PORTFOLIO STRUCTURE

- $c_i = c_{0i} + c_{1i} + c_{2i}$

- $c_{1i} = s_{1i}$

- $c_{2i} = s_{2i}$

- $S_1 = \sum_1^N \blacksquare s_{1i}$

- $S_2 = \sum_1^N \blacksquare s_{2i}$

- $PS = S_1 / S_2$

ASSET STRUCTURE

- $q_j = q_{1j} + q_{2j}$
- $q_{1j} \equiv \bar{c}_{1j}^{*}$
- $q_{2j} \equiv \bar{c}_{2j}^{*}$
- $Q_1 = \sum_1^T \boxplus q_{1j}$
- $Q_2 = \sum_1^T \boxplus q_{2j}$
- $AS = Q_1 / Q_2 \equiv \bar{C}_1^{*} / \bar{C}_2^{*}$

LIABILITY STRUCTURE

- $l_j = l_{1j} + l_{2j}$

- $l_{1j} \equiv c_{1j}^{p}$

- $l_{2j} \equiv c_{2j}^{p}$

- $L_1 = \sum_1^T \blacksquare l_{1j}$

- $L_2 = \sum_1^T \blacksquare l_{2j}$

- $LS = L_1 / L_2$

EQUILIBRIUM 1ST MODEL

- $AS=LS=PS$

- $Q{\downarrow}1\ /Q{\downarrow}2\ =L{\downarrow}1\ /L{\downarrow}2\ =S{\downarrow}1\ /S{\downarrow}2$

- $=\sum 1{\uparrow}T▨ q{\downarrow}1i\ /\sum 1{\uparrow}T▨ q{\downarrow}2i\ =\sum 1{\uparrow}Z▨ l{\downarrow}1i\ /\sum 1{\uparrow}Z▨ l{\downarrow}2i\ =\sum 1{\uparrow}N▨ s{\downarrow}1i\ /\sum 1{\uparrow}N▨ s{\downarrow}2i$

- $=\sum 1{\uparrow}T▨ \bar{c}{\downarrow}1j{\uparrow}*\ /\sum 1{\uparrow}T▨ \bar{c}{\downarrow}2j{\uparrow}*\ =\sum 1{\uparrow}T▨ c{\downarrow}1j{\uparrow}p\ /\sum 1{\uparrow}T▨ c{\downarrow}2j{\uparrow}p\ =\sum 1{\uparrow}N▨ c{\downarrow}1i\ /\sum 1{\uparrow}N▨ c{\downarrow}2i$

FINANCIAL INTERMEDIARIES ASSETS

- $fa_k = fa_{1k} + fa_{2k}$

- $FA_1 = \sum_1^Z fa_{1k}$

- $FA_2 = \sum_1^Z fa_{2k}$

- $FA = FA_1 / FA_2$

- $\sum_1^Z l_{1k} / \sum_1^Z l_{2k} = \sum_1^Z fa_{1k} / \sum_1^Z fa_{2k}$

FINANCIAL INTERMEDIARIES LIABILITIES

- $fl_k = fl_{1k} + fl_{2k}$

- $FL_1 = \sum_1^Z fl_{1k}$

- $FL_2 = \sum_1^Z fl_{2k}$

- $FL = FL_1 / FL_2$

- $\sum_1^Z fl_{1k} / \sum_1^Z fl_{2k} = \sum_1^Z s_{1k} / \sum_1^Z s_{2k}$

EQUILIBRIUM WITH FINANCIAL INTERMEDIARIES

- $AS=LS=PS$

- $AS=LS=FA=FL=PS$

- $Q{\downarrow}1\ /Q{\downarrow}2\ =L{\downarrow}1\ /L{\downarrow}2\ =FA{\downarrow}1\ /FA{\downarrow}2\ =FL{\downarrow}1\ /FL{\downarrow}2\ =S{\downarrow}1\ /S{\downarrow}2$

- $\sum 1{\uparrow}T▒q{\downarrow}1j\ /\sum 1{\uparrow}T▒q{\downarrow}2j\ =\sum 1{\uparrow}T▒l{\downarrow}1j\ /\sum 1{\uparrow}T▒l{\downarrow}2j\ =\sum 1{\uparrow}Z▒fa{\downarrow}1k\ /\sum 1{\uparrow}Z▒fa{\downarrow}2k\ =\sum 1{\uparrow}Z▒fl{\downarrow}1k\ /\sum 1{\uparrow}Z▒fl{\downarrow}2k\ =\sum 1{\uparrow}N▒s{\downarrow}1i\ /\sum 1{\uparrow}N▒s{\downarrow}2i$

CENTRAL BANK AS AN UNLIMITED LIQUIDITY PROVIDER

- $CB = FA_2 \uparrow C / FL_1 \uparrow BM$

- Maturity mismatch

- $FA_1 / FA_2 < FL_1 / FL_2$

- $\sum_1^Z \blacksquare fa_{1k} / \sum_1^Z \blacksquare fa_{2k} < \sum_1^Z \blacksquare fl_{1k} / \sum_1^Z \blacksquare fl_{2k}$

CENTRAL BANK AS AN UNLIMITED LIQUIDITY PROVIDER

- $AS=LS=FA<FL=PS$

- $Q_1/Q_2 = L_1/L_2 = FA_1/FA_2 < FL_1/FL_2 = S_1/S_2$

- $\sum_1^T q_{1j} / \sum_1^T q_{2j} = \sum_1^T l_{1j} / \sum_1^T l_{2j} = \sum_1^Z fa_{1k} / \sum_1^Z fa_{2k} < \sum_1^Z fl_{1k} / \sum_1^Z fl_{2k} = \sum_1^N s_{1i} / \sum_1^N s_{2i}$

MATURITY MISMATCH IN THE PRODUCTIVE STRUCTURE

- $\sum_1\uparrow T▒ q{\downarrow}1j \,/\sum_1\uparrow T▒ q{\downarrow}2j \,<\sum_1\uparrow N▒ s{\downarrow}1i \,/\sum_1\uparrow N▒ s{\downarrow}2i$

- $=\sum_1\uparrow T▒^- c{\downarrow}1j\uparrow* \,/\sum_1\uparrow T▒^- c{\downarrow}2j\uparrow* \,<\sum_1\uparrow N▒ c{\downarrow}1i \,/\sum_1\uparrow N▒ c{\downarrow}2i$

FORCED SAVINGS

- $\sum_1^T \overline{c}_{1j}^* \; < \sum_1^N c_{1i}$
- $\sum_1^T \overline{c}_{2j}^* \; > \sum_1^N c_{2i}$

FORCED SAVINGS

- $\sum_{1}^{N}\blacksquare c_{1i} = \sum_{1}^{N'}\blacksquare c_{1i}' + \sum_{N'}^{N}\blacksquare c_{1i}''$

- $\sum_{1}^{N}\blacksquare s_{1i} = \sum_{1}^{N'}\blacksquare s_{1i}' + \sum_{N'}^{N}\blacksquare s_{1i}''$

- $\sum_{1}^{N}\blacksquare c_{1i}'' = \sum_{1}^{N}\blacksquare s_{1i}''$

INFLATION

- $FL_{1}^{BM} = \sum_1^{\blacksquare} fl_{1}^{BM}$

- $\sum_1^{Z\blacksquare} fl_{1i} + \sum_1^{\blacksquare} fl_{1}^{BM} = \sum_1^{N\blacksquare} c_{1i}^{D}$

- $\sum_1^{T\blacksquare^{-}} c_{1j}^{*} = \sum_1^{N\blacksquare} c_{1i}^{\curvearrowright} = \sum_1^{N\blacksquare} c_{1i}^{D}$

ECONOMIC CRISIS

- $\sum1\uparrow T\boxtimes^{-}c\downarrow1j\uparrow* =\sum1\uparrow Z\boxtimes fa\downarrow1k =\sum N\uparrow\uparrow N\boxtimes s\downarrow1i\uparrow <\sum1\uparrow Z\boxtimes fl\downarrow1k =\sum1\uparrow N\boxtimes s\downarrow1i =\sum1\uparrow N\boxtimes c\downarrow1i$

- $\sum1\uparrow Z\boxtimes fl\downarrow1k =\sum1\uparrow Z\uparrow\boxtimes fl\downarrow1k\uparrow +\sum Z\uparrow\uparrow Z\boxtimes fl\downarrow1k\uparrow'$

- $\sum Z\uparrow\uparrow Z\boxtimes fl\downarrow1i\uparrow' =\sum N\uparrow\uparrow N\boxtimes s\downarrow1i\uparrow'$

Figure 1
Recession mechanism stages
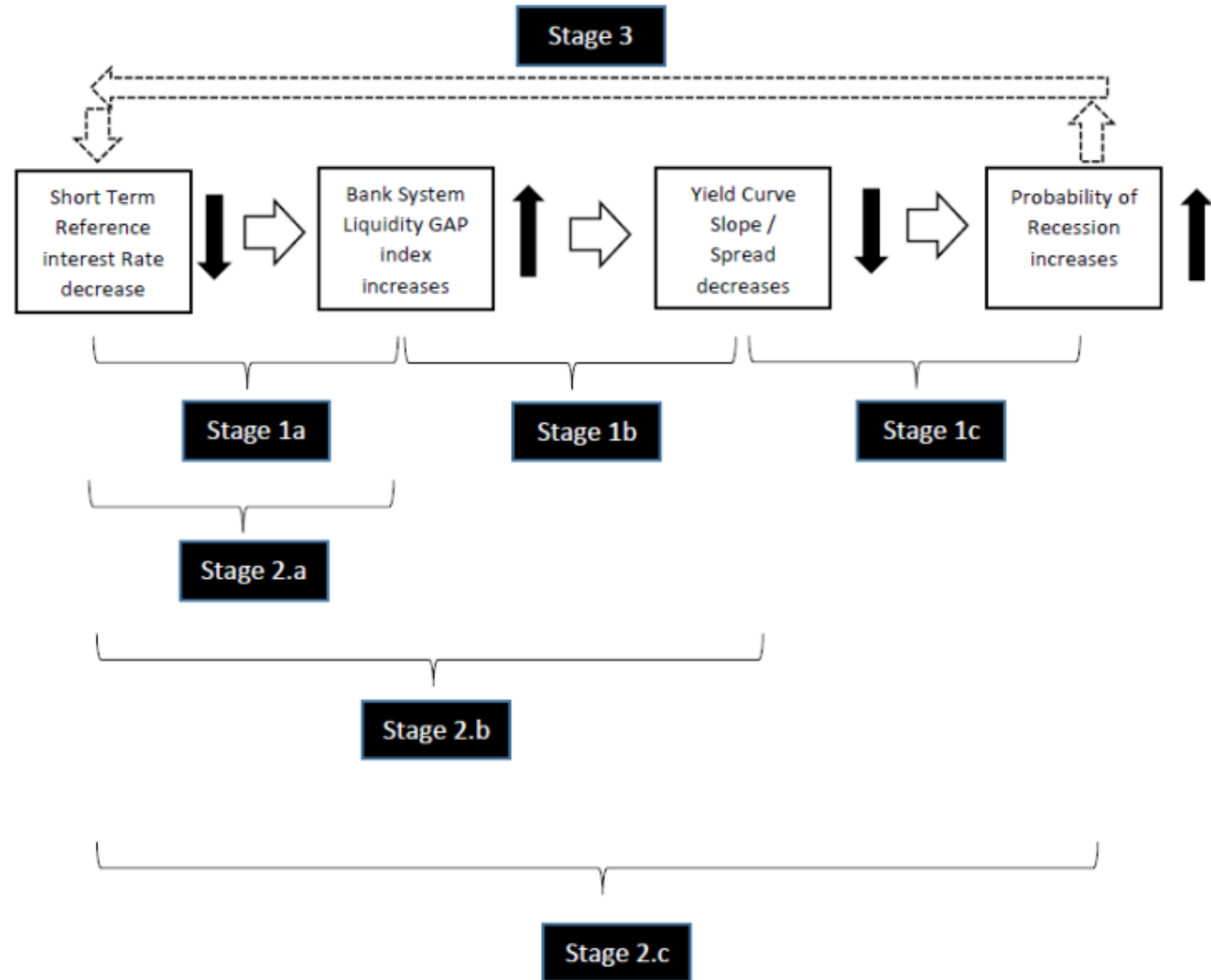
Methodology

- What is the structure of the lags in terms of signs and p values?

- Which sign dominates in size and p value? Is it the expected sign?

- Which lag hast the lowest p value?

- Which lag has the lowest p value with the expected sign?

$$Liquidity_{Gap} = \frac{STL/LTL}{STA/LTA}$$

Table 1-a
Links to database sources and estimation details

Variable	Source	Link	Data Dates and other estimation details
Libor overnight	Federal Reserve Bank of St. Louis	https://fred.stlouisfed.org/series/EURONTD156N	*Dates: Jan 2001-Sept 2016* Overnight London Interbank Offered Rate (LIBOR), based on Euro©, Percent, Daily, Not Seasonally Adjusted
EU Liquidity Gap	European Central Bank	http://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=117.BSI.M.U2.N.A.L60.X.1.Z5.0000.Z01.E	*Dates: Sept 1997-June 2016* Proposed indicator that takes the form: $\dfrac{STL/LTL}{STA/LTA}$ STL are financial sector liabilities with less than one year until maturity. LTL are financial sector liabilities with more than one year until maturity. STA are financial sector assets with less than one year until maturity. LTA are financial sector assets with more than one year until maturity.
German spread and rates	European Central Bank	http://sdw.ecb.europa.eu/quickview.do?SERIES_KEY=229.IRS.M.DE.L.L40.CI.0000.EUR.N.Z	*Dates: Sept 2004-Sept 2016* To deal with seasonality issues, both series within the spread where equivalent. The 10Y and 3M monthly values where estimated from averages of daily values.
USA Spread and Yield rates including FFR.	Federal Reserve System	https://www.federalreserve.gov/releases/h15/data.htm	*Dates: Jan 1982-June 2016* To deal with seasonality issues, both series within the spread where equivalent. The 10Y and 3M monthly values where estimated from averages of daily values.
Euro Recessions	Center of Economic Policy Research	http://cepr.org/content/euro-area-business-cycle-dating-committee	*Dates: Jan 1970-Sept 2016* The recessions where adapted to coincide with NBER recession classification, that is the beginning of peak and the end of a through. The data from the source is quarterly, it was adapted to a monthly database.
USA Recessions	Federal Reserve Bank of St. Louis	https://fred.stlouisfed.org/series/USREC#	*Dates: Dec 1854-Aug 2014* NBER based Recession Indicators for the United States from the Period following the Peak through the Trough, +1 or 0, Monthly, Not Seasonally Adjusted
Euro Monetary Aggregates	Federal Reserve Bank of St. Louis	https://fred.stlouisfed.org/series/MYAGM3EZM196N	*Dates: July 1980-Sept 2016* Monthly data in billions of Euros. This where seasonality adjusted using 2x12 MA by the researches to use them in the regressions.
USA Monetary Aggregates	Federal Reserve Bank of St. Louis	https://fred.stlouisfed.org/series/M1SL	*Dates: Jan 1959-Augest 2016* Monthly data in billions of dollars and seasonality adjusted.

Table 1-b
European Union recession mechanism

	(a)	(b)	(c)
Dependent variable	Stage 1a: Liquidity Gap	Stage 1b: Yield Curve Spread	Stage 1c: Recession
Main Explanatory variable LAG	Libor Euro Overnight	Liquidity Gap	Yield Curve Spread
Intercept	4.579*** (0.250)	11.4629*** (1.0570)	11.9168 (1.8957)
Lag 0	-0.0512*** (0.0133)	−3.7185*** (1.1535)	2.2700** (0.8171)
Lag 6	-0.0594*** (0.0010)	2.4087** (1.1953)	-2.2104*** (0.61546)
Lag 12	-0.0454*** (0.0077)	−0.0322 (0.9468)	0.400617 (0.2982)
Lag 18	-0.03607*** (0.0.0072)	-2.6968*** (0.8591)	-1.9264*** (0.7554)
Lag 24	-0.0146 (0.0108)	0.2849 (1.3448)	0.9247 (0.6197)
Lag 30	-0.0086 (0.0.0118)	−2.1573~ (1.3286)	2.4158*** (0.8162)
Lag 36	-0.0297* (0.0162)	4.7831*** (0.9745)	0.6888 (0.5116)
Lag 42	-0.0280* (0.0158)	-2.3345*** (0.9279)	-0.3750 (0.5740)
Lag 48	-0.0234 (0.0165)	−1.8124** (1.0142)	-1.668*** (1.72e-08)
Lag 54	-0.0187 (0.0185)	2.7324*** (1.0560)	NA
Lag 60	-0.0701*** (0.0126)	−0.12073 (0.8996)	NA
Reference rate lag 0		−0.7422*** (0.0549)	NA
M2 lag 0	NA	NA	NA
M2 Lag 6	NA	NA	NA
M2 lag 12	-2.1789 e -13*** (0.0000)	4.006e-013*** (0.00000)	NA
N	126	142	97
R2 adj	0.913	0.938	0.507 (McFadden adj R2)
Proportion of negative relationships	11 (-) /11	7 (-) /11	4 (-) / 9
Period of Dependent Variable	Sept 1997-June 2016	Sept 2004-Sept 2016	Jan 1970-Sept 2016

Table 1-c

European Union crisis mechanism increasing lagged impact of Libor overnight rate

Dependent variable	(a) Stage 2a: Liquidity Gap	(b) Stage 2b: Yield Curve Spread	(c) Stage 2c: Recession
Main Explanatory variable LAG	Libor Overnight	Libor Overnight	Libor Overnight
Intercept	4.579*** (0.250)	-1.6332 (1.1508)	-4.1201 (4.7358)
Lag 0	-0.0512*** (0.0133)	-0.7406*** (0.0611)	-3.6220 (1.0916)***
Lag 6	-0.0594*** (0.0010)	0.2377*** (0.0457)	3.4594*** (1.2467)
Lag 12	-0.0454*** (0.0077)	0.0699* (0.0357)	-0.0303 (0.7824)
Lag 18	-0.03607*** (0.0.0072)	0.27060*** (0.0314)	10.7905*** (3.1693)
Lag 24	-0.0146 (0.0108)	-0.2490*** (0.0551)	-13.5179*** (4.0412)
Lag 30	-0.0086 (0.0.0118)	0.3340*** (0.0628)	2.1464** (0.9516)
Lag 36	-0.0297* (0.0162)	0.1356** (0.0641)	NA
Lag 42	-0.0280* (0.0158)	0.1535* (0.0779)	NA
Lag 48	-0.0234 (0.0165)	0.0236 (0.0535)	NA
Lag 54	-0.0187 (0.0185)	-0.1128* (0.0594)	NA
Lag 60	-0.0701*** (0.0126)	0.3554*** (0.0482)	NA
M2 lag 0	NA	NA	NA
M2 Lag 6	NA	NA	NA
M2 lag 12	-2.1789 e -13*** (0.0000)	2.368e-13* (1.369e-13)	3.1793e-13 (5.094e-13)
N	126	129	142
R2 adj	0.913	0.919	0.6419 (McFadden adj R2)
Proportion of expected relationships	11(-)/11	8(+)/11	3(-)/6

Lagging relationship against Libor Overnight
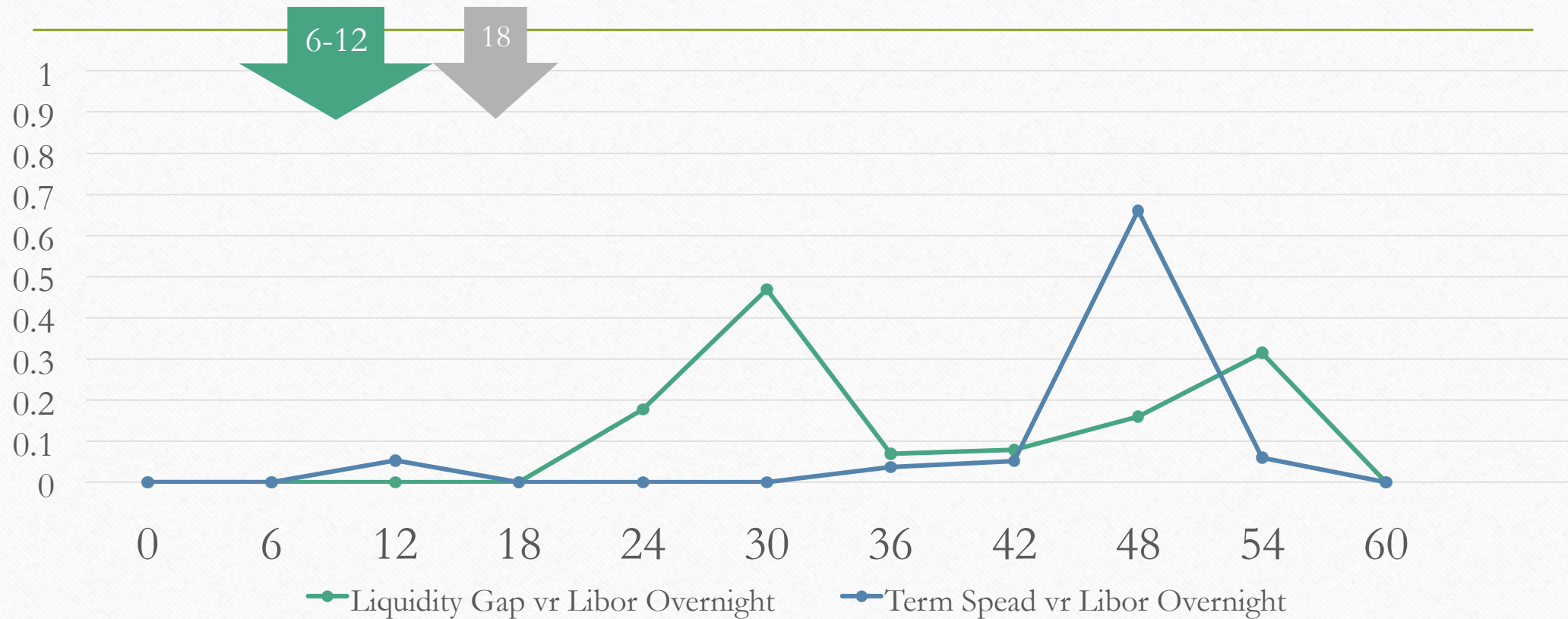Y axis: p values / X axis Lag for Libor Overnigh

Lagging relationship against Libor Overnight
Y axis: p values / X axis Lag for Libor Overnigh
Arrows show the lag witht he lowest p value and of the expected sign
In parenthesis number of coefficients with the expected sign out of the total lags tested
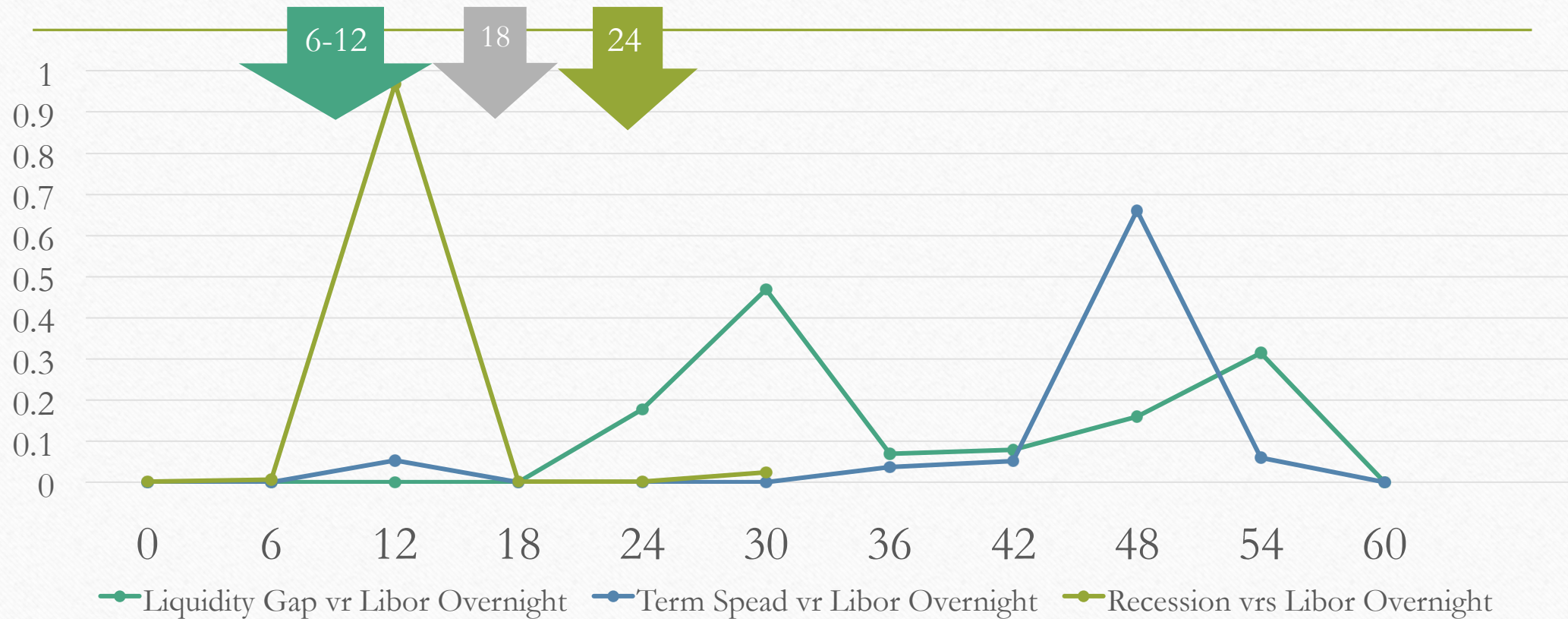
(11/11 -)   (8/11 +)   (3/6 -)

6-12   18   24

Table 2-a
United States recession mechanism

Dependent variable	(a) Stage 1a: Liquidity Gap	(b) Stage 1b: Yield Curve Spread	(c) Stage 1c: Recession	(d) Stage 1c: Recession
Main Explanatory variable LAG	FFR	Liquidity Gap	Yield Curve Spread	Yield Curve Spread without lag 0
Intercept	2.4184*** (0.2931)	0.9906 (1.1313)	-22.4023*** (7.4470)	-2.3696 (2.1712)
Lag 0	0.0625** (0.0300)	-1.5067*** (0.5742)	3.2291*** (0.9974)	Omitted
Lag 6	-0.0690 (0.0517)	3.3968*** (1.000)	-0.7971 (0.5358)	0.36031 (0.3919)
Lag 12	-0.01394 (0.0613)	-1.9965** (0.9734)	-1.6303** (0.6918)	-1.7154*** (0.5864)
Lag 18	0.0048 (0.0492)	-0.3417 (1.0706)	-0.4688 (0.8089)	-0.5693 (0.4266)
Lag 24	-0.0171 (0.0472)	1.4844 (1.5145)	-2.8932** (1.1853)	-1.5968 (0.5864)***
Lag 30	--0.0280 (0.0501)	-2.8687* (1.6657)	-0.7342 (0.9095)	-0.8126* (0.4185)
Lag 36	0.0052 (0.0472)	1.47305 (1.2871)	0.0948 (0.6071)	0.4102 (0.4573)
Lag 42	0.0234 (0.0426)	1.0450 (1.0875)	-1.5301** (0.6705)	-1.4960*** (0.5488)
Lag 48	-0.0166 (0.0387)	1.1703 (0.9819)	-1.0340~ (0.6454)	0.0972 (0.4324)
Lag 54	-0.00519 (0.0313)	1.1604 (1.1258)	1.2622** (0.5463)	0.1295 (0.4461)
Lag 60	-0.01353 (0.0182)	-1.5656** (0.7402)	0.9058* (0.47650)	0.9851*** (0.3573)
Reference rate lag 0		-0.7637*** (0.0385)	2.6828*** (0.7993)	Lag 1: 0.5067** (0.2222)
M2 lag 0	-0.000104 (0.00023)	-.00119*** (0.00037)	0.0182*** (0.0056)	Omitted
M2 Lag 6	-9.333 e -5 (0.0000)	0.00102*** (0.00039)	-0.0184*** (0.0066)	-0.00474 (0.0055)
M2 lag 12	0.000196 (0.000232)	-8.1729e-05 (0.000372)	0.0014 (0.0085)	0.00519 (0.0058)
N	226	166	354	357
R2 adj	0.467	0.937	0.626 (McFadden adj R2)	0.505
Proportion of negative relationships	7 (-) /11	4 (-) /11	7 (-) / 11	5 (-) /10
Period of Dependent Variable	Sept 1997-June 2016	Jan 1982-June 2016	Dec 1854-Aug 2014	Dec 1854-Aug 2014

Table 2-b

United States crisis mechanism increasing lagged impact of FFR

Dependent variable	(a) Stage 2a: Liquidity Gap	(b) Stage 2b: Yield Curve Spread	(c) Stage 2c: Recession
Main Explanatory variable LAG	FFR	FFR	FFR
Intercept	2.4184*** (0.2931)	0.9989** (0.5062)	−1.68360*** (0.2113)
Lag 0	0.0625** (0.0300)	−0.4504*** (0.0608)	−0.2243*** (0.0603)
Lag 6	−0.0690 (0.0517)	−0.02014 (0.0932)	0.3552*** (0.0925)
Lag 12	−0.01394 (0.0613)	0.1729** (0.0816)	0.2322*** (0.0690)
Lag 18	0.0048 (0.0492)	0.00784 (0.0631)	0.0589 (0.751)
Lag 24	−0.0171 (0.0472)	−0.0195 (0.0628)	−0.2047*** (0.0670)
Lag 30	−0.0280 (0.0501)	0.03979 (0.0.0504)	−0.0376 (0.0578)
Lag 36	0.0052 (0.0472)	0.0983*** (0.0088)	−0.0653 (0.0664)
Lag 42	0.0234 (0.0426)	0.12448*** (0.0303)	0.09680 (0.0771)
Lag 48	−0.0166 (0.0387)	0.0424 (0.0327)	−0.1038~ (0.0636)
Lag 54	−0.00519 (0.0313)	−0.012296 (0.0310)	0.1193** (0.0463)
Lag 60	−0.01353 (0.0182)	0.00399 (0.0331)	−0.2216*** (0.0512)
M2 lag 0	−0.000104 (0.00023)	−0.00265*** (0.00069)	0.0039*** (0.0014)
M2 Lag 6	−9.333 e -5 (0.0000)	0.0021*** (0.0008)	−0.0016 (0.0022)
M2 lag 12	0.000196 (0.000232)	0.00075 (0.00062)	−0.0024 (0.0018)
N	226	414	680
R2 adj	0.467	0.558	0.323 (McFadden adj R2)
Proportion of expected relationships	7 (-) /11	7(+)/11	6 (-) / 11

Table 3

Is endogeneity a relevant issue?

No change means the dominant and relevant signs are the same with and without the lag 0 component. The conclusion is the same.

Stage	Europe Union	United States
Stage 1a: Liquidity Gap versus Reference rate	No change: relevant negative lag is still around Lag 6. The Tobit regression improves the significance of all the negative lags. *Robust conclusion: Lag 6.* Ok	No change: again no coefficients are significant although most are of the expected sign. If we remove the least significant lags (24, 36, 48), we get lags 12 and 30 negative and significant. With the Tobit regression and no lag 0 variables, lag 12 is the relevant result. *Robust result: Lag 12* Ok
Stage 1b: Term Spread versus Liquidity Gap	Again the strongest negative lag is 18 and then 42 and 48. In terms of number of negative signs: 6 of 10 are negative instead of 7/11. There are now only two inconsistent positive values instead of 3. *Robust conclusion Lag 18.* Ok	4/10 are negative instead of 4/11, lag 60 is the most significant of the negatives, and then again lag 30. *Robust Result: Lag 30* Ok
Stage 1c: Recession versus Term Spread	Now 5 of 8 are negative signs instead of 4/9. Lag 36 is now significant and inconsistent but it is the only one because it is a positive sign. The strong result for the negative sign in lag 48 is still there. Lag 6 and 18 are still negative but now insignificant. *Sensible result: This result shows some sensitivity to the removal of lag 0 because the negative effect lags a little more. This might be a sample size issue because this is the smallest sample of the three stages.* *Lag 6-48 probably 48*	We still get a strong result for lag 12, but also for later lags. *Robust result: Lag 12* Ok
Stage 2b: Term Spread versus reference rate	Again Lag 18 is the strongest result, but now Lag 60 is not significant although it is still positive. Now only 5 of 10 lags are positive instead of 8/11, however, now two are positive and significant (12 and 18) and only one is negative and significant (Lag 6). We are unable to use M2 as controls. *Robust result: Lag 18 OK*	7/10 are positive instead of 7 out of 11. Lag 48 and then 42 are the strongest and positive. Lag 48 is now significant. Lag 12 is no longer strongly significant but still positive and significant at 88%. *Robust result for Lag 42 OK*
Stage 2c: Recession versus reference rate	The proportion of expected negatives signs improves, now 5/9 are negatives instead of 3/6, the strongest negative lag economically and statistically is Lag 30 instead of 24. Thus the relevant lag shifts 6 months but the result is essentially the same. *Robust result: lag 24-30 OK*	5/10 are negative instead of 6 of 11. Strongest significance is negative with lag 60. Again 3 inconsistent positive results. *Robust result for lag 24-60 probably 60* Ok
TOTAL LAGGED EFFECT	Stage 1(a,b,c): 6+18+48 = 72 → 6 years Stage 2(a,b,c): 24 to 30 → 2-3 years	Stage 1(a,b,c): 12+30+12 = 54 → 5-6 years Stage 2(a,b,c): 60 → 2-5 years

Empirical Conclusion

- The process begins with the lowering of the reference rate, followed by an increase in the liquidity gap, an inversion of the term spread and a recession.

- The Liquidity Gap seems to antecede a recession by roughly 5 years $\pm$ 2 years.

- The total time between the start of the lowering of an interest reference rate until the recession seems to be about 6 years with $\pm$ 4 years.

- We still need to estimate a liquidity Gap for USA.