Irina Zviadadze: Term structure of risk in expected returns

Discussion by Jaroslav Borovička (NYU)

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A BRIEF HISTORY OF ASSET PRICING

1980s: asset pricing puzzles

- Shiller (1982), Hansen, Singleton (1983), Mehra, Prescott (1985)
- inability of existing macro-based models to fit elementary asset-pricing moments

1990s–2000s: a range of proposed solutions

- Campbell, Cochrane (1999), Bansal, Yaron (2004), Rietz (1988), Barro (2006)
- long-run risk, habits, disasters, higher moments, ambiguity, heterogeneity, financial frictions, ...

2010s: a new puzzle

- which of the many models that fit essentially the same aggregate moments is the 'right' description of the underlying risk
- new ways of comparing models to data needed

TAKING INSIGHTS FROM MACRO

Matching dynamic responses

- estimate an ‘empirical’ model (VAR) describing the joint dynamics of a vector of macro variables
- identify ‘structural’ shocks from reduced-form disturbances
    - Christiano, Eichenbaum, Evans (2005), ...
    - technology, monetary policy, financial conditions, preferences, ...
- compare impulse responses to those for analogous shocks in a DSGE model

Asset pricing counterparts

- sensitivity of expected returns at various horizons to identified shocks
- temporal decomposition of risk

Implementation

- A ‘structural’ linear model (Hurwicz (1962))

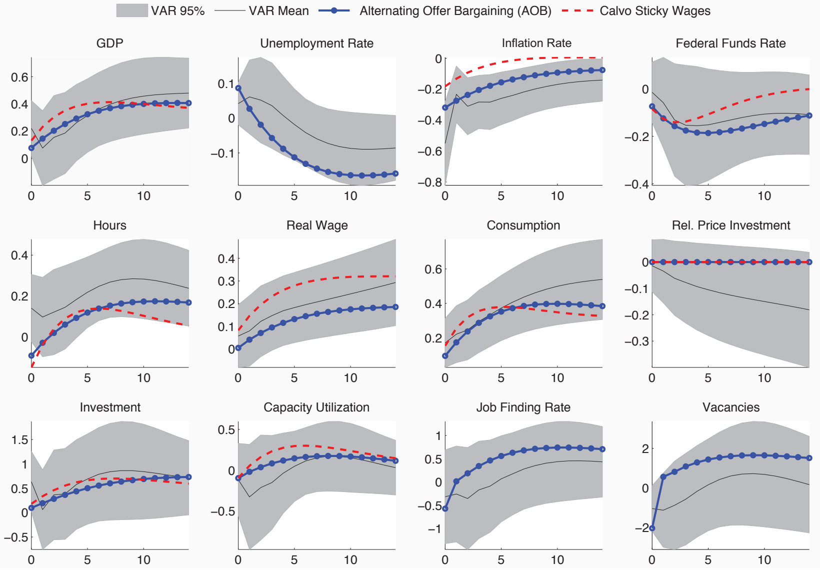
$$\Gamma_0 X_t + \Gamma_1 X_{t-1} = \varepsilon_t \qquad \varepsilon_t \sim N(0, I)$$

  - ε are structural shocks: policy interventions, or changes in the economy
- Estimate a VAR

$$X_t = -\Gamma_0^{-1}\Gamma_1 X_{t-1} + w_t, \qquad w_t = \Gamma_0^{-1}\varepsilon_t$$

  - Identification assumptions needed to infer Γ_0^{-1} from $Var[w_t]$.

Figure 2: Responses to a Neutral Technology Shock: AOB vs. Calvo



SHOCK ELASTICITIES

Cash flows (dividends, consumption) consist of strips with different maturities

- study sensitivity of expected payoffs and expected returns (yields to maturity) of these strips ot alternative shocks
- recover the term structure of exposure to shocks and risk prices assigned to these shocks
  - shock-exposure elasticities
  - shock-price elasticities

Borovička, Hansen (also with Hendricks, Scheinkman)

- decomposition of risk premia to contributions of alternative shocks
- comparisons of theoretical models

This paper: an empirical implementation (plus much more)

Want to formally compare two models

- an 'empirical' model with minimal restrictions (akin a VAR)
- an equilibrium model (e.g., a long-run risk model)

Estimate responses of expected buy-and-hold returns at various horizons to identified shocks

- Assess the term structures of sensitivities of expected returns for alternative shocks

Motivated by reduced-form return forecasting regressions

$$r_{t,t+1} = a + b \log pd_t + w_{r,t+1}$$

- $w_{r,t+1}$ a reduced form shock
- pd_t a function of underlying fundamental sources of risk

$$\log pd_t = q_0 + q_x x_t + q_v v_t + \sigma_{pd} \varepsilon_{pd,t}$$

where x_t is mean consumption growth rate and v_t stochastic variance (both latent)

EMPIRICAL MODEL

$$
\begin{aligned}
\begin{pmatrix} \log r_{t,t+1} \\ \log g_{t,t+1} \\ x_{t+1} \end{pmatrix} &= G \begin{pmatrix} 1 \\ \log g_t \\ x_t \end{pmatrix} + H_v \left(v_{t+1} - E_t v_{t+1} \right) + v_t^{1/2} H \begin{pmatrix} \varepsilon_{g,t+1} \\ \varepsilon_{x,t+1} \\ \varepsilon_{d,t+1} \end{pmatrix} \\
v_{t+1} &= (1 - \varphi_v) + \varphi_v v_t + \sigma_v \left((1 - \varphi_v + 2\varphi_v v_t) / 2 \right)^{1/2} \varepsilon_{v,t+1} \\
\log pd_t &= q_0 + q_x x_t + q_v v_t + \sigma_{pd} \varepsilon_{pd,t}
\end{aligned}
$$

- Implied restriction

$$
\log r_{t,t+1} = \kappa_0 + \kappa_1 \log pd_{t+1} - \log pd_t + \log d_{t,t+1}
$$

- structural shocks $(\varepsilon_{g,t+1}, \varepsilon_{x,t+1}, \varepsilon_{d,t+1}, \varepsilon_{v,t+1})'$
    - interpretation?
- latent variables $x_t, v_t \implies$ estimate using ML

Exogenous dynamics

$$\begin{aligned}
\log g_{t,t+1} &= g + x_t + \gamma_g v_t^{1/2} \varepsilon_{g,t+1} \\
\log d_{t,t+1} &= d + \mu_x x_t + \gamma_d v_t^{1/2} \varepsilon_{d,t+1} \\
x_{t+1} &= \varphi_x x_t + \gamma_x v_t^{1/2} \varepsilon_{x,t+1} \\
v_{t+1} &= (1-\varphi_v) + \varphi_v v_t + \sigma_v \left((1-\varphi_v + 2\varphi_v v_t)/2\right)^{1/2} \varepsilon_{v,t+1}
\end{aligned}$$

Preferences

$$V_t = \left[(1-\beta) C_t^{1-\rho} + \beta \left(E_t\left[V_{t+1}^{1-\gamma}\right]\right)^{\frac{1-\rho}{1-\gamma}}\right]^{\frac{1}{1-\rho}}$$

Equilibrium price-dividend ratio and returns

$$\begin{aligned}
\log pd_t &= q_0 + q_x x_t + q_v v_t \\
\log r_{t,t+1} &= \log r + r_x x_t + r_v v_t + r_{\varepsilon x} v_t^{1/2} \varepsilon_{v,t+1} + r_{\varepsilon d} v_t^{1/2} \varepsilon_{d,t+1} + r_{\varepsilon v} v_{t+1}
\end{aligned}$$

INCREMENTAL EXPECTED RETURNS

Construct τ-period buy-and-hold returns

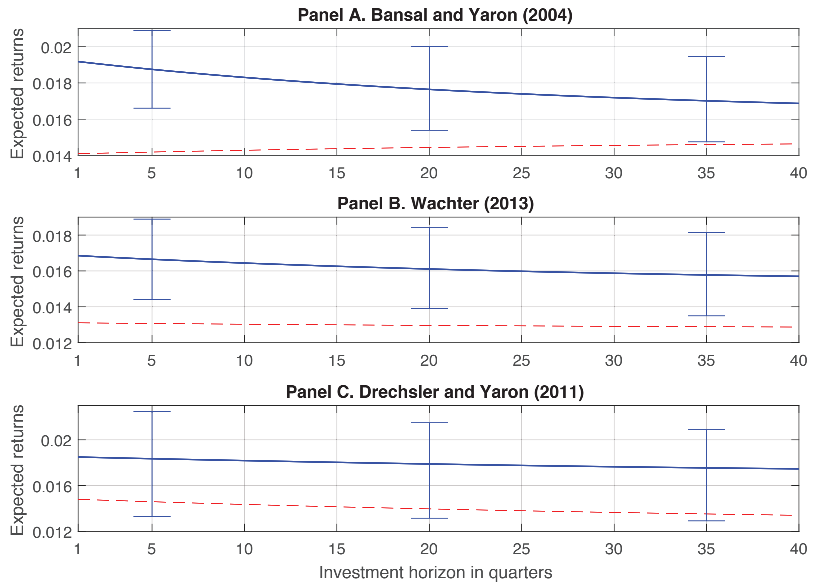
$$r_{t,t+\tau} = \prod_{s=1}^{\tau} r_{t+s-1,r+s}$$

Compare the expected return with a counterfactual

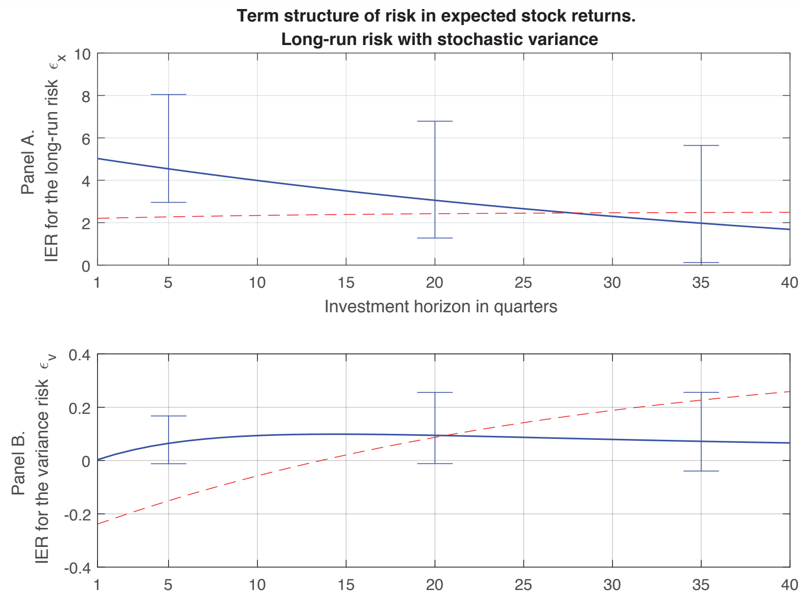
$$\mathcal{IER}\left(r_{t,t+\tau}, \varepsilon_{v,t+1}\right) = E_t\left[r_{t,t+\tau} \mid \mathcal{F}_t, \tilde{v}_{t+1} = v_{t+1} + \Delta_v\right] - E_t\left[r_{t,t+\tau}\right]$$

- sensitivity of expected returns to $\varepsilon_{v,t+1}$ across alternative horizons
    - using stock returns across horizons instead of returns on strips
    - returns on strips can perhaps be reconstructed (if needed)

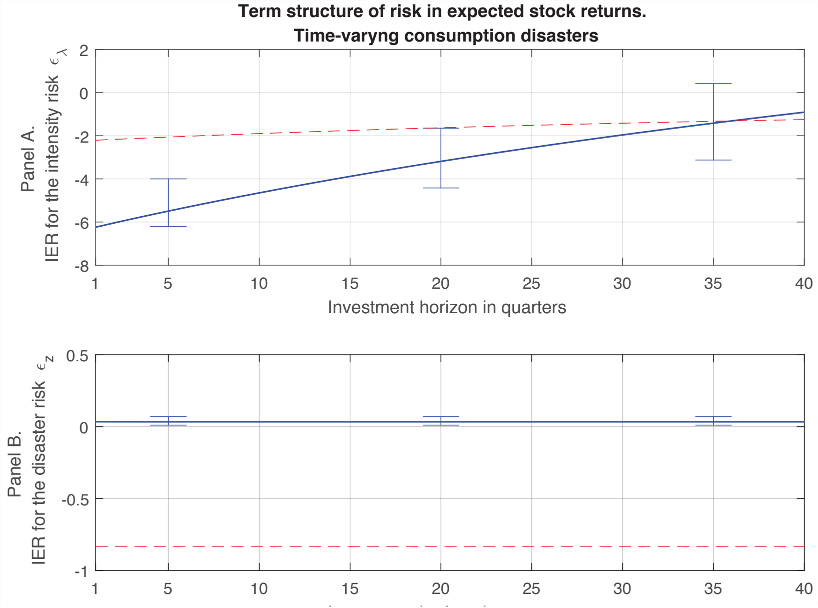
TERM STRUCTRURE OF EXPECTED RETURNS



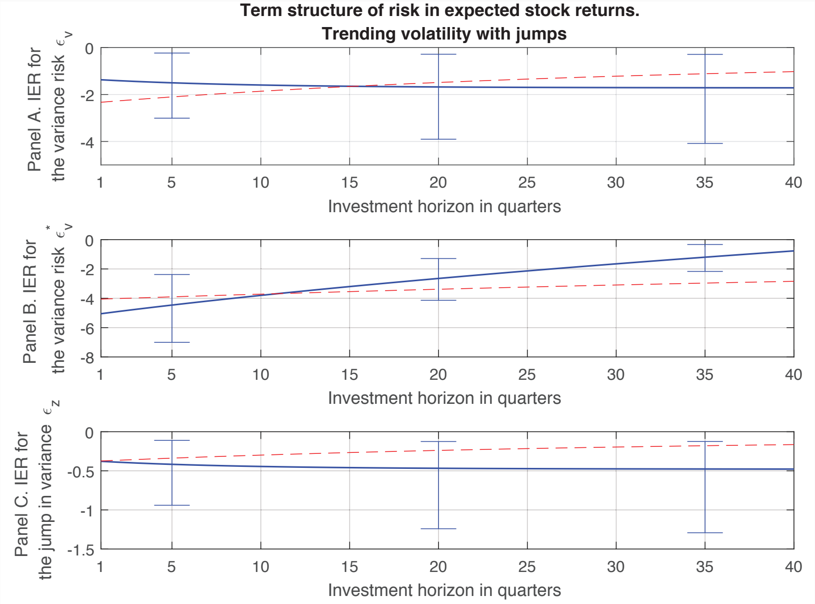
INCREMENTAL EXPECTED RETURNS — BANSAL, YARON (2004)



INCREMENTAL EXPECTED RETURNS — WACHTER (2013)



INCREMENTAL EXPECTED RETURNS — DRECHSLER, YARON (2011)



DISCUSSION

1. Are the alternative models that different?
2. Matching jointly responses of expected returns and expected cash flows
3. Imposing other types of restrictions
4. What are the structural shocks?

ARE THE ALTERNATIVE MODELS THAT DIFFERENT?

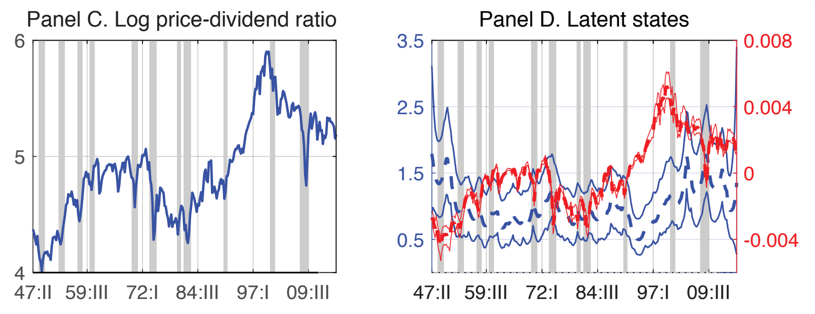
Empirical model motivated by predictability of returns using price-dividend ratio

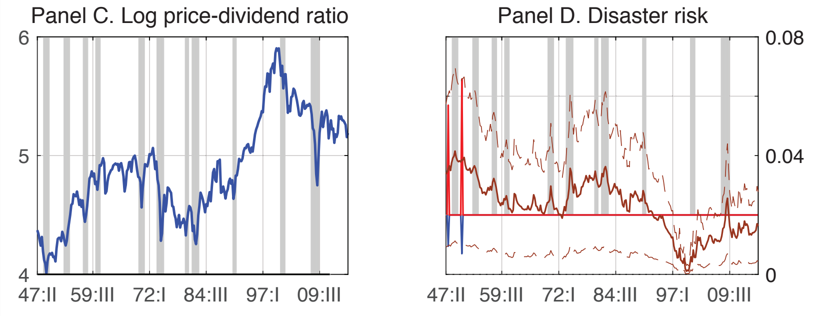
- In each model, the price-dividend ratio is a function of different state variables.
- These latent variables must have similar paths to explain the same path of the price-dividend ratio.

Structural models differ, because

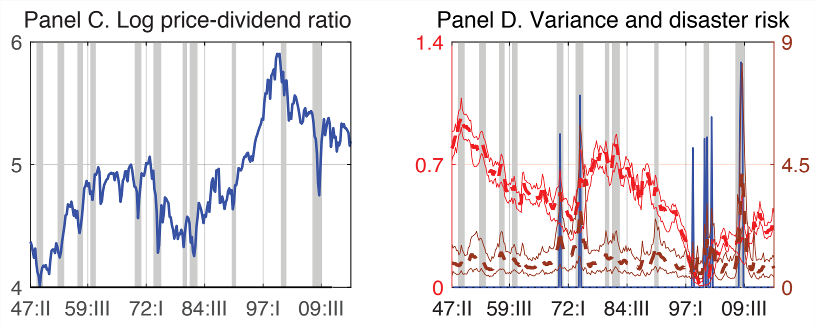
- they impose different parametric restrictions
- they imply different mappings between fundamentals and returns

This paper provides a useful way of discriminating among these mappings.


Panel C. Log price-dividend ratio
6
5
4
47:II
59:III
72:I
84:III
97:I
09:III
Panel D. Latent states
3.5
2.5
1.5
0.5
0.008
0.004
0
-0.004
47:II
59:III
72:I
84:III
97:I
09:III


Panel C. Log price-dividend ratio
6
5
4
47:II
59:III
72:I
84:III
97:I
09:III
Panel D. Disaster risk
0.08
0.04
0
47:II
59:III
72:I
84:III
97:I
09:III

DYNAMICS OF LATENT VARIABLES — DRECHSLER, YARON (2011)



MATCHING RESPONSES OF EXPECTED RETURNS AND EXPECTED CASH FLOWS

One of central tensions in asset pricing models is to square

- predictability of returns
- predictability of fundamentals (e.g., consumption)

The paper focuses solely on returns.

- Why not add responses of expected cash flows to the analysis?
- Assess joint fit.
  - shock-exposure and shock-price elasticties

IMPOSING OTHER TYPES OF RESTRICTIONS

Methodology in the paper

- prescribe one-period dynamics
- extrapolate into future
- economically interesting restrictions may not be one-period relations

Blanchard, Quah (1989): imposing long-run restrictions

- can impose which shocks have long-run impact on returns
- e.g., technology yes, monetary policy no (real vs nominal?)

Empirical implementation of identifying martingale components of cash flows and SDFs

- Hansen, Scheinkman (2009), Borovička, Hansen, Scheinkman (2016)
- conditions not as simple as i Blanchard, Quah (1989) due to lack of additivity of level returns

WHAT ARE THE STRUCTURAL SHOCKS?

The models treat as structural shocks those directly affecting

- consumption growth
- probability of disasters
- stochastic volatility

Are these interesting structural shocks in the sense of Hurwicz (1962)?

- Do they correspond to interesting independent innovations in policy, technology and other fundamental forces?
- E.g., consumption can move for many reasons, and each of those reasons can have a very different propagation through consumption dynamics?
- Old problem going back to the Cowles Commission (1950s) and Frisch (1930s).

SUMMARY

What does the paper achieve?

- Substantial progress in empirical implementation of using term structure of expected returns as a source of information for asset-pricing models.
- Methodology that treats various types of innovations (normal, gamma mixture, jumps)
- Applications to relevant quantitative models

What else to do?

- Joint cash flow and return term structure
- Sharper interpretation of the role of latent variables