Expectations Driven Business Cycles: An Empirical Evaluation

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June 2009

Expectations Driven Business Cycle Hypothesis

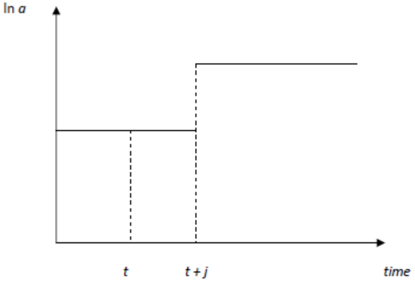
- Expectations of future fundamentals a driving force behind aggregate fluctuations
  - Pigou (1927)
  - Beaudry and Portier (2004 and 2006): expectations of future technological change drive the business cycle
- Potentially very appealing idea
- Is there empirical evidence in favor of this theory of fluctuations?

News Shock

- Example process for log technology:

$$\ln a_t = \ln a_{t-1} + \varepsilon_{1,t} + \varepsilon_{2,t-j}$$

- ε_2 is a "news shock": a technology shock anticipated by agents in advance

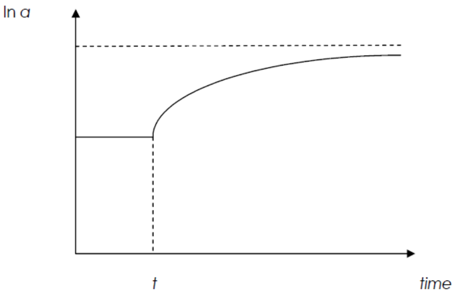


News Shock

- Alternative "smooth" news process:

$$\begin{aligned} \ln a_t &= g_{t-1} + \ln a_{t-1} + \varepsilon_{1,t} \\ g_t &= \rho g_{t-1} + \varepsilon_{2,t} \end{aligned}$$

- ε_2 is a "news shock": a technology shock anticipated by agents in advance



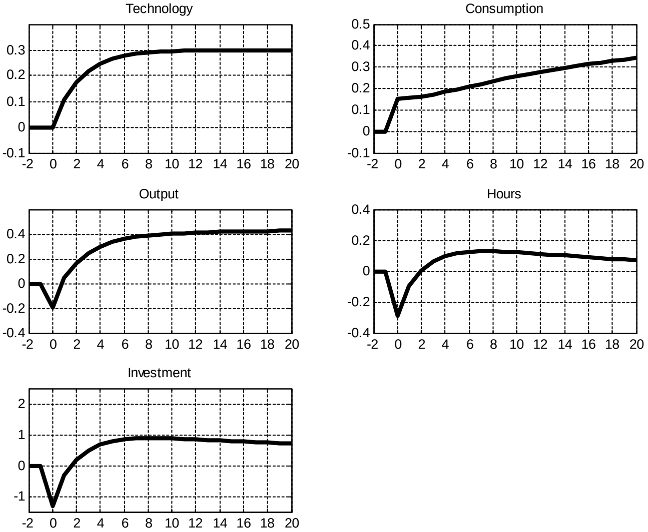
Questions

- Are there news shocks in the data?
- What are the effects of news shocks on macro variables?
- Motivations:
  - Empirical: are news shocks an important source of business cycles?
  - Theoretical: how do empirical responses to a news shock compare with predicted responses from standard models?

Appeal

- The idea of news about future fundamentals driving business cycles is appealing
  - Intuitively plausible
  - If good news about future can cause a "boom" today, then a realization worse than expected will cause a "bust"
    - Boom-bust cycles (i.e. Pigou cycles) absent any change in fundamentals at all
  - Could generate recessions absent large technological regress
- Problem: story doesn't work in most standard models
  - Good news causes a bust, not a boom, and induces negative comovement between consumption and output, hours, and investment
    - Completely at odds with basic fact of strong, positive aggregate comovement

News Shocks in a Simple RBC Model



Existing Empirical Evidence

- Beaudry and Portier (2006), Beaudry, Dupaigne, and Portier (2008), Beaudry and Lucke (2008)
  - Use structural vector auto regression (VAR) techniques and argue:
    - News shocks about future technology lead to positive, broad-based comovement
    - News shocks explain large fraction of forecast error variance of aggregate variables at business cycle frequencies
- Partly in response to these findings, a literature has developed attempting to modify standard DSGE models in such a way as to make news shocks work
  - Beaudry and Portier (2004), Jaimovich and Rebelo (2008), Den Haan and Kaltenbrunner (2006)
  - Has not proven an easy task

This Paper

- Implements a general approach to identification of news shocks
  - Shock which best explains variation in future measured technology among all structural shocks orthogonal to technology innovations in a VAR model
- Findings:
  - Good news about future technology → rising consumption but falling output, hours, and investment
    - Impulse responses broadly consistent with implications of a simple neoclassical model
  - News shocks explain relatively modest fraction of variance of aggregate variables at business cycle frequencies
- Conclusion:
  - News shocks not an important source of fluctuations
  - Standard models not fundamentally flawed

Identifying News Shocks and Implications for Macro Aggregates

- Since news shock is contemporaneously orthogonal to true technology, identification must come from surprise movements in variables other than technology
  - Vector autoregression (VAR) a natural way to proceed
    - Potential "invertibility" problems?
  - How to measure true technology? Total factor productivity (TFP), important to control for unobserved input variation
    - Need a measure of true technology because of the orthogonality restriction
    - Use a quarterly version of Basu, Fernald, and Kimball (2006) TFP measure
    - Results robust with alternative measures of TFP

Measuring True Technology

- Solow residual:

$$y_t = a_t f(k_t, n_t)$$

$$\Delta \ln a_t = \Delta \ln y_t - \alpha \Delta \ln k_t - (1-\alpha)\Delta \ln n_t$$

  - TFP is the residual after measuring y, k, n, and α in the data
    - Problem: unobserved input variation, potentially in both capital and labor

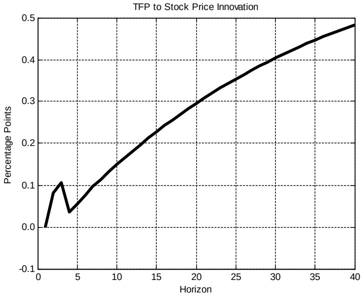
- "Corrected" TFP:

$$y_t = a_t f(u_t k_t, e_t n_t)$$

$$\Delta \ln a_t = \Delta \ln y_t - \alpha(\Delta \ln k_t + \Delta \ln u_t) - (1-\alpha)(\Delta \ln n_t + \Delta \ln e_t)$$

  - Basu, Fernald, Kimball (2006): exploit first order condition to proxy for unobserved variation in both capital and labor

Beaudry and Portier's Essential Observation:



- Response of TFP to orthogonalized stock price innovation in bivariate VAR looks like a news shock
  - In expanded VAR, leads to broad-based expansion in advance of TFP improvement
    - Response of TFP is much more delayed in larger system

Improvements Over Existing Empirical Work

- Bigger VAR with more variables
  - Stock price innovation is not sufficient to identify news shock
  - More variables alleviates any potential "invertibility" issue
- More general approach to identification
  - A pure recursive identification likely won't work
  - Long run restrictions often perform poorly in practice
- Verify effectiveness of empirical approach through simulation

Benchmark VAR in This Paper

- Benchmark VAR including TFP, "information" variables, and macroeconomic aggregates
  - TFP: quarterly version of Basu, Fernald, and Kimball (2006) utilization corrected Solow residual
  - Information variables: stock prices, consumer confidence, consumer prices
  - Macroeconomic aggregates: output, hours, consumption
- x_t stacked $N \times 1$ vector of these variables ($N = 7$) with T observations.
  - Variables either enter in levels or as a stationary VECM representation

VAR Notation

- Reduced form moving average:

$$x_t = B(L)u_t$$

- u_t a $N \times 1$ vector of innovations with variance-covariance matrix Σ
- Structural shocks to innovations:

$$u_t = A_0 \varepsilon_t$$

$$A_0 A_0' = \Sigma$$

- Structural impulse response function: $B(L)A_0$

Variance Decomposition

- h step ahead forecast error in terms of structural shocks is:

$$x_{t+h} - E_{t-1}x_{t+h} = \sum_{\tau=0}^{h} B_\tau A_0 \varepsilon_{t+h-\tau}$$

- Fraction of forecast error variance of variable i due to shock j at horizon h is then:

$$\phi_{i,j}(h) = \frac{\sum_{\tau=0}^{h} B_{i,\tau}\alpha\alpha' B_{i,\tau}'}{\sum_{\tau=0}^{h} B_{i,\tau}\Sigma B_{i,\tau}'}$$

- Above α is j^{th} column of impact matrix A_0, while $B_{i,\tau}$ is the i^{th} row of moving average coefficient matrix at horizon τ

Identifying Assumption

- How to identify impact matrix A_0?
  - Not unique, must impose some restrictions
  - Don't need to identify full matrix, just impulse vector, α, corresponding to news shock
- Assumption: *Technology is driven by two structural disturbances,* ε_1 *and* ε_2*.* ε_1 *affects technology contemporaneously while* ε_2 *affects it with a delay.*
  - Assumption corresponds with theoretical work: ε_1 is standard contemporaneous technology shock and ε_2 is the news shock
    - No restrictions on whether one or both of these shocks have permanent effects
    - Consistent with any lag structure or smooth diffusion process of news into technology

Implication of Identifying Assumption

- Contemporaneous and news shocks completely explain the forecast error variance of TFP at all horizons
- Let TFP be first variable in VAR, contemporaneous technology shock be first shock, and news shock be second shock:

$$\phi_{1,1}(h) + \phi_{1,2}(h) = 1 \quad \forall \; h$$

$$\phi_{1,2}(0) = 0$$

- Identify news shock by picking second column of A_0 to make this expression come as close as possible to holding in the data
- Partial identification – this is enough to identify news shock (and contemporaneous technology shock)

Implementation and Related Literature

- Basic intuitive idea:
  - Consider the entire space of possible orthogonalizations of the reduced form (i.e. all matrices, $\widetilde{A}_0$, satisfying $\widetilde{A}_0\widetilde{A}_0^{'} = \Sigma$)
  - Search over this space for the impulse response vector, α, which (a) has no immediate impact on TFP but (b) maximally explains variation in TFP over some future horizon
- Identification strategy related to work by Francis, Owyang, and Roush (2007), Uhlig (2003 and 2004), and Faust (1998)

Advantages of Identification Strategy

- One to one mapping between theory and identification
    - Only imposes that a limited number of shocks explain variation in TFP
    - Few restrictions on persistence of these shocks or on transmission of news into TFP
- Identifying restriction holds across competing economic models
- Easy to check robustness
    - Vary truncation horizon, H, or variables in the VAR

Alternative Identification Strategies

- Pure recursive identification (BP (2006) or BDP (2008)):
  - If conditions for this interpretation are valid, my identification strategy will (asymptotically) pick out same shock and impulse responses
- Combination of short and long run restrictions (BP (2006) and BL (2008)):
  - Also encompassed by my identification strategy
  - Doesn't fully exploit implications of theory
  - Long run restrictions have poor finite sample properties
    - FOR (2007): medium identification performs better in Monte Carlo simulations than does long run restriction
  - May not be valid anyway
- Estimation of DSGE model (Schmitt-Grohe and Uribe (2008)):
  - Requires taking strong stand on model structure; impose tight priors
    - Potential for misspecification

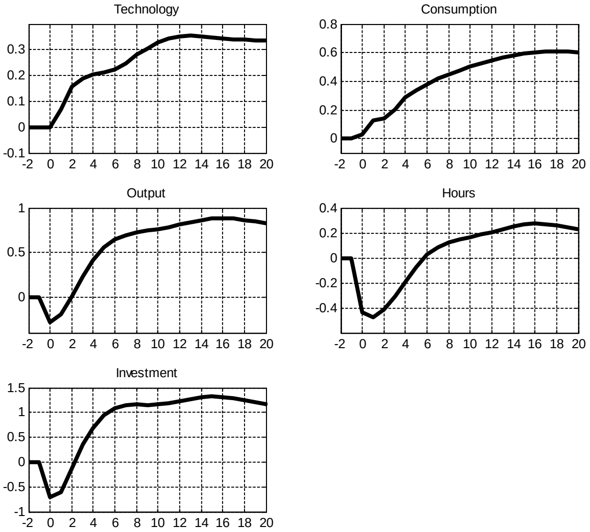
Suitability of Identification Strategy

- Can my strategy identify news shocks from DSGE models?
  - Potential "invertibility" problem?
  - Even if not, SVAR methodology may still perform poorly
- Simulate data from DSGE models augmented with news shocks, apply identification strategy to simulated data
  - Estimate VAR with four lags: technology, output, consumption, hours. Same variables as in empirical part of paper (minus "information" variables)
  - Identify news shock by maximizing contribution to technology's forecast error variance share over 5 years
    - Median correlation between true and identified news shock 80 percent or greater
    - Impulse responses roughly unbiased at low horizons, capture dynamics well; slightly downward-biased at longer horizons

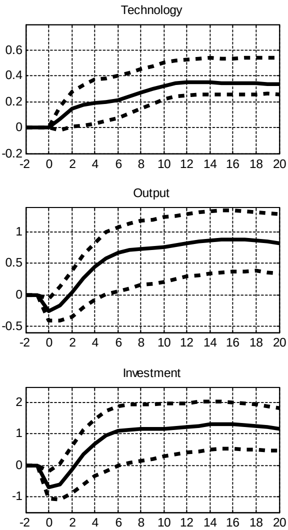
Benchmark Results

- Vector error correction (VECM); results nearly identical from VAR in levels
- Identify news shock by maximizing contribution to TFP forecast error variance over 40 quarters
- Main results:
  - Most of TFP movement occurs relatively soon
  - Negative comovement on impact
  - Aggregate variables track TFP: peak responses occur after peak response of TFP
  - Responses broadly consistent with implications of simple RBC model

Impulse Responses to News Shock



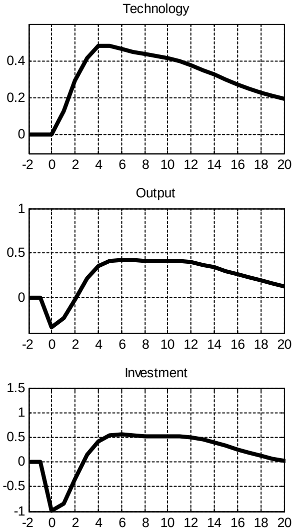
Impulse Responses with Confidence Bands



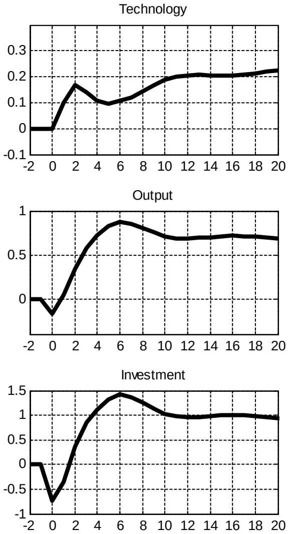
Robustness

- General pattern of impulse responses appears very robust
  - Alternate measures of technology: standard Solow residual, BP's corrected TFP measure, labor productivity
  - Different sample periods
  - Smaller dimensional system
  - VECM vs. levels
  - Lag length
  - Different specifications of the optimization problem underlying identification
    - Longer or shorter truncation horizon; maximize variance share at one horizon as opposed to over several

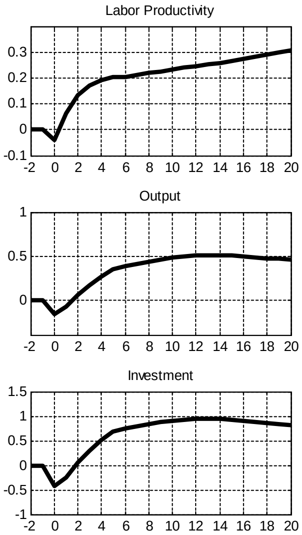
Impulse Responses (Solow Residual)



Impulse Responses (Smaller System)



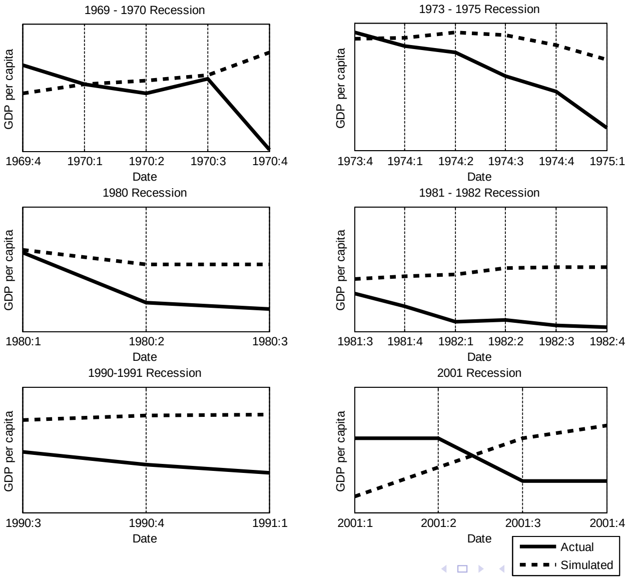
Labor Productivity



Comparison with Existing Work

- My news shock has much larger implications for technology at business cycle frequencies than does shock identified by other authors
  - "it [stock price innovation] has almost no impact on TFP during the first five years" BDP (2008, p. 3)
  - My news shock, along with contemporaneous innovation, explains 90% or more of technology variance at horizons 1-10 years
    - In contrast, combined short/long run restriction leaves as much as 40% unexplained at these horizons
    - Stock price identification does even worse in this regard

Historical Decomposition



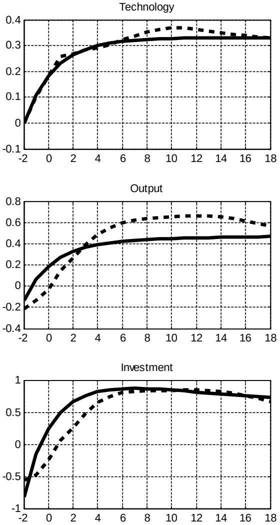
Discussion

- News shocks induce explain a relatively small fraction of forecast error variances of macro aggregates at low horizons
  - More substantial at longer horizons
- Historical decomposition: news shocks particularly poor at accounting for specific episodes
  - Fails to predict output declines in five out of six US recessions since 1961
- Conclusion: news shocks not a particularly important feature of fluctuations

News Shocks and Macro Models

- Most salient feature of aggregate data is broad comovement
- Standard business cycle models do not generate conditional comovement in response to news shocks
- Lots of theoretical work on building models which generate broad-based expansions in response to good news:
  - BP (2004), Jaimovich and Rebelo (2008), Den Haan and Kaltenbrunner (2006), Christiano, Ilut, Motto, and Rostagno (2007)
- My results: this work not necessary
  - Impulse responses to news shocks consistent with a broad class of standard models

Estimated vs. RBC Model Responses



Discussion

- Estimated and RBC model responses are very similar to one another
  - Impact effects are same sign, dynamic paths are qualitatively identical
- Discrepancies:
  - Model doesn't match large swings after a number of quarters (lack of propagation)
  - Consumption jumps by too little on impact, not smooth enough
  - Hours response too large in data
- Bottom line: this very basic neoclassical model is clearly in the ballpark
  - Simple modifications would make it fit better

Conditional vs. Unconditional Comovement

- Stylized fact of comovement refers to unconditional correlations between filtered macro aggregates
- Basic RBC model matches conditional responses to a news shock. Could it match unconditional correlations of data when driven only by news shocks?
- HP filtered correlations with output:

	RBC Model	US Data
Consumption	0.20	0.88
Hours	0.88	0.88
Investment	0.93	0.80
TFP	0.90	0.78

Conclusion

- Implement new approach to identifying news shocks about future technology
- Good news about future:
  - Consumption rises; output, hours, and investment fall on impact
  - Variables track technology rather than anticipate it
  - News shocks account for small fraction of variance of macro aggregates at business cycle frequencies, fail to account for US recessions
  - Estimated impulse responses roughly consistent with standard models
- Conclusion: news shocks about future TFP not an important source of fluctuations

Extensions

- Core question: what are business cycle implications of technology shocks?
  - This paper: two very different kinds of technology shocks
  - Sector specific news shocks?
  - Developed vs. developing economies?
- Methodological contribution: empirical strategy is well-suited for identifying news/expectations shocks in other series of interest
  - Oil, government spending, taxes, monetary policy, etc.
  - Potential econometric challenges

News Shocks in a Basic RBC Model

- Basic RBC model with news shocks:

$$\frac{1}{c_t} = \beta E_t\left((1+r_t)\frac{1}{c_{t+1}}\right) \qquad n_t^{1/\eta} = \frac{1}{c_t}w_t$$

$$w_t = (1-\theta)a_t\left(\frac{k_t}{n_t}\right)^{\theta} \qquad r_t+\delta = \theta a_t\left(\frac{k_t}{n_t}\right)^{\theta-1}$$

$$k_{t+1} = i_t + (1-\delta)k_t \qquad y_t = c_t + i_t$$

$$\ln a_t = g_{t-1} + \ln a_{t-1} + \varepsilon_{1,t} \qquad g_t = \rho g_{t-1} + \varepsilon_{2,t}$$

- Smooth diffusion process of news into actual technology
- Pick ρ and σ_{ε_2} to match estimated empirical response of TFP to news shock; standard calibration of remaining parameters (King and Rebelo (2000))