Financial Intermediaries and Bond Risk Premia

(joint with Garbiele Zinna)

Rodrigo Guimarães

Bank of England

2 August 2013

This presentation represents the views of the presenter and should not be thought to represent those of the Bank of England, Monetary Policy Comittee or Financial Policy Committee members.

The great recession has sparked a reassessment of the role of financial intermediary balance sheets (FIBS) for the macroeconomics and asset pricing.

Two important aspects of the resulting theories and debate:

1. Large literature focusing on impact of FIBS on asset prices

   - recent theory predicts changes in FIBS explain time variation in risk (prices of risk) - focus on 'shadow banking', not standard bank lending

2. Academic and policy debate on link between monetary policy, financial stability and FIBS

   - did MP contribute to FIBS expansion leading up to the financial crisis?

This paper

- Use unspanned ADTSM with US macro and FIBS variables to study impact on bond risk premia (term premia, Sharpe ratios, excess returns)
  - separately identify time-varying price and quantity of risk

- Identify monetary policy and term premia shocks on FIBS, and feedback to differentiate between three hypothesis for causes of FIBS expansion:
  - monetary policy: "search-for-yield" (e.g. BIS);
  - savings glut: exogenous risk premia (e.g. global imbalances);
  - incentives/other: innovation and/or deregulation.

Results

- We confirm the contribution of FIBS to counter-cyclical prices of risk using Shadow Bank's asset growth (SBAG). In particular, SBAG contributed to compressed risk premia in the run up to the crises and to sharp increase in risk premia after the crises

- Using standard orthogonalisation identification techniques we find evidence for significant feedback effects of term premia and SBAG on MP, but no significant role for MP shocks in explaining FIBS expansion. Instead we find evidence that monetary policy reacts to financial risk taking behaviour in a "lean against the wind" fashion.
  - different results using Broker Dearler's Leverage: related to measurement of equity as residual, point to care needed in studying FIBS

Outline

- **Motivation**
- Methodology
- Risk premia impact
- Monetary policy link
- Conclusion

FIBS and Asset Prices

A common feature in fast growing line of research is that the wealth of financial intermediaries is an important determinant of the economy's aggregate liquidity, credit and risk premia.

The mechanisms, relevant constraints and channels are diverse, but the underlying intuition is that financial intermediaries will be an important marginal investor in the economy for a wide set of asset prices, and their wealth will determine effective risk appetite.

The common prediction from existing literature is for a negative correlation between FIBS size and risk premia: in periods of expanding FIBS the required risk premia embedded in asset prices will be lower.

Theoretical papers include He & Krishnamurthy (12, 13), **Adrian & Boyarchenko (12)**, Brunermeier & Sannikov (12, 13), Garleanu, Panageas & Yu (13), Muir (13), Parlour, Stanton & Walden (11), Danielsson, Shin & Zigrand (12), Phelan (12), Rampini & Visnawathan (12) and Acharya & Visnawathan (11), among others.

Empirical papers include Adrian, Moench & Shin (10), He, Khang & Krishnamurthy (10), Adrian, Muir & Etula (12), Muir (12), Adrian, Colla & Shin (11), Gorton & Metrick (12), Bruno & Shin (13), among others.

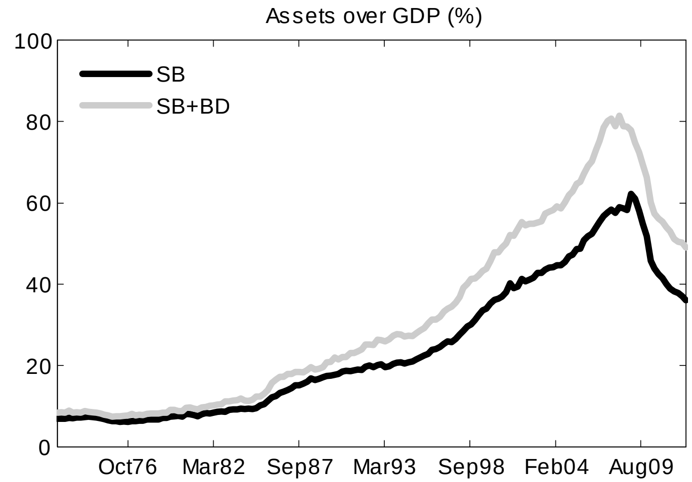
Within the empirical literature, two studies are particularly relevant for our analysis and inform our choice of data:

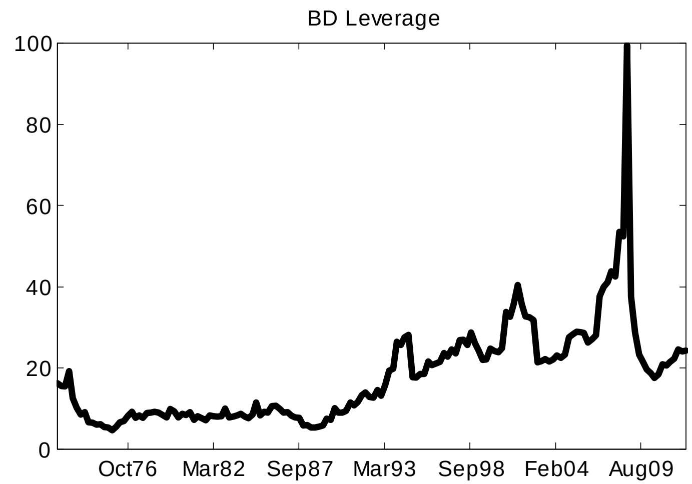
-Adrian, Moench & Shin (10)

-Adrian, Etula & Muir (12)

1. Adrian, Moench & Shin (2010) show different financial intermediary balance sheet variables have substantial **forecasting power** for most assets
   (a) Shadow Banks asset growth (better for treasuries)
   (b) Broker Dealer leverage (better for equities)

2. Adrian, Etula & Muir (12, AEM) show financial intermediary **leverage is priced**, good proxy for SDF
   (a) Do this by pricing cross-section average return of portfolios, less success in time series
   (b) **BUT** use a framework with constant price of risk.


Assets over GDP (%)
SB
SB+BD
100
80
60
40
20
0
Oct76
Mar82
Sep87
Mar93
Sep98
Feb04
Aug09


BD Leverage
100
80
60
40
20
0
Oct76
Mar82
Sep87
Mar93
Sep98
Feb04
Aug09

Debate on causes of FIBS expansion

- loose monetary policy: "search-for-yield" or "risk taking channel" (Rajan (05), Borio & Zhu (08) and Adrian & Shin (11)), which focuses on the role of loose monetary policy as the root cause in the buildup in leverage/BS.

- financial deregulation and innovation as driving the build up in FIBS risks (Acharya, Schnabl & Suarez (13), Sherman (09), Philippon & Reshef (12, 13)), which would suggest that innovations to FIBS are mostly exogenous relative to monetary policy and might itself be driving risk premia.

- global imbalances or savings glut (Caballero, Farhi & Gourrinchas (2008) and Bernanke (2005)) as the origin of excess risk taking, which would suggest that exogenous changes in term premia played an important role in the dynamics of balance sheets.

Outline

- Motivation
- **Methodology**
- Risk premia impact
- Monetary policy link
- Conclusion

Two empirical questions:

1. Impact of FIBS on prices of risk
2. Link between innovations to monetary policy, term premia and FIBS

Need a framework that allows for time-varying prices of risk and identification of monetary policy with the inclusion of FIBS data

$\longrightarrow$ tractability and interest in MP dictates we focus on bond yields

$\longrightarrow$ unspanned Affine Dynamic Term Structure Models (ADTSM)

- Recent results on estimation/identification (Joslin, Singleton & Zhu (11, JSZ)) and spanning of macro information by yields in ADTSM (Joslin, Priebsch & Singleton (13, JPS)) have shed new light on old models

- With JPS unsppaned framework can assess importance of variables for which we do not have observable asset prices, but believe to be important in explaining the risk factors and the price of risk for observable asset prices. This is precisely the case with FIBS. In a nutshel:

  -pricing (risk-neutral/Arrow-Debreu world) remains unchanged
  $\longrightarrow$ ADTSM: VAR (risk adjusted) dynamics for pricing factors X_t

  - real world (econometrician/observed) dynamics are expanded to include interaction with observed (macro) variables M_t
  $\longrightarrow$ VAR dynamics on expanded $Z_t = [X_t', M_t']'$

Data and Model Estimation

Data: Quarterly data for the US, 1972:2012: nominal zero-coupon yields with maturities of $\{1, 2, 3, 4, 5, 7, 10\}$ years; inflation and GDP growth; and 2 measures of FIBS: Shadow Bank's Asset Growth and Broker Dearler's Leverage from Flow of Funds (as in Adrian, Moench & Shin (10)).

Methodology: estimation strategy of JSZ - JPS using Bayesian MCMC with $Z_t = [X_t', M_t']'$ where

$$X_t = \begin{bmatrix} PC1_t & PC2_t & PC3_t \end{bmatrix}'$$

$$M1 \;:\; M_t = \begin{bmatrix} GDP_t & Inf_t & FIBS_t \end{bmatrix}'$$
$$M2 \;:\; M_t = \begin{bmatrix} GDP_t & Inf_t \end{bmatrix}'$$

Outline

- Motivation
- Methodology
- **Risk premia impact**
- Monetary policy link
- Conclusion

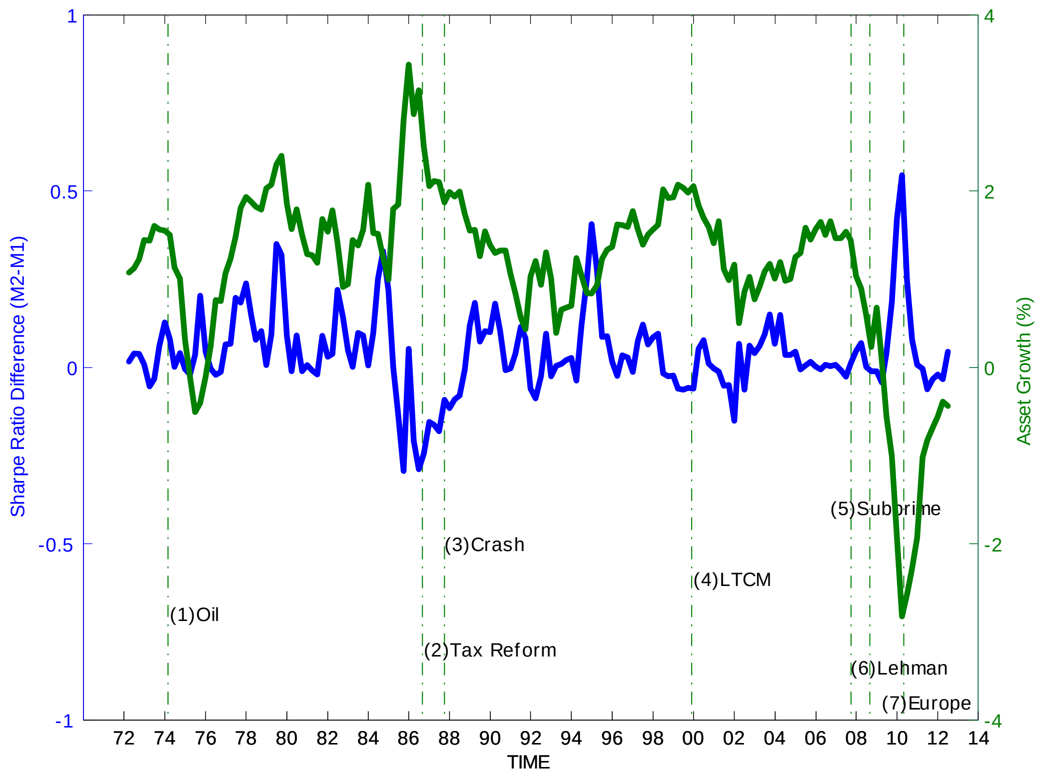
- For all three samples the models with FIBS are preferred to the model with only macro variables,

- For all three samples the model with shadow bank's asset growth (M2) is preferred to the model with broker-dealer leverage (M3).

- model with shadow bank's asset growth (M2) outperforms the model with only macro (M1) and broker-dealer leverage (M3) for forecast horizons out to two years.

→combined with measurement concerns with BDL (and timing), in the remainder we focus on the results for model with SBAG (M2).

Sharpe ratio impact: M2 (SBAG) - M1



Risk premia impact

- Model confirms SBAG is inversely related to prices of risk,
- SBAG had significant counter-cyclical impact on excess returns
- Results with BDL (not shown) do not generate counter-cyclical impact predicted by theory (discuss why later)
- Though model uses only bond yield data, has similar performance on some equity portfolios as AEM

Outline

- Motivation
- Methodology
- Risk premia impact
- **Monetary policy link**
- Conclusion

Identifying Monetary Policy

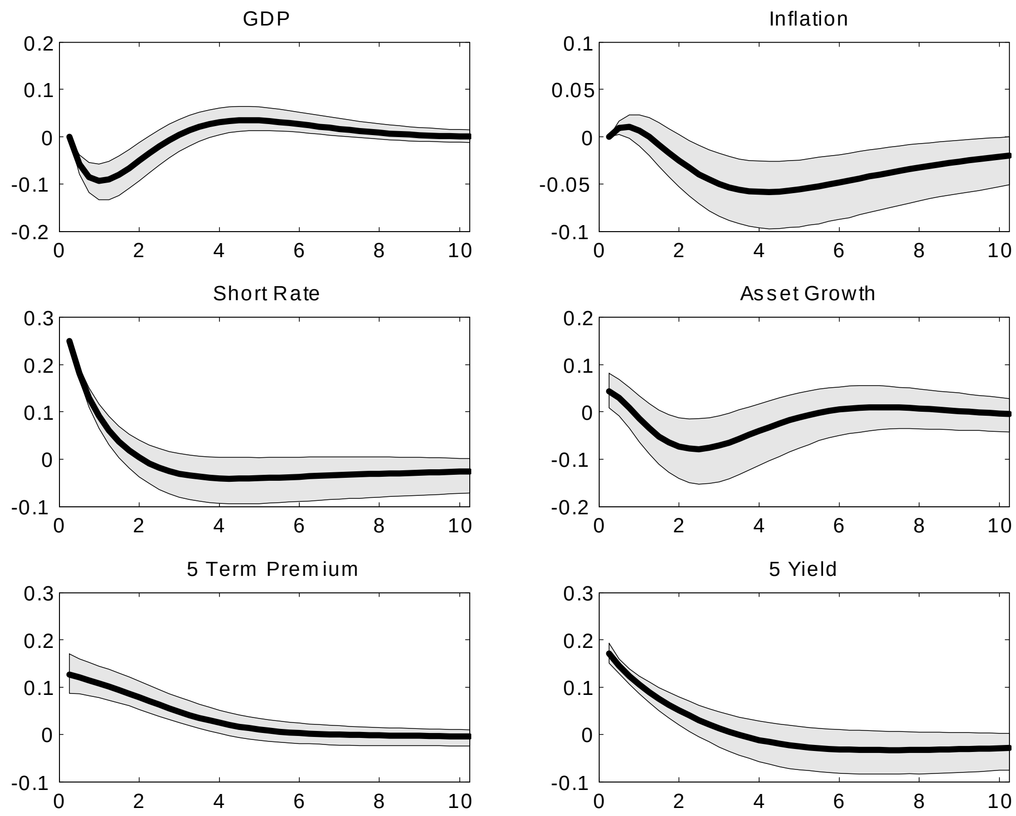
In GADTSM every quantity of interest is a linear combination of the factors, we can rotate the original vector of variables Z_t to express the VAR with both expected and risk premia components instead of pricing factors X_t (see Pericoli & Taboga (2012) and Ferman (2012)).

With rotated vector $\tilde{Z}_t = W_0 + W_1 Z_t$ we can apply any of the standard identification methods used to identify structural shocks.

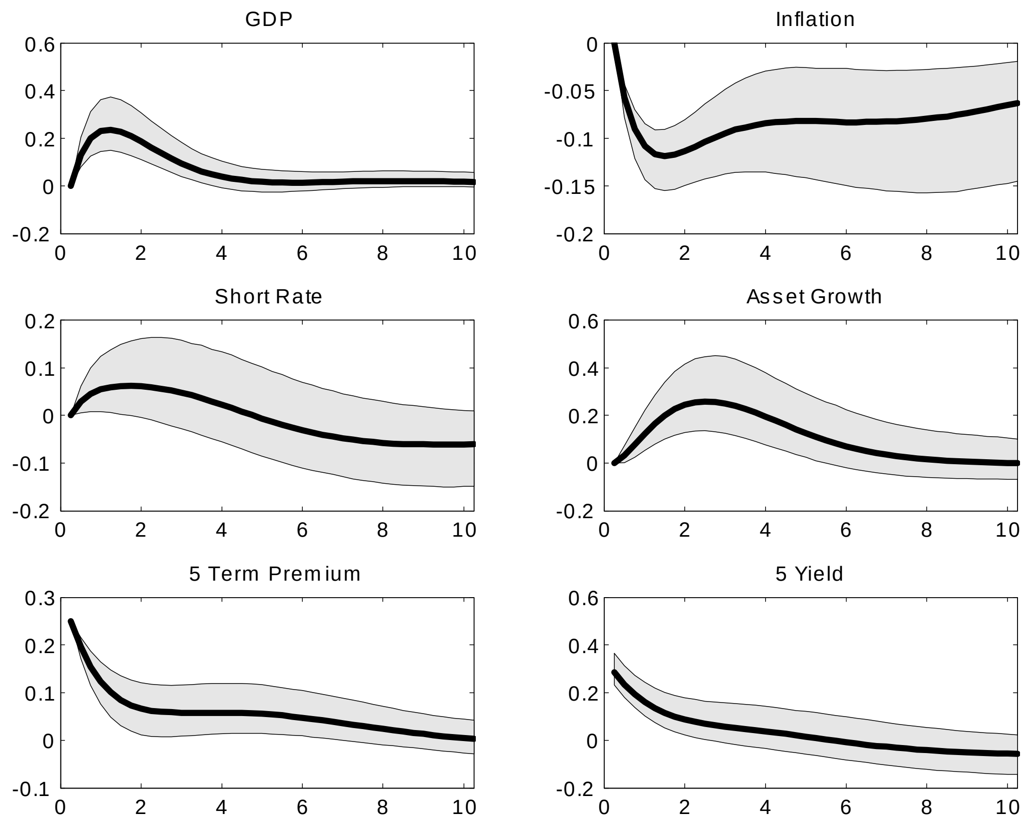
We use Choleski with the following ordering: GDP growth, inflation, expected 1 year risk-free rate, 5-year spot term premia, FIBS and 5-year spot yield.

This is similar ordering to Adrian, Moench &Shin (10), but in addition we have the expected short rate and term premium in our VAR.

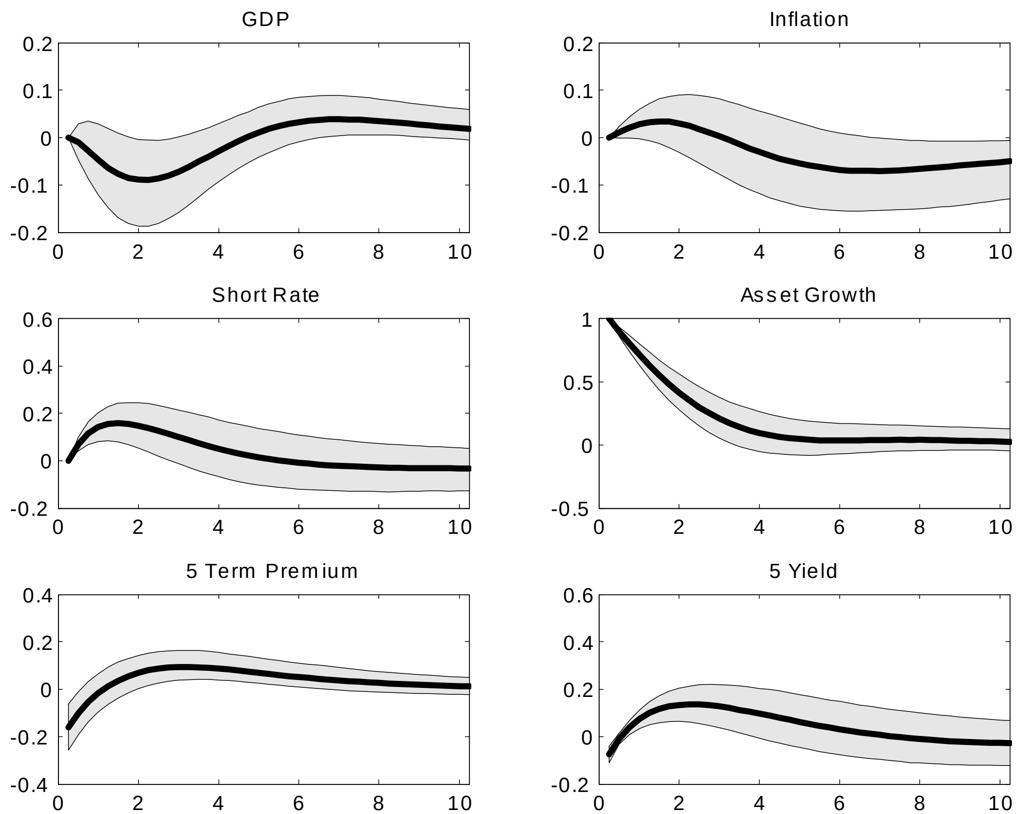
Impulse Response Function Monetary Policy Shock



Impulse Response Function Term Premia Shock



Impulse Response Function SBAG Shock



Monetary policy link

- MP shock actually has a small positive effect on SBAG on impact, before becoming insignificant, which resembles the "price puzzle".

- Term premia shock is opposite of "savings glut" hypothesis.consistent with a tfp news shock (Kurmann & Otrok 2012),

- SBAG shock leads to increase in expected interest rates and fall in term premia on impact, consistent with monetary policy reacting to the expansion of FIBS as a demand shock/compressing risk premia

$\longrightarrow$ monetary policy ‘leaning against the wind’ rather than driving SBAG

Results with Broker-Dealers

Reaction of BDL to tightening in monetary policy is a sharp contraction (as in Nelson, Pinter & Theodoridis 13) in line with the search-for-yield story in the Great Moderation sample.

Term premium shock has opposite effects on BDL

An expansionary shock to BDL leads to loosening monetary policy.

Importance of repos and behaviour in current crisis suggest they are not capturing the role implied by theory: BDL rose sharply between July 07 and Lehman

$\longrightarrow$ BDL dominated by funding pressure rather than increased risk taking

Right proxy for FIBS?

IRFs for SBAG are stable across sub-samples (unlike GDP and inflation), but BDL is not.

These differences in part reflect the difficulties and uncertainties with structural idetification in VAR well known in monetary policy analysis.

However, (i) the magnitude of the responses of BDL, (ii) estimation diagnostics for the model with BDL vs SBAG, combined with (iii) the measurement issues for BDL and (iv) behaviour in recent crisis, leads us to place less weight on this measure of BDL as proxy for recent theory

Deregulation, Monetary Policy and Imbalances

SBAG had a high positive correlation with short term real rates (above 0.5 for the whole sample, and above 0.6 since 1984), difficult to reconcile with the search-for-yield argument (which would imply negative correlation between short term rates and asset growth and focuses on early 2000).

In addition, the long term rise in size of the balance sheet relative to GDP and in leverage begin mid to late 1980s, substantially earlier than the global imbalances or "savings glut" phenomena.

Time series of FIBS seems more consistent with the timing of financial liberalization, deregulation and innovation that began in the early 1980s. Indeed Shadow Bank's asset over GDP share has a correlation of 0.94 with the US financial deregulation index of Philippon & Reshef (12)

Outline

- Motivation
- Methodology
- Risk premia impact
- Monetary policy link
- **Conclusion**

SBAG plays an important role in the counter-cyclical behavior of prices of risk

Results favour deregulation over "search for yield" for the US: MP 'leaning against the wind' rather than causing SBAG expansion.

Evidence is not that "search for yield" doesn't exist, but not through SBAG, and distinction of short term reaction to MP and extended periods of low rates.

Different evidence for commercial banks (Nelson, Pinter & Theodoridis13). consistent with micro evidence for the risk taking channel (lending channel?)

Evidence, timing and comovement of SBAG is easier to reconcile with factors other than MP, including deregulation , in explaining the long run expansion of shadow banks' balance sheets prior to the Great Recession, and consistent with recen theory

Gaussian Affine DTSM - yields only

Just two model ingredients:

$$\begin{aligned} i_t &= \rho_0 + \rho_1 X_t \\ X_{t+1} &= K_0^Q + K_1^Q X_t + \Sigma \varepsilon_{t+1}^Q \end{aligned}$$

Imply affine bond yields:

$$y_{t,n} = A_n + B_n X_t$$

where $\{A_n, B_n\}_{n=0}^{T}$ solve recursive equations as a function of $\left\{\rho_0, \rho_1, K_0^Q, K_1^Q, \Sigma\right\}$

To estimate the model we also need $\mathbb{P}$-dynamics (risk premia):

$$\begin{aligned} X_{t+1} &= K_0^P + K_1^P X_t + \Sigma \varepsilon_{t+1}^P \\ & \quad or \\ \Lambda_t &= \lambda_0 + \lambda_1 X_t \end{aligned}$$

Unspanned ADTSM - adding macro

Pricing as before (short-rate and $\mathbb{Q}$-VAR function of X only), but have expanded $\mathbb{P}$-VAR

$$\begin{bmatrix} X_{t+1} \\ M_{t+1} \end{bmatrix} = \begin{bmatrix} K_0^P \\ \mathcal{K}_{0,m}^P \end{bmatrix} + \begin{bmatrix} K_1^P & \mathcal{K}_{1,xm}^P \\ \mathcal{K}_{1,mx}^P & \mathcal{K}_{1,m}^P \end{bmatrix} \begin{bmatrix} X_t \\ M_t \end{bmatrix} + \begin{bmatrix} \mathbf{\Sigma} & \mathbf{\Sigma}_{mx} \\ \mathbf{\Sigma}_{mx} & \mathbf{\Sigma}_m \end{bmatrix} \begin{bmatrix} \varepsilon_{t+1}^P \\ u_{t+1}^P \end{bmatrix}$$

In this setting pricing is not affected by M, but time-varying risk premia is, since $\mathbb{P}$-dynamics of X are affected by M

$$\tilde{\Lambda}_t = \underbrace{K_0^P - K_0^K}_{\lambda_0} + \underbrace{\begin{bmatrix} K_1^P & \mathcal{K}_{1,xm}^P \end{bmatrix} - \begin{bmatrix} K_1^Q & 0 \end{bmatrix}}_{\tilde{\lambda}_1} \begin{bmatrix} X_t \\ M_t \end{bmatrix}$$

Risk premia

We follow Duffee (10) and examine term structure of bond (log) expected excess returns and maximal Sharpe ratio.

Epected excess (log) return for bond with maturity n-years:

$$E_t\left[xr_{t+1,n}\right] \equiv p_{t+1,n-1} - p_{t,n} - r_t \propto -B_{n-1}\tilde{\Lambda}_t$$

Maximal (log) Sharpe ratio:

$$SR_t = \sqrt{\left(\Sigma^{-1}\tilde{\Lambda}_t\right)'\Sigma^{-1}\tilde{\Lambda}_t}$$

where

$$\tilde{\Lambda}_t = \lambda_0 + \tilde{\lambda}_1 Z_t$$

Model Fit

	Yields ($\mathbb{Q}$)		Factors ($\mathbb{P}$)	
	logL	MAE	logML	logL
	1972Q1-2012Q2			
M1: Macro	57.87	1.47	23.74	26.33
M2: SBAG	57.87	1.47	27.88	30.81
M3: BDL	57.87	1.47	25.82	28.78
	1972Q1-2007Q2			
M1: Macro	58.29	1.55	23.56	26.50
M2: SBAG	58.29	1.55	27.78	31.11
M3: BDL	58.29	1.55	25.79	29.15
	1984Q1-2012Q2			
M1: Macro	58.67	1.19	23.89	27.72
M2: SBAG	58.67	1.19	27.86	32.13
M3: BDL	58.67	1.19	25.83	30.20

Pricing Errors and Forecasting

	MAE				RMSE			
	t,t	t,t+1	t,t+4	t,t+8	t,t	t,t+1	t,t+4	t,t+8
				M1: Macro				
1yr	1.30	16.1	32.8	46.1	1.87	23.8	41.1	55.3
5yr	1.60	13.7	24.7	32.9	2.26	17.6	31.9	41.5
10yr	1.77	11.7	21.4	26.7	2.40	15.3	28.0	34.9
				M2: Macro and Shadow Banks Asset Growth (SBAG)				
1yr	1.30	16.0	31.3	43.5	1.87	23.2	39.1	52.5
5yr	1.60	13.2	23.6	30.6	2.26	17.2	30.4	38.8
10yr	1.77	11.3	20.6	25.0	2.40	15.1	26.9	32.4
				M3: Macro and Broker Dealer Leverage (BDL)				
1yr	1.30	16.1	32.5	46.0	1.87	23.7	40.9	55.4
5yr	1.60	13.8	25.0	33.3	2.26	17.6	32.0	41.9
10yr	1.77	11.7	21.5	27.4	2.40	15.3	28.2	35.6

VAR Parameter Estimates

	$K_0^{\mathbb{P}}$	$K_1^{\mathbb{P}}$					
	const	PC1	PC2	PC3	INF	GDP	SBAG
PC1	-0.0038	0.8545	-0.4308	1.3744	0.4364	0.119	0.1617
	[-0.01;-0.00]	[0.82;0.89]	[-0.63;-0.23]	[0.65;2.10]	[0.33;0.54]	[0.04;0.20]	[0.11;0.21]
PC2	-0.0004	-0.024	0.7797	-0.4743	0.0635	0.0494	0.0188
	[-0.00;-0.00]	[-0.03;-0.02]	[0.73;0.83]	[-0.71;-0.25]	[0.04;0.09]	[0.03;0.07]	[0.01;0.03]
PC3	0.0003	0.0006	-0.0073	0.6816	-0.0007	-0.0011	-0.0011
	[0.00;0.00]	[-0.00;0.00]	[-0.02;0.00]	[0.63;0.74]	[-0.01;0.00]	[-0.01;0.00]	[-0.00;0.00]
INF	-0.0003	-0.0169	0.0866	0.6758	1.0224	0.0603	0.0144
	[-0.00;0.00]	[-0.02;-0.01]	[0.05;0.12]	[0.47;0.87]	[1.00;1.04]	[0.05;0.07]	[0.00;0.02]
GDP	0.0013	0.0029	-0.3337	-1.7582	-0.0145	0.8583	-0.0287
	[0.00;0.00]	[-0.01;0.02]	[-0.44;-0.22]	[-2.22;-1.27]	[-0.07;0.04]	[0.81;0.90]	[-0.06;-0.00]
AG	-0.0003	0.0043	-0.0569	-0.4947	0.0788	0.2295	0.8932
	[-0.00;0.00]	[-0.01;0.02]	[-0.18;0.06]	[-1.01;0.05]	[0.02;0.14]	[0.18;0.27]	[0.86;0.93]

- confirm JPS results for Inf and GDP, significant impact of SBAG

Market Price of Risk Estimates

	$K_0^{\mathbb{P}}$-$K_0^{\mathbb{Q}}$	$K_1^{\mathbb{P}}$-$K_1^{\mathbb{Q}}$					
	const	PC1	PC2	PC3	INF	GDP	SBAG
PC1	-0.004	-0.1418	-0.0762	2.3364	0.4364	0.119	0.1617
	[-0.01;-0.00]	[-0.17;-0.11]	[-0.28;0.12]	[1.62;3.07]	[0.33;0.54]	[0.04;0.20]	[0.11;0.21]
PC2	-0.0005	-0.0303	-0.0568	0.4303	0.0635	0.0494	0.0188
	[-0.00;-0.00]	[-0.04;-0.02]	[-0.10;-0.01]	[0.20;0.66]	[0.04;0.09]	[0.03;0.07]	[0.01;0.03]
PC3	0.0003	-0.0046	-0.0059	0.007	-0.0007	-0.0011	-0.0011
	[0.00;0.00]	[-0.01;-0.00]	[-0.02;0.01]	[-0.05;0.06]	[-0.01;0.00]	[-0.01;0.00]	[-0.00;0.00]

- SBAG has significant impact on price of risk of level (and slope) factor
- Results with BDL (not shown) are insignificant