future fiscal plans ("news shocks," see Davis 2007 or Schmitt-Grohe and Uribe 2012) can influence the behavior of economic agents even though these plans may never materialize. Understanding how news about future tax policy—and government policy in general—affect the business cycle is essential for policymakers and government officials. This paper takes a novel approach to measure the extent to which news shocks to fiscal policy affect the business cycle. Using a DSGE model where agents receive news about changes in future policy every period and data from a cross-section of 45 countries we identify the effect of news shocks to capital and labor income taxes, as well as government consumption. Using the cross-country data generated from the model we empirically analyze what factors play a role in determining the relative performance of the model with news shock compared to the one without. Empirical analysis highlights a couple of economic and political factors in this regard.

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1 Introduction

Economic agents' expectations about future tax policy are not constant over time. News about changes in future tax plans (for example the continued and often contradictory news regarding the expiration of the Bush tax cuts during 2010) can influence the behavior of economic agents even though these plans may never materialize. In turn, the changes in behavior created by these news may have important economic consequences in the short run.

Some conventional models of fiscal policy—see the work of Braun (1994) or McGrattan (1994) as an example—assume that tax rates and government consumption follow an exogenous stochastic process. In such models, expectations of future policy are determined by current policy only. Recently, the literature has started to explore the implications of changes in expectations about future policy.[1] However, to the best of the authors' knowledge, there has been no systematic analysis of how news about future tax policy affect the business cycle.

Expectations about future policy can change as economic agents receive news about what future policy might look like. These news directly influence the agents' expected value for fiscal policy variables: expectations can change even though actual policy remains the same.

The logic underlying the availability of news about future policy is straightforward: changes in the future path of tax rates or government consumption are rarely surprises, as it is often the case that firms and households have a clear idea about the prospective path of policy variables. Proposed changes to existing tax laws and new pieces of legislation are subject to lengthy debates in Congress before they are approved; moreover, these debates are frequently highlighted in the media and their pros and cons are usually explained in detail. Considerable lags can also be introduced from the time the proposals are signed into law and the moment they go into effect. While it is true that the original proposal may not be exactly the same as the one that gets signed and implemented, it seems difficult to believe that the news have no real effects over the business cycle.

Preliminary results (see Solis-Garcia 2011) show that when agents receive news about future policy, the variables in the economy can vary before any policy change takes place. These movements can be consistent with expansions or recessions, depending on the particular policy variable that is

[1] Some researchers are also analyzing the effects of uncertainty over the business cycle: see for example Bloom et al. (2012) and Ilut and Schneider (2012), as well as Fernández-Villaverde et al. (2011) for the case of fiscal policy uncertainty.

expected to change.

This project builds upon and expands the literature by analyzing whether the importance of news documented in Solis-Garcia (2011) is robust to different countries and different institutional frameworks. Does a model that include news shocks perform better—in terms of accounting for the statistical properties of the data—than one where there are no news? Are there any significant differences when distinguishing between developed and developing countries? Do news shocks matter more for some countries than for others? What can account for these differences? These are the kinds of questions that this paper will answer. Our preliminary results show that a higher newspaper circulation, a higher level of democracy, better institutional quality for corruption perceptions, and higher GDP per-capita is associated with a higher probability that the model with news shocks performs better than one without.[2]

Understanding how news about future tax policy—and government policy in general—affect the business cycle is essential for policymakers and government officials. It is our intention to provide elements to determine the conditions under which news shocks matter for creating business cycle fluctuations, by taking the theory to the data in a multi-country setting.

1.1 Background

Research on the effects of changes in expectations about future policy is fairly recent. While the notion of thinking about news shocks can be dated back to Cochrane (1994), most of the work in news shocks was related to total factor productivity news. A (non-exhaustive) list of references should include Beaudry and Portier (2004, 2007), Christiano et al. (2007), Jaimovich and Rebelo (2009), and Schmitt-Grohe and Uribe (2008, 2012).

In terms of models with news about changes in future policy, one of the earliest models with news shocks was provided by Yang (2005). She builds a simple dynamic stochastic general equilibrium (DSGE) model where agents receive news about future changes to capital and labor income taxes. She finds that news about future increases to the labor and capital income tax rates create pre-implementation movements in the economy's variables.

Mertens and Ravn (2011) estimate a vector autoregresion (VAR) to obtain empirical impulse-

[2] We are currently revising the paper in the following directions: (1) experimenting with changes to the functional forms and structure of the model (e.g. log vs. GHH utility; investment-specific technology shocks, etc.), (2) adding news shocks to non-fiscal exogenous variables, and (3) improving the econometric analysis outlined in Section 4.5.

responses to announced, exogenous changes in tax liabilities. They then match the VAR moments to a stylized DSGE model; in their work, anticipated tax cuts are consistent with a recession.[3]

Leeper et al. (2009) suggested using Bayesian methods to estimate a model with news shocks; to the best of the authors' knowledge, there has been no work which estimates the statistical properties of the fiscal policy news terms using this methodology. Schmitt-Grohe and Uribe (2008) build and estimate a model with news using Bayesian econometrics; while they think about news on four different exogenous processes (permanent and stationary neutral productivity shocks, permanent investment-specific shocks, and a government spending shock), one of them being of a fiscal nature, our paper actually models tax rate processes and does so for a variety of countries. Schmitt-Grohe and Uribe conclude that anticipated shocks account for an important fraction of business cycle fluctuations.[4]

1.2 Modeling strategy

To uncover the effect that news about future tax policy have over the business cycle, we need to make a comparison between a model subject to these shocks and one where agents receive no information whatsoever (and is identical in every other respect). In this case, a DSGE model is the natural choice to measure and test the effect of news shocks—or the absence of them.

In the no-news version of the model, the expectation of the tax rates is a function of the current value of these variables: there are no changes in fiscal policy expectations unless the underlying tax rate changes. This modeling strategy is similar to what traditional models use to think about fiscal policy.

To accommodate the case where agents receive news about future policy, the no-news model is modified to include the following informational assumption: agents receive news about changes in fiscal policy several periods before they occur. (Naturally, in the no-news economy agents do not receive any news until the policy change gets implemented.) In a model like this, we can estimate the volatilities of the news terms. This is particularly important as the standard deviation of these terms has a first-order effect on the ability of the model with news to account for real-world data.

For each of the countries in the sample,[5] we fit a model with news and one with no news.

[3] Other related papers are those of Leeper et al. (2010) and Mertens and Ravn (2010a,b).

[4] See also the revised version of this paper, Schmitt-Grohe and Uribe (2012).

[5] See Appendix B for a list of the countries in the analysis.

We then calculate the statistical properties of the artificial data generated by the models and establish whether news can improve the ability of the model to replicate the behavior of the real world. Specifically, we look at four variables generated by the models to measure the relative performances of each of them. These are the standard deviation of output and the standard deviations of consumption, investment and hours worked relative to output. In a second step, we try to identify the factors that determine when news are relevant for accounting for a good match in the data. In our empirical analysis, we find that the performance of the model with news shocks relative to the one without is very much affected by newspaper circulation, GDP per-capita, the level of democracy and the existence of free press.

The rest of the paper is organized as follows. Section 2 presents and characterizes a benchmark model without news shocks. Next, in Section 3 we show how news shocks are added to the benchmark model and how these changes alter its structure. In Section 4, we simulate both models and then empirically investigate the performance of the model with new shocks relative to the one without. Finally, Section 5 provides some concluding remarks.

2 Benchmark (no news) model

The following model will be used as a benchmark case as it does not include news. In this economy, there are three kinds of agents: a representative household, a representative firm, and a government. All agents are assumed to be price takers and behave competitively.

2.1 Agents' problems

The representative household chooses sequences of consumption C_t, investment I_t, and labor supply n_t to solve the following dynamic problem:

$$\begin{aligned} \max \quad & E_0 \sum_{t=0}^{\infty} \beta^t [\log C_t + \phi \log(1 - n_t)] \qquad (2.1) \\ \text{s.t.} \quad & C_t + I_t = r_t K_t + W_t n_t + V_t - \tau_{kt}(r_t - \delta) K_t - \tau_{nt} W_t n_t \\ & K_{t+1} = (1 - \delta) K_t + I_t. \end{aligned}$$

In problem (2.1) $\beta \in (0,1)$ is the household's discount factor; $\phi > 0$ is a parameter expressing the relative weight between consumption and leisure; r_t and W_t denote the real interest rate and real wage rate, respectively; K_t denotes the stock of physical capital; V_t denotes government (lump-sum) taxes or transfers; τ_{kt} and τ_{nt} are distorting taxes over capital and labor income, respectively, and $\delta \in [0,1]$ is the depreciation rate of physical capital.

Each period, the representative firm hires capital K_{Ft} and labor n_{Ft} from the household in order to produce output following a constant returns to scale technology. Output can be consumed or invested. The firm's profit maximization problem is summarized by

$$\begin{aligned} \max \quad & Y_t - r_t K_{Ft} - W_t n_{Ft} \\ \text{s.t.} \quad & Y_t = z_t K_{Ft}^{\alpha} (X_t n_{Ft})^{1-\alpha} \end{aligned} \tag{2.2}$$

In problem (2.2) z_t denotes a stationary productivity shock following

$$\log z_t = (1-\rho_z) \log z + \rho_z \log z_{t-1} + \epsilon_{zt} \tag{2.3}$$

where $\rho_z \in (0,1)$ is a persistence parameter, z denotes the steady-state level of the productivity shock, and ϵ_{zt} is a stochastic disturbance with zero mean and constant variance. The process X_t denotes a non-stationary neutral productivity shock obeying

$$\log X_t = \log X_{t-1} + \log \mu_t \tag{2.4}$$

where

$$\log \mu_t = (1-\rho_m) \log \mu + \rho_m \log \mu_{t-1} + \epsilon_{mt}. \tag{2.5}$$

In equation (2.5) $\rho_m \in (0,1)$ is a persistence parameter, μ denotes the steady-state level of the growth rate of X_t, and ϵ_{mt} is a stochastic disturbance with zero mean and constant variance.

The government uses tax revenue to finance an exogenously given sequence of consumption G_t. It chooses lump-sum taxes or transfers to balance its budget constraint

$$G_t + V_t = \tau_{kt}(r_t - \delta) K_t + \tau_{nt} W_t n_t.$$

Let $g_t \equiv G_t/Y_t$ denote the government consumption to output ratio. Then the budget constraint becomes

$$g_t Y_t + V_t = \tau_{kt}(r_t - \delta)K_t + \tau_{nt} W_t n_t. \tag{2.6}$$

We assume that the policy processes for taxes and government consumption are given by

$$\tau_{kt} = (1-\rho_k)\tau_k + \rho_k \tau_{k,t-1} + \epsilon_{kt} \tag{2.7}$$

$$\tau_{nt} = (1-\rho_n)\tau_n + \rho_n \tau_{n,t-1} + \epsilon_{nt} \tag{2.8}$$

$$g_t = (1-\rho_g)g + \rho_g g_{t-1} + \epsilon_{gt}. \tag{2.9}$$

In the equations above $\{\tau_k, \tau_n, g\}$ denote steady-state levels; for $j \in \{k, n, g\}$ the terms $\rho_j \in (0, 1)$ are persistence parameters and the variables ϵ_{jt} are stochastic disturbances with zero mean and constant variance.

2.2 Detrending

Since the model as is expressed above is non-stationary, we need to make some adjustments in order to convert it to a stationary one. Begin by defining

$$a_t \equiv \frac{A_t}{X_t}$$

for $A_t \in \{C_t, I_t, W_t, V_t, Y_t\}$. In addition, define

$$b_t \equiv \frac{B_t}{X_{t-1}}$$

for $B_t \in \{K_t, K_{Ft}\}$. Finally, note equation (2.4) implies

$$\mu_t = \frac{X_t}{X_{t-1}}. \tag{2.10}$$

With these expressions at hand, simple substitutions show that the household's (stationary) problem is now given by

$$\begin{aligned}
\max \quad & E_0 \sum_{t=0}^{\infty} \beta^t [\log c_t + \phi \log(1 - n_t)] \\
\text{s.t.} \quad & c_t + i_t = \frac{r_t k_t}{\mu_t} + w_t n_t + v_t - \frac{\tau_{kt}(r_t - \delta) k_t}{\mu_t} - \tau_{nt} w_t n_t \\
& k_{t+1} = \frac{(1-\delta) k_t}{\mu_t} + i_t.
\end{aligned} \tag{2.11}$$

Similarly, the firm's problem is

$$\begin{aligned}
\max \quad & y_t - \frac{r_t k_{Ft}}{\mu_t} - w_t n_{Ft} \\
\text{s.t.} \quad & y_t = \frac{z_t k_{Ft}^{\alpha} n_{Ft}^{1-\alpha}}{\mu_t^{\alpha}}
\end{aligned} \tag{2.12}$$

and the government's budget constraint is now

$$g_t y_t + v_t = \frac{\tau_{kt}(r_t - \delta) k_t}{\mu_t} + \tau_{nt} w_t n_t. \tag{2.13}$$

2.3 State vector and equilibrium

Given the stochastic processes described in (2.3), (2.5), and (2.7)-(2.9), the exogenous state vector is given by $\{z_t, \mu_t, \tau_{kt}, \tau_{nt}, g_t\}$. The description of the model's state vector is completed by adding the endogenous state variables, which in this case corresponds to the household's capital stock k_t. We will use $\mathbf{s}_t$ as shorthand for the state vector, so that

$$\mathbf{s}_t \equiv \{k_t; z_t, \mu_t, \tau_{kt}, \tau_{nt}, g_t\}.$$

In what follows, the history of states up to period t will be denoted by $\mathbf{s}^t$.

We now proceed to characterize the equilibrium conditions of the model. We first start by defining a (tax-distorted) competitive equilibrium in this economy:

Definition 2.1. A (tax-distorted) competitive equilibrium is composed of sequences of prices $\{r(\mathbf{s}^t), w(\mathbf{s}^t)\}$, household allocations $\{c(\mathbf{s}^t), i(\mathbf{s}^t), n(\mathbf{s}^t)\}$, firm allocations $\{k_F(\mathbf{s}^t), n_F(\mathbf{s}^t)\}$, and government transfers $\{v(\mathbf{s}^t)\}$ such that, for all periods,

1. The sequences $\{c(\mathbf{s}^t), i(\mathbf{s}^t), n(\mathbf{s}^t)\}$ solve the household's problem (2.11).

2. The sequences $\{k_F(\mathbf{s}^t), n_F(\mathbf{s}^t)\}$ solve the firm's problem (2.12).

3. The government constraint (2.13) holds.

4. The capital and labor markets clear:

$$k(\mathbf{s}^t) = k_F(\mathbf{s}^t),\ n(\mathbf{s}^t) = n_F(\mathbf{s}^t).$$

Now we derive the model's equilibrium conditions. As a first step, we impose market clearing on the model's variables; then, starting from the firm's problem (2.12), it is straightforward to verify that the following conditions are required:

$$y_t = \frac{z_t k_t^{\alpha} n_t^{1-\alpha}}{\mu_t^{\alpha}} \tag{2.14}$$

$$\alpha y_t = \frac{r_t k_t}{\mu_t} \tag{2.15}$$

$$(1-\alpha) y_t = w_t n_t. \tag{2.16}$$

For the household problem (2.11) let λ_t and ζ_t denote nonnegative Lagrange multipliers over the budget constraint and the law of motion for capital, respectively. Then, the household's equilibrium conditions are given by

$$\lambda_t = \frac{1}{c_t} \tag{2.17}$$

$$\lambda_t = \zeta_t \tag{2.18}$$

$$\phi = (1-\tau_{nt}) w_t \lambda_t (1-n_t) \tag{2.19}$$

$$\zeta_t = \beta E_t \left[\frac{(r_{t+1} - \tau_{k,t+1}(r_{t+1} - \delta))\lambda_{t+1} + (1-\delta)\zeta_{t+1}}{\mu_{t+1}} \right] \tag{2.20}$$

$$c_t + i_t = \frac{r_t k_t}{\mu_t} + w_t n_t + v_t - \frac{\tau_{kt}(r_t - \delta) k_t}{\mu_t} - \tau_{nt} w_t n_t \tag{2.21}$$

$$k_{t+1} = \frac{(1-\delta) k_t}{\mu_t} + i_t. \tag{2.22}$$

Finally, solve the government's budget constraint (2.13) for transfers v_t and substitute in equation

(2.21); together with (2.15) and (2.16) we get the aggregate feasibility constraint

$$c_t + i_t = (1 - g_t)y_t. \tag{2.23}$$

Summing up, the model's equilibrium conditions are given by equations (2.14)-(2.20), (2.22), and (2.23). We also need to add the laws of motion (2.3), (2.5), and (2.7)-(2.9). Details about the model's steady state values are presented in Appendix A.

3 Adding news

In this section we explain how we can include news shocks to the model outlined above. In particular, we modify the benchmark model to include the following informational assumption: agents receive news about changes in fiscal policy one period before they occur. (In the benchmark economy, agents do not receive any news until the policy change gets implemented.)

In order to accommodate for news about future policy, we first detail how the laws of motion for fiscal policy change to include news. Then, we redeclare the state vector and adjust the definition of competitive equilibrium.

3.1 News about future fiscal policy

Let $x_t \in \{\tau_{kt}, \tau_{nt}, g_t\}$ be a fiscal policy process, which according to (2.7)-(2.9) follows

$$x_t = (1 - \rho)x + \rho x_{t-1} + \epsilon_{xt}.$$

News about future fiscal policy enter the ϵ_{xt} term as

$$\epsilon_{xt} = \eta_{xt} + \xi^t_{x,t-1} + \xi^t_{x,t-2} + \cdots + \xi^t_{x,t-p} \tag{3.1}$$

where η_{xt} and each of the $\xi^t_{x,t-j}$ terms ($j = 1, \ldots, p$) are i.i.d. disturbances with mean zero and finite variance, uncorrelated across time and with each other. In this case the η_{xt} term is an unanticipated shock; the $\xi^t_{x,t-j}$ terms are news about future policy, representing a j-period anticipated change in x_t (i.e. $\xi^t_{x,t-j}$ is a change in period t policy that is revealed in period $t - j$).

Remark 3.1. The variable $p \geq 1$ represents the anticipation horizon. In what follows, we set $p = 1$ for all of the fiscal policy processes (2.7)–(2.9).

The key departure from the standard informational framework is the assumption that agents have an information set that is larger than the one containing current and past realizations of ϵ_{xt}: in period t, agents are assumed to observe current and past values of the innovations η_{xt} and ξ_{xt}^{t+1}. Agents can use this information to forecast $\epsilon_{x,t+1}$ in period t since

$$E_t \epsilon_{x,t+1} = E_t[\eta_{xt} + \xi_{xt}^{t+1}] = \xi_{xt}^{t+1}.$$

Note that $E_t \epsilon_{x,t+s} = 0$ for $s \geq 2$.

3.2 State vector

Given the stochastic processes described in (2.3), (2.5), and (2.7)–(2.9), the state vector $\mathbf{s}_t$ can be updated to

$$\tilde{\mathbf{s}}_t \equiv \{k_t; z_t, \mu_t, \tau_{kt}, \xi_{kt}^{t+1}, \tau_{nt}, \xi_{nt}^{t+1}, g_t, \xi_{gt}^{t+1}\}.$$

The history of states up to period t will be denoted by $\tilde{\mathbf{s}}^t$.

3.3 Characterizing the equilibrium

It is straightforward to verify that Definition 2.1 is valid provided the state vector now equals $\tilde{\mathbf{s}}_t$. The equilibrium in this economy is still described by equations (2.14)-(2.20), (2.22), and (2.23). While the laws of motion (2.3) and (2.5) still hold, we need to modify (2.7)–(2.9) to include the news terms as described in (3.1). Clearly, this changes the approximated laws of motion for the model variables.

4 Estimation and results

We now outline the procedure we use to estimate the model described above.

4.1 Data sources

Aggregate data for consumption, investment and government spending are obtained from the Penn World Tables 7.0. Data for the tax rates is obtained from SourceOECD.

4.2 Observable variables

We use annual data from 1950 to 2009. For each country, the series used as observables are the gross growth rates of output, consumption, and investment, as well as the government consumption to output ratio, and a measure of market hours as a fraction of total household time.[6] We assume that all observables have measurement error, denoted ϵ_{hjt}^{me}, where $h \in \{y, c, i, g, n\}$ and j indexes the country. For each j, the vector of observable variables is

$$\begin{bmatrix} Y_t/Y_{t-1} \\ C_t/C_{t-1} \\ I_t/I_{t-1} \\ G_t/Y_t \\ n_t \end{bmatrix} + \begin{bmatrix} \epsilon_{yt}^{me} \\ \epsilon_{ct}^{me} \\ \epsilon_{it}^{me} \\ \epsilon_{gt}^{me} \\ \epsilon_{nt}^{me} \end{bmatrix} = \begin{bmatrix} \mu_t y_t/y_{t-1} \\ \mu_t c_t/c_{t-1} \\ \mu_t i_t/i_{t-1} \\ g_t \\ n_t \end{bmatrix} + \begin{bmatrix} \epsilon_{yt}^{me} \\ \epsilon_{ct}^{me} \\ \epsilon_{it}^{me} \\ \epsilon_{gt}^{me} \\ \epsilon_{nt}^{me} \end{bmatrix},$$

where the left hand side of the expression corresponds to real-world data and the right hand side corresponds to model variables. Details on the construction of the data series are contained in Appendix B.

4.3 Priors and calibrated parameters

We use a naive approach to setting up the priors of the model. Our goal is to quantify the effect of news on all the countries in the sample without imposing a number of a priori restrictions based on each country's nature. To accomplish this, we start with a similar prior for all parameters (with minor exceptions, as discussed below) in all the countries that are analyzed.

Priors for the household, firm, technology, policy, and growth rate parameters, as well as the model's various standard deviations are shown in Table 1 below. These values constitute the set of priors for all the countries in the sample.

[6] Some countries do not have all the data points for all the years in this sample; in these cases, the estimation exercise begins at the first year where all the observable variables are available. See Appendix B for details.

Table 1: Parameter priors

Parameter	Description	Distribution	Mean	SD
β	Discount factor	Beta	1/1.05	0.01
ϕ	Leisure weight	Gamma	4	0.75
α	Capital share	Beta	0.33	0.03
δ	Depreciation	Inv. Gamma	0.08	∞
ρ_z, ρ_k, ρ_n, ρ_g	Autocorrelation	Beta*	0.7	0.1
ρ_m	Autocorrelation	Beta*	0.0	0.05
σ_z, σ_m, σ_k, σ_n, σ_g	Standard deviation	Inv. Gamma	0.05	∞
σ_k^1, σ_n^1, σ_g^1	Standard deviation	Gamma	0.05	0.025
$\sigma_{h,j}^{me}$	Measurement error	Gamma	$0.5\hat{\sigma}_{h,j}$	$0.15\hat{\sigma}_{h,j}$

Notes: SD = standard deviation; $h \in \{c, i, y, g, n\}$. The symbol $\hat{\sigma}_{h,j}$ denotes the sample standard deviation of the empirical measure of variable h for country j. Beta* indicates that a linear transformation of the parameter has a Beta prior distribution. See Schmitt-Grohe and Uribe (2008).

We do incorporate several values that are specific to each economy; in particular, we use the long-run averages of the capital and labor income tax rates to calibrate the steady-state tax rates. We also use the long-run average of the government expenditure to GDP ratio to calibrate for the steady-state G/Y ratio; the long-run growth rate of GDP is also included in the list.

4.4 Econometric procedure I: Bayesian analysis

We start from same set of priors as described in Table 1 and the set of calibrated values. We use a Bayesian estimation procedure where one chain of 2 million draws is calculated and the first 1.5 million draws are dropped. We perform this routine for all countries and for both the news and no news case.[7]

Table 4 in Appendix C presents a subset of the estimation results, namely, the estimated values (posteriors) of all the news shock volatilities for all countries in the panel.[8] Using the calculated parameters, we obtain second moments for both models which can then be compared with the data. This is the basis for the analysis that follows.

[7] For all countries, the acceptance ratio falls in the interval $[0.22, 0.26]$.

[8] Due to size limitations we do not include the results for all the estimated parameters in all the countries in both versions of the model (news and no news). These results—as well as the relevant computer codes—are available upon request from the authors.

4.5 Econometric procedure II: cross-section analysis

Our purpose in this section is to further our understanding of the strength of the model with news shocks relative to the one without. To achieve this we create a variable to proxy for this strength. First, given the data counterpart Y_{data} we intend to account for, we define the measure Z_i as

$$Z_i = \frac{|Y_{news} - Y_{data}|}{|Y_{nonews} - Y_{data}|}.$$

For each country i, the measure Z_i shows the relative underperformance of the model with news shocks relative to the one without them. For example, when Z_i is larger than 1 the Y series generated by the model without news is closer to its data counterpart than the one with news shocks. In our estimations below we use four different independent variables for Y_{data}. These are (1) the standard deviation of output and the standard deviations of (2) consumption, (3) investment, and (4) hours, all relative to output.

Define the binary variable κ_i as

$$\kappa_i = \begin{cases} 0 & \text{if } Z_i > 1 \\ 1 & \text{otherwise.} \end{cases}$$

This is, κ_i is equal to 0 when the model with news underperforms and is equal to 1 in the opposite case. We use the variable κ_i to run the following regression equation:

$$\kappa_i = \beta_0 + \sum_{k=1}^{n} \beta_k X_{k_i} + \epsilon_i. \tag{4.1}$$

In equation (4.1), X_k denotes a vector of independent variables that might account for the variation in κ_i and ϵ_i is an error term. Due to the binary nature of the dependent variable, the appropriate econometric model is given by

$$E[\kappa_i|x_i] = F(x_i'\beta)$$

$$Pr(\kappa_i = 1|x_i) = F(x_i'\beta)$$

$$Pr(\kappa_i = 0|x_i) = 1 - Pr(y_i = 1|x_i) = 1 - F(x_i'\beta).$$

We will use several variables in X_k. First we add GDP per capita and openness (defined as the ratio of sum of exports and imports to GDP), which are obtained from the Penn World Tables 7.1. We also add bureaucratic quality and democratic accountability indices from the International Country Risk Guide; a corruption perceptions index obtained from Transparency International; a measure of newspaper circulation per thousand persons, marginal taxes on capital and labor, government spending and finally a press freedom violation index obtained from the Freedom House. Table 2 provides descriptive statistics of all the variables used in the regression analysis.

Table 2: Complete dataset summary statistics: 1950-2010.

	Mean	SD	Minimum	Maximum
Y_{data} variables				
Output	0.24	0.43	0.00	1.00
Consumption	0.20	0.40	0.00	1.00
Investment	0.78	0.32	0.00	1.00
Hours	0.38	0.49	0.00	1.00
X_k variables				
GDP per-capita (USD×1000)	17.59	8.76	4.85	41.00
Openness (%GDP)	63.26	49.91	15.37	230.35
Bureaucratic quality	3.17	0.86	0.73	4.00
Corruption perceptions index	6.34	2.32	1.90	9.50
Democratic accountability index	6.34	2.32	1.90	9.50
Press freedom violation	27.56	16.20	10.00	76.00
Newspaper circulation	211.36	148.04	22.70	563.34
Marginal Tax on Labor	22.52	9.00	4.00	45.99
Marginal Tax on Capital	24.58	7.06	10.00	40.69
Government Spending (%GDP)	7.52	2.47	3.46	15.80

In Table 3 we report the coefficient estimates obtained using the probit approach with F being a normal distribution. We report results of both probit and two-stage probit regressions. The latter has been done to control for the endogeneity of our regressors.[9]

[9] We use latitude, a dummy variable for the type of the regime (presidential vs. parliamentary) and dummies for type of the law system (French, British, German, Scandinavian, or Post-Socialist) as instruments.

Table 3: Two-stage probit estimation results

	Output		Consumption		Investment		Hours	
	Probit	2-Step	Probit	2-Step	Probit	2-Step	Probit	2-Step
Newspaper	0.69**	0.58**	0.44***	0.47**	0.37*	0.40**	0.55**	0.50
	(0.29)	(0.22)	(0.24)	(0.23)	(0.08)	(0.18)	(0.26)	0.22**
Newspaper	0.13**	0.17**	0.18**	0.17**	0.19**	0.20**	0.21**	0.32*
× democracy	(0.05)	(0.07)	(0.08)	(0.07)	(0.08)	(0.10)	(0.09)	(0.08)
Democracy	0.34*	0.33**	0.30***	0.38**	0.27*	0.30**	0.25***	0.29**
	(0.05)	(0.15)	(0.16)	(0.14)	(0.03)	(0.13)	(0.13)	(0.14)
Corruption	9.22**	8.90**	7.13**	7.27**	3.10	5.02***	6.90**	9.12*
perception	(4.35)	(4.42)	(3.50)	(3.39)	(3.21)	(2.59)	(3.39)	(3.33)
Free press	-0.66**	-1.03*	-0.67**	-0.75**	-0.95*	-0.70**	-0.44	-0.46***
violations	(0.30)	(0.34)	(0.31)	(0.29)	(0.29)	(0.30)	(0.33)	(0.24)
GDP per capita	7.66**	6.90**	9.14*	10.01*	8.99*	6.32**	5.34***	4.80
	(3.23)	(3.32)	(3.10)	(3.55)	(3.01)	(3.03)	(2.78)	(3.02)
Openness	1.16	2.17	1.14	1.37	4.99***	-0.98	3.14	1.77
	(2.10)	(1.80)	(2.01)	(1.99)	(2.55)	(2.32)	(2.87)	(1.90)
Bureaucratic	-0.36	-0.42**	0.97	0.84	0.12	0.15	-1.10***	-0.75
quality	(0.23)	(0.20)	(1.10)	(1.03)	(1.03)	(1.00)	(0.58)	(0.60)
Labor Tax	0.14**	0.09**	0.23	0.18	0.05	0.03	0.05**	0.09*
	(0.06)	(0.04)	(0.19)	(0.18)	(0.13)	(0.13)	(0.02)	(0.03)
Capital Tax	0.04	0.03	0.07	0.08	0.17*	0.19*	0.01	0.02
	(0.08)	(0.11)	(0.08)	(0.10)	(0.04)	(0.03)	(0.03)	(0.03)
Govt. Sp.	0.25**	0.21**	0.09	0.08	0.07	0.08	0.05	0.01
	(0.05)	(0.11)	(0.10)	(0.12)	(0.08)	(0.08)	(0.15)	(0.14)
Observations	45	45	45	45	45	45	45	45

Notes: robust z-statistics are reported in parenthesis. *, **, and *** denote 1, 5, and 10% confidence levels, respectively. In all regressions a constant is also included but not reported.

From Table 3 we observe that for all of our four different independent variables, a higher newspaper circulation, a higher level of democracy, better institutional quality for corruption perceptions, and a higher GDP per-capita is associated with a higher probability that the model with news shocks performs better than the one without. Moreover, government spending is positively associated with the performance of the model with news to account for output, marginal tax on labor for output and hours and marginal tax on capital for investment.

5 Conclusion

In this paper, using a DSGE framework we allowed agents to receive news shocks about changes in future policy and then compared this model with the one without with respect to their relative strength to account for various moments observed in the data. Then we use cross-country data in a cross-section of 45 countries to understand what factors contribute to the relative strength of the model with news shocks. Our empirical analysis imply that newspaper circulation, corruption perceptions, GDP per-capita, level of democracy and free press violations are among the factors that are significantly associated with the relative performance of the model with news shocks.

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A Steady states

We impose steady state conditions over the equilibrium equations (2.14)-(2.20), (2.22), and (2.23). Normalizing $z = 1$ and letting $g \equiv G/Y$ denote the steady-state government consumption to output ratio we get

$$
\begin{aligned}
y &= \frac{k^{\alpha} n^{1-\alpha}}{\mu} && \text{(A.1)} \\
\alpha y &= \frac{rk}{\mu} && \text{(A.2)} \\
(1-\alpha) y &= wn && \text{(A.3)} \\
\lambda &= \frac{1}{c} && \text{(A.4)} \\
\phi &= (1-\tau_n) w \lambda (1-n) && \text{(A.5)} \\
1 &= \beta \left[\frac{r - \tau_k (r - \delta) + (1-\delta)}{\mu} \right] && \text{(A.6)} \\
c + i &= (1-g) y && \text{(A.7)} \\
k &= \frac{(1-\delta) k}{\mu} + i && \text{(A.8)}
\end{aligned}
$$

where we have already substituted the equivalency $\zeta = \lambda$ (equation (2.18)). This describes a system of 8 equations in

$$\{y, k, n, r, w, \lambda, c, i\}.$$

To solve it, we start by obtaining r from (A.6):

$$r = \frac{\mu - \beta[1 - \delta(1 - \tau_k)]}{\beta(1 - \tau_k)}.$$

It's easy to use this value in (A.2) to obtain y as a function of k:

$$y = \left(\frac{r}{\alpha \mu} \right) k \equiv \omega_y k$$

and from (A.8), we can express i as a function of k:

$$i = \left(\frac{\mu - 1 + \delta}{\mu} \right) k \equiv \omega_i k.$$

From (A.7), use the two expressions above to get c as a function of k:

$$c = [(1-g)\omega_y - \omega_i]k \equiv \omega_c k.$$

From (A.4),

$$\lambda = \frac{1}{\omega_c k}$$

and from (A.3),

$$w = \frac{(1-\alpha)\omega_y k}{n}.$$

Plugging these last two expressions into (A.5) allows us to solve for n directly:

$$n = \frac{(1-\tau_n)(1-\alpha)\omega_y}{\phi\omega_c + (1-\tau_n)(1-\alpha)\omega_y}.$$

Finally, from (A.1),

$$k = \frac{n}{(\omega_y \mu^\alpha)^{1/(1-\alpha)}}.$$

All other values follow from here.

B Data

Here we describe the data used in the project as well as the transformations that are used to construct the model's observable variables.

B.1 Data transformations

The consumption, investment, and government to output ratios are obtained directly from the data. The gross growth rate of GDP per capita is obtained with the simple quotient Y_t/Y_{t-1}. The data on hours takes the original value for hours worked, divides it by the population, and then divides again by a value of 5200 (equivalent to 100 available hours per week times 52 weeks per year).

B.2 Country list

The following countries are included in the analysis: Argentina, Australia, Austria, Barbados*, Belgium, Brazil, Bulgaria*, Canada, Chile*, Colombia, Cyprus*, Czech Republic*, Denmark, Finland, France, Germany*, Greece*, Hong Kong*, Hungary*, Iceland*, Ireland, Italy, Jamaica*, Japan, Korea*, Luxembourg, Malta*, Mexico, Netherlands, New Zealand*, Norway, Peru, Poland*, Portugal, Romania*, Singapore*, Spain, Sweden, Switzerland, Taiwan*, Trinidad and Tobago*, Turkey, United Kingdom, United States, and Venezuela.

As mentioned in Section 4, some countries have a limited data sample. These are indicated with a * in the list above.

C Additional econometric results

The following table shows the value of the news volatility parameters for all countries in the panel (continued next page).

Table 4: Standard deviation of the news shocks terms.

	Parameter		
Country	σ_k^1	σ_n^1	σ_g^1
Argentina	0.0305	0.0085	0.0035
Australia	0.0164	0.0049	0.0020
Austria	0.0163	0.0042	0.0019
Barbados	0.0495	0.0147	0.0166
Belgium	0.0232	0.0043	0.0022
Brazil	0.0390	0.0084	0.0036
Bulgaria	0.0437	0.0258	0.0226
Canada	0.0148	0.0043	0.0019
Chile	0.0431	0.0161	0.0026
Colombia	0.0259	0.0086	0.0022
Cyprus	0.0435	0.0127	0.0059
Czech Republic	0.0358	0.0138	0.0074
Denmark	0.0163	0.0034	0.0020
Finland	0.0258	0.0059	0.0024
France	0.0138	0.0033	0.0021
Germany	0.0192	0.0047	0.0027
Greece	0.0363	0.0087	0.0024
Hong Kong	0.0386	0.0043	0.0024
Hungary	0.0379	0.0161	0.0050
Iceland	0.0348	0.0089	0.0028

Notes: Entries represent the estimated standard deviations for the capital income tax news shock (σ_k^1), the labor income tax news shock (σ_n^1), and the government consumption to income ratio news shock (σ_g^1). Results are based on a single chain of 2,000,000 draws, discarding the first 1,500,000 draws.

Table 4: Standard deviation of the news shocks terms (continued).

	Parameter		
Country	σ_k^1	σ_n^1	σ_g^1
Ireland	0.0240	0.0070	0.0020
Italy	0.0145	0.0054	0.0019
Jamaica	0.0369	0.0136	0.0080
Japan	0.0151	0.0047	0.0023
Korea	0.0262	0.0102	0.0030
Luxembourg	0.0208	0.0067	0.0020
Malta	0.0382	0.0127	0.0055
Mexico	0.0216	0.0060	0.0018
Netherlands	0.0183	0.0064	0.0022
New Zealand	0.0310	0.0091	0.0022
Norway	0.0234	0.0047	0.0019
Peru	0.0354	0.0113	0.0020
Poland	0.0305	0.0141	0.0053
Portugal	0.0381	0.0090	0.0020
Romania	0.0413	0.0177	0.0072
Singapore	0.0301	0.0156	0.0040
Spain	0.0137	0.0052	0.0020
Sweden	0.0166	0.0032	0.0021
Switzerland	0.0179	0.0047	0.0017
Taiwan	0.0187	0.0083	0.0046
Trinidad	0.0499	0.0198	0.0093
Turkey	0.0325	0.0090	0.0023
United Kingdom	0.0151	0.0041	0.0019
United States	0.0134	0.0039	0.0021
Venezuela	0.0308	0.0096	0.0024

Notes: Entries represent the estimated standard deviations for the capital income tax news shock (σ_k^1), the labor income tax news shock (σ_n^1), and the government consumption to income ratio news shock (σ_g^1). Results are based on a single chain of 2,000,000 draws, discarding the first 1,500,000 draws.