An Empirical Decomposition of Risk and Liquidity in Nominal and Inflation-Indexed Government Bonds

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Bond Risk

- Unlike single stocks, government bonds are exposed to multiple sources of systematic risk.

- Government bonds (Treasury Bonds in the U.S.) of stable large economies are not subject to credit risk (at least not until recently).

- But nominal bonds are subject to real interest risk (or reinvestment risk) and inflation risk.

- Inflation-indexed bonds (TIPS in the US) are subject to real interest rate risk

Nominal Bond Pricing

- Evidence that U.S. nominal bond excess returns are predictable (Campbell and Shiller 1991, Fama and Bliss 1987, Cochrane and Piazzesi 2005).
  - Strong rejection of the expectations hypothesis in nominal interest rates.

- Hypotheses:
  - Time-varying risk premium resulting from a time-varying aggregate market price of risk, a time-varying quantity of bond risk or a combo (Campbell, Sunderam, and Viceira, 2011).

  - Supply/market segmentation effects resulting from habitat preferences and limits to arbitrage (Modigliani and Sutch 1966, Vayanos and Vila 2009, Greenwood and Vayanos 2008, Hamilton and Wu 2010)

Real Bond Risk Premium

- Time-varying risk premium: Which one? Inflation risk? Real interest rate risk?
- Recent evidence that U.S. and UK inflation-indexed bonds are also predictable (Pflueger and Viceira 2011).
  - It suggests a time-varying real interest risk premium.
- But how about inflation risk?
- And liquidity?
  - Liquidity differential between inflation-indexed and nominal bond markets.

Breakeven Inflation

$$b_{n,t} = y^{\$}_{n,t} - y_{n,t}$$

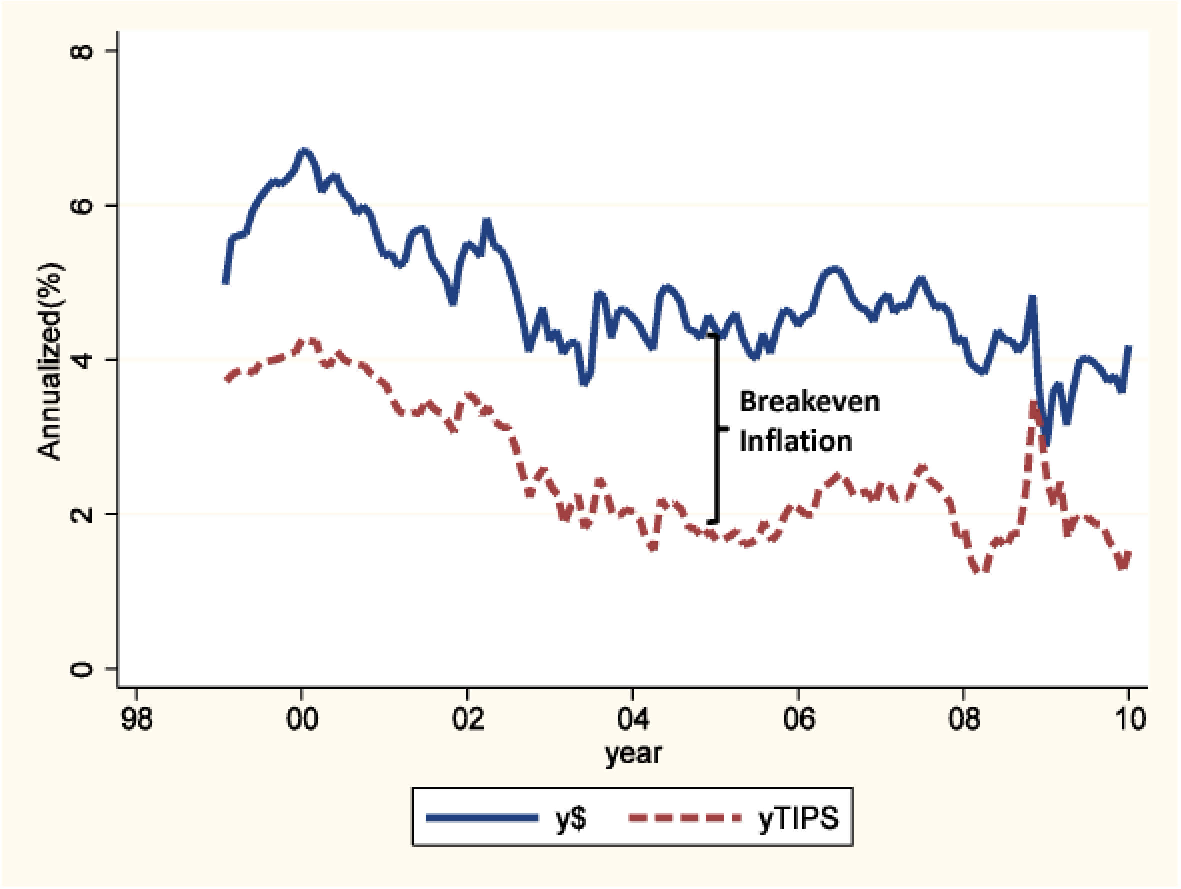


Figure: US 10 Year TIPS and Nominal Yields

Breakeven Inflation

- Breakeven inflation reflects expected inflation, inflation risk premium and a liquidity premium:

$$y_{n,t}^{TIPS} = y_{n,t} + L_{n,t}^{TIPS}$$

$$y_{n,t}^{\$} = y_{n,t} + \pi_{n,t}^{e} + \psi_{n,t} + L_{n,t}^{\$}$$

$$b_{n,t} = y_{n,t}^{\$} - y_{n,t} = \pi_{n,t}^{e} + \psi_{n,t} + L_{n,t}^{Diff}$$

- We can't tell what drives time variation in breakeven inflation and the return differential between TIPS and Treasuries without an identification strategy.

This Paper

- Can liquidity explain differences in yields and returns?
  – D'Amico, Kim, and Wei (2009), Campbell, Shiller, and Viceira (2009), Gurkaynak, Sack, and Wright (2010),

- Empirical examination of the liquidity differential between the Treasury and TIPS markets.
  – Use empirical proxies to identify the liquidity discount in TIPS relative to Treasuries, and its variation over time.
  – Show that it has a TIPS market-specific component, and an aggregate component.
  – Evidence of existence of a *systematic* liquidity risk premium

- This paper is about liquidity in the TIPS market, not about liquidity and mispricing in the inflation swap market
  – Fleckenstein, Longstaff and Lustig (2010)

This Paper

- Time-varying real interest rate risk premia and/or time-varying inflation risk premia?
  - Christensen, Lopez, and Rudebusch (2010), Campbell, Sunderam, and Viceira (2011), D'Amico, Kim, and Wei (2009), Haubrich, Pennachi and Ritchken (2010), Piazzesi and Schneider (2006)

- Use liquidity-adjusted yields and returns on TIPS to disentangle inflation and real interest rate risk premia in inflation-indexed bonds and nominal bonds.
  - Interpret return predictability of inflation-indexed bonds as resulting from time-varying real interest rate risk and liquidity risk premia.
  - Interpret return predictability of nominal bonds as resulting from time-varying real interest rate risk and inflation risk premia.

This Paper

- Can investors'habitat preferences explain differences in yields and returns?
  - Greenwood and Vayanos (2008), Hamilton and Wu (2010)

- Examine evidence of habitat preference driven predictability in inflation indexed bond market.
  - No evidence of supply/segmentation effects in the TIPS market or the UK ILB market.

Data

- Zero-coupon US yields from Gurkaynak, Sack, and Wright (2007) and Gurkaynak, Sack, and Wright (2010).
  - Focus on 10-year maturity
  - 1999-2010

- Zero-coupon UK yields from the Bank of England (Anderson and Sleath 2001)
  - Focus on 20-year maturity
  - 1985-2009

- Empirical proxies for market-specific and market-wide liquidity in US market

Data

- Empirically proxy for short-term real interest rate as in Pflueger and Viceira (2011):
  - US: Fama-Bliss 3 month riskfree rate from Center for Research in Security Prices.
  - UK: 3-month short rate from Datastream
  - US inflation measured by all-urban seasonally adjusted consumer price index.
  - UK inflation measured by Retail Price Index (RPI).

Fitted US Short-Term Real Rate

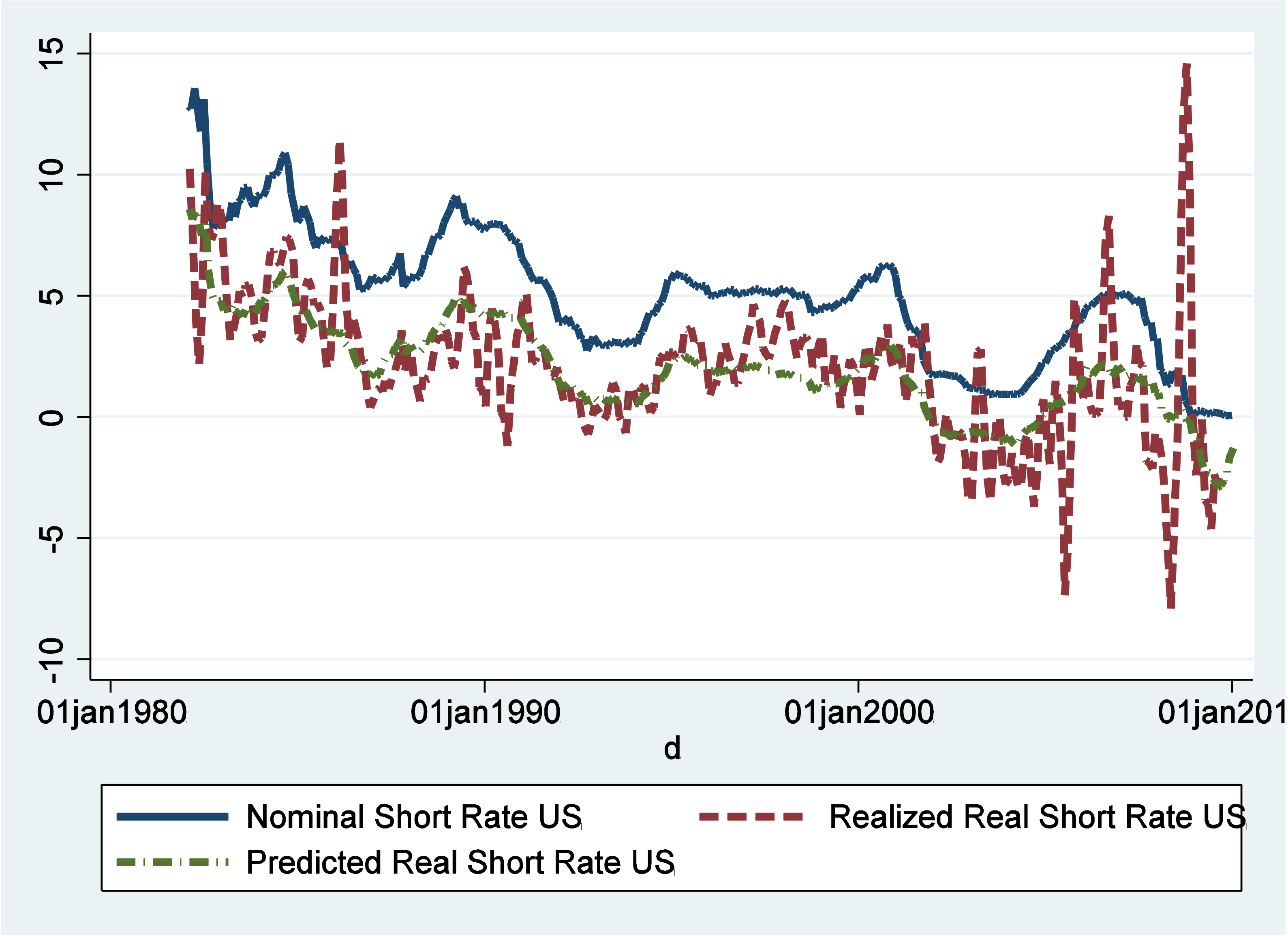


Table I
Summary Statistics

US data is monthly 1999.7-2010.12 and UK data is monthly 1985.4-2009.12.

	Panel A: US 10 YR				**Panel B: UK 20 YR**			
	Mean	Std	Min	Max	Mean	Std	Min	Max
$y_{n,t}^{\$}$	4.68	0.87	2.66	6.70	6.38	1.94	3.79	9.93
$y_{n,t}^{TIPS}$	2.44	0.91	0.59	4.29	2.79	1.14	0.56	4.57
$b_{n,t}$	2.24	0.39	0.39	2.87	3.59	0.94	2.07	5.50
$xr_{n,t+1}^{\$}$	3.88	17.56	-30.73	56.62	3.47	14.67	-104.94	109.32
$xr_{n,t+1}^{TIPS}$	3.15	18.22	-64.97	58.15	1.66	9.25	-67.90	64.47
$xr_{n,t+1}^{b}$	0.74	17.75	-42.78	74.34	1.81	11.97	-103.21	84.79

Estimating the Liquidity Component

- Regress breakeven onto liquidity proxies X_t:

$$b_{n,t} = a_1 + a_2{}' X_t + \varepsilon_t$$

- Estimate liquidity premium as fitted values:

$$\hat{L}_{n,t} = -a_2{}' X_t$$

  – Liquidity variables are normalized to equal zero when liquidity is perfect.

- Adjust yields and breakeven for liquidity:

$$y_{n,t}^{TIPS,adj} = y_{n,t}^{TIPS} - \hat{L}_{n,t}$$

$$b_{n,t}^{adj} = b_{n,t} + \hat{L}_{n,t}$$

  – Breakeven should be lower when TIPS are less liquid

Estimating the Liquidity Component

- Need to distinguish between
  - Liquidity discount/premium
  - Liquidity risk premium

Liquidity Proxies

- Market-wide desire to hold only most liquid Treasuries:
  - Off-the-run spread (Krishnamurthy 2002)
  - Based on same off-the-run issue as GSW
  - [GNMA spread (Longstaff 2004)]
  - Source: Bloomberg, Federal Reserve

- Learning and search costs in the TIPS market:
  - Transaction volume of TIPS relative to nominal Treasuries (Gurkaynak, Sack and Wright 2010, Fleming and Krishnan 2009, Duffie, Garleanu and Pedersen 2005, 2007, Weill 2007)
  - Source: Primary Dealers' transaction volumes from Federal Reserve.

Liquidity Proxies

- Transaction costs
  - Bid-ask spread for the 10-year TIPS market (scaled by 10).
  - Source: Bloomberg (via George Pennachi).

- Cost to levered investors of holding TIPS.
  - Asset-Swap-Spread (ASW), 10 year maturity.
  - If ASW investor is marginal the slope of breakeven onto the ASW should equal -1 (Campbell, Shiller, and Viceira 2009)
  - Spread between synthetic (or inflation swap) breakeven and cash breakeven, 10 year maturity (Viceira 2011).
  - Source: Barclays Live, and Bloomberg

ASW market and IS market

- The inflation swap market and the ASW market are flipsides of the same coin:
  - Jeremie Banet (BNP Paribas): “It is key that the inflation derivatives market has actually two completely different complements: one, which is the inflation swap; and the flipside, which is the asset swaps.” (Risk Magazine, November 2009)

TBond-TIPS-Inflation Swap Arbitrage

	Payoff	Payoff
Zero investment T-Bond – TIPS portfolio	$y_t - s_t - \pi_{t \to T}$	cash bei $- \pi_{t \to T}$
Short IS	$f - \pi_{t \to T}$	IS bei $- \pi_{t \to T}$

Note: bei = breakeven inflation

- Empirically, IS bei > cash bei consistently.
- If IS bei > cash bei:
  - Short T-Bond, long TIPS, enter IS receiving IS bei (and paying inflation)

ASW market and IS market

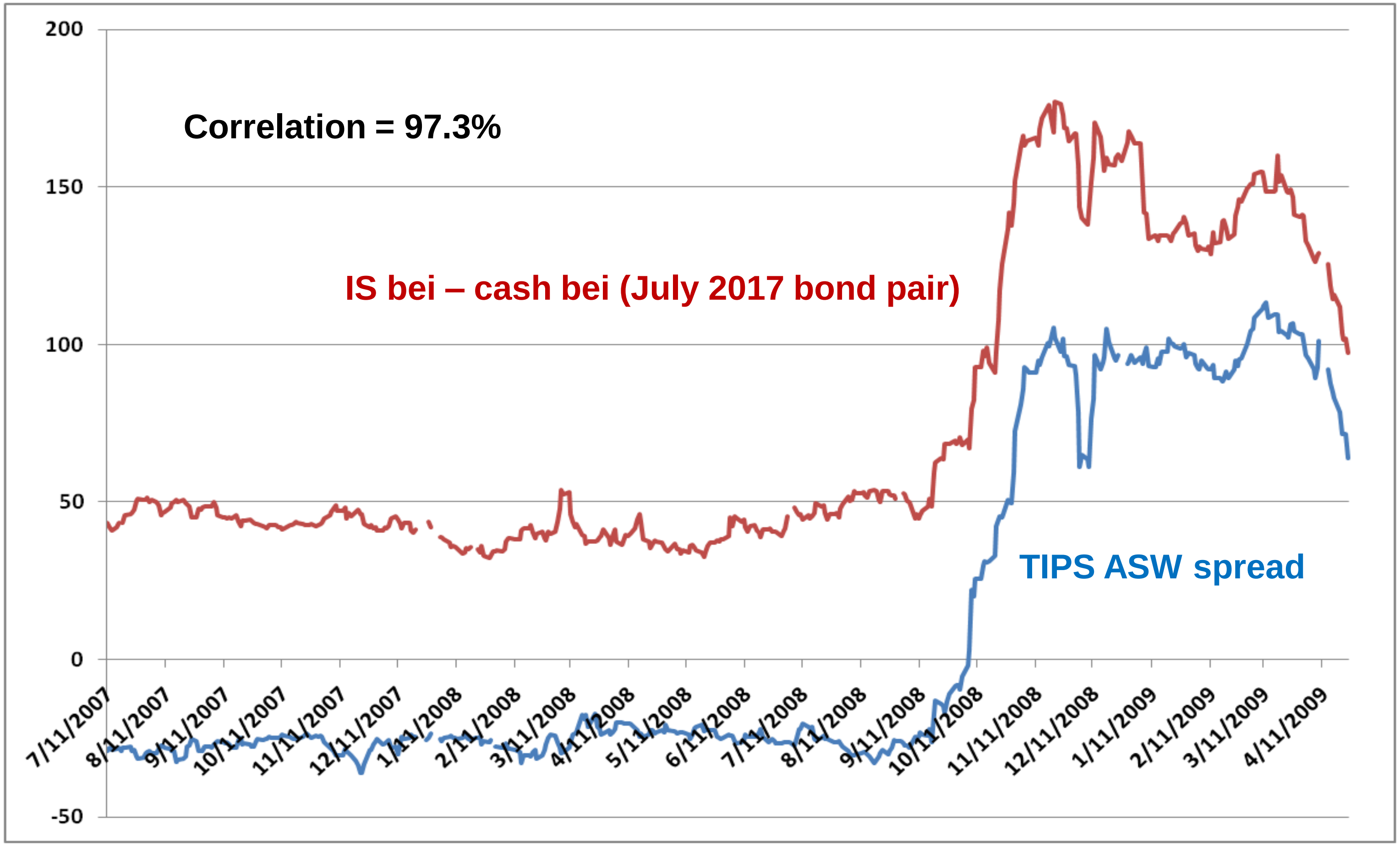
- If you are a levered investor (bank, hedge fund), taking advantage of the arbitrage implies:
  - Entering a long TIPS position through an asset swap, paying LIBOR + TIPS ASW spread, and receiving TIPS payoffs.
  - Entering a short T-Bond position through an asset swap, paying T-Bond payoffs and receiving LIBOR + TB ASW spread.

- Cost = TIPS ASW spread - TB ASW spread
  - Normally, both spreads are negative
  - And | TIPS ASW spread | < | TB ASW spread |
  - Arbitrage is costly

- Abnormal times (Fall 2008 and Winter 2009): TIPS ASW spread >> 0.

Implementation

- In practice, (IS bei – cash bei) appears to have moved in sync with asset swap spread differential:



Source: Campbell, J.Y., Robert J. Shiller, and L.M. Viceira, "Understanding Inflation-Indexed Bond Markets," with, Brookings Papers on Economic Activity 79-120, Spring 2009.

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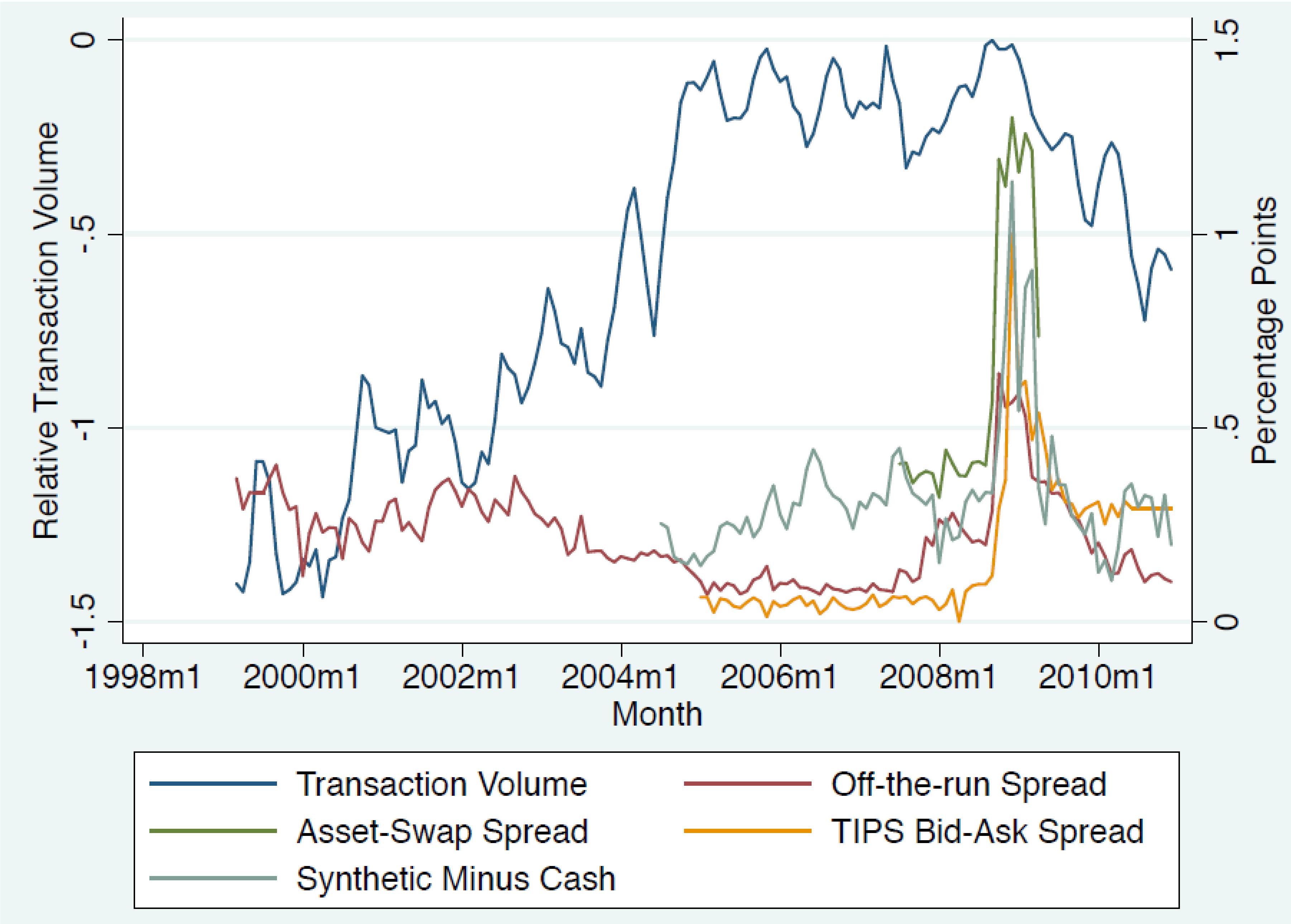
$y_{n,t}^{TIPS}$	2.44	0.91	0.59	4.29
$b_{n,t}$	2.24	0.39	0.39	2.87
$xr_{n,t+1}^{\$}$	3.88	17.56	-30.73	56.62
$xr_{n,t+1}^{TIPS}$	3.15	18.22	-64.97	58.15
$xr_{n,t+1}^{b}$	0.74	17.75	-42.78	74.34
Off-the-run Spr.	0.21	0.11	0.07	0.64
Asset-swap Spr.	0.53	0.29	0.32	1.30
Transaction Vol.	-0.57	0.45	-1.44	0.00
Bid-ask Spr. x 10	0.17	0.18	0.00	1.00
Synthetic - Cash	0.32	0.17	0.11	1.13

Figure 1. US Liquidity Proxies



Estimating the Liquidity Premium

Table II
Breakeven onto Liquidity Proxies US

$$b_{n,t} = a_1 + a_2{}' X_t + \varepsilon_t$$

	(1)	(2)	(3)	(4) $y^{\$}_{n,t} - y^{TIPS}_{n,t}$	(5)	(6)
Off-the-run Spr.	−2.48**	−1.78**	−1.20**	−1.07**	−1.15*	−2.00**
	(0.39)	(0.31)	(0.41)	(0.38)	(0.55)	(0.54)
Asset-Swap-Spr.		−0.80**	−1.17**	−0.89**		
		(0.20)	(0.28)	(0.20)		
Transaction Vol.			0.20*	0.23**	0.31	0.12
			(0.09)	(0.09)	(0.29)	(0.10)
Bid-ask Spr.				−0.60*	-0.58	3.27
				(0.28)	(0.37)	(2.71)
Synthetic - cash					−1.25**	
					(0.28)	
const.	2.78**	2.98**	3.13**	3.07**	3.08**	2.60**
	(0.08)	(0.08)	(0.10)	(0.09)	(0.12)	(0.12)
p-value	0.00	0.00	0.00	0.00	0.00	0.00
R^2	0.53	0.60	0.63	0.65	0.81	0.50
Sample		1999.3 – 2010.12			2004.9 - 2010.12	1999.3 – 2006.12

Estimating the Liquidity Premium

Table II
Breakeven onto Liquidity Proxies US

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				$y^{\$}_{n,t} - y^{TIPS}_{n,t}$			$y^{\$}_{n,t} - y^{TIPS}_{n,t} - \pi^{SPF}$
Off-the-run Spr.	-2.48^{**}	-1.78^{**}	-1.20^{**}	-1.07^{**}	-1.15^{*}	-2.00^{**}	-1.40
	(0.39)	(0.31)	(0.41)	(0.38)	(0.55)	(0.54)	(0.70)
Asset-Swap-Spr.		-0.80^{**}	-1.17^{**}	-0.89^{**}			-1.21^{**}
		(0.20)	(0.28)	(0.20)			(0.34)
Transaction Vol.			0.20^{*}	0.23^{**}	0.31	0.12	0.18
			(0.09)	(0.09)	(0.29)	(0.10)	(0.13)
Bid-ask Spr.				-0.60^{*}	-0.58	3.27	-0.14
				(0.28)	(0.37)	(2.71)	(0.43)
Synthetic - cash					-1.25^{**}		
					(0.28)		
const.	2.78^{**}	2.98^{**}	3.13^{**}	3.07^{**}	3.08^{**}	2.60^{**}	0.73^{**}
	(0.08)	(0.08)	(0.10)	(0.09)	(0.12)	(0.12)	(0.13)
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R^2	0.53	0.60	0.63	0.65	0.81	0.50	0.64
Sample		1999.3 – 2010.12			2004.9 - 2010.12	1999.3 – 2006.12	1999.Q2 - 2010.Q4

Figure 2. TIPS Liquidity Premium

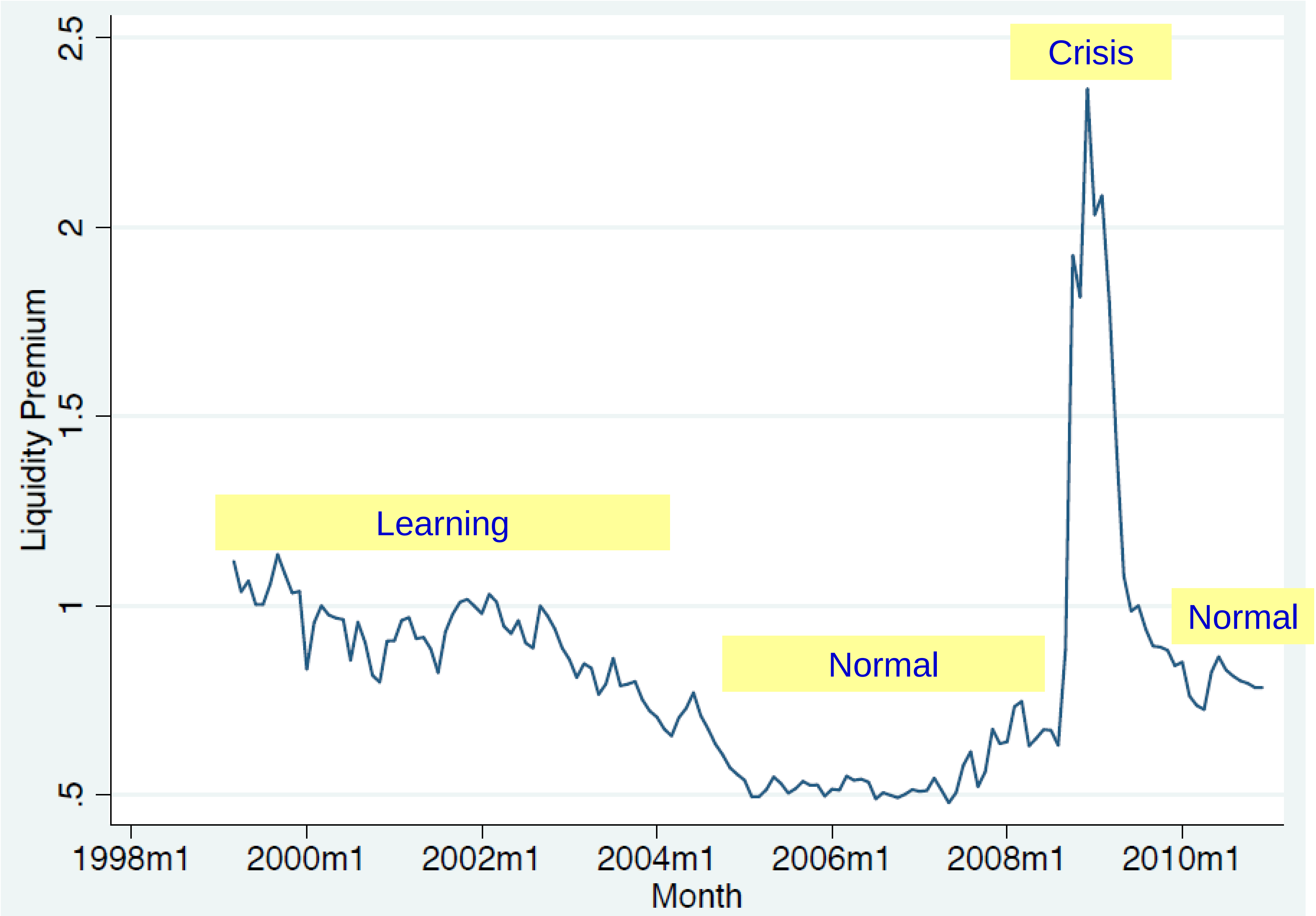


Figure 3. Liquidity-Adjusted Breakeven Inflation

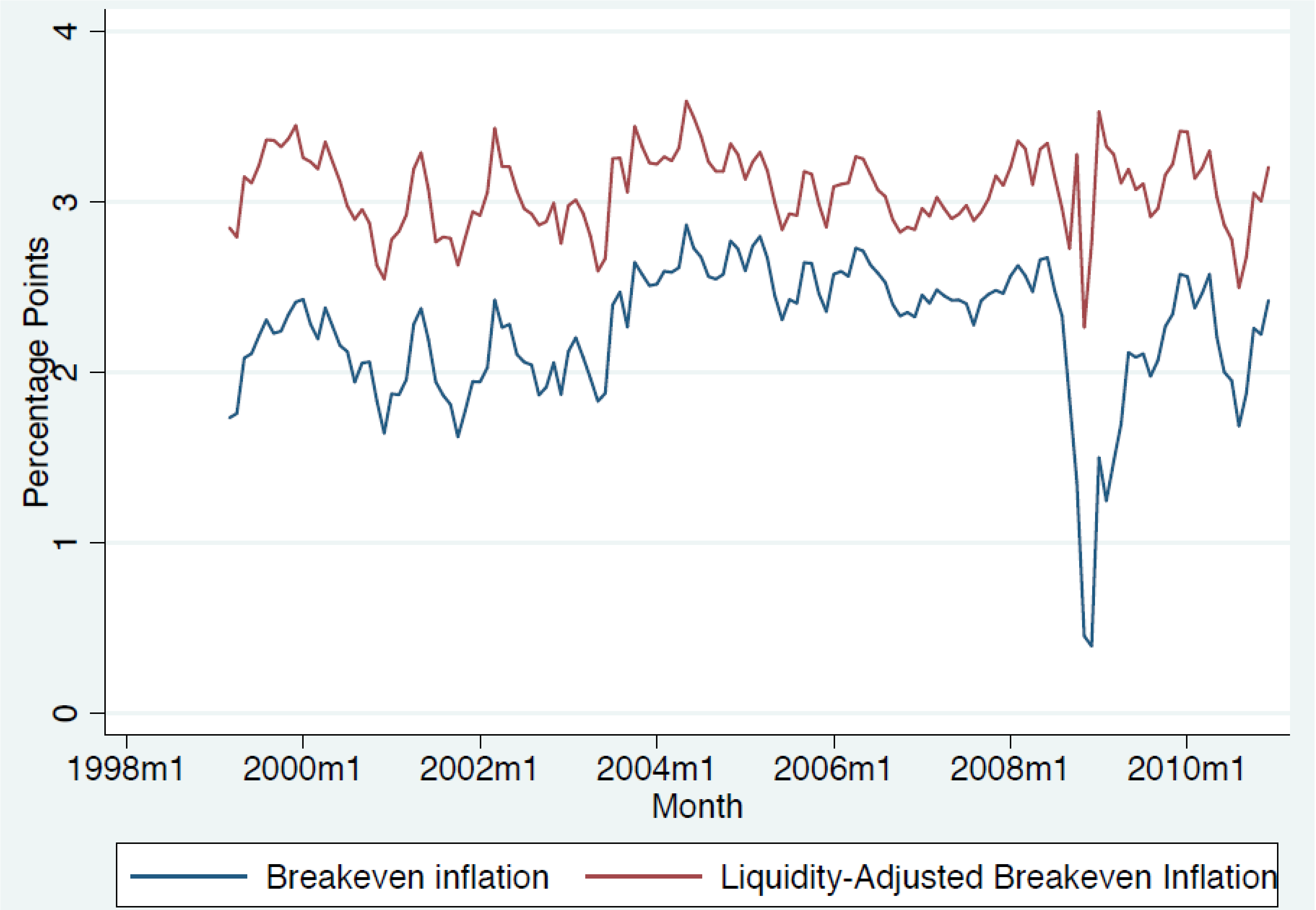
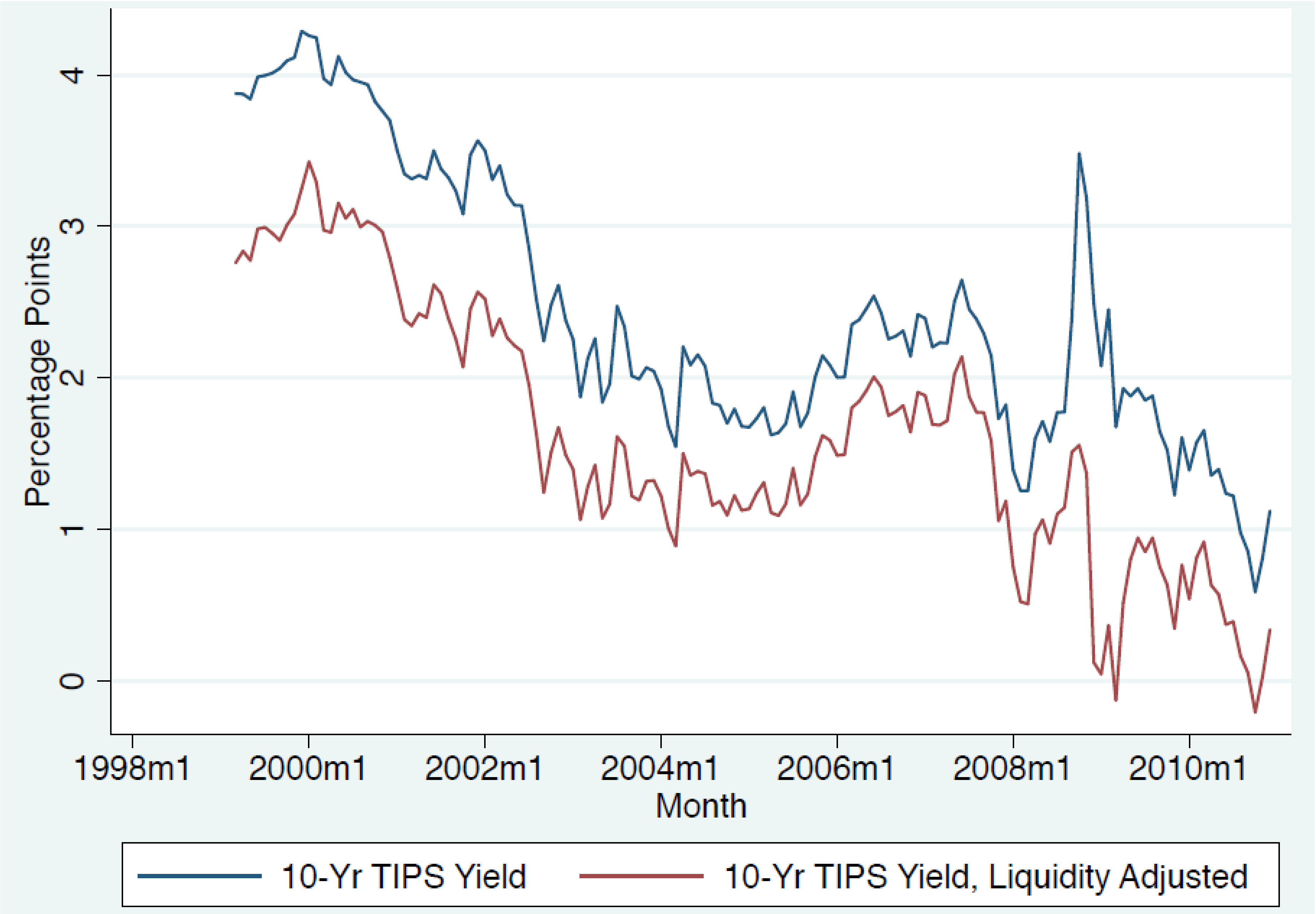


Figure 4. Liquidity-Adjusted TIPS



Time-Varying Risk Premia

- Nominal bond excess returns are predictable from nominal term spreads (Campbell and Shiller 1991):
  - time-varying inflation risk premia or
  - time-varying real rate risk premia
- Return-predictability of liquidity-adjusted TIPS returns would indicate a time-varying real interest rate risk premium.
- Liquidity-Adjusted Breakeven Returns = Nominal excess returns - Liquidity-adjusted TIPS excess returns.
  - Breakeven return predictability would indicate a time-varying inflation risk premium.
- Liquidity returns = component of TIPS returns due to changes in liquidity.

Table V
Liquidity-Adjusted Return Predictability US

	(1) $xr_{n,t+1}^{TIPS-L}$	(2) $xr_{n,t+1}^{b+L}$	(3) $xr_{n,t+1}^{b+L}$	(4) $r_{n,t+1}^{L}$
$(y_{n,t}^{TIPS} - L_{n,t}) - y_{1,t}^{TIPS}$	3.17*		-1.14	0.65
	(1.56)		(1.39)	(0.92)
$(b_{n,t} + L_{n,t}) - b_{1,t}$		3.80*	4.27**	-1.91
		(1.56)	(1.61)	(2.61)
$L_{n,t}$	- 0.39	-6.10	-4.80	13.97**
	(10.25)	(4.88)	(5.72)	(5.11)
p-value	0.08	0.04	0.04	0.03
R^2	0.05	0.08	0.09	0.20
Sample	1999.6 – 2010.12			

Table VI
Moments of Realized and Fitted Bond Returns

Panel A: US	$\hat{E}\left(xr_{n,t}\right)$	$\hat{\beta}\left(xr_{n,t}\right)$	$\sigma\left(E_t xr_{n,t+1}\right)$	$\frac{\sigma^2\left(E_t xr_{n,t+1}\right)}{\sigma^2\left(xr^{\$}_{n,t}\right)}$	$\frac{\sigma^2\left(E_t xr_{n,t+1}\right)}{\sigma^2\left(xr^{TIPS}_{n,t}\right)}$
Excess Log Return Nominal	3.26	-0.40^{**}	1.56	3%	
Excess Log Return TIPS	4.16	0.06	2.70	10%	12%
Excess Log Return BEI	-0.91	-0.47^{*}	3.24	14%	
Liq.-Adj. Exc. Log Ret. BEI	0.74	0.07	1.38	3%	
Liq.-Adj. Exc. Log Ret. TIPS	2.87	-0.46^{**}	1.90	5%	6%
Log Return Liquidity	1.36	0.53^{**}	3.15		12%
Panel B: UK	$\hat{E}\left(xr_{n,t}\right)$	$\hat{\beta}\left(xr_{n,t}\right)$	$\sigma\left(E_t xr_{n,t+1}\right)$	$\frac{\sigma^2\left(E_t xr_{n,t+1}\right)}{\sigma^2\left(xr^{\$}_{n,t}\right)}$	$\frac{\sigma^2\left(E_t xr_{n,t+1}\right)}{\sigma^2\left(xr^{TIPS}_{n,t}\right)}$
Excess Log Return Nominal	3.47	0.16	3.13	5%	
Excess Log Return TIPS	1.66	0.15^{**}	1.84	2%	4%
Excess Log Return BEI	1.81	0.01	2.55	3%	

Table A.IX
Sub-Period Betas

Panel A: US	1999.4-2009.12		1999.4-2006.12		2002.1-2009.12	
	$\widehat{\beta}$	$\widehat{\alpha}$	$\widehat{\beta}$	$\widehat{\alpha}$	$\widehat{\beta}$	$\widehat{\alpha}$
Excess Log Return Nominal	-0.40^{**}	2.52	-0.51^{*}	2.47	-0.38^{**}	3.46
Excess Log Return TIPS	0.06	4.28^{*}	-0.34^{*}	3.74^{*}	0.11	4.50
Excess Log Return BEI	-0.47^{*}	-1.76	-0.17	-1.28	-0.49^{*}	-1.03
	1999.6-2009.12		1999.6-2006.12		2002.1-2009.12	
	$\widehat{\beta}$	$\widehat{\alpha}$	$\widehat{\beta}$	$\widehat{\alpha}$	$\widehat{\beta}$	$\widehat{\alpha}$
Liq.-Adj. Exc. Log Ret. BEI	0.07	0.87	0.02	0.72	0.09	0.97
Liq.-Adj. Exc. Log Ret. TIPS	-0.46^{**}	1.96	-0.51^{**}	2.17	-0.47^{*}	2.49
Log Return Liquidity	0.53^{**}	2.40^{*}	0.17^{**}	1.62^{**}	0.58^{**}	2.00

Panel B: UK	1985.3-2009.12		1985.3-2006.12		1985.3-1998.12		1999.1-2009.12	
	$\widehat{\beta}$	$\widehat{\alpha}$	$\widehat{\beta}$	$\widehat{\alpha}$	$\widehat{\beta}$	$\widehat{\alpha}$	$\widehat{\beta}$	$\widehat{\alpha}$
Excess Log Return Nominal	0.16	2.98	0.19	3.25	0.31	3.96	-0.06	0.41
Excess Log Return TIPS	0.15^{**}	1.21	0.14^{*}	1.13	0.17^{*}	0.09	0.13	2.40
Excess Log Return BEI	0.01	1.78	0.05	2.12	0.13	3.87	-0.19^{*}	-1.98

Table A.XI
Four Factor Regressions

Panel A: 1999.6-2009.12	$xr^{\$}_{n,t+1}$	$xr^{TIPS}_{n,t+1}$	$xr^{b}_{n,t+1}$	$xr^{TIPS-L}_{n,t+1}$	$xr^{b+L}_{n,t+1}$	$r^{L}_{n,t+1}$
xr^{equity}_{t+1}	-0.25	0.21	-0.47^{*}	-0.37^{*}	0.12	0.58^{**}
	(0.13)	(0.25)	(0.20)	(0.17)	(0.11)	(0.16)
HML	0.05	-0.00	0.05	-0.01	0.06	0.00
	(0.05)	(0.08)	(0.06)	(0.06)	(0.04)	(0.03)
SMB	-0.13^{*}	-0.10	-0.03	-0.10	-0.03	0.01
	(0.06)	(0.06)	(0.05)	(0.06)	(0.05)	(0.03)
Pastor-Stambaugh	-0.09^{**}	-0.10^{**}	0.00	-0.05	-0.04^{*}	-0.05^{*}
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
const.	3.08	4.67^{**}	-1.59	2.56	0.52	2.11
	(1.73)	(1.72)	(1.42)	(1.58)	(1.11)	(1.17)

Panel B: 1999.6-2006.12	$xr^{\$}_{n,t+1}$	$xr^{TIPS}_{n,t+1}$	$xr^{b}_{n,t+1}$	$xr^{TIPS-L}_{n,t+1}$	$xr^{b+L}_{n,t+1}$	$r^{L}_{n,t+1}$
xr^{equity}_{t+1}	-0.33	-0.23	-0.10	-0.42^{**}	0.09	0.18^{**}
	(0.23)	(0.15)	(0.14)	(0.14)	(0.13)	(0.04)
HML	0.06	0.09^{*}	-0.03	0.09	-0.03	0.01
	(0.06)	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)
SMB	-0.10	0.01	-0.10^{*}	0.00	-0.10	0.01
	(0.06)	(0.04)	(0.05)	(0.04)	(0.05)	(0.02)
Pastor-Stambaugh	-0.11^{**}	-0.08^{**}	-0.03	-0.06^{*}	-0.04	-0.01
	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)	(0.01)
const.	3.22	2.86	0.36	1.35	1.87	1.51^{**}
	(2.28)	(1.58)	(1.20)	(1.43)	(1.28)	(0.54)

Economic Significance of Liquidity Returns

- Estimated average liquidity return 1.36% p.a. (average TIPS excess returns 4.16% p.a)
- Liquidity returns highly systematic (Beta=0.53).
- Liquidity risk explains most of the systematic exposure of breakeven inflation.

Figure 6A. Estimated US Bond Risk Premia

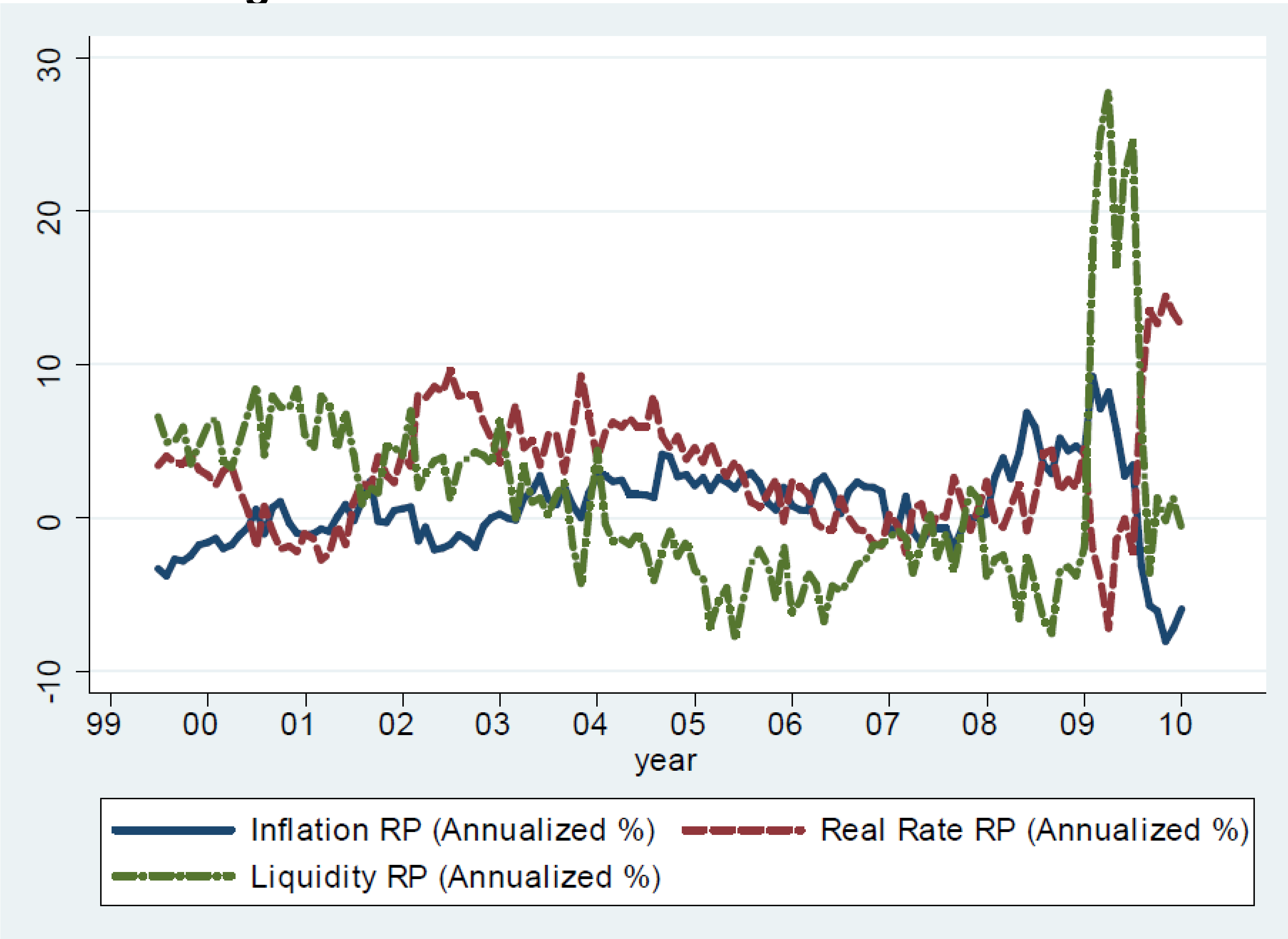
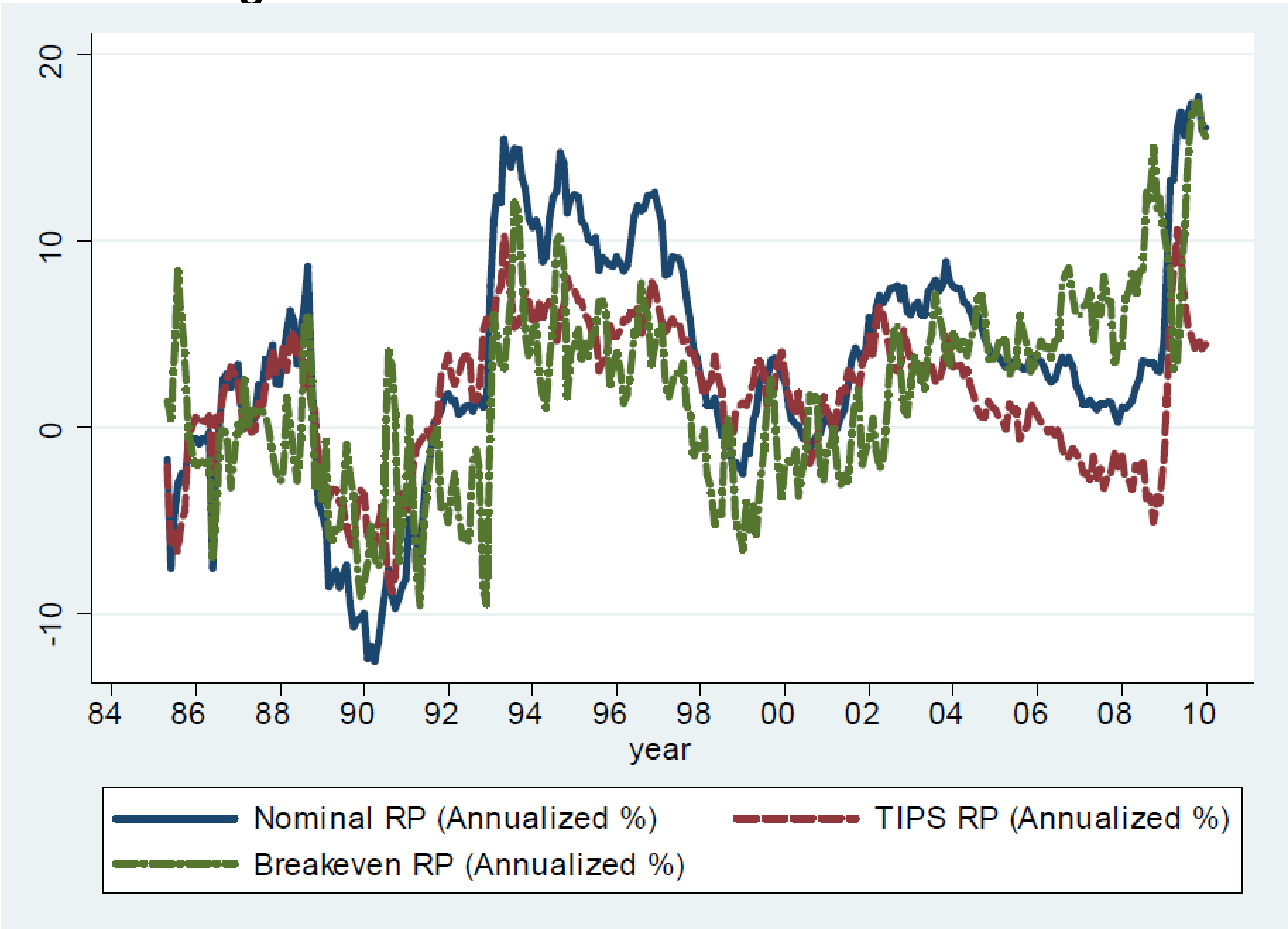


Figure 6B. Estimated UK Bond Risk Premia



The Market Segmentation Hypothesis

- Preferred-Habitat hypothesis argues that the preference of certain types of investors for specific bond-maturities can result in price pressure (Modigliani and Sutch, 1966, Vayanos and Vila, 2009, Greenwood and Vayanos, 2008, Hamilton and Wu 2010)

- Just as investors differ in preferences for different maturities they might differ between inflation-indexed and nominal bonds.

- Market segmentation between nominal and real bond markets could be a source of return predictability.

The Market Segmentation Hypothesis

- Following Greenwood and Vayanos (2008) use the outstanding supply of real bonds relative to total government debt in the US and in the UK to proxy for supply shocks.

- If supply experiences exogenous shocks and demand is stable, shocks to the relative supply of inflation-indexed bonds should move
  - negatively with breakeven inflation
  - negatively with future breakeven returns

- In a different scenario the government could accommodate changes in demand. In that case expect no relationship of returns with quantities.

Figure 5A. US Relative Supply and 10 Year Breakeven Inflation

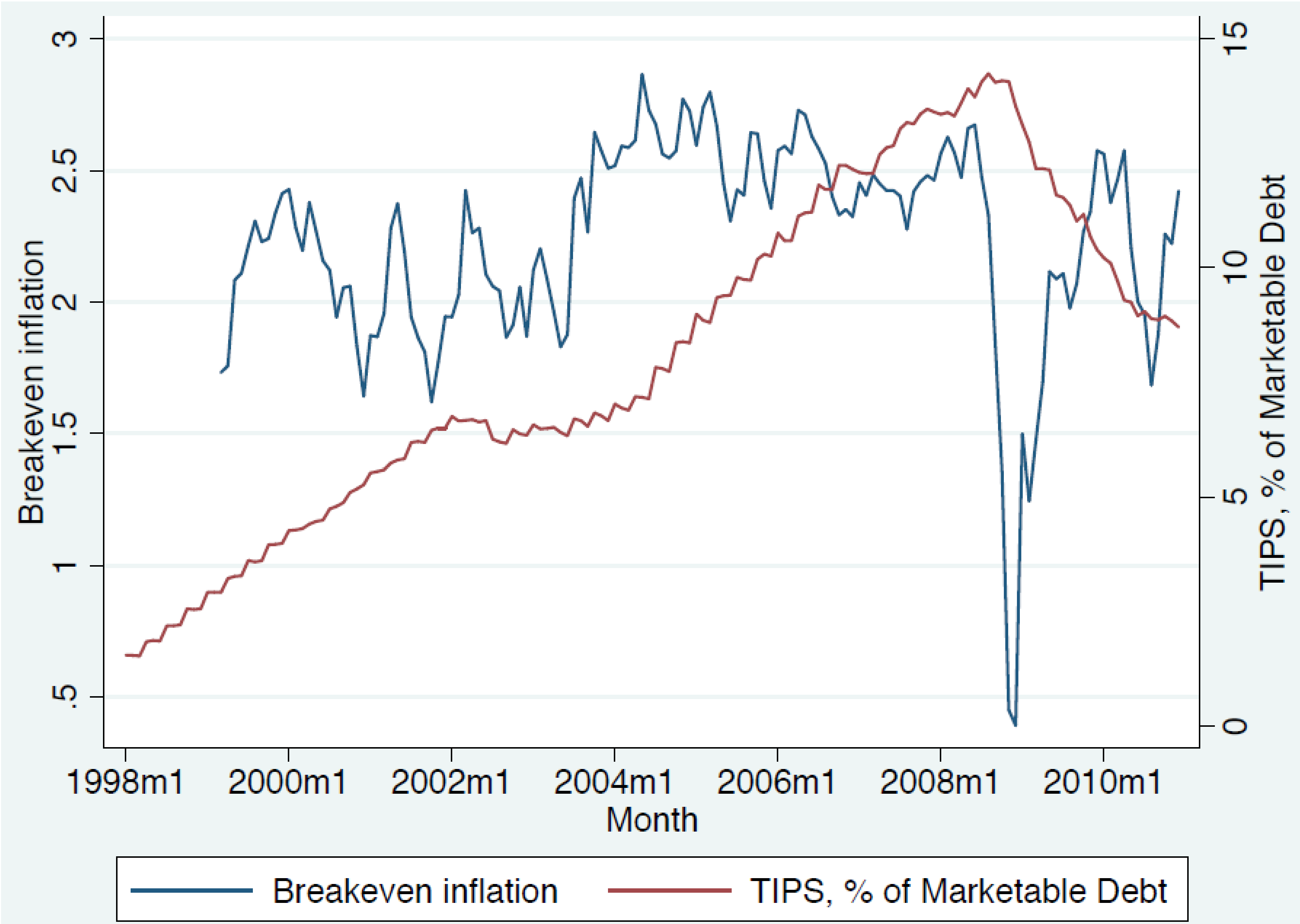


Figure 5A. UK Relative Supply and 20 Year Breakeven

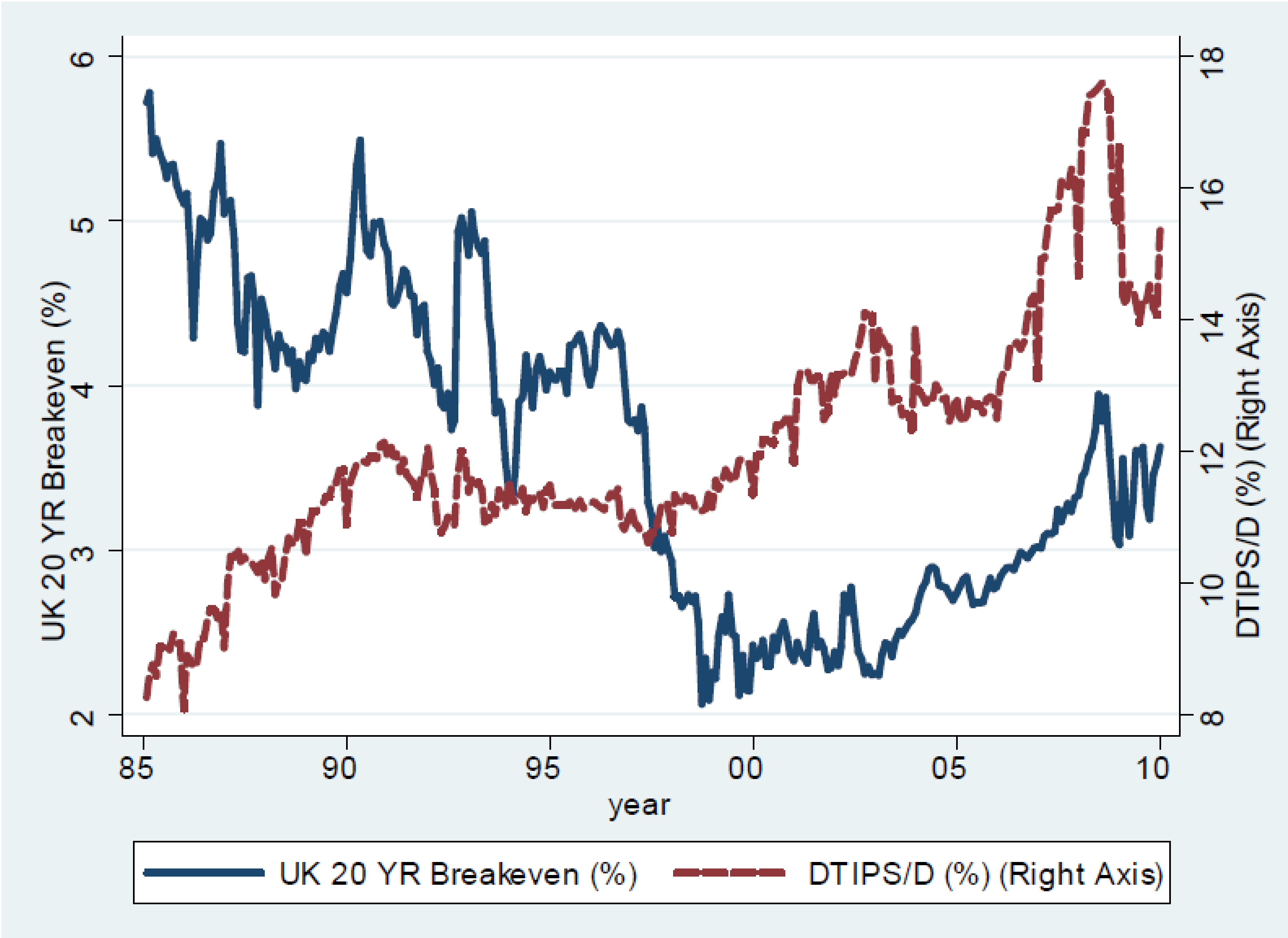


Table III
Breakeven Inflation onto Relative Supply

	Panel A: US				Panel B: UK				
$Supply_t$	0.01			−0.02	−0.27**		0.29**		
	(0.03)			(0.02)	(0.06)		(0.05)		
$\Delta Supply_t$		0.03		0.00		0.01	−0.01		
		(0.02)		(0.01)		(0.01)	(0.01)		
ε_t^{Supply}			0.03	0.00				0.00	0.00
			(0.02)	(0.01)				(0.02)	(0.01)
Off-the-run Spr.				−1.00*					
				(0.39)					
Asset-Swap-Spr.				−0.81**					
				(0.29)					
Transaction Vol.				0.32					
				(0.17)					
Bid-ask Spr.				−0.81*					
				(0.31)					
$month$				0.00			−3.43		−1.96**
				(0.00)			(0.29)		(0.21)
p-value	0.76	0.07	0.12	0.00	0.00	0.42	0.00	0.69	0.00
R^2	0.00	0.05	0.03	0.68	0.26	0.00	0.66	0.00	0.53
Sample		2000.2-2010.2				1985.1 – 2009.12			1986.1 – 2009.12

Table IV
Excess Bond Returns onto Relative Supply of Inflation-Indexed Bonds

Panel A: US

	$xr^{\$}_{n,t+1}$	$xr^{TIPS}_{n,t+1}$	$xr^{b}_{n,t+1}$	$xr^{b}_{n,t+1}$	$xr^{b}_{n,t+1}$
$y^{\$}_{n,t} - y^{\$}_{1,t}$	2.35				
	(1.52)				
$y^{TIPS}_{n,t} - y^{TIPS}_{1,t}$		3.30**		−1.81	−1.78
		(1.23)		(1.19)	(1.25)
$b_{n,t} - b_{1,t}$			5.67	6.44*	7.00*
			(2.88)	(2.75)	(3.47)
$L_{n,t}$	−3.27	9.61	−13.10**	−9.78*	−10.49*
	(6.49)	(6.02)	(3.78)	(4.65)	(4.27)
$Supply_t$	0.26	0.14	−0.01	−0.21	
	(0.70)	(0.75)	(0.62)	(0.61)	
$\Delta Supply_t$	0.17	0.10	0.17	0.04	
	(0.45)	(0.36)	(0.28)	(0.25)	
ε^{Supply}_t					−0.47
					(0.37)
$month \times 10^{-4}$					−1.27
					(−1.38)
p-value	0.60	0.01	0.00	0.00	0.00
R^2	0.04	0.16	0.21	0.22	0.23
Sample	1999.3 – 2009.12				2000.5 – 2009.12

Table IV
Excess Bond Returns onto Relative Supply of Inflation-Indexed Bonds

Panel B: UK

	$xr^{\$}_{n,t+1}$	$xr^{TIPS}_{n,t+1}$	$xr^{b}_{n,t+1}$	$xr^{b}_{n,t+1}$	$xr^{b}_{n,t+1}$
$y^{\$}_{n,t} - y^{\$}_{1,t}$	3.23				
	(1.76)				
$y^{TIPS}_{n,t} - y^{TIPS}_{1,t}$		2.17		-3.02	-2.58
		(1.41)		(1.95)	(2.19)
$b_{n,t} - b_{1,t}$			7.39**	8.97**	9.00**
			(2.27)	(2.65)	(2.85)
$L_{n,t}$					
$Supply_t$	-2.98	-2.72	-0.51	-1.75	
	(2.30)	(1.78)	(2.25)	(2.18)	
$\Delta Supply_t$	-0.14	-0.12	0.00	-0.05	
	(0.49)	(0.34)	(0.39)	(0.41)	
ε^{Supply}_t					0.02
					(0.53)
$month \times 10^{-4}$	0.73	1.83*	-1.69	-1.33	-2.05**
	(1.41)	(0.89)	(1.13)	(1.09)	(0.69)
p-value	0.09	0.01	0.01	0.01	0.02
R^2	0.06	0.07	0.10	0.11	0.10
Sample	1985.4 – 2009.12				1986.4 – 2009.12

Interpretation of Supply Regressions

- EH results are robust to controlling for bond supply variables.
- Bond return predictability does not appear to be driven by temporary price pressures.
- No relationship between relative supply and breakeven or returns in the US.
- Some evidence of bond supply effects in UK.

Conclusions

- Large and time-varying liquidity premium in TIPS between 50 bps and 200 bps.
- Liquidity-adjusted breakeven inflation has been stable over time.
- Is the liquidity premium a discount on TIPS or a convenience yield on nominal Treasuries?
  - Very different implications for Treasury issuance policy in light of benefits of TIPS to long-term savers.

Conclusions

- Empirical evidence for three sources of excess return predictability:
  - Real interest rate risk in inflation-indexed bonds and nominal bonds
  - Liquidity risk in inflation-indexed bonds
  - Inflation-risk in nominal bonds

- No evidence for market segmentation as a source of return predictability in inflation-indexed bonds.

Further Research

- Important to understand macroeconomic foundations of changing nominal-real covariance.
  - We are exploring new Keynesian macroeconomic models with changing volatilities of shocks to productivity, aggregate demand, and monetary policy.
- Adjust breakeven for liquidity and inflation risk risk premia to obtain a predictor of expected inflation.
- Implications of liquidity, real interest rate risk and inflation risk for portfolio management and pension-investing.