Expectations Driven Business Cycles: An Empirical Evaluation

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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?
Example process for log technology:

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

\( \varepsilon_2 \) is a “news shock”: a technology shock anticipated by agents in advance.
Alternative “smooth” news process:

\[
\ln a_t = g_{t-1} + \ln a_{t-1} + \varepsilon_{1,t}
\]

\[
g_t = \rho g_{t-1} + \varepsilon_{2,t}
\]

\(\varepsilon_2\) 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

- Technology
- Consumption
- Output
- Hours
- Investment
Existing Empirical Evidence

  - 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
  - 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
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 \( \alpha \) 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
  - 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 \( \Sigma \)

- 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 $\alpha$ 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 $\tau$
How to identify impact matrix $A_0$?

- Not unique, must impose some restrictions
- Don’t need to identify full matrix, just impulse vector, $\alpha$, corresponding to news shock

Assumption: *Technology is driven by two structural disturbances, $\varepsilon_1$ and $\varepsilon_2$. $\varepsilon_1$ affects technology contemporaneously while $\varepsilon_2$ affects it with a delay.*

- Assumption corresponds with theoretical work: $\varepsilon_1$ is standard contemporaneous technology shock and $\varepsilon_2$ 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).
Basic intuitive idea:

- Consider the entire space of possible orthogonalizations of the reduced form (i.e. all matrices, $\tilde{A}_0$, satisfying $\tilde{A}_0\tilde{A}_0' = \Sigma$)
- Search over this space for the impulse response vector, $\alpha$, 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

- Technology
- Consumption
- Output
- Hours
- Investment
Impulse Responses with Confidence Bands

- Technology
- Consumption
- Output
- Hours
- Investment

Sims (Michigan)
Expectations and the Business Cycle
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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)

- **Technology**
  - Graph showing the response of technology over time.

- **Consumption**
  - Graph showing the response of consumption over time.

- **Output**
  - Graph showing the response of output over time.

- **Hours**
  - Graph showing the response of hours over time.

- **Investment**
  - Graph showing the response of investment over time.
Labor Productivity

- Labor Productivity
- Consumption
- Output
- Hours
- Investment

Sims (Michigan)  Expectations and the Business Cycle  06/09  29 / 39
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

1969 - 1970 Recession

1973 - 1975 Recession

1980 Recession

1981 - 1982 Recession

1990-1991 Recession

2001 Recession

Actual

Simulated
News shocks 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.
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:


My results: this work not necessary

- Impulse responses to news shocks consistent with a broad class of standard models
Estimated vs. RBC Model Responses

- Technology
- Consumption
- Output
- Hours
- Investment
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:

<table>
<thead>
<tr>
<th></th>
<th>RBC Model</th>
<th>US Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption</td>
<td>0.20</td>
<td>0.88</td>
</tr>
<tr>
<td>Hours</td>
<td>0.88</td>
<td>0.88</td>
</tr>
<tr>
<td>Investment</td>
<td>0.93</td>
<td>0.80</td>
</tr>
<tr>
<td>TFP</td>
<td>0.90</td>
<td>0.78</td>
</tr>
</tbody>
</table>
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:

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

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

\[
k_{t+1} = i_t + (1 - \delta) k_t \quad y_t = c_t + i_t
\]

\[
\ln a_t = g_{t-1} + \ln a_{t-1} + \varepsilon_{1,t} \quad g_t = \rho g_{t-1} + \varepsilon_{2,t}
\]

- Smooth diffusion process of news into actual technology

- Pick $\rho$ and $\sigma_{\varepsilon_2}$ to match estimated empirical response of TFP to news shock; standard calibration of remaining parameters (King and Rebelo (2000))