Internet Appendix to Stock Market Liquidity and the Business Cycle

Randi Næs
Johannes A. Skjeltorp
Bernt Arne Ødegaard

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This internet appendix contains additional material to the paper "Stock Market Liquidity and the Business Cycle"

The appendix contains the following additional material:

1. **A microscope on the recent financial crisis (section 1:**
   We show the evolution of liquidity measures for the period 2004–2008 for the US, and 2004-2009 for Norway.

2. **Liquidity correlation across countries:**
   We show the correlation of liquidity measures, both across liquidity measures and across countries.

3. **Additional US size results:**
   Report estimation results for liquidity measures constructed separately for small and large firms for additional macro variables (dUE, $dCONSR$ and $dINV$). This is to supplement table 7 in the paper.

4. **Predictability results and causality tests for Norway:**
   Report of the results for Norway, discussed in section 4.1 in the paper.

5. **Additional predictability and causality tests for the US:**
   We redo the analysis in tables 4, 5 and 7 in the paper for two alternative time series transformations of the ILR and LOT liquidity measures (demeaning and Hodrick-Prescott filtering).

6. **Additional predictability tests for the US:**
   We redo the analysis in table 4 in the paper using a VAR (vector auto regression) specification. We report Granger causality tests between all variables in VAR and analyze the impulse response functions (we focus on the response of $dGDPR$ to a shock in $dILR$) and examine the robustness of the response function to different orderings of the endogenous variables.

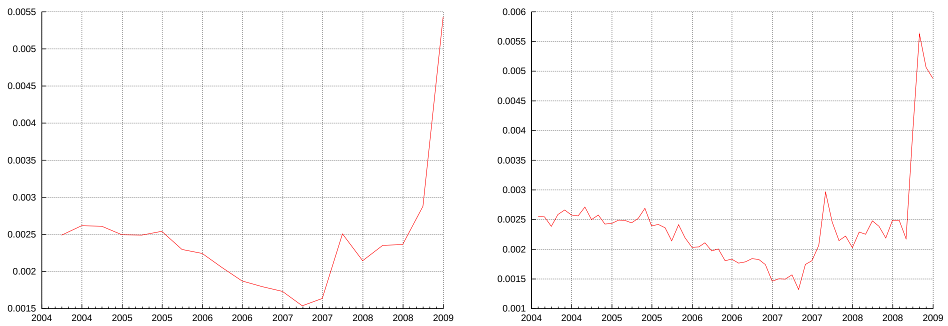
1 A microscope on the recent financial crisis

The recent finanial crisis is of particular interest for the purposes of this paper, because it has been argued to be a prime example of lack of liquidity leading to a crisis, and a real economic recession. To illustrate how stock market liquidity has "played out" during the crisis in the markets considered in the paper, we show some time series plots of the various liquidity measures, starting in 2004, for both the US (figure 1) and Norway (figure 2.)

Figure 1: Liquidity evolution of NYSE in the period 2004–2008

The figures below show time series of aggregate measures of liquidity at the NYSE in the period 2004–2008. The measures are calculated for each firm at the NYSE using data for either one month or one quarter. We then calculate (equally weighted) averages of the liquidity measures calculated for individual firms. In panel A we show the relative spread, calculated as quarterly (left) or monthly (right) averages over daily closing spread. In panel B, the *Roll* (left) and *LOT* (right) measures are calculated using one quarter of daily returns. In panel C, the *ILR* measure is calculated using one quarter (left) or one month (right) worth of daily measures.

Panel A: Relative Spread, quarterly (left), monthly (right)



Panel B: Quarterly *Roll* (left) and *LOT* (right)

Panel C: *ILR*, quarterly (left) and monthly (right)

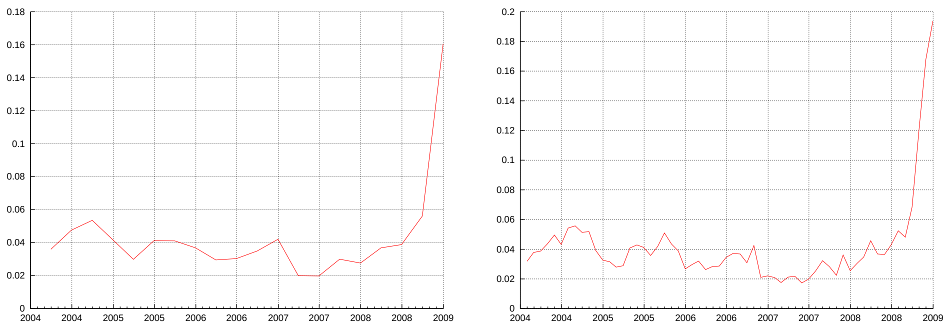
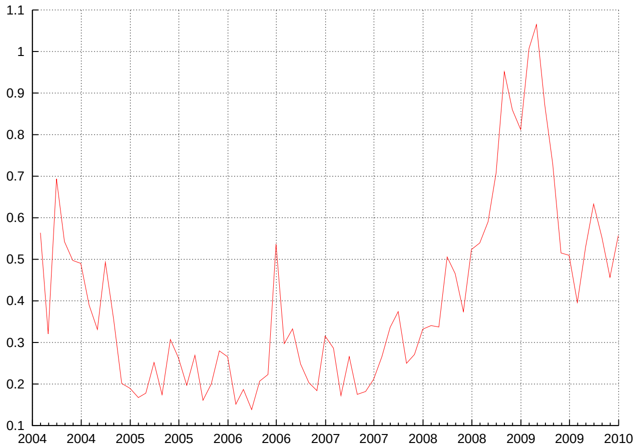


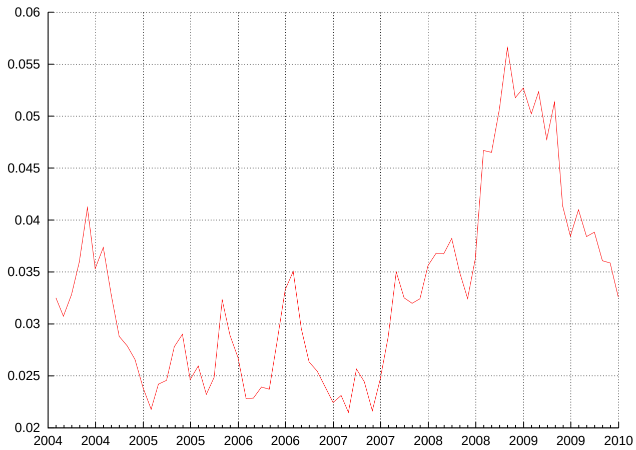
Figure 2: Liquidity evolution in Norway during the period 2004–2009

The figures plot the evolotion of various liquidity measures at the Oslo Stock Exchange in the period 2004–2009. The *ILR* is Amihuds illiquidity ratio, calculated with data for one month, the relative spread is the average over the month of the crossectional averages of (end of day) relative spreads. The turnover is the fraction of a stock's outstanding equity traded during a month.

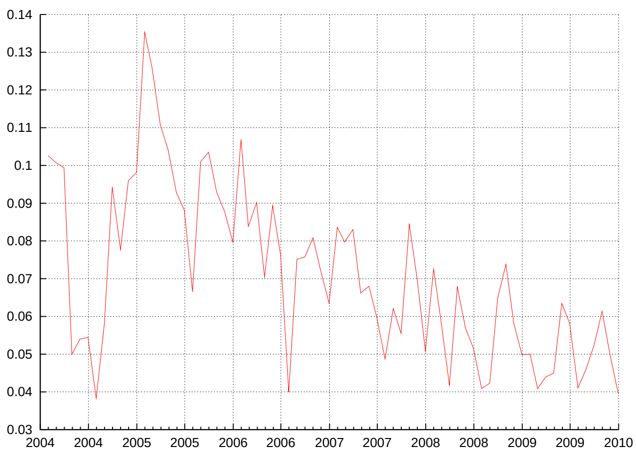
Panel A: *ILR* liquidity measure



Panel B: Relative spread



Panel C: Monthly Turnover



2 Liquidity correlation across countries

In the paper we show correlations between liquidity measures by calculating different liquidity measures for the same stock in a given quarter, and use this as the basic piece of data for calculating the correlation between liquidity measures. An alternative way of calculating a correlation between liquidity measures, which also allow comparisons across exchanges, is to instead use a crossectional liquidity measure for the whole market as the basic piece of data used to calculate the correlation. In table 1 we show such correlations of the aggregate liquidity measures, both within and across exchanges, i.e. the correlations between two time series of crossectional averages,

Table 1: Correlations between time series of average liquidity measures

The table shows correlations between time series of average liquidity measure. For each liquidity measure, on each date, we calculate the equally weighted average across all stocks present at that date. The numbers in the table are correlations between the resulting time series of averages. The time series used differ. For the US, we have *LOT*, *ILR* and *Roll* for 1947–2008. The relative spread (*RS*) for NYSE starts in 1980, the same time as the Norwegian data start. All series stop at the end of 2008.

	US *RS*	US *LOT*	US *ILR*	US *Roll*	Norway *RS*	Norway *LOT*	Norway *ILR*
US *LOT*	0.66						
US *ILR*	0.40	0.07					
US *Roll*	0.18	0.35	-0.06				
Norway *RS*	0.35	0.45	0.55	0.49			
Norway *LOT*	0.41	0.57	0.56	0.39	0.84		
Norway *ILR*	0.25	0.60	0.65	0.16	0.67	0.72	
Norway *Roll*	0.35	0.33	0.32	0.59	0.67	0.68	0.44

3 Additional US size results

In section 3 of the paper we look at liquidity measures calculated separately for small and large stocks, and do the predictive regression

$$y_{t+1} = \alpha + \beta_S^{LIQ} LIQ_t^{small} + \beta_L^{LIQ} LIQ_t^{large} + \gamma \mathbf{X}_t + u_{t+1},$$

In the paper we only report the results with respect to GDP growth (*dGDPR*) as the dependent variable. In this appendix we show these regressions also for *dUE*, *dCONSR* and *dINV* as dependent variables.

Table 2: Predicting macro with market liquidity - size portfolios

The table shows the multivariate OLS estimates from regressing next quarters macro variables on current market illiquidity of small and large firms and four control variables for the US sample. We examine three different proxies for market illiquidity, sampled for small and large firms. Both *ILR* and *LOT* is first (log) differenced for stationarity reasons while *Roll* is unaltered. The estimated model is $y_{t+1} = \alpha + \beta_S^{LIQ} LIQ_t^{small} + \beta_L^{LIQ} LIQ_t^{large} + \gamma \mathbf{X_t} + u_{t+1}$, where y_{t+1} is one of real GDP growth (*dGDPR*), growth in the unemployment rate (*dUE*), real consumption growth (*dCONSR*) or growth in private investments (*dINV*), LIQ^{small} is the illiquidity proxy sampled for the 25% smallest firms and LIQ^{large} is the illiquidity of the 25% largest firms, $\mathbf{X_t}$ contains the additional control variables (*Term*, *Cred*, *Vola* and er_m) and γ' is the vector of the respective coefficient estimates for the control variables. The Newey-West corrected t-statistics (with 4 lags) is reported in parentheses below the coefficient estimates, and $\bar{R}^2$ is the adjusted R^2.

Panel A: *dILR* liquidity measure

Dependent variable (y_t)	Const.	β_S^{LIQ}	β_L^{LIQ}	$\hat{\gamma_1}^{Term}$	$\hat{\gamma_2}^{Cred}$	$\hat{\gamma_3}^{Vola}$	$\hat{\gamma_4}\,er_m$	$\bar{R}^2$	ex.LIQ $\bar{R}^2$	ex.LIQ^S $\bar{R}^2$	ex.LIQ^L $\bar{R}^2$
dGDPR	0.008	-0.008	0.003	0.000	-0.014	0.001	0.021	0.14	0.12	0.12	0.14
	(7.64)	(-3.74)	(1.09)	(0.54)	(-3.16)	(0.21)	(2.31)				
dUE	0.002	0.030	-0.043	-0.006	0.109	-0.029	-0.253	0.13	0.13	0.13	0.13
	(0.20)	(1.70)	(0.08)	(-1.60)	(3.34)	(-0.83)	(-4.00)				
dCONSR	0.008	-0.001	0.002	0.001	-0.004	0.001	0.028	0.08	0.09	0.09	0.09
	(8.27)	(-0.35)	(0.57)	(1.91)	(-1.45)	(0.15)	(3.15)				
dINV	0.007	-0.019	0.011	0.003	-0.044	0.015	0.062	0.19	0.17	0.17	0.19
	(2.18)	(-3.53)	(1.17)	(2.08)	(-4.22)	(1.10)	(2.40)				

Panel B: *dLOT* liquidity measure

Dependent variable (y_t)	Const.	β_S^{LIQ}	β_L^{LIQ}	$\hat{\gamma_1}^{Term}$	$\hat{\gamma_2}^{Cred}$	$\hat{\gamma_3}^{Vola}$	$\hat{\gamma_4}\,er_m$	$\bar{R}^2$	ex.LIQ $\bar{R}^2$	ex.LIQ^S $\bar{R}^2$	ex.LIQ^L $\bar{R}^2$
dGDPR	0.009	-0.014	0.000	0.000	-0.015	0.009	0.029	0.14	0.12	0.12	0.15
	(7.52)	(-2.12)	(-0.06)	(0.42)	(-3.61)	(1.58)	(3.55)				
dUE	0.003	0.108	0.014	-0.005	0.107	-0.099	-0.237	0.15	0.13	0.13	0.15
	(0.38)	(3.55)	(0.37)	(-1.40)	(3.26)	(-2.45)	(-4.62)				
dCONSR	0.008	-0.005	-0.005	0.001	-0.004	0.005	0.026	0.10	0.09	0.10	0.09
	(8.17)	(-1.39)	(-1.00)	(1.83)	(-1.35)	(0.98)	(3.91)				
dINV	0.007	-0.016	-0.012	0.003	-0.047	0.027	0.074	0.18	0.17	0.18	0.18
	(2.28)	(-1.17)	(-0.95)	(1.97)	(-4.63)	(1.85)	(3.63)				

Panel C: *Roll* liquidity measure

Dependent variable (y_t)	Const.	β_S^{LIQ}	β_L^{LIQ}	$\hat{\gamma_1}^{Term}$	$\hat{\gamma_2}^{Cred}$	$\hat{\gamma_3}^{Vola}$	$\hat{\gamma_4}\,er_m$	$\bar{R}^2$	ex.LIQ $\bar{R}^2$	ex.LIQ^S $\bar{R}^2$	ex.LIQ^L $\bar{R}^2$
dGDPR	0.017	-0.306	-0.251	0.001	-0.013	0.007	0.022	0.15	0.12	0.14	0.15
	(5.14)	(-2.38)	(-0.91)	(1.39)	(-3.12)	(1.29)	(2.74)				
dUE	-0.051	2.463	0.768	-0.010	0.096	-0.075	-0.197	0.15	0.13	0.14	0.15
	(-1.75)	(2.74)	(0.31)	(-2.62)	(2.78)	(-1.89)	(-3.85)				
dCONSR	0.014	-0.298	-0.002	0.001	-0.002	0.005	0.023	0.11	0.09	0.10	0.12
	(4.67)	(-2.49)	(-0.01)	(2.87)	(-0.91)	(1.03)	(3.39)				
dINV	0.033	-1.092	-0.595	0.005	-0.040	0.034	0.056	0.23	0.17	0.20	0.23
	(4.00)	(-2.94)	(-0.65)	(3.11)	(-4.25)	(2.79)	(2.72)				

4 Predictability results and causality tests for Norway

In section 4 of the paper we discuss the results from running predictive in sample regressions, Granger causality tests and out of sample tests for Norway, but do not give the actual results. In this appendix we report the estimation results for Norway.

Table 3: In-sample predictive regressions - Norway

The table shows the results from predictive regressions for different macro variables for Norway covering the period 1980-2009. The regressions estimated are $y_{t+1} = \alpha + \beta^{LIQ} LIQ_t + \gamma' \mathbf{X}_t + u_{t+1}$, where y_{t+1} is one of quarterly real GDP growth (*dGDPR*), growth in the unemployment rate (*dUE*), real consumption growth (*dCONSR*) or growth in private investments (*dINV*). LIQ is either *RS* or *ILR*, and the variables in $\mathbf{X}$ are *Term*, *Vola* and er_m and the lag of the dependent variable. The Newey-West corrected t-statistics (with 4 lags) is reported in parentheses below the coefficient estimates, and $\bar{R}^2$ is the adjusted R^2 for the estimated model.

Panel A: *RS* liquidity measure

Dependent variable (y_{t+1})	$\hat{\alpha}$	$\hat{\beta}^{LIQ}$	$\hat{\gamma}^{y}$	$\hat{\gamma}^{Term}$	$\hat{\gamma}^{Vola}$	$\hat{\gamma}^{er_m}$	$\bar{R}^2$
dGDPR	0.023	-0.397	-0.243				0.12
	(5.28)	(-4.03)	(-4.03)				
dUE	-0.443	11.387	-0.150				0.12
	(-3.94)	(3.95)	(-1.56)				
dCONSR	0.016	-0.216	-0.153				0.03
	(3.75)	(-2.43)	(-1.62)				
dINV	0.073	-1.686	-0.415				0.19
	(3.79)	(-4.01)	(0.19)				
dGDPR	0.019	-0.361	-0.259	0.001	0.240	0.001	0.11
	(3.11)	(-3.43)	(-4.25)	(1.64)	(0.62)	(0.08)	
dUE	-0.358	12.365	-0.166	-0.007	-14.022	-0.183	0.11
	(-3.20)	(3.05)	(-1.39)	(-0.57)	(-1.00)	(-0.77)	
dCONSR	0.018	-0.115	-0.127	0.000	-0.738	-0.010	0.03
	(2.83)	(-0.97)	(-1.33)	(0.22)	(-1.88)	(-1.20)	
dINV	0.052	-1.325	-0.418	0.003	0.547	0.044	0.18
	(1.56)	(-2.66)	(-5.03)	(0.93)	(0.24)	(0.73)	

Panel B: *ILR* liquidity measure

Dependent variable (y_{t+1})	$\hat{\alpha}$	$\hat{\beta}^{LIQ}$	$\hat{\gamma}^{y}$	$\hat{\gamma}^{Term}$	$\hat{\gamma}^{Vola}$	$\hat{\gamma}^{er_m}$	$\bar{R}^2$
dGDPR	0.012	-0.006	-0.225				0.11
	(5.99)	(-3.04)	(-3.69)				
dUE	-0.108	0.141	-0.080				0.06
	(-2.16)	(2.49)	(-0.82)				
dCONSR	0.011	-0.004	-0.142				0.04
	(5.85)	(-2.72)	(-1.49)				
dINV	0.021	-0.018	-0.404				0.16
	(2.23)	(-2.44)	(-4.94)				
dGDPR	0.010	-0.006	-0.231	0.001	0.165	0.007	0.10
	(2.36)	(-2.26)	(-3.42)	(0.85)	(0.45)	(0.67)	
dUE	-0.012	0.145	-0.085	-0.007	-10.323	-0.335	0.05
	(-0.14)	(2.22)	(-0.78)	(-0.45)	(-1.01)	(-1.39)	
dCONSR	0.016	-0.003	-0.128	0.000	-0.732	-0.007	0.04
	(3.71)	(-1.68)	(-1.32)	(-0.02)	(-1.85)	(-0.92)	
dINV	0.011	-0.009	-0.404	0.004	-0.071	0.057	0.16
	(0.50)	(-0.80)	(-4.96)	(1.06)	(-0.03)	(0.88)	

Table 4: Granger causality tests Norway

The table shows the results of Granger causality tests between growth in real GDP (*dGDPR*), unemployment (*dUE*), real consumption (*dCONSR*) and investments (*dINV*) and the two liquidity proxies for Norway (*RS* and *ILR*) using quarterly data for the period 1980-2009. The first column states which macro variable we are looking at. The second to fourth column, report the Granger causality tests when we proxy liquidity with the relative spread (*RS*), and columns 5 to 7 report the causality tests when we use *ILR* as our liquidity proxy. The second column state the null hypothesis tested, with the associated χ^2 and p-value in the third and fourth column (sixth and seventh column for *ILR*), respectively. *, ** denote rejection of the null hypothesis at the five and one percent significance level, respectively.

	RS			*ILR*		
	H0:	χ^2	p-value	H0:	χ^2	p-value
(a) *dGDPR*	$dGDPR \nrightarrow RS$	2.58	0.11	$dGDPR \nrightarrow ILR$	2.52	0.11
	$RS \nrightarrow dGDPR$	14.64	0.00**	$ILR \nrightarrow dGDPR$	13.83	0.00**
(b) *dUE*	$dUE \nrightarrow RS$	0.38	0.54	$dUE \nrightarrow ILR$	4.23	0.04*
	$RS \nrightarrow dUE$	17.14	0.00**	$ILR \nrightarrow dUE$	9.58	0.00**
(c) *dCONSR*	$dCONSR \nrightarrow RS$	1.47	0.22	$dCONSR \nrightarrow ILR$	1.03	0.31
	$RS \nrightarrow dCONSR$	3.84	0.05*	$ILR \nrightarrow dCONSR$	5.05	0.02*
(d) *dINV*	$dINV \nrightarrow RS$	0.47	0.49	$dINV \nrightarrow ILR$	0.00	0.99
	$RS \nrightarrow dINV$	8.46	0.00**	$ILR \nrightarrow dINV$	3.17	0.07

Table 5: Granger causality tests Norway - size portfolios

The table shows the results of Granger causality tests between real GDP growth and the illiquidity of small and large firms for the two different liquidity proxies for the Norwegian sample for the period 1980 to 2009. The first column denote the liquidity variable, column two and three shows the χ^2 and associated p-value from Granger causality tests where the null hypothesis is that GDP growth *does not* Granger cause the liquidity variables. Similarly, columns four and five show the results when the null hypothesis is that the liquidity variable *does not* Granger cause GDP growth. *, ** denote rejection of H0 at the five and one percent significance level, respectively.

	$dGDPR \nrightarrow$ LIQ		LIQ $\nrightarrow dGDPR$	
Liquidity variable (LIQ)	χ^2	p-value	χ^2	p-value
RS^{S}	0.69	(0.71)	5.90*	(0.05)
RS^{L}	1.93	(0.37)	0.61	(0.73)
ILR^{S}	0.15	(0.67)	4.92*	(0.03)
ILR^{L}	1.63	(0.20)	0.66	(0.42)

Table 6: Out of sample analysis for Norway

The table in panel A reports the results from nested model comparisons for predicting quarterly real GDP growth out of sample one-quarter ahead using relative spread (*RS*) and the illiquidity ratio (*ILR*). The first column shows the variables in the unrestricted model, and the second column shows the variable included in the restricted (baseline) model. Columns 3 to 5 shows the relative MSE, the MSE-F test for equality of MSE and the ENC-NEW test for the one-quarter-ahead forecast. Panel C shows the results from when the baseline model is an autoregressive model (of order 1) for GDP growth. In that case the unrestricted model adds *RS* or *ILR* to the restricted model. ** and * denotes a rejection of the null hypothesis (at the 1% and 5% level, respectively) of equal forecast precision for the MSE-F test, while it denotes a rejection of the null that the restricted model encompasses the unrestricted model for the ENC-NEW test.

Panel A: Liquidity vs. other financial variables

		1 quarter-ahead forecasts		
Unrestricted model	Restricted model	$\frac{MSE_u}{MSE_r}$	MSE-F	ENC-NEW
RS, *Term*	*Term*	0.974	1.590*	1.003
RS, er_m	er_m	0.963	2.243*	1.427*
RS, *Vola*	*Vola*	0.946	3.351*	2.087*
ILR, *Term*	*Term*	1.004	-0.246	-0.062
ILR, er_m	er_m	0.967	2.015*	1.249*
ILR, *Vola*	*Vola*	0.979	1.245	0.825

Panel B: Liquidity vs. an AR model for GDP growth

		1 quarter-ahead forecasts		
Unrestricted model	Restricted model	$\frac{MSE_u}{MSE_r}$	MSE-F	ENC-NEW
RS, *dGDPR*	*dGDPR*	0.888	7.43**	4.75**
ILR, *dGDPR*	*dGDPR*	0.938	3.89**	2.38*

5 Predictability of US macro, alternative time series liquidity specifications

In section 1.5 of the paper we discuss our choices of time series transformations of ILR and LOT to achieve stationarity, and in the paper we fall down on using (log) differences for ILR and LOT. But there are alternative ways to achieve stationarity. In this appendix we show two alternative transformations. First, in section 5.1 we show the results when we demean ILR and LOT measures using a two year (backward looking) moving average. Second, in section 5.2 we show results using a Hodrick-Prescott filter to detrend on ILR and LOT. Note that the series using a Hodrick-Prescott filter could not be used in our out of sample forecasting analysis, since it is estimated using future data. The first method, though, only uses data available when the mean is removed, and could be used in forecasting exercises. In the paper we use the first (log) different versions of the liquidity variables for both the in sample and out of sample analysis.

5.1 Time demeaned versions of *ILR* and *LOT*

In the following tables we redo the analysis reported in tables 4, 5 and 7 in the paper using the time de-meaned versions of ILR and LOT to make each series stationary. The de-meaning is done by taking the difference between the quarter `t` realization of the variable and the moving average over the most recent 8 quarters. Essentially, we are removing a time-varying trend in the ILR and LOT series.

Table 7: In-sample prediction of macro variables - demeaned *ILR* and *LOT*

The table shows the results from predictive regressions where we regress next quarters growth in different macro variables on three proxies for market illiquidity for the period 1947-2008. Market illiquidity (LIQ) is proxied by one of two illiquidity measures: the Amihud Illiquidity ratio (*ILR*) and the *LOT* measure. Both *ILR* and *LOT* is demeaned relative to their two year moving average to preserve stationarity. The model estimated is $y_{t+1} = \alpha + \beta \mathrm{LIQ}_t + \gamma' \mathbf{X}_t + u_{t+1}$ where y_{t+1} is one of real GDP growth (*dGDPR*), growth in the unemployment rate (*dUE*), real consumption growth (*dCONSR*) or growth in private investments (*dINV*). We include one lag of the dependent variable (y_t) in addition to *Term*, *Cred*, *Vola* and er_m as control variables. The Newey-West corrected t-statistics (with 4 lags) is reported in parentheses below the coefficient estimates, and $\bar{R}^2$ is the adjusted R^2. The last column report the adjusted R-squared when we exclude the liquidity variable in the respective models.

Panel A: *ILR* liquidity measure (demeaned)

Dependent variable (y_{t+1})	$\hat{\alpha}$	$\hat{\beta}^{LIQ}$	$\hat{\gamma}^{y}$	$\hat{\gamma}^{Term}$	$\hat{\gamma}^{Cred}$	$\hat{\gamma}^{Vola}$	$\hat{\gamma}^{er_m}$	$\bar{R}^2$	ex.liq. $\bar{R}^2$
dGDPR	0.007	-0.016	0.005					0.22	0.03
	(9.71)	(-4.81)	(0.08)						
dUE	0.009	0.146	0.102					0.33	0.07
	(1.73)	(6.42)	(1.80)						
dCONSR	0.006	-0.006	0.241					0.12	0.08
	(5.96)	(-1.90)	(2.43)						
dINV	0.007	-0.030	0.118					0.14	0.06
	(3.15)	(-2.39)	(1.65)						
dGDPR	0.007	-0.014	0.016	0.000	-0.010			0.24	0.10
	(6.78)	(-4.23)	(0.25)	(0.50)	(-2.83)				
dUE	0.015	0.133	0.121	-0.006	0.054			0.35	0.15
	(2.23)	(6.00)	(2.12)	(-1.50)	(2.41)				
dCONSR	0.005	-0.005	0.251	0.001	-0.002			0.14	0.12
	(3.48)	(-1.60)	(2.62)	(2.09)	(-0.83)				
dINV	0.003	-0.022	0.128	0.003	-0.036			0.22	0.17
	(0.87)	(-1.88)	(1.94)	(2.24)	(-4.32)				
dGDPR	0.008	-0.013	0.030	0.000	-0.009	-0.002	0.015	0.25	0.15
	(7.47)	(-3.68)	(0.47)	(0.26)	(-2.74)	(-0.33)	(1.90)		
dUE	0.010	0.120	0.146	-0.005	0.057	-0.020	-0.127	0.36	0.22
	(1.54)	(5.02)	(2.50)	(-1.38)	(2.48)	(-0.66)	(-2.78)		
dCONSR	0.005	-0.003	0.274	0.001	-0.002	0.001	0.024	0.18	0.18
	(4.41)	(-0.93)	(2.99)	(2.01)	(-0.86)	(0.29)	(3.81)		
dINV	0.005	-0.017	0.154	0.003	-0.036	0.004	0.056	0.24	0.22
	(1.58)	(-1.43)	(2.35)	(2.08)	(-4.08)	(0.31)	(2.96)		

Panel B: *LOT* liquidity measure (demeaned)

Dependent variable (y_{t+1})	$\hat{\alpha}$	$\hat{\beta}^{LIQ}$	$\hat{\gamma}^{y}$	$\hat{\gamma}^{Term}$	$\hat{\gamma}^{Cred}$	$\hat{\gamma}^{Vola}$	$\hat{\gamma}^{er_m}$	$\bar{R}^2$	ex.liq. $\bar{R}^2$
dGDPR	0.007	-0.812	0.142					0.08	0.03
	(8.12)	(-3.39)	(2.21)						
dUE	0.003	5.758	0.240					0.11	0.07
	(0.52)	(2.76)	(4.00)						
dCONSR	0.006	-0.415	0.270					0.10	0.08
	(6.94)	(-2.27)	(3.48)						
dINV	0.007	-2.212	0.187					0.10	0.06
	(3.21)	(-3.10)	(2.87)						
dGDPR	0.006	-0.586	0.141	0.000	-0.014			0.13	0.10
	(5.67)	(-2.82)	(2.22)	(0.73)	(-3.35)				
dUE	0.012	3.737	0.254	-0.008	0.096			0.17	0.15
	(1.62)	(2.13)	(4.30)	(-2.39)	(3.18)				
dCONSR	0.005	-0.271	0.278	0.001	-0.004			0.12	0.12
	(3.97)	(-1.58)	(3.70)	(2.10)	(-1.15)				
dINV	0.003	-1.372	0.182	0.003	-0.040			0.19	0.17
	(0.92)	(-2.30)	(2.94)	(2.30)	(-4.49)				
dGDPR	0.008	-0.628	0.134	0.000	-0.013	0.005	0.029	0.17	0.15
	(6.64)	(-3.23)	(2.31)	(0.23)	(-3.35)	(1.07)	(3.68)		
dUE	0.002	4.290	0.269	-0.005	0.094	-0.070	-0.264	0.23	0.22
	(0.35)	(2.56)	(5.39)	(-1.75)	(3.10)	(-1.93)	(-5.58)		
dCONSR	0.005	-0.294	0.283	0.001	-0.003	0.004	0.027	0.18	0.18
	(4.86)	(-1.73)	(3.93)	(1.85)	(-1.07)	(0.97)	(4.45)		
dINV	0.006	-1.537	0.186	0.003	-0.040	0.020	0.077	0.24	0.22
	(1.89)	(-2.74)	(2.96)	(1.90)	(-4.31)	(1.39)	(3.94)		

Table 8: Granger causality tests - demeaned *ILR* and *LOT*

The table shows Granger causality tests between the quarterly real GDP growth (*dGDPR*) and the demeaned versions of the (a) Amihud Illiquidity ratio (*ILR*) and (b) the *LOT* measure. Both *ILR* and *LOT* is demeaned relative to their two year moving average to preserve stationarity. The test is performed for the whole sample, and different sub-periods. For each measure we first test the null hypothesis that real GDP growth *do not* Granger cause market illiquidity and the whether market illiquidity *do not* Granger cause real GDP growth. We report the χ^2 and p-value (in parenthesis) for each test. We choose the optimal lag length for each test based on the Schwartz criterion. For each illiquidity variable the test is performed on the whole sample period (1947q1-2008q4), the first (1947q1-1977q4) and second half (1978q1-2008q4) of the sample, and for rolling 20 year subperiods overlapping by 10 years. The first two rows report the number of quarterly observations covered by each sample period and the number of NBER recession periods within each sample.

	Whole sample	First half	Second half	20 year sub-periods				
	1947-2008	1947-1977	1977-2008	1950-1970	1960-1980	1970-1990	1980-2000	1990-2008
N (observations)	243	119	124	84	84	84	84	76
NBER recessions	11	6	5	5	4	4	2	3
(a) *ILR* (demeaned)								
H_0: $dGDPR \nrightarrow ILR$								
χ^2	2.21	1.32	3.66	3.58	3.34	3.50	1.17	4.53
p-value	0.33	0.52	0.16	0.17	0.19	0.17	0.56	0.10
H_0: $ILR \nrightarrow dGDPR$								
χ^2	46.8**	32.44**	11.79**	25.1**	18.73**	11.72**	13.89**	10.73**
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(b) *LOT* (demeaned)								
H_0: $dGDPR \nrightarrow LOT$								
χ^2	1.92	0.83	1.26	2.10	0.83	1.18	0.21	0.48
p-value	0.17	0.36	0.26	0.15	0.36	0.28	0.65	0.49
H_0: $LOT \nrightarrow dGDPR$								
χ^2	11.06**	12.25**	1.72	10.54**	9.82**	8.59**	2.31	1.42
p-value	0.00	0.00	0.19	0.00	0.00	0.00	0.13	0.23

Table 9: Predicting macro with market liquidity - size portfolios (demeaned *ILR* and *LOT*)

The table shows the multivariate OLS estimates from regressing next quarters macro variables on current market illiquidity of small and large firms and four control variables. We examine two different proxies for market illiquidity, sampled for small and large firms. Both *ILR* and *LOT* is demeaned relative to their two year moving average to preserve stationarity. The estimated model is $y_{t+1} = \alpha + \beta_S^{LIQ} LIQ_t^{small} + \beta_L^{LIQ} LIQ_t^{large} + \gamma \mathbf{X_t} + u_{t+1}$, where y_{t+1} is one of real GDP growth (*dGDPR*), growth in the unemployment rate (*dUE*), real consumption growth (*dCONSR*) or growth in private investments (*dINV*), LIQ^{small} is the respective illiquidity proxy sampled for the 25% smallest firms and LIQ^{large} is the illiquidity of the 25% largest firms, $\mathbf{X_t}$ contains the additional control variables (*Term*, *Cred*, *Vola* and er_m) and γ is the vector with the respective coefficient estimates for the control variables. The Newey-West corrected t-statistics (with 4 lags) is reported in parentheses below the coefficient estimates, and $\bar{R}^2$ is the adjusted R^2.

Panel A: *ILR* liquidity measure (demeaned)

Dependent variable (y_t)	Const.	β_S^{LIQ}	β_L^{LIQ}	$\hat{\gamma}_1{}^{Term}$	$\hat{\gamma}_2{}^{Cred}$	$\hat{\gamma}_3{}^{Vola}$	$\hat{\gamma}_4{}^{er_m}$	$\bar{R}^2$
dGDPR	0.008	-0.004	-0.019	0.000	-0.010	-0.001	0.016	0.25
	(7.80)	(-3.27)	(-0.46)	(0.29)	(-2.76)	(-0.24)	(1.95)	
dUE	0.008	0.047	-0.045	-0.004	0.059	-0.027	-0.121	0.31
	(1.10)	(5.24)	(0.87)	(-0.91)	(2.44)	(-0.85)	(-2.48)	
dCONSR	0.007	-0.001	-0.033	0.001	-0.002	0.000	0.020	0.12
	(6.95)	(-0.42)	(-1.15)	(1.83)	(-0.67)	(-0.08)	(2.97)	
dINV	0.006	-0.005	-0.045	0.003	-0.039	0.011	0.054	0.21
	(1.71)	(-0.91)	(-0.32)	(1.84)	(-4.07)	(0.92)	(2.39)	

Panel B: *LOT* liquidity measure (demeaned)

Dependent variable (y_t)	Const.	β_S^{LIQ}	β_L^{LIQ}	$\hat{\gamma}_1{}^{Term}$	$\hat{\gamma}_2{}^{Cred}$	$\hat{\gamma}_3{}^{Vola}$	$\hat{\gamma}_4{}^{er_m}$	$\bar{R}^2$
dGDPR	0.009	-0.317	-0.239	0.000	-0.014	0.007	0.030	0.16
	(7.79)	(-3.40)	(-0.47)	(0.00)	(-3.50)	(1.42)	(3.71)	
dUE	0.001	2.246	2.207	-0.003	0.100	-0.083	-0.246	0.16
	(0.10)	(3.39)	(0.62)	(-0.89)	(3.20)	(-2.30)	(-4.84)	
dCONSR	0.008	-0.080	-0.937	0.001	-0.003	0.005	0.026	0.11
	(8.14)	(-1.20)	(-1.89)	(1.52)	(-0.94)	(1.13)	(3.92)	
dINV	0.008	-0.669	-1.236	0.003	-0.044	0.030	0.078	0.21
	(2.45)	(-2.66)	(-0.99)	(1.56)	(-4.46)	(2.27)	(3.82)	

Table 10: Granger causality - size portfolios (demeaned *LOT* and *ILR*)

The table shows the results of Granger causality tests between real GDP growth and the illiquidity of small and large firms for the two different illiquidity proxies. Both *ILR* and *LOT* is demeaned relative to their two year moving average to preserve stationarity. The first column denote the liquidity variable, column two and three shows the χ^2 and associated p-value from Granger causality tests where the null hypothesis is that GDP growth *does not* Granger cause the liquidity variables. Similarly, columns four and five, show the results when the null hypothesis is that the liquidity variable *does not* Granger cause GDP growth.

Liquidity variable (LIQ)	*dGDPR* $\nrightarrow$ LIQ χ^2	p-value	LIQ $\nrightarrow$ *dGDPR* χ^2	p-value
ILR^S	0.00	(0.97)	13.10**	(0.00)
ILR^L	0.40	(0.53)	1.39	(0.24)
LOT^S	0.67	(0.72)	6.44*	(0.04)
LOT^L	0.19	(0.91)	5.60	(0.06)

5.2 Hodrick-Prescott filtered versions of *ILR* and *LOT*

In the following tables we use a Hodrick-Prescott filter on *ILR* and *LOT* to detrend the series.

Table 11: In-sample prediction of macro variables - HP filtered *ILR* and *LOT*

The table shows the results from predictive regressions where we regress next quarters growth in different macro variables on two proxies for market illiquidity for the period 1947-2008. Market illiquidity (LIQ) is proxied by one of two illiquidity measures: the Amihud Illiquidity ratio (*ILR*) and the *LOT* measure. The *ILR* and *LOT* series have been detrended using a Hodrick-Prescott filter to preserve stationarity. The model estimated is $y_{t+1} = \alpha + \beta \text{LIQ}_t + \gamma' \mathbf{X}_t + u_{t+1}$ where y_{t+1} is one of real GDP growth (*dGDPR*), growth in the unemployment rate (*dUE*), real consumption growth (*dCONSR*) or growth in private investments (*dINV*). We include one lag of the dependent variable (y_t) in addition to *Term*, *Cred*, *Vola* and er_m as control variables. The Newey-West corrected t-statistics (with 4 lags) is reported in parentheses below the coefficient estimates, and $\bar{R}^2$ is the adjusted R^2.

Panel A: *ILR* liquidity measure (HP filtered)

Dependent variable (y_{t+1})	$\hat{\alpha}$	$\hat{\beta}^{LIQ}$	$\hat{\gamma}^{y}$	$\hat{\gamma}^{Term}$	$\hat{\gamma}^{Cred}$	$\hat{\gamma}^{Vola}$	$\hat{\gamma}^{er_m}$	$\bar{R}^2$	ex.liq. $\bar{R}^2$
dGDPR	0.007	-0.007	0.095					0.09	0.03
	(8.01)	(-3.31)	(1.31)						
dUE	0.002	0.087	0.120					0.20	0.07
	(0.31)	(4.27)	(1.65)						
dCONSR	0.006	-0.002	0.272					0.09	0.08
	(6.36)	(-1.30)	(3.22)						
dINV	0.008	-0.016	0.155					0.09	0.06
	(3.43)	(-2.24)	(2.34)						
dGDPR	0.007	-0.006	0.094	0.001	-0.014			0.15	0.10
	(5.80)	(-3.15)	(1.32)	(1.17)	(-3.40)				
dUE	0.013	0.079	0.139	-0.009	0.086			0.26	0.15
	(1.66)	(4.09)	(1.96)	(-2.40)	(3.15)				
dCONSR	0.004	-0.002	0.274	0.001	-0.004			0.12	0.12
	(3.77)	(-1.20)	(3.32)	(2.38)	(-1.36)				
dINV	0.003	-0.014	0.147	0.004	-0.042			0.20	0.17
	(0.93)	(-2.18)	(2.47)	(2.61)	(-4.57)				
dGDPR	0.008	-0.006	0.099	0.000	-0.013	-0.001	0.025	0.18	0.15
	(6.87)	(-3.08)	(1.54)	(0.69)	(-3.23)	(-0.17)	(3.15)		
dUE	0.005	0.071	0.169	-0.007	0.082	-0.024	-0.216	0.30	0.22
	(0.67)	(3.79)	(2.72)	(-2.11)	(2.99)	(-0.72)	(-4.24)		
dCONSR	0.005	-0.001	0.287	0.001	-0.003	0.001	0.026	0.18	0.18
	(4.64)	(-0.92)	(3.64)	(2.23)	(-1.19)	(0.34)	(4.23)		
dINV	0.005	-0.012	0.166	0.003	-0.039	0.005	0.069	0.24	0.22
	(1.76)	(-2.01)	(2.82)	(2.33)	(-4.21)	(0.35)	(3.41)		

Panel B: *LOT* liquidity measure (HP filtered)

Dependent variable (y_{t+1})	$\hat{\alpha}$	$\hat{\beta}^{LIQ}$	$\hat{\gamma}^{y}$	$\hat{\gamma}^{Term}$	$\hat{\gamma}^{Cred}$	$\hat{\gamma}^{Vola}$	$\hat{\gamma}^{er_m}$	$\bar{R}^2$	ex.liq. $\bar{R}^2$
dGDPR	0.007	-0.242	0.150					0.04	0.03
	(7.82)	(-1.97)	(2.34)						
dUE	0.002	2.066	0.231					0.08	0.07
	(0.39)	(2.02)	(3.72)						
dCONSR	0.006	-0.069	0.285					0.08	0.08
	(6.88)	(-0.66)	(3.81)						
dINV	0.007	-0.503	0.200					0.05	0.06
	(3.13)	(-1.11)	(2.98)						
dGDPR	0.006	-0.232	0.138	0.001	-0.015			0.11	0.10
	(5.60)	(-2.23)	(2.13)	(1.36)	(-3.58)				
dUE	0.015	2.060	0.236	-0.010	0.105			0.17	0.15
	(1.98)	(2.79)	(3.95)	(-3.00)	(3.34)				
dCONSR	0.004	-0.092	0.281	0.001	-0.004			0.12	0.12
	(3.87)	(-1.01)	(3.78)	(2.48)	(-1.44)				
dINV	0.002	-0.538	0.177	0.004	-0.044			0.18	0.17
	(0.66)	(-1.52)	(2.87)	(2.72)	(-4.70)				
dGDPR	0.007	-0.261	0.131	0.000	-0.014	0.002	0.029	0.16	0.15
	(6.80)	(-2.86)	(2.27)	(0.89)	(-3.46)	(0.36)	(3.71)		
dUE	0.005	2.358	0.250	-0.008	0.100	-0.050	-0.269	0.24	0.22
	(0.75)	(3.92)	(5.11)	(-2.71)	(3.21)	(-1.42)	(-5.64)		
dCONSR	0.005	-0.118	0.285	0.001	-0.003	0.003	0.027	0.18	0.18
	(4.80)	(-1.40)	(3.94)	(2.39)	(-1.25)	(0.60)	(4.45)		
dINV	0.005	-0.617	0.184	0.004	-0.042	0.011	0.078	0.23	0.22
	(1.66)	(-1.93)	(2.97)	(2.51)	(-4.35)	(0.80)	(4.01)		

Table 12: Granger causality tests - HP filtered *ILR* and *LOT*

The table shows Granger causality tests between the quarterly real GDP growth (dGDPR) and the (a) Amihud Illiquidity ratio (*ILR*) and (b) the *LOT* measure We use specifications of *ILR* and *LOT* which have been detrended with a Hodrick-Prescott filter to preserve stationarity. The test is performed for the whole sample, and different sub-periods. For each measure we first test the null hypothesis that real GDP growth *do not* Granger cause market illiquidity and the whether market illiquidity *do not* Granger cause real GDP growth. We report the χ^2 and p-value (in parenthesis) for each test. We choose the optimal lag length for each test based on the Schwartz criterion. For each illiquidity variable the test is performed on the whole sample period (1947q1-2008q4), the first (1947q1-1977q4) and second half (1978q1-2008q4) of the sample, and for rolling 20 year subperiods overlapping by 10 years. The first two rows report the number of quarterly observations covered by each sample period and the number of NBER recession periods within each sample.

	Whole sample	First half	Second half	20 year sub-periods				
	1947-2008	1947-1977	1977-2008	1950-1970	1960-1980	1970-1990	1980-2000	1990-2008
N (observations)	243	119	124	84	84	84	84	76
NBER recessions	11	6	5	5	4	4	2	3
(a) ILR (HP filtered)								
H0: GDP$\nrightarrow$ ILR								
χ^2	0.53	0.22	2.75	1.86	3.00	3.26	0.93	2.27
p-value	0.77	0.90	0.25	0.40	0.22	0.20	0.63	0.32
H0: ILR$\nrightarrow$ GDP								
χ^2	33.11**	22.59**	7.05**	15.09**	13.13**	10.01**	10.39**	7.60*
p-value	0.00	0.00	0.03	0.00	0.00	0.01	0.01	0.02
(b) LOT (HP filtered)								
H0: GDP$\nrightarrow$ LOT								
χ^2	7.62*	6.25*	2.70	4.72	5.40	4.93	0.78	2.87
p-value	0.02	0.04	0.26	0.09	0.07	0.08	0.68	0.24
H0: LOT$\nrightarrow$ GDP								
χ^2	11.51**	12.83**	1.74	7.86*	9.69**	7.69*	1.35	1.12
p-value	0.00	0.00	0.42	0.02	0.01	0.02	0.51	0.57

Table 13: Predicting macro with market liquidity - size portfolios (HP filtered *ILR* and *LOT*)

The table shows the multivariate OLS estimates from regressing next quarters macro variables on current market illiquidity of small and large firms and four control variables. We examine two different proxies for market illiquidity, sampled for small and large firms. We use specifications of *ILR* and *LOT* which have been detrended with a Hodrick-Prescott filter to preserve stationarity. The estimated model is $y_{t+1} = \alpha + \beta_S^{LIQ} LIQ_t^{small} + \beta_L^{LIQ} LIQ_t^{large} + \gamma \mathbf{X_t} + u_{t+1}$, where y_{t+1} is real GDP growth, LIQ^{small} is the respective illiquidity proxy sampled for the 25% smallest firms and LIQ^{large} is the illiquidity of the 25% largest firms, $\mathbf{X_t}$ contains the additional control variables (*Term*, *Cred*, *Vola* and er_m) and γ' is the vector with the respective coefficient estimates for the control variables. The Newey-West corrected t-statistics (with 4 lags) is reported in parentheses below the coefficient estimates, and $\bar{R}^2$ is the adjusted R^2.

Panel A: *ILR* liquidity measure (HP filtered)

Dependent variable (y_t)	Const.	β_S^{LIQ}	β_L^{LIQ}	$\hat{\gamma}_1^{\,Term}$	$\hat{\gamma}_2^{\,Cred}$	$\hat{\gamma}_3^{\,Vola}$	$\hat{\gamma}_4\, er_m$	$\bar{R}^2$
dGDPR	0.008	-0.002	-0.029	0.000	-0.013	0.000	0.024	0.183
	(7.91)	(-1.34)	(-0.77)	(0.64)	(-3.32)	(-0.07)	(3.02)	
dUE	0.005	0.019	0.382	-0.007	0.082	-0.024	-0.178	0.265
	(0.73)	(2.39)	(0.20)	(-1.83)	(3.11)	(-0.76)	(-3.64)	
dCONSR	0.008	-0.001	-0.015	0.001	-0.003	0.000	0.024	0.101
	(8.20)	(-0.69)	(-0.60)	(1.98)	(-1.06)	(0.09)	(3.63)	
dINV	0.007	-0.005	-0.021	0.003	-0.042	0.013	0.068	0.210
	(2.23)	(-1.22)	(-0.19)	(2.13)	(-4.45)	(1.05)	(3.25)	

Panel B: *LOT* liquidity measure (HP filtered)

Dependent variable (y_t)	Const.	β_S^{LIQ}	β_L^{LIQ}	$\hat{\gamma}_1^{\,Term}$	$\hat{\gamma}_2^{\,Cred}$	$\hat{\gamma}_3^{\,Vola}$	$\hat{\gamma}_4\, er_m$	$\bar{R}^2$
dGDPR	0.008	-0.119	-0.164	0.001	-0.015	0.003	0.029	0.144
	(7.49)	(-2.81)	(-0.64)	(0.92)	(-3.58)	(0.65)	(3.60)	
dUE	0.006	1.252	1.564	-0.008	0.107	-0.059	-0.247	0.172
	(0.76)	(4.29)	(0.79)	(-2.23)	(3.28)	(-1.71)	(-4.97)	
dCONSR	0.008	-0.049	-0.471	0.001	-0.003	0.003	0.027	0.108
	(8.48)	(-1.04)	(-1.51)	(2.07)	(-1.07)	(0.64)	(4.08)	
dINV	0.006	-0.284	-0.581	0.004	-0.047	0.021	0.077	0.193
	(2.07)	(-1.89)	(-0.65)	(2.36)	(-4.60)	(1.60)	(3.87)	

Table 14: Granger causality - size portfolios (HP filtered *ILR* and *LOT*)

The table shows the results of Granger causality tests between real GDP growth and the illiquidity of small and large firms for the two different illiquidity proxies. We use specifications of *ILR* and *LOT* which have been detrended with a Hodrick-Prescott filter to preserve stationarity. The first column denote the liquidity variable, column two and three shows the χ^2 and associated p-value from Granger causality tests where the null hypothesis is that GDP growth *does not* Granger cause the liquidity variables. Similarly, columns four and five, show the results when the null hypothesis is that the liquidity variable *does not* Granger cause GDP growth.

Liquidity	*dGDPR* $\nrightarrow$ LIQ		LIQ $\nrightarrow$ *dGDPR*	
variable (LIQ)	χ^2	p-value	χ^2	p-value
ILR ^{S}	3.08	(0.38)	22.13**	(0.00)
ILR ^{L}	6.61	(0.09)	1.76	(0.62)
LOT ^{S}	7.59*	(0.02)	10.55**	(0.01)
LOT ^{L}	3.16	(0.21)	0.58	(0.75)

6 Predicting US macro with liquidity, VAR specifications

Chordia, Sarkar, and Subrahmanyam (2005) argue that returns, volatility and liquidity are endogenous and should be estimated in a system. Thus, to supplement the predictive regressions in table 4, we first estimate a VAR with endogenous equity market variables in section 6.1 to examine the causal relationships between these. In addition, we also include equity market turnover. In the second set of VAR models reported in section 6.2, we also include the credit spread (*Cred*) and term spread (*Term*) as endogenous variables. In the VAR estimations we use the first (log) differenced versions of *ILR* and *LOT*, while *Roll* is not transformed.

6.1 VAR - only equity market variables

In table 15 we report the estimation results for a VAR system with *dGDPR*, $\mathtt{er_m}$, *Vola* and either *dILR* (Panel A), *dLOT* (Panel B) or *Roll* (Panel C). The model is estimated tiwh a one quarter lag for all variables. The number of lags is obtained testing for optimal lag length using the Schwartz criterion. Looking first at the equation for *dGDPR*, first row in all panels, the results are very similar as in the single equation predictive regressions in the paper. Both *dILR*, *dLOT* and *Roll* measures are very significant. For the equation for the respective liquidity measures (second row), we find that $\mathtt{er_m}$ is a strong predictor of both *dILR* and *dLOT*, although $\mathtt{er_m}$ does not have any predictive power for *Roll*. Next, in the equation for $\mathtt{er_m}$ there are no variables that enters significantly. In the equation for *Turn* (stock market turnover), we find that both *dGDPR*, $\mathtt{er_m}$ enter significantly in all equations, and in Panel B, we also find that *dLOT* is significant in the *Turn* equation. Finally, in the equation for *Vola*, we find that lagged market returns $\mathtt{er_m}$ is significant in the VAR with the *Roll* measure.

In table 16 we test the Granger causality between all the endogenous variables. In the table the null hypothesis is that the row-variable does not Granger cause the column variable. For all three liquidity proxies we reject the null that the liquidity measures does not Granger cause *dGDPR*, while we cannot reject the reverse hypothesis that *dGDPR* does not Granger cause any of the liquidity variables. While there is no causality from $\mathtt{er_m}$ to *dGDPR* in the systems with *dILR* or *Roll*, we reject the null in favor of $\mathtt{er_m}$ (at the 5% level) Granger causing *dGDPR* in the system with *LOT*. Interestingly, for all three models we find support for a strong one-way causality from *dGDPR* to *Turn* and from $\mathtt{er_m}$ to *Turn*. Finally, we also find a strong causality from $\mathtt{er_m}$ to both *dILR* and *dLOT*, but not for *Roll*. The result that market return cause liquidity is similar to what is documented in Chordia et al. (2005), although we do not find a causality between liquidity and volatility or volatility and returns. One reason for this difference is probably that they look at a daily frequency while we look at a quarterly frequency.

Table 15: Vector autoregression - equity market variables

The table shows the results from estimating a VAR with endogenous variables *dGDPR*, er_m, *Turn*, *Vola* and market liquidity proxied either by *ILR* (panel A), *LOT* (panel B) or the *Roll* measure (panel C). *ILR* and *LOT* are in first (log) differences for stationarity reasons. The VAR is estimated with a lag of one quarter and a constant term. We choose the optimal number of lags based on the Schwartz criterion.

Panel A: *ILR* liquidity measure

Dependent variable	Const.	*dGDPR* (-1)	*dILR* (-1)	er_m (-1)	*Turn* (-1)	*Vola* (-1)	adj.R^2
dGDPR	0.005	0.308	-0.012	0.014	-0.006	-0.050	0.19
	(6.97)	(5.23)	(-3.10)	(1.56)	(-1.50)	(-0.26)	
dILR	-0.014	2.764	-0.256	-1.495	-0.023	6.135	0.15
	(-0.67)	(1.71)	(-2.52)	(-6.06)	(-0.20)	(1.14)	
er_m	0.014	0.033	0.045	0.129	0.034	1.009	0.00
	(2.08)	(0.06)	(1.32)	(1.56)	(0.86)	(0.56)	
Turn	0.035	-4.075	0.089	0.672	-0.182	4.852	0.07
	(1.99)	(-2.92)	(1.01)	(3.15)	(-1.79)	(1.05)	
Vola	0.000	-0.005	0.000	-0.007	-0.002	-0.111	0.02
	(1.12)	(-0.18)	(-0.12)	(-1.75)	(-0.88)	(-1.24)	

Panel B: *LOT* liquidity measure

Dependent variable	Const.	*dGDPR* (-1)	*dLOT* (-1)	er_m (-1)	*Turn* (-1)	*Vola* (-1)	adj.R^2
dGDPR	0.005	0.317	-0.014	0.021	0.003	-0.094	0.17
	(6.73)	(5.33)	(-2.19)	(2.33)	(0.94)	(-0.46)	
dLOT	0.013	-0.870	-0.119	-0.416	-0.054	2.215	0.13
	(1.42)	(-1.24)	(-1.59)	(-3.96)	(-1.46)	(0.91)	
er_m	0.015	-0.055	0.003	0.106	-0.002	2.031	-0.01
	(2.18)	(-0.10)	(0.05)	(1.30)	(-0.06)	(1.09)	
Turn	0.036	-3.907	0.334	0.609	-0.258	1.474	0.09
	(2.04)	(-2.83)	(2.27)	(2.95)	(-3.53)	(0.31)	
Vola	0.000	-0.002	0.002	-0.007	-0.002	-0.154	0.02
	(1.10)	(-0.07)	(0.83)	(-1.79)	(-1.13)	(-1.67)	

Panel C: *Roll* liquidity measure

Dependent variable	Const.	*dGDPR* (-1)	*Roll* (-1)	er_m (-1)	*Turn* (-1)	*Vola* (-1)	adj.R^2
dGDPR	0.013	0.287	-0.512	0.015	0.003	-0.165	0.18
	(4.18)	(4.67)	(-2.63)	(1.65)	(1.06)	(-0.89)	
Roll	0.003	0.001	0.806	-0.003	0.000	-0.093	0.50
	(3.17)	(0.05)	(13.61)	(-1.20)	(-0.17)	(-1.65)	
er_m	0.024	-0.107	-0.551	0.100	-0.001	2.246	-0.01
	(0.83)	(-0.19)	(-0.31)	(1.21)	(-0.04)	(1.32)	
Turn	0.056	-4.364	-1.231	0.613	-0.251	7.344	0.07
	(0.76)	(-3.02)	(-0.27)	(2.87)	(-3.40)	(1.68)	
Vola	0.003	-0.019	-0.170	-0.009	-0.001	-0.063	0.04
	(2.16)	(-0.70)	(-1.94)	(-2.15)	(-0.97)	(-0.75)	

Table 16: Granger causality tests between equity market variables

The table presents χ^2 statistics of pairwise Granger causality tests between the endogenous variables. The null hypothesis is that the row variables does not Granger-cause column variables, and * and ** denote rejection of the null at the 5% and 1% significance levels, respectively.

Panel A: ILR liquidity measure

	dGDPR	*dILR*	er_m	*Turn*	*Vola*
dGDPR		2.94	0.00	8.55**	0.03
dILR	9.59**		1.75	1.03	0.01
er_m	2.43	36.72**		9.93**	3.05
Turn	2.24	0.04	0.75		0.78
Vola	0.07	1.31	0.32	1.10	

Panel B: LOT liquidity measure

	dGDPR	*dLOT*	er_m	*Turn*	*Vola*
dGDPR		1.53	0.01	8.03**	0.00
dLOT	4.81*		0.00	5.15*	0.68
er_m	5.42*	15.65**		8.70**	3.21
Turn	0.89	2.13	0.00		1.28
Vola	0.21	0.83	1.18	0.10	

Panel C: ROLL liquidity measure

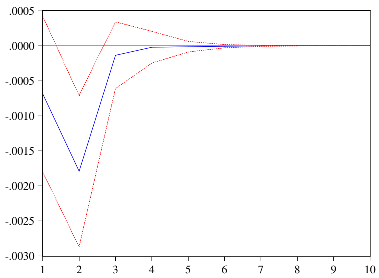
	dGDPR	*Roll*	er_m	*Turn*	*Vola*
dGDPR		0.00	0.04	9.15**	0.49
Roll	6.93**		0.10	0.07	3.78*
er_m	2.72	1.43		8.24**	4.63*
Turn	1.12	0.03	0.00		0.94
Vola	0.79	2.72	1.74	2.81	

Impulse response functions - only stock market variables

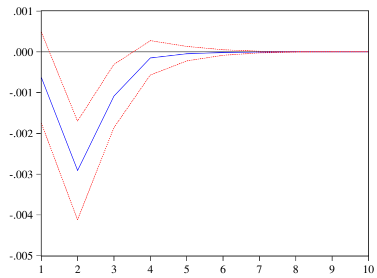
To examine more closely the dynamic relationship between market liquidity, stock returns, stock market volatility, turnover and GDP growth, we compute impulse response functions (IRFs) for GDP growth. By "shocking" one variable by a one unit standard deviation, the IRF traces the impact on real GDP growth. The (inverse) Cholesky decomposition is used to orthogonalize the residual covariance matrix since the innovations are correlated. Also, it is important to note that the IRFs are sensitive to the ordering of the endogenous variables in the VAR. However, the ordering of the variables do not affect the results in the estimated VAR or the Granger causality tests. Since we in the paper is mainly interested in the information in liquidity about future GDP growth (and to keep the number of figures down) we show only the responses of GDP growth to a shock in *dILR*. We base the initial ordering of the variables on Chordia et al. (2005), who argue that information and endowment shocks generally affect prices and liquidity through trading. Therefore we place stock turnover (*Turn*) first in the ordering. Chordia et al. (2005) also note that the ordering of stock returns, stock volatility and liquidity is unclear. We use their initial ordering of these variables, and for robustness also look at whether different relative ordering of these variables affect the response of *dGDPR* to shocks in *dILR*. Finally, since *dGDPR* at t is not observed by the market participants before the following quarter, we always put *dGDPR* last in the ordering. Thus, uur initial ordering of the variables is: *Turn*, *Vola*, er_{m}, *dILR*, *dGDPR*.

Figure 3: Impulse response functions - VAR with *dGDPR* and stock market variables

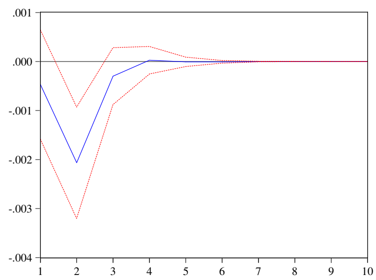
The figures below show the impulse response functions from a VAR of real GDP growth (*dGDPR*) and the equity market variables, *dILR*, er_{m}, *Vola* and *Turn*. The figures show the response of *dGDPR* to a Cholesky one standard deviation *dILR* innovation. The ordering of the variables in the VAR is stated in the caption of each figure. The dotted (red) lines show the +/- two standard deviation uncertainty band.



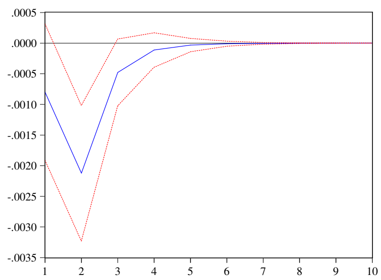
(a) *Turn*, *Vola*, er_{m}, *dILR*, *dGDPR*



(b) *Turn*, *dILR*, *Vola*, er_{m}, *dGDPR*



(c) *Turn*, er_{m}, *dILR*, *Vola*, *dGDPR*



(d) *Turn*, *Vola*, *dILR*, er_{m}, *dGDPR*

From Figure 3 we see that the response of *dGDPR* to a shock in *dILR* is not greatly affected by the relative ordering of the variables $\mathtt{er_m}$, *Vola* and *dILR*. While we keep *Turn* as the first variable across all four estimations, we have also examined the effect of changing the ordering of *Turn*. The results are insensitive to the placement of *Turn* in the ordering.

6.2 VAR - all market variables

In section 6.1 we estimated a system where we included only stock market variables in addition to *dGDPR*. In this section we estimate a VAR where we also include the two bond market variables *Cred* and *Term*. The main reason for this is that several other studies show that these variables have predictive power for GDP growth aswell as being related to stock market variables. Since we are mainly interested in adding them as control variables to see whether equity market liquidity contain additional information about future GDP growth, we have chosen not to put any restrictions on the equations for these variables. The first thing to note from the table, is that in the equation for *dGDPR* (first row in each panel), all three liquidity variables have significant coefficients of the same size as in the single equation estimations reported in the paper. With respect to the additional variables, *Cred* and *Term*, there are a few interesting results. First, we find that er_m is significant and negative in the equation for *Cred* across all three models. Thus a lower realized stock market return predict an increase in the credit spread. Also, we find that the coefficient on *Roll* is significantly positive in the *Term* equation, indicating that a high spread costs predicts a larger term spread.

In table 18 we perform Granger causality tests between all the variables in the VAR. The results are very similar to those in the previous section, however there are a few interesting additional results. First, we see that there is a causality going from er_m to *Cred*, and also from *Roll* to *Term*.

Table 17: Vector autoregression - all market variables

The table shows the results from estimating a VAR with endogenous variables *dGDPR*, er_m, *Turn*, *Vola* and market liquidity proxied either by *dILR* (panel A), *dLOT* (panel B) or the *Roll* measure (panel C). *ILR* and *LOT* are in first (log) differences for stationarity reasons. The VAR is estimated with a lag of one quarter and a constant term. We choose the optimal number of lags based on the Schwartz criterion.

Panel A: ILR liquidity measure

Dependent variable	Const.	*dGDPR* (-1)	*dILR* (-1)	er_m (-1)	*Turn* (-1)	*Vola* (-1)	*Cred* (-1)	*Term* (-1)	adj.R^2
dGDPR	0.005	0.282	-0.011	0.016	-0.007	0.079	-0.004	0.001	0.22
	(4.68)	(4.67)	(-2.85)	(1.74)	(-1.53)	(0.39)	(-1.72)	(1.10)	
dILR	0.014	3.088	-0.266	-1.501	-0.018	4.098	0.035	-0.023	0.18
	(0.50)	(1.87)	(-2.60)	(-6.05)	(-0.15)	(0.73)	(0.60)	(-1.67)	
er_m	0.007	-0.009	0.046	0.127	0.032	1.364	-0.003	0.006	0.03
	(0.71)	(-0.02)	(1.34)	(1.52)	(0.82)	(0.72)	(-0.14)	(1.32)	
Turn	0.001	-3.687	0.074	0.621	-0.188	3.886	0.070	0.024	0.11
	(0.06)	(-2.59)	(0.84)	(2.91)	(-1.87)	(0.81)	(1.40)	(1.96)	
Vola	0.000	0.000	0.000	-0.008	-0.002	-0.132	0.001	0.000	0.04
	(0.84)	(0.00)	(-0.21)	(-1.81)	(-0.88)	(-1.40)	(0.70)	(-0.15)	
Cred	0.092	-2.958	0.207	-0.864	0.252	1.906	-0.207	-0.024	0.09
	(2.37)	(-1.28)	(1.45)	(-2.49)	(1.54)	(0.24)	(-2.55)	(-1.20)	
Term	0.333	-5.604	-0.283	-1.349	0.175	-0.208	0.259	0.793	0.61
	(4.04)	(-1.14)	(-0.93)	(-1.83)	(0.50)	(-0.01)	(1.50)	(18.95)	

Panel B: LOT liquidity measure

Dependent variable	Const.	*dGDPR* (-1)	*dLOT* (-1)	er_m (-1)	*Turn* (-1)	*Vola* (-1)	*Cred* (-1)	*Term* (-1)	adj.R^2
dGDPR	0.005	0.285	-0.013	0.022	0.002	0.066	-0.004	0.001	0.21
	(4.59)	(4.69)	(-2.11)	(2.49)	(0.64)	(0.31)	(-2.01)	(1.04)	
dLOT	0.011	-0.687	-0.122	-0.426	-0.050	1.391	0.026	0.000	0.15
	(0.92)	(-0.95)	(-1.63)	(-4.02)	(-1.32)	(0.54)	(1.01)	(0.00)	
er_m	0.007	-0.074	0.004	0.102	-0.004	2.283	0.001	0.006	0.02
	(0.75)	(-0.13)	(0.07)	(1.24)	(-0.13)	(1.16)	(0.03)	(1.34)	
Turn	0.001	-3.486	0.329	0.566	-0.253	0.205	0.072	0.024	0.13
	(0.05)	(-2.47)	(2.25)	(2.74)	(-3.46)	(0.04)	(1.45)	(2.00)	
Vola	0.000	0.003	0.002	-0.007	-0.001	-0.176	0.001	0.000	0.05
	(0.83)	(0.10)	(0.79)	(-1.83)	(-1.03)	(-1.80)	(0.64)	(-0.15)	
Cred	0.092	-2.798	0.496	-1.000	0.080	-1.618	-0.198	-0.023	0.10
	(2.39)	(-1.21)	(2.08)	(-2.97)	(0.67)	(-0.20)	(-2.47)	(-1.17)	
Term	0.331	-5.216	-0.037	-1.191	0.397	-5.630	0.239	0.793	0.61
	(4.01)	(-1.06)	(-0.07)	(-1.65)	(1.56)	(-0.32)	(1.39)	(18.91)	

Panel C: *Roll* liquidity measure

Dependent variable	Const.	dGDPR(-1)	ROLL(-1)	Rm(-1)	Turn(-1)	Vola(-1)	Cred(-1)	Term(-1)	adj.R^2
dGDPR	0.013	0.253	-0.556	0.016	0.002	0.015	-0.004	0.001	0.22
	(4.15)	(4.06)	(-2.80)	(1.71)	(0.78)	(0.07)	(-1.73)	(1.68)	
Roll	0.003	0.003	0.810	-0.003	0.000	-0.106	0.000	0.000	0.51
	(3.18)	(0.16)	(13.21)	(-1.18)	(-0.11)	(-1.74)	(0.35)	(-0.43)	
er_m	0.024	-0.170	-1.144	0.089	-0.002	2.676	0.002	0.007	0.02
	(0.83)	(-0.30)	(-0.62)	(1.06)	(-0.08)	(1.47)	(0.12)	(1.45)	
Turn	0.061	-4.121	-4.002	0.537	-0.241	6.623	0.081	0.026	0.11
	(0.84)	(-2.81)	(-0.85)	(2.50)	(-3.27)	(1.42)	(1.62)	(2.11)	
Vola	0.003	-0.014	-0.184	-0.009	-0.001	-0.086	0.001	0.000	0.06
	(2.19)	(-0.50)	(-2.03)	(-2.25)	(-0.85)	(-0.96)	(0.94)	(0.32)	
Cred	0.046	-3.005	3.252	-0.943	0.086	5.364	-0.196	-0.025	0.08
	(0.39)	(-1.25)	(0.43)	(-2.70)	(0.71)	(0.71)	(-2.40)	(-1.24)	
Term	-0.362	-1.362	47.282	-0.676	0.339	-19.943	0.173	0.763	0.62
	(-1.47)	(-0.27)	(2.97)	(-0.93)	(1.35)	(-1.26)	(1.02)	(18.02)	

Table 18: Granger causality tests between all market variables

The table presents χ^2 statistics of pairwise Granger causality tests between the endogenous variables. The null hypothesis is that the row variables does not Granger-cause column variables, and * and ** denote rejection of the null at the 5% and 1% significance levels, respectivel

Panel A: ILR liquidity measure

	dGDPR	*dILR*	er_m	*Turn*	*Vola*	*Cred*	*Term*
dGDPR		3.49	0.00	6.70**	0.00	1.63	1.29
dILR	8.12**		1.80	0.71	0.05	2.09	0.86
er_m	3.01	36.60**		8.45**	3.27	6.19**	3.33
Turn	2.34	0.02	0.68		0.77	2.36	0.25
Vola	0.15	0.54	0.53	0.65		0.06	0.00
Cred	2.94	0.36	0.02	1.97	0.49		2.24
Term	1.21	2.80	1.75	3.82*	0.02	1.43	

Panel B: LOT liquidity measure

	dGDPR	*dLOT*	er_m	*Turn*	*Vola*	*Cred*	Term
dGDPR		0.90	0.02	6.09**	0.01	1.47	1.12
dLOT	4.46*		0.00	5.07*	0.63	4.32	0.01
er_m	6.22**	16.19**		7.52**	3.36	8.82**	2.73
Turn	0.41	1.74	0.02		1.06	0.45	2.42
Vola	0.09	0.30	1.34	0.00		0.04	0.10
Cred	4.04*	1.03	0.00	2.11	0.41		1.92
Term	1.07	0.00	1.80	4.01*	0.02	1.36	

Panel C: ROLL liquidity measure

	dGDPR	*Roll*	er_m	*Turn*	*Vola*	*Cred*	*Term*
dGDPR		0.03	0.09	7.88**	0.25	1.57	0.07
Roll	7.84**		0.39	0.73	4.11*	0.18	8.80**
er_m	2.92	1.40		6.27**	5.08*	7.28**	0.86
Turn	0.61	0.01	0.01		0.72	0.51	1.82
Vola	0.01	3.02	2.16	2.03		0.50	1.59
Cred	3.00	0.12	0.01	2.64	0.88		1.03
Term	2.83	0.18	2.10	4.47*	0.10	1.53	

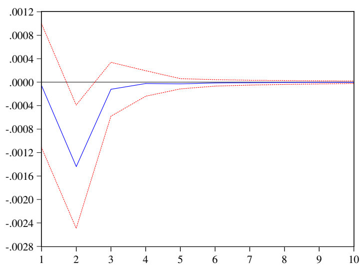
Impulse response functions - all market variables

In Figure 3 we examined the IRFs in a system with only stock market variables. In table 17 we estimated a full unrestricted VAR where we also added the credit spread (*Cred*) and the term spread (*Term*) as control variables since these have been shown to contain important information about future economic growth. In Figure 4 we perform a similar analysis as in Figure 3, but now also include the two non-equity market variables *Cred* and *Term*.

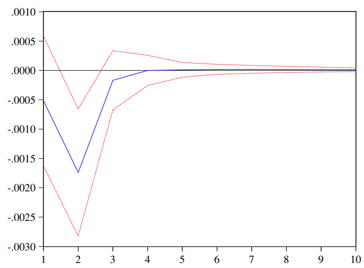
With respect to the ordering of the variables we base our main ordering on Chordia et al. (2005) who in their initial ordering put bond market variables before stock market variables. Although we examine different types of variables than Chordia et. al, we use that general ordering as our base case, and see how sensitive the response of *dGDPR* to a shock in *dILR* is to the change of ordering of the variables. The initial ordering we use is: *Cred*, *Term*, *Turn*, *Vola*, er_m, *dILR*, *dGDPR*. In part (a) of Figure 4 we show the IRF for *dGDPR* from a shock in *dILR* in the base ordering case, in part (b) of the figure, we move the bond market variables after the stock market variables keeping the relative ordering of the stock market variables fixed as in (a), in part (c) we order the bond market variables first again and put *dILR* between *Vola* and before er_m while *Turn* is kept fixed as the first of the stock market variables, and in part (d) we put *dILR* after *Turn*, but before *Vola* and er_m. While we could have tried several other ordering schemes, we believe the selected orderings should detect whether the response function of *dGDPR* to a shock in *dILR* is very sensitive to the ordering of the variables in the system.

Figure 4: Impulse response functions - VAR with *dGDPR* and all market variables

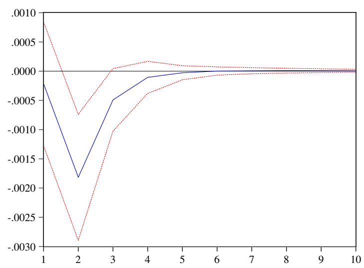
The figures below show the impulse response functions from a VAR of real GDP growth (*dGDPR*) and the equity market variables, *dILR*, er_m, *Vola* and *Turn* and the bond market variables *Cred* and *Term*. The figures show the response of *dGDPR* to a Cholesky one standard deviation *dILR* innovation. The ordering of the variables in the VAR is stated in the caption of each figure.



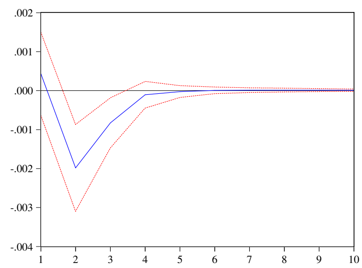
(a) *Cred*, *Term*, *Turn*, *Vola*, er_m, *dILR*, *dGDPR*



(b) *Turn*, *Vola*, er_m, *dILR*, *Cred*, *Term*, *dGDPR*



(c) *Cred*, *Term*, *Turn*, *Vola*, *dILR*, er_m, *dGDPR*



(d) *Cred*, *Term*, *Turn*, *dILR*, *Vola*, er_m, *dGDPR*

From Figure 4 we see that the response of *dGDPR* from a shock in *dILR* is not greatly affected by the relative ordering of the variables *Cred*, *Term*, $\mathtt{er}_{\mathtt{m}}$, *Vola* and *dILR*.

References

Tarun Chordia, Asani Sarkar, and Avanidhar Subrahmanyam. An empirical analysis of stock and bond market liquidity. *Review of Financial Studies*, 18(1):85–129, 2005.