News Shocks and Asset Price Volatility in a DSGE Model

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Motivation

- Asset prices seem unrelated to the current fundamentals and are very volatile.
- Cochrane (1994) attributes our (economists') lack of understanding of business cycles to shocks unobservable to econometricians but observable to agents — News Shocks
- Recently business cycle models with news shocks gained a lot of attention and achieved some successes.
- "News Shocks" may help explain asset price puzzles.
    - e.g. Link between "current fundamental" and asset price becomes weaker when agents receive news about future.
- Related Literature
    - Business Cycle with News Shocks: Beaudry and Portier(2004, 2007), Jaimovich and Rebelo(2009), Schmitt-Grohe and Uribe (2008), Christiano, Ilut, Motto, and Rostagno (2007),
    - News Shocks and Asset Prices: Beaudry and Portier(2006), West (1988).

Motivation

- However, West (1988) shows that
  - in a present discounted value model (with constant discounting)[PVM], the conditional variance of asset prices is less volatile if agents have more information than the history of cash flows given the stochastic process of underlying cash flows.
    - that is, more information would reduce asset price volatility in a partial equilibrium setting.
- So introduction of “news shocks” may make asset price puzzle worse on the volatility front though disconnecting the asset prices from current fundamentals.

This Paper

- Proposes a way to introduce news shocks in a present discount value model that keeps asset price volatility high relative to fundamentals.
  - In a PVM, while introducing news always reduces (or keeps) the conditional variance of asset prices, it does not imply that the conditional variance of asset prices relative to underlying cash flow has to be low.
    1. Relative to the world without news
    2. Relative to the cash flow process
  - One can use the same mechanism of the "magnification effects" literature, e.g., Frenkel (1976), when one introduces news shocks.

This Paper

- **More importantly, this paper shows that in GE, introduction of news may increase asset price volatility relative to the world without news, i.e. the same stochastic processes but agents do not observe news.**
  - Does not try to match the asset price volatility in the data.
  - We provide a simple "counterexample" to show the conjecture "more information will always reduce asset price volatility", based on the West's theorem, cannot extend to a GE environment where "more information" alters agents behavior.

Preview of Results

- In a present discounted value model with given cash flow process, we show that
  - If news about future cash flow is correlated with current surprise then this cash flow process has serial correlation;
  - Thus, this will keep asset price volatility high relative to underlying cash flow in a simple PVM or GE where magnification effect can be operative.
- We investigate how asset prices volatility is affected by introduction of news in a GE setting. We find that
  - News about future productivity can change agents' behavior, e.g., consumption, pricing and so on.
  - The dividend process changes accordingly.
  - Therefore, asset price volatility can be higher depending on the parameter values relative to the world without news.
  - That is, providing more information does not necessarily reduce asset price volatility in GE.

Outline

- Review of West's Theorem
  - More information reduces asset price volatility in present discount value model.
- Results in PE
  - Correlated news shocks can keep asset price volatility high relative to the cash flow.
- Results in GE
  - Introduction of news can increase asset price volatility relative to the world without news.
- Conclusions

Theorem by West (1988)

Let $\mathcal{F}_t$, be the linear space spanned by the current and past values of a finite number of random variables, with $\mathcal{F}_t$, a subset of $\mathcal{F}_{t+1}$ for all t. Let f_t, be one of these variables. Let $\mathcal{H}_t$, and $\mathcal{I}_t$ be subsets of $\mathcal{F}_t$ consisting of the space spanned by current and past values of some subset of the variables in $\mathcal{F}_t$ including **at a minimum current and past values of f_t**. Let $\mathrm{P}(\cdot|\cdot)$ denote linear projections.

$$\text{PVM: } x_t(\mathcal{F}_t) = \sum_{j=0}^{\infty} \beta^j \, \mathrm{P}(f_{t+j}| \; \mathcal{F}_t) \quad \text{where } 0 < \beta < 1$$

If $\mathcal{H}_t \subset \mathcal{I}_t$ then,

$$\mathrm{Var}(x_t(\mathcal{I}_t)|\mathcal{I}_{t-1}) \leq \mathrm{Var}(x_t(\mathcal{H}_t)|\mathcal{H}_{t-1})$$

where

$$\mathrm{Var}(x_t(\mathcal{F}_t)|\mathcal{F}_{t-1}) \equiv \mathrm{E}[x_t(\mathcal{F}_t) - \mathrm{P}(x_t(\mathcal{F}_t)|\mathcal{F}_{t-1})]^2$$

Theorem by West (1988)

Points:

- Any additional information, including news about future cash flow, can *only* reduce (never increase) the asset price volatility.
- However, it does not necessarily imply that the asset price volatility has to be lower than volatility of cash flow.
- Nonetheless, including "news" makes it harder to generate higher volatility in a partial equilibrium setting.
- Note that f_t is given, i.e., cash flow is exogenous.

Definition of news

What is news?

- News (new information about future) is information that is *useful* to predict *future* value of some variables. In our paper, we label
  - news about future as "news shocks"
  - new information about today as "current shocks."
    - A lot of empirical papers on 'news' are about new information about today, i.e. current shocks.
- We call
  z_t a news about f_t, if $\text{Var}(f_{t+k}|\mathcal{H}_t, z_t) < \text{Var}(f_{t+k}|\mathcal{H}_t)$ where $\mathcal{H}_t$ is a linear space spanned by at a minimum a history of f_t (current and past value).

Example: Introducing news shocks in PVM

$$f_t = f_{t-1} + \varepsilon_t + z_{t-1}$$

where $(\varepsilon_t, z_t)'$ are jointly i.i.d. normal zero mean processes, with $\mathrm{Var}(\varepsilon_t) = \sigma_1^2$, $\mathrm{Var}(z_t) = \sigma_2^2$ and $\mathrm{Cov}(\varepsilon_t, z_t) = \varrho\sigma_1\sigma_2$ and $-1 < \varrho < 1$. i.e., correlation between "news shocks (z_t)" and "current shocks(ε_t)" to be ϱ and $\mathrm{Var}(\Delta f_t) = \sigma_1^2 + \sigma_2^2$.

$$z_t = \varrho\frac{\sigma_2}{\sigma_1}\varepsilon_t + \eta_t$$

where η_t is orthogonal to ε_t and $\mathrm{Var}(\eta_t) = (1 - \varrho^2)\sigma_2^2$.

$$\begin{aligned} \text{So, } f_t &= f_{t-1} + \varepsilon_t + z_{t-1} && \text{News} \\ &= f_{t-1} + \varepsilon_t + \varrho\frac{\sigma_2}{\sigma_1}\varepsilon_{t-1} + \eta_{t-1} && \text{Delayed} \\ &= f_{t-1} + \theta_t + \varrho_\theta\theta_{t-1} && \text{Econometrician} \end{aligned}$$

Example: Asset Price Implication

The asset price at time t conditional on $\mathcal{I}_t$ is

$$x_t(\mathcal{I}_t) = \sum_{j=0}^{\infty} \beta^j \operatorname{E}(f_{t+j}|\mathcal{I}_t) = \frac{1}{1-\beta} f_t + \frac{\beta}{1-\beta} z_t$$

$$x_t(\mathcal{H}_t) = \sum_{j=0}^{\infty} \beta^j \operatorname{E}(f_{t+j}|\mathcal{H}_t) = \frac{1}{1-\beta} f_t + \frac{\beta}{1-\beta} \varrho \frac{\sigma_2}{\sigma_1} \varepsilon_t.$$

Note that when agents observe news asset price depends not only on the current fundamental but also on the 'news' shock z_t.

- We might want to reconsider how to evaluate the asset price model empirically.
- See for instance Engel, Mark, and West (2008) on exchange rates. (vs. Meese and Rogoff)
- The same logic applies to equity as well.

The Volatility of Asset Price

$$\mathrm{Var}(x_t(\mathcal{I}_t)|\mathcal{I}_{t-1}) = \mathrm{Var}\left(\frac{1}{1-\beta}(\varepsilon_t + \beta z_t)\right)$$
$$= (1-\beta)^{-2}\left((\sigma_1^2 + 2\beta\varrho\sigma_1\sigma_2 + \beta^2\sigma_2^2)\right)$$
$$\mathrm{Var}(x_t(\mathcal{H}_t)|\mathcal{H}_{t-1})) = \mathrm{Var}\left(\frac{1}{1-\beta}(\varepsilon_t + \eta_{t-1} + \beta\varrho\frac{\sigma_2}{\sigma_1}\varepsilon_t)\right)$$
$$= (1-\beta)^{-2}\left((\sigma_1^2 + 2\beta\varrho\sigma_1\sigma_2 + [\beta^2 + (1-\beta^2)(1-\varrho^2)]\sigma_2^2)\right).$$

- News reduces volatility of asset prices relative to the world w/o news.
- However, when news shocks are correlated (i.e. higher ϱ) with current shocks, then the asset price volatility can be high relative to the fundamental, which does not depend on ϱ. *Magnification effects*.
- Correlated news shocks disconnect asset prices from current fundamental while keeping the asset price volatility high.

General Equilibrium: Main Results

- News about future productivity changes agents' behavior.
- Therefore, asset price volatility can be higher than in the world without news, where the exogenous productivity process is the same but agents cannot observe news about productivity.
- That is, providing more information does not necessarily reduce asset price volatility relative to the world without news.

Model Setup

Households

$$\max_{C_t(j),M_t(j),L_t(j)} \mathrm{E}_t \sum_{s=t}^{\infty} \frac{C_s(j)^{1-\rho}}{1-\rho} + \frac{\kappa_1}{1-\varepsilon}\left(\frac{M_s(j)}{P_s}\right)^{1-\varepsilon} - \frac{\kappa_2}{1+\psi} L_s(j)^{1+\psi},$$

where $C_t(j) \equiv \left[\int_0^1 C_t(j,i)^{(\lambda-1)/\lambda} di\right]^{\lambda/(\lambda-1)}$, and s.t. budget constraints. Firms set price one period in advance to maximize expected profit and supply goods as demanded.

$$Y_t(i) = A_t L_t(i).$$

Two exogenous variables. Money M_t and productivity A_t.

Shocks

$$\ln A_t \equiv a_t = a_{t-1} + \nu_{1,t} + \underbrace{\nu_{2,t-1}}_{\text{news}}$$

$$\ln M_t \equiv m_t = m_{t-1} + \mu_{1,t} + \underbrace{\mu_{2,t-1}}_{\text{news}}$$

- We assume no correlation between current shocks and news shocks in the presentation. (see paper for correlated case.)
- News about future money stock can be regarded as monetary policy announcement.
    - The known reaction to productivity can be also regarded as 'news' (see paper.)

Solution

Surprise to the equity price (equity: claim to the firm profit)

$$
\begin{aligned}
q_{t+1} - \mathrm{E}_t\, q_{t+1} =& (\Lambda_1 + \Lambda_2)\nu_{1,t+1} + \Lambda_2 \nu_{2,t+1} \\
& + \Lambda_m \left[(1-\beta)\varepsilon(\mu_{1,t+1}) + \beta(\mu_{1,t+1} + \mu_{2,t+1})\right]
\end{aligned}
$$

where

$$
\begin{aligned}
\Lambda_1 \equiv& (1-\beta)\frac{\zeta}{1-\zeta}(\psi+1) \\
\Lambda_2 \equiv& \left\{ \left[1 + (1-\beta)\left(\frac{1-\rho}{\rho} - \frac{\zeta}{1-\zeta}\frac{\rho+\psi}{\rho} \right) \right] \rho \left(1 - \frac{1}{\varepsilon} \right) + (1-\rho) \right\} \beta \frac{\psi+1}{\rho+\psi} \\
\Lambda_m \equiv& \left[1 + (1-\beta)\left(\frac{1-\rho}{\rho} - \frac{\zeta}{1-\zeta}\frac{\rho+\psi}{\rho} \right) \right]
\end{aligned}
$$

(We will ignore money shocks for simplicity.)

With or Without News Shocks

Equity price (claim to the firm profit) surprise

- With news

$$q_{t+1}(\mathcal{I}_{t+1}) - \mathrm{E}(q_{t+1}(\mathcal{I}_{t+1})|\mathcal{I}_t) = (\Lambda_1 + \Lambda_2)\underbrace{\nu_{1,t+1}}_{\text{current}} + \Lambda_2\underbrace{\nu_{2,t+1}}_{\text{news}}$$

- Without news. When agents do not observe news, 'current' surprise component is $\nu_{1,t+1} + \nu_{2,t}$.

$$q_{t+1}(\mathcal{H}_{t+1}) - \mathrm{E}(q_{t+1}(\mathcal{H}_{t+1})|\mathcal{H}_t) = (\Lambda_1 + \Lambda_2)(\nu_{1,t+1} + \nu_{2,t})$$

- Thus, the difference of conditional variances are

$$\mathrm{Var}(q_{t+1}(\mathcal{I}_{t+1})|\mathcal{I}_t) - \mathrm{Var}(q_{t+1}(\mathcal{H}_{t+1})|\mathcal{H}_t) = -(\Lambda_1 + 2\Lambda_2)\Lambda_1\sigma^2_{\nu 2}.$$

  - Sign of $\Lambda_1 + 2\Lambda_2$ is the key.

With or Without News Shocks 2

Recall

$$\Lambda_1 \equiv (1-\beta)\frac{\zeta}{1-\zeta}(\psi+1)$$

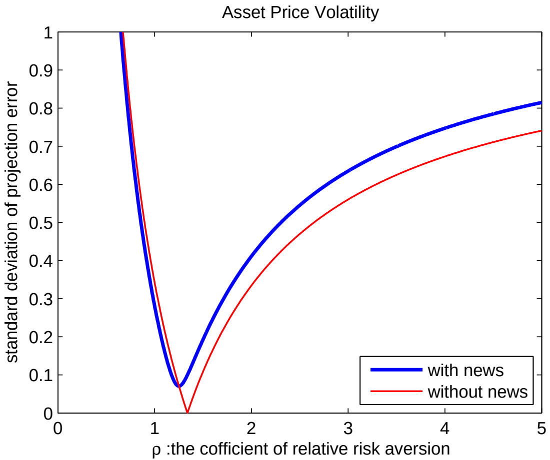
$$\Lambda_2 \equiv \left\{ \left[1+(1-\beta)\left(\frac{1-\rho}{\rho}-\frac{\zeta}{1-\zeta}\frac{\rho+\psi}{\rho}\right)\right]\rho\left(1-\frac{1}{\varepsilon}\right)+(1-\rho)\right\}\beta\frac{\psi+1}{\rho+\psi}$$

If $\varepsilon = 1$ and $\psi = 0$, then $\Lambda_2 = (1-\rho)\beta\frac{1}{\rho}$.

$$\Lambda_1 + 2\Lambda_2 = 2\beta\frac{1-\rho}{\rho} + (1-\beta)\frac{\zeta}{1-\zeta}$$

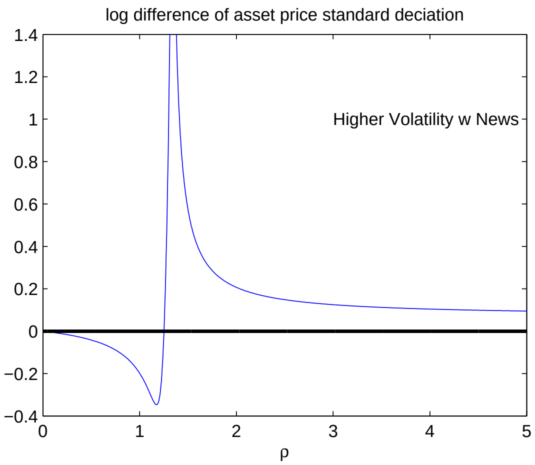
So the equity price can be more volatile than without news when $\rho \geq (1 - \frac{1-\beta}{2\beta}\frac{\zeta}{1-\zeta})^{-1}$.

How big is the effect of news?



$$\varepsilon = 1,\ \psi = 0,\ \zeta = 2/3,\ \beta = 0.95$$

How big is the effect of news?



$$\varepsilon = 1,\ \psi = 0,\ \zeta = 2/3,\ \beta = 0.95$$

Intuition

Why extra information to agents can increase asset price volatility?
When agents know about future, they behave differently.

- current shocks have two offsetting effects on equity return.
  - With nominal rigidity, positive current shocks on productivity have redistribution effects as in Engel and Matsumoto (2009): increase current profit.
  - But in the future, higher productivity reduce nominal profit because the price goes down as it is cheaper to produce: reduce future profit.
- news shocks have only second effects.

Note that dividend process is not invariant to information set unlike the assumption in West's theorem. That's why one cannot extend the conjecture derived from West (1988)

Other Results in the Paper

In the paper,

- We setup two country world to study
    - exchange rates
    - relative equity returns
- We find
    - exchange rates volatility cannot be increased by the introduction of news with preset price as exchange rates looks like a simple present discount value model of relative money supply. But magnification effects can be used to induce higher volatility relative to fundamentals as shown in PE.
    - the volatility of relative equity returns can increase with the introduction of news relative to the world without news. Similar to what we have shown.

Conclusion

In this paper,

- We argue that introduction of news shocks helps to understand disconnect between asset prices and current fundamentals.
- We show that correlated news shocks in a PVM generate higher asset price volatility relative to fundamentals.
- We show that introduction of news shocks does not necessarily reduce asset price volatility in a simple DSGE model.

For future

- Realistic DSGE modeling. (e.g. leverage, more frictions)
- Relate 'news' to unobservable stochastic discount factor.