A Macroeconomic Model of Equities and Real, Nominal, and Defaultable Debt

Eric T. Swanson
University of California, Irvine

Bank of Canada/Federal Reserve Bank of San Francisco
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San Francisco
November 5, 2015
Motivation

Goal: Show that a simple macroeconomic model (with Epstein-Zin preferences) is consistent with a wide variety of asset pricing facts
- equity premium puzzle
- long-term bond premium puzzle (nominal and real)
- credit spread puzzle
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- financial intermediaries: Adrian-Etula-Muir (2013)
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Implications for Finance:

- unifying explanation for asset pricing puzzles
- structural model of asset prices (provides intuition, robustness to breaks and policy interventions)
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Two key ingredients:
- Epstein-Zin preferences
- nominal rigidities
Households

Period utility function:

\[ u(c_t, l_t) \equiv \log c_t - \eta \frac{l_t^{1+\chi}}{1 + \chi} \]

- additive separability between \( c \) and \( l \)
- SDF comparable to finance literature
- log preferences for balanced growth, simplicity

Flow budget constraint:

\[ a_{t+1} = e^t a_t + w_t l_t + d_t - c_t \]

Calibration: (IES = 1), \( \chi = 3 \), \( l = 1 \) (\( \eta = .54 \))
Generalized Recursive Preferences

Household chooses state-contingent \( \{(c_t, l_t)\} \) to maximize

\[
V(a_t; \theta_t) = \max_{(c_t, l_t)} u(c_t, l_t) - \beta \alpha^{-1} \log [E_t \exp(-\alpha V(a_{t+1}; \theta_{t+1}))]
\]

Calibration: \( \beta = .992 \), RRA \((R^c) = 60 \) \( (\alpha = 59.15) \)
Firms

Firms are very standard:

- continuum of monopolistic firms (gross markup $\lambda$)
- Calvo price setting (probability $1 - \xi$)
- Cobb-Douglas production functions, $y_t(f) = A_t k^{1-\theta} l_t(f)^\theta$
- fixed firm-specific capital stocks $k$

Random walk technology: $\log A_t = \log A_{t-1} + \varepsilon_t$

- simplicity
- comparability to finance literature
- helps match equity premium

Calibration: $\lambda = 1.1$, $\xi = 0.8$, $\theta = 0.6$, $\sigma_A = .007$, $(\rho_A = 1)$, $k_{4Y} = 2.5$
Fiscal and Monetary Policy

No government purchases or investment:

\[ Y_t = C_t \]

Taylor-type monetary policy rule:

\[ i_t = r + \pi_t + \phi_\pi (\pi_t - \bar{\pi}) + \phi_y (y_t - \bar{y}_t) \]

“Output gap” \((y_t - \bar{y}_t)\) defined relative to moving average:

\[ \bar{y}_t \equiv \rho \bar{y}_{t-1} + (1 - \rho \bar{y})y_t \]

Rule has no inertia:

- simplicity

Calibration: \(\phi_\pi = 0.5, \phi_y = 0.75, \bar{\pi} = 0.008, \rho \bar{y} = 0.9\)
Solution Method

Write equations of the model in recursive form
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Divide nonstationary variables \((Y_t, C_t, w_t, \text{etc.})\) by \(A_t\)
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- second-order: risk premia are constant
- third-order: time-varying risk premia
- higher-order: more accurate over larger region
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Model has 2 state variables \( (\bar{y}_t, \Delta_t) \), one shock \( (\varepsilon_t) \)
Impulse Responses

Technology $A_t$
Impulse Responses

Consumption $C_t$

percent

0.0
0.2
0.4
0.6
0.8
1.0

percent

0 10 20 30 40 50
Impulse Responses

Inflation $\pi_t$

ann. pct.
Impulse Responses

Short-term nominal interest rate $i_t$
Impulse Responses

Short-term real interest rate $r_t$
Equity: Levered Consumption Claim

Equity price

\[ p_t^e = E_{t} m_{t+1}(C_{t+1}^\nu + p_{t+1}^e) \]

where \( \nu \) is degree of leverage
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Calibration: \( \nu = 3 \)
Table 2: Equity Premium

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Real $n$-period zero-coupon bond price:

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# Real Yield Curve

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\(^a\)Gürkaynak, Sack, and Wright (2010) online dataset  
\(^b\)Evans (1999)  
\(^c\)Bank of England web site
## Nominal Yield Curve

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Supply shocks make nominal long-term bonds risky: inflation risk.
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<td>0.95</td>
</tr>
<tr>
<td>UK gilts, 1990–2007(^b)</td>
<td>6.20</td>
<td>6.29</td>
<td>6.38</td>
<td>6.47</td>
<td>6.50</td>
<td>6.48</td>
<td>0.28</td>
</tr>
<tr>
<td>macroeconomic model</td>
<td>5.35</td>
<td>5.59</td>
<td>5.80</td>
<td>6.09</td>
<td>6.27</td>
<td>6.44</td>
<td>1.09</td>
</tr>
</tbody>
</table>

\(^a\) Gürkaynak, Sack, and Wright (2007) online dataset
\(^b\) Bank of England web site

Supply shocks make nominal long-term bonds risky: inflation risk
Nominal Term Premium

Nominal term premium $\psi_t^{(40)}$

ann. bp

0

10

20

30

40

50

-10

-8

-6

-4

-2

0

ann. bp
Defaultable Debt

Default-free depreciating nominal consol:

\[ p_t^c = E_t m_{t+1} e^{-\pi_{t+1}} (1 + \delta p_{t+1}^c) \]
Defaultable Debt

Default-free depreciating nominal consol:

\[ p_t^C = E_t m_{t+1} e^{-\pi_{t+1}} (1 + \delta p_{t+1}^C) \]

Yield to maturity:

\[ i_t^C = \log \left( \frac{1}{p_t^C} + \delta \right) \]
Defaultable Debt

Default-free depreciating nominal consol:

\[ p^c_t = E_t m_{t+1} e^{-\pi t+1} (1 + \delta p^c_{t+1}) \]

Yield to maturity:

\[ i^c_t = \log \left( \frac{1}{p^c_t} + \delta \right) \]

Nominal consol with default:

\[ p^d_t = E_t m_{t+1} e^{-\pi t+1} \left[ (1 - 1^d_{t+1}) (1 + \delta p^d_{t+1}) + 1^d_{t+1} \omega_{t+1} p^d_t \right] \]
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Yield to maturity:

\[ i_t^d = \log \left( \frac{1}{p_t^d} + \delta \right) \]

The credit spread is \( i_t^d - i_t^c \)
## Table 5: Credit Spread

<table>
<thead>
<tr>
<th>average ann. default prob.</th>
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<th>average recovery rate</th>
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If default isn’t cyclical, then it’s not risky
Default Rate is Countercyclical

source: Chen (2010)
Recovery Rate is Procyclical

B. Recovery rates

% of Par


source: Chen (2010)
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<td>2.5</td>
<td>143.1</td>
</tr>
</tbody>
</table>
Discussion

1. Endogenous conditional heteroskedasticity
2. IES $\leq 1$ vs. IES $> 1$
3. Volatility shocks
4. Monetary and fiscal policy shocks
5. Financial accelerator
Rudebusch and Swanson (2012) consider similar model with
- technology shock
- government purchases shock
- monetary policy shock
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All three shocks help the model fit macroeconomic variables.
Monetary and Fiscal Policy Shocks

Rudebusch and Swanson (2012) consider similar model with

- technology shock
- government purchases shock
- monetary policy shock

All three shocks help the model fit macroeconomic variables

But technology shock is most important (by far) for fitting asset prices:

- technology shock is more persistent
- technology shock makes nominal assets risky
No Financial Accelerator

With model-implied stochastic discount factor $m_{t+1}$, we can price any asset

Economy affects $m_{t+1} \Rightarrow$ economy affects asset prices

However, asset prices have no effect on economy
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To generate feedback, want financial intermediaries whose net worth depends on assets.

...but not in this paper.
Conclusions

1. The standard textbook New Keynesian model (with Epstein-Zin preferences) is consistent with a wide variety of asset pricing facts/puzzles.

2. Unifies asset pricing puzzles into a single puzzle—Why does risk aversion in macro models need to be so high? (Literature provides good answers to this question).

3. Provides a structural framework for intuition about risk premia.

4. Suggests a way to model feedback from risk premia to macroeconomy.