Cardiff Economics Working Papers

Working Paper No. E2017/7

How Should News Shocks Be Specified Under Rational Expectations?

Vo Phuong Mai Le, David Meenagh and Patrick Minford

July 2017

ISSN 1749-6010

Cardiff Business School
Cardiff University
Colum Drive
Cardiff CF10 3EU
United Kingdom
t: +44 (0)29 2087 4000
f: +44 (0)29 2087 4419
business.cardiff.ac.uk

How Should News Shocks Be Specified Under Rational Expectations?

Vo Phuong Mai Le*
(Cardiff Business School, Cardiff University)

David Meenagh
(Cardiff Business School, Cardiff University)

Patrick Minford
(Cardiff Business School, Cardiff University, and CEPR)

July 2017

Abstract

A number of studies have found that news shocks account for a large part of the aggregate fluctuations of the main macroeconomic variables. We show that when taking rational expectations into consideration there is a limit on the size of the variance of the news shocks, which has not been considered in the literature. We offer an explanation to why this restriction should be imposed and show, with an empirical example from a recent paper, that if you do impose the rational expectations restriction the importance of the news is drastically reduced.

Keywords: News shocks; DSGE; Rational Expectations

JEL Classification: E2; E3

*Corresponding author: Aberconway building, Cardiff Business School, Colum Drive, Cardiff, UK, CF10 3EU. Tel.: +44 (0)29 20876566. Fax: +44 (0)29 2087 4419. (Levp@cardiff.ac.uk)

1 Introduction

In this paper we consider the way in which 'news shocks' have been incorporated into DSGE models. We argue that this has been done incorrectly, ignoring an important restriction on the element of the shock that represents an incorrect forecast. This error has greatly exaggerated the effect of news shocks in DSGE models.

When incorporating 'news about future shocks' in to a model, we are postulating that there is a direct link to the future that comes from an unobservable (to the econometrician) current shock. If this is the case, then there must be some agents who observe this news and act upon it. This action will have some effects in some of the equations of the model. In the following exposition we will assume, as our example of what is going on, that the news is about future productivity, that it comes from current R&D spending, and that its effects will show up in the investment equation, but our analysis can be applied to any other source of news about the future. The paper proceeds as follows. Section 2 derives the restriction to the variance of the news shock due to rational expectations. Section 3 gives an application of this restriction and shows the effect it has on the results of a recent paper. Section 4 concludes.

2 A Rational Expectations Approach to News

When there is news agents can either exactly know the future (through their R&D programmes, RD) or know it with some random error. The latter is similar to 'signal extraction' where agents have a current noisy process from which they extract the signal they wish to identify[1]: it can be assumed that these agents can obtain a statistical relationship from R&D to the latter effects by observing previous R&D programmes in their firm, and the consequences of these.

Therefore, we have a relationship such as

$$u_{t+1} = \gamma RD_t + \varepsilon_{t+1} \tag{1}$$

Given the agents' failure to have complete future information, their rational expectation of u_{t+1}, $E_t u_{t+1}$, is

$$E_t u_{t+1} = \gamma RD_t \tag{2}$$

This would be what agents predict will be the outcome for u_{t+1} given their observation of RD_t; this will be the 'news shock'. However of course the econometricians modelling this news shock cannot observe RD_t and simply observe the current disturbance and (in time and over the past) the disturbance u. In recent work (see Fujiwara et al. (2011), Schmitt-Grohe and Uribe (2012), Khan and Tsoukalas (2012), Gortz and Tsoukalas (2017) and Kamber et al. (2017)), we find that the way news is specified is really of the form $f(u_{t+1}) + \epsilon_t$; we will call these two elements respectively: the 'fundamental', $f(u_{t+1})$, and the 'extraneous', ϵ_t, news shocks. The extraneous element, ϵ_t, is treated by these authors as a pure i.i.d shock whose variance is unknown and can be found by fitting the model to the data; it is a free variable.

However, even though econometricians cannot observe RD, they can in fact put limits on the variance of ϵ. Thus, from Equations 1 and 2, we know that $E_t u_{t+1} = u_{t+1} - \varepsilon_{t+1}$. The two polar limiting possibilities are that agents know u_{t+1} exactly, in which case the variance of ε (and of ϵ) is zero and $f(u_{t+1}) = u_{t+1}$; or that they do not know it at all ($\gamma = 0$) then the variance of ε is the same as that of u and $u_{t+1} = \varepsilon_{t+1}$. In this last case there is also no news shock and so the variance of ϵ is by definition zero.

Therefore, we should write the news shock as $N_t = u_{t+1} - \varepsilon_{t+1}$, where the maximum variance of ε is that of u and tends to this as N_t tends to zero. The minimum variance of ε is zero and tends to this as N_t tends to u_{t+1}. This relationship between the news shock and its 'true content' can be represented as

$$N_t = \phi u_{t+1} + \epsilon_t \tag{3}$$

where in general we can show that

$$var(\epsilon) = \phi(1 - \phi) var(u) \tag{4}$$

[1] These micro-foundations and how they affect rational expectations models have been well-known for some time: see for example Minford and Peel, 2002, chapter 3, for the workings of signal extraction and see ibid, chapter 2, pp. 65-69, for how a perfectly forecast future shock is solved for in the model.

Equation 4 is obtained as follows. The regression coefficient of u_{t+1} on RD_t is $\gamma = cov(RD, u)/var(RD)$. By implication there is also a relationship in the opposite direction, of RD_t on u_{t+1}[2]. The regression coefficient of RD_t on u_{t+1} is $\frac{cov(RD,u)}{var(u)} = \gamma\frac{var(RD)}{var(u)}$ and the regression error is w_t so that $RD_t = \gamma\frac{var(RD)}{var(u)}u_{t+1}+w_t$. Hence

$$N_t = E_t u_{t+1} = \gamma RD_t = \gamma^2\frac{var(RD)}{var(u)}u_{t+1} + \gamma w_t \tag{5}$$

so that

$$\phi = \gamma^2\frac{var(RD)}{var(u)} \tag{6}$$

The variance of $\epsilon_t = \gamma w_t$ is obtained as follows. The explained variance of RD is $\gamma^2(\frac{var(RD)}{var(u)})^2 var(u) = \gamma^2(\frac{var(RD)}{var(u)})var(RD)$. The unexplained variance of RD is $var(w)$ and hence

$$\begin{aligned} var(w) &= (1-\gamma^2(\frac{var(RD)}{var(u)}))var(RD) \\ &= (1-\phi)(\frac{var(RD)}{var(u)})var(u) \end{aligned} \tag{7}$$

which we obtain by using Equation 6 and multiplying top and bottom by $var(u)$.Hence

$$\begin{aligned} var(\epsilon) &= var(\gamma w) = \gamma^2 var(w) \\ &= \gamma^2(\frac{var(RD)}{var(u)})(1-\phi)var(u) \\ &= \phi(1-\phi)var(u) \end{aligned} \tag{8}$$

This is saying that when $\phi = 0$ the news shock has no variance because there is no news; when $\phi = 1$ the news shock is simply equal to u_{t+1} and it has no additional variance due to ϵ. Under rational expectations this restriction on the variance of the news shock ϵ needs to be enforced. In general where ϕ lies between 0 and 1, $N_t = \phi u_{t+1} + \epsilon_t$,the news shock, has the part ϕu_{t+1} that is related systematically to the future event and the part that is unrelated to it, ϵ_t, which is a random draw. The point of this derivation is that the distribution from which this is a random draw is tightly circumscribed, with its variance related to the variance of the future shock and the signal extraction parameter, ϕ. It is this restriction that has not been respected in this news shock branch of rational expectations modelling.[3]

Now it is well-known that the fundamental news shock displaces the effects of the future shock, now partially correctly forecast, from the future to the present and has little effect on the total variance of macro variables (see Le et al, 2016 where this point is carefully explored and demonstrated). What these authors appear to be claiming is that the extraneous news shock may have a major effect on macro variance because it consists of people expecting what will not happen.

We use the model of Schmitt-Grohe and Uribe (2012) to illustrate that when this restriction is imposed it guarantees that extraneous news shocks have little effect on the behaviour of these DSGE models.

Schmitt-Grohe and Uribe examined the share of macro variance accounted for by news about a variety of shocks to a DSGE model of the US. Their model is an RBC model augmented with four real rigidities (internal habit formation in consumption, investment adjustment costs, variable capacity utilisation, and imperfect competition in labour markets). They estimate the news shocks using both Bayesian and classical likelihood-based methods, allowing the extraneous shock to be estimated freely. Using their codes and data we have been able to replicate their work and show on it the force of our critique.

Table 1 shows our replication of part of Table V in Schmitt-Grohe and Uribe (2012). It shows the share of the main macro variables' variance that comes from all the news shocks when using the coefficients estimated

[2] Notice that the regressions are both unbiased as the errors are in both cases exogenous and independent of the right hand side variable. Thus w_t consists of RD_t events that do not cause u_{t+1} — 'failed R&D'; ε_{t+1} consists of u_{t+1} events that are not caused by RD_t — 'other-sourced productivity'.

[3] Plainly it is possible for there to be modelling approaches other than rational expectations. There are models of learning, of erroneous beliefs, and of behavioural biases, to mention just a few. Such approaches are also testable (e.g. Liu and Minford, 2012). But the point here is that if the models being proposed assume rational expectations, then this implies restrictions on the news errors. To our knowledge all this work on news shocks assumes rational expectations and so do we in this paper.

by maximum likelihood. Notice how large this is, nearly 49% of output variance for example. As noted above if the news shock consisted only of the fundamental element, it could only have a negligible effect on macro variance such as that of output. Thus these shares would have to be the shares of extraneous news shocks in macro variances.

	Y	C	I	h
Maximum Likelihood Estimation	48.7298	70.3834	40.5834	71.8180

Table 1: Share of Unconditional Variance Explained by Anticipated Shocks in Schmitt-Grohe and Uribe (2012)

Yet Table 2 shows what the actual shares of extraneous news shocks are in macro variances when we impose the restriction above from signal extraction under rational expectations. Depending on how large ϕ is assumed to be for all these shocks, the share of variances of these major macro variables drops to quite low levels. Of course, with $\phi = 0$ there are no news shocks and therefore they account for 0% of the variance of the variables, but even with $\phi = 0.5$ the extraneous news shocks, and so in effect total news shocks, account for less than 17% of output variation against 48% in Schmitt-Grohe and Uribe's estimate[4].

ϕ	Y	C	I	h
0.0	0.0000	0.0000	0.0000	0.0000
0.1	5.9829	2.7939	10.1744	4.2412
0.2	10.6363	4.9669	18.0878	7.5399
0.3	13.9602	6.5191	23.7403	9.8961
0.4	15.9545	7.4504	27.1317	11.3099
0.5	16.6192	7.7608	28.2622	11.7811

Table 2: Share of Unconditional Variance Explained by Extraneous Shocks under Rational Expectations Restriction

The reason for their result is that they do not impose this restriction on the variance of the extraneous news shocks. What we can see here is that these extraneous shocks, when their variance is appropriately restricted, can have only a small effect on macro variances. Since the accurately forecast part of the news shock will also only have a small effect, the effect of news shocks on macro volatility must also be small.

3 Conclusions

Recent work on news shocks has found that they can have big effects on the variances of macro variables in a variety of DSGE models. These news shocks are related to future events that are partially-correctly forecast at an earlier date, what we call the fundamental news shock, but are also subject to a forecast error, which we call the extraneous news shock. The former is not generally found to have much effect on macro variance since it simply represents an advancing in time of the fundamental shock's effect; the latter extraneous shock is the driver of this variance. The usual practice in this work is to estimate the extraneous shock without any restriction on its variance. However we show in this paper that the signal extraction procedures under rational expectations imply a particular restriction on this variance, related to the variance of the future event being forecast. Intuitively we can say that the future event's possible variation places natural limits on the variation of its forecast error, given that the event is partially known. When this restriction is duly enforced in estimation of the extraneous error variance, then we find that news shocks have little effect on macro variance, regardless of the model environment. The reason is that the extraneous error variance is fairly small, while the advancing of the date at which the future event is partially known simply creates a lead in the error process without changing the time series property of the shock.

[4] $var(\epsilon) = \phi(1-\phi)var(u)$ is maximised when $\phi = 0.5$.

References

[1] Fujiwara, I., Horise, Y. and Shintani, M (2011). 'Can news be a major source of aggregate fluctuations? A Bayesian DSGE approach', *Journal of Money, Credit and Banking*, 43(1), 1–29.

[2] Gortz, C. and Tsoukalas, J. D. (2017). 'New and Financial Intermediation in Aggregate Fluctuations', *Review of Economics and Statistics*, 99(3), 514–530.

[3] Kamber, G., Theodoridis, K. and Thoenissen, C. (2017). 'News-driven business cycles in small open economies', *Journal of International Economics*, 105, 77–89.

[4] Khan, H. and Tsoukalas, J. D. (2012). 'The quantitative importance of news shocks in estimated DSGE models', *Journal of Money Credit and Banking*, 44 (8), 1535–1561.

[5] Le, V. P. M, Meenagh, D. and Minford, A. P. L. (2016) 'A note on news about the future: the impact on DSGE models and their VAR representation', Cardiff Economics Working Papers E2016_11.

[6] Liu, C. and Minford, P. (2014). 'Comparing behavioural and rational expectations for the US post-war economy', *Economic Modelling*, 43, (C), 407–415.

[7] Minford, P. and Peel, D. (2002) Advanced Macroeconomics- a primer, Edward Elgar.

[8] Schmitt-Grohe, S. and Uribe, M. (2012). 'What's News in Business Cycles,' *Econometrica*, 80(6), 2733–2764.