New Perspectives on Monetary Operations and Repo Markets Before and During the Financial Crisis and Great Recession

ECB Workshop: "Structural changes in money markets: Implications for monetary policy implementation." 30th Sept to 1st Oct 2013

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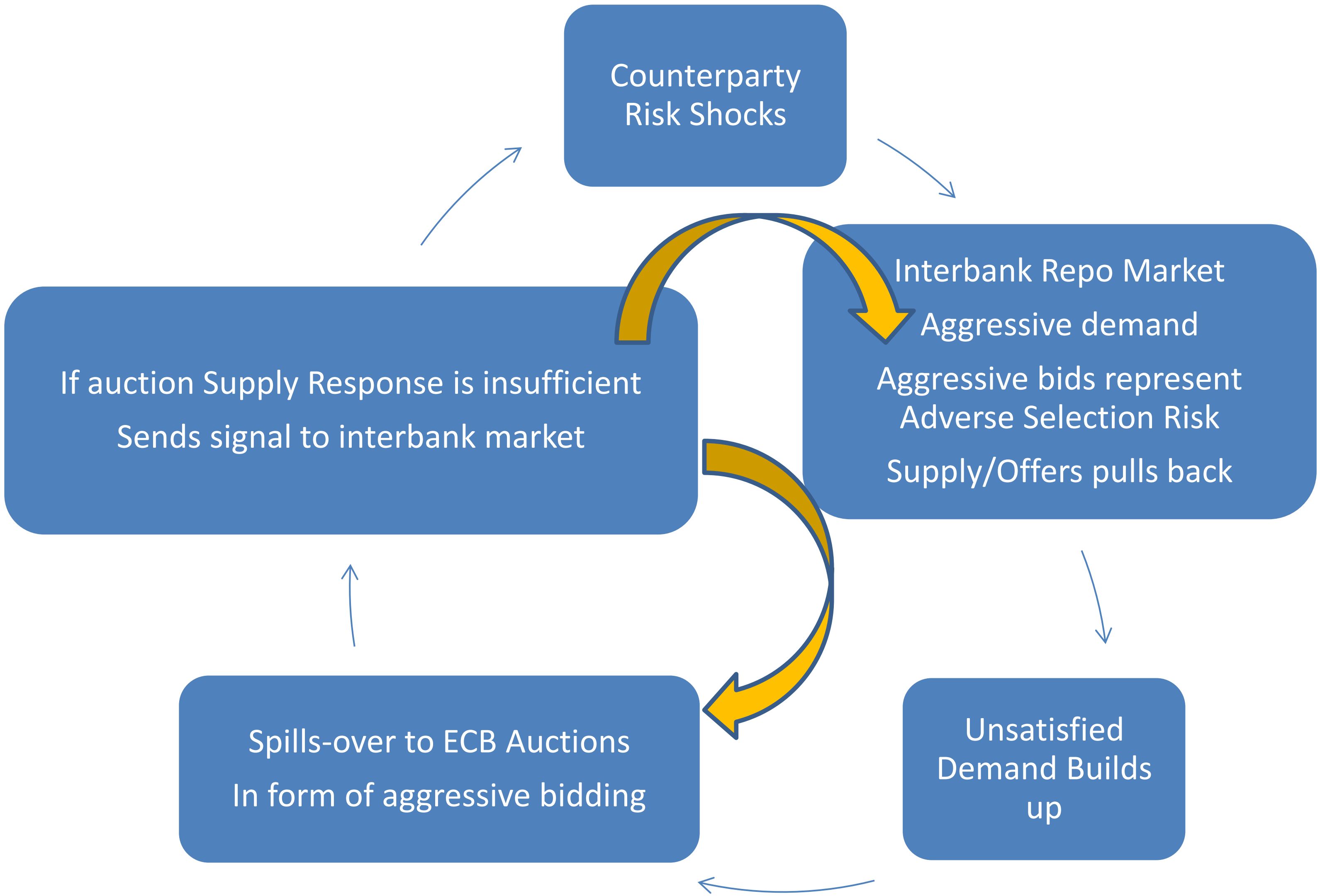
Introduction

- The liquidity puzzle revisited:
  - What is the evidence for transmission from monetary operations to the volume of secured interbank trading?
- Crisis:
  - Assessing the contribution of monetary operations to easing of interbank market conditions
- Policy implications:
  - What is the best path back to normal?

Pre-Crisis background

- Very credible interest rate targeting
  - Targeted marginal settlement rate provided a strongly accepted benchmark
    - Repo rate is priced against the benchmark with occasional "specialness" deviations
- The benchmark did not constrain repo volume
  - Low stable rate from post-dot-com to late 2005 coincides with increased repo volume
- The repo market was experiencing improved efficiency
  - More participants better connected
  - More collateral lending networks
- End-of-year effects.
  - well-known settlement-rate effects but unknown repo-volume effects
  - Perhaps important because end-of-year blockage constrains term.
    - Importance to assessing leveraged financial investment.

Crisis Period Background (Pre-Lehman)



No liquidity puzzle

"The Fed can and does affect total balances by changing interest rates. However, ... there are two things to emphasize: First, the decline in supply of balances follows a demand adjustment (and does not precede it), and second, the Fed's control over broader aggregates is limited to total balances."

Carpenter and Demiralp (2010, 2008).

It is generally accepted that the policy rate drives the demand for reserves and monetary operations are designed to mop-up excess supply when necessary.

But….

Is excess supply identifiable in bidding behaviour at monetary operations?

Is excess supply identifiable in the interbank market (specifically the repo mkt)?

Are these related?

Could demand for unconstrained balances be funding leveraged short-term speculation that is indirectly affecting yields on collateral?

Pre-Crisis Empirical Analysis

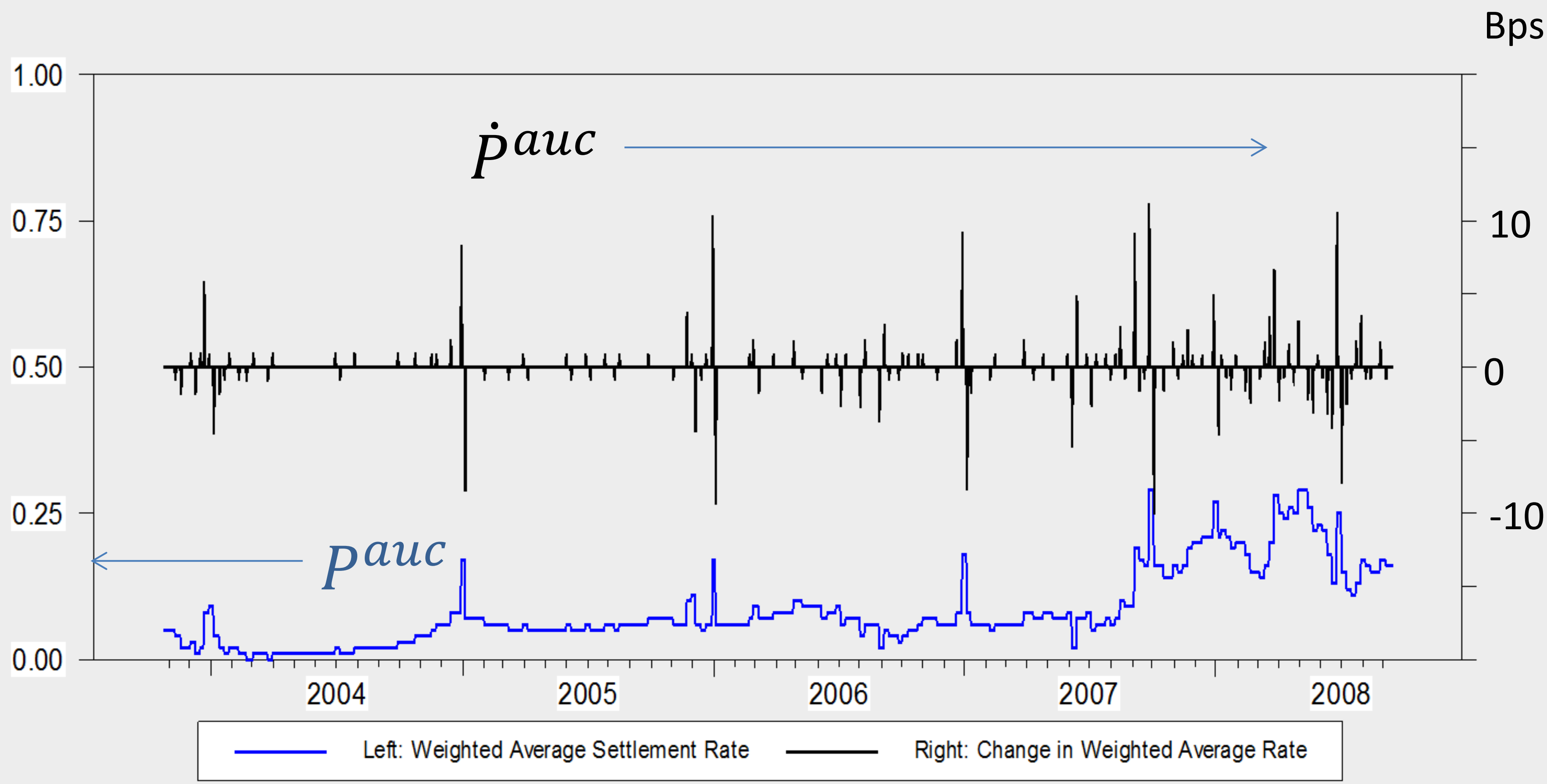
- VAR: Endogeneous variables
  - bidding aggressiveness in auctions
  - average daily repo roll-over (excess or shortfall) between auctions
- Standard VAR doesn’t work
  - Therefore we develop a modified-VAR
  - Seasonality (maintenance period and end-year)
  - Causality analysis
- We use VAR residuals to assess effects of interest rate increases
  - Cumulative effects (CAR in ±5 operations each side)

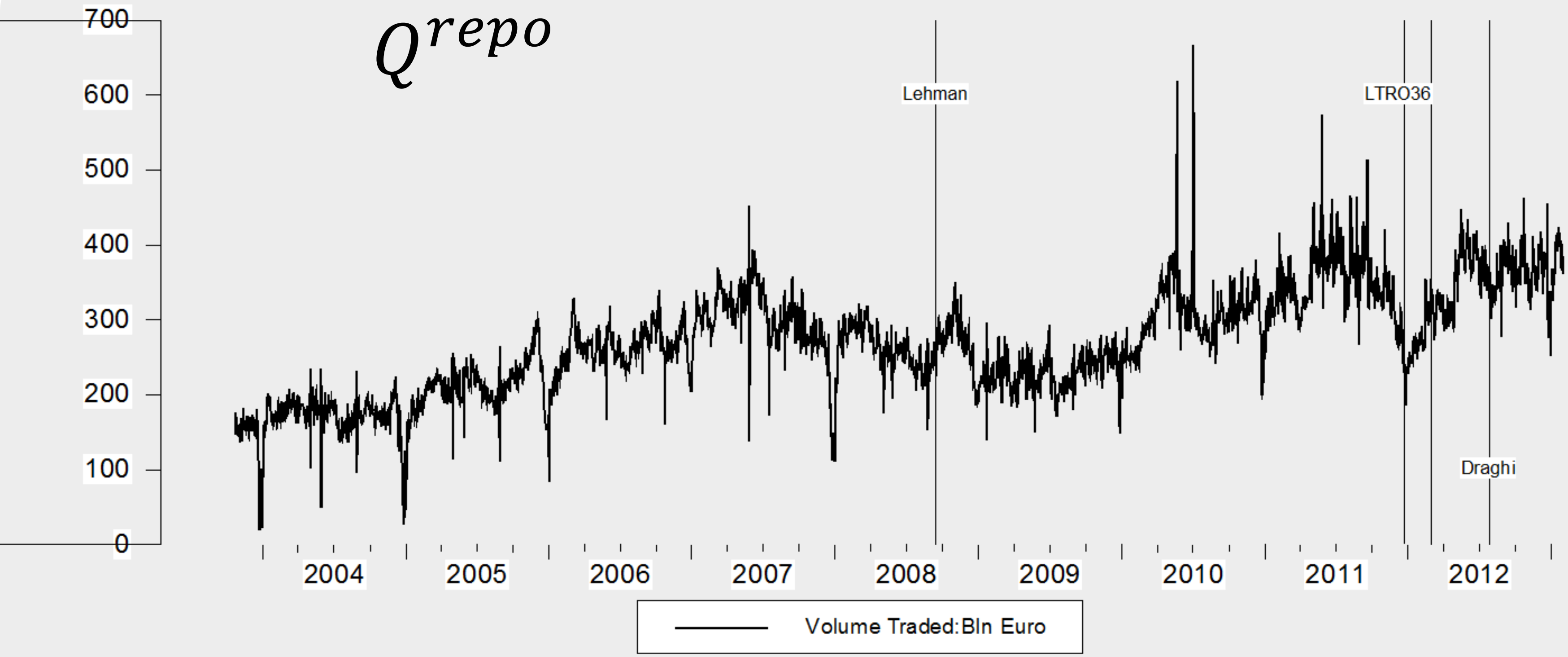
Modified VAR

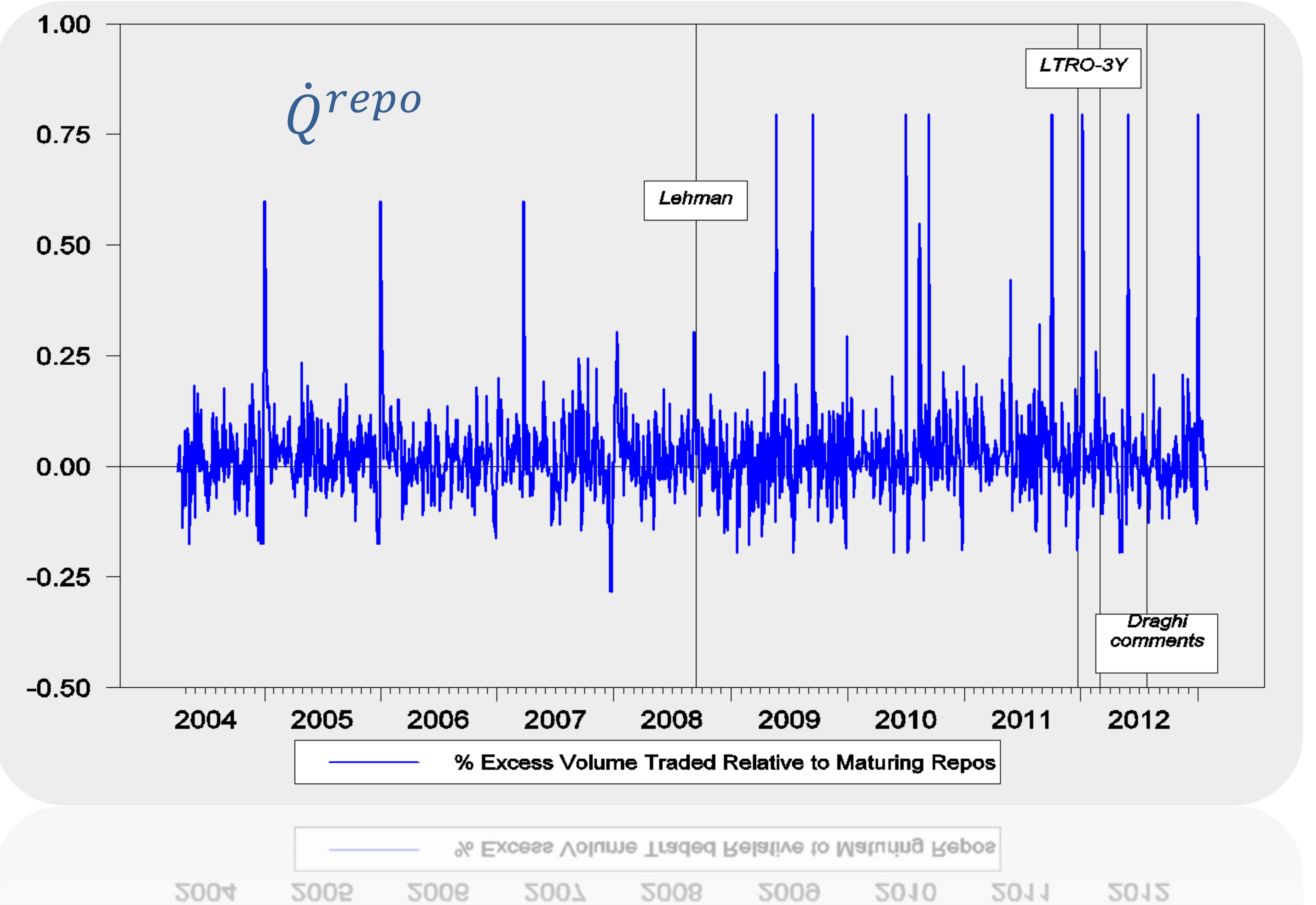
$$\begin{bmatrix} P_t^{auc} \\ Q_t^{repo} \end{bmatrix} = \begin{bmatrix} \boldsymbol{a}_{0,01} \\ \boldsymbol{a}_{0,02} \end{bmatrix} \boldsymbol{d}_0 + \begin{bmatrix} 0 & \boldsymbol{a}_{1,12} \\ 0 & 0 \end{bmatrix} \boldsymbol{d}_1 \begin{bmatrix} P_t^{auc} \\ Q_t^{repo} \end{bmatrix} + \begin{bmatrix} \boldsymbol{a}_{2,11} & \boldsymbol{a}_{2,12} \\ \boldsymbol{a}_{2,21} & \boldsymbol{a}_{2,22} \end{bmatrix} \boldsymbol{d}_2 \begin{bmatrix} P_{t-1}^{auc} \\ Q_{t-1}^{repo} \end{bmatrix} + \cdots + \begin{bmatrix} \epsilon_t \\ \eta_t \end{bmatrix}$$

$$\boldsymbol{d}_0 = \begin{bmatrix} 1 \\ LAST_t \\ EOYA_t \\ EOYB_t \\ LTR_t \end{bmatrix}, \boldsymbol{d}_1 = \begin{bmatrix} 1 \\ LAST_t \\ EOY_t \\ LTR_t \end{bmatrix} \; and \;\; for \; i > 1 \; \boldsymbol{d}_i, = \begin{bmatrix} WITHIN_i \\ ACROSS_i \\ LAST_i \\ EOY_i \\ LTR_i \\ LTRL_i \end{bmatrix}.$$

Weighted average auction settlement rate – ECB announced rate




Q^{repo}
700
600
500
400
300
200
100
0
Lehman
LTRO36
Draghi
2004
2005
2006
2007
2008
2009
2010
2011
2012
Volume Traded:Bln Euro



$\dot{Q}^{repo}$
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
Lehman
LTRO-3Y
Draghi comments
2004
2005
2006
2007
2008
2009
2010
2011
2012
% Excess Volume Traded Relative to Maturing Repos

		Dependent Variable: P_t^{auc}					
		Within	*Across*	*Last*	$EOY_{(a,b)}$	*LTR*	*LTRL*
	a_{01}	1.088***		−0.793*	2.57***	−2.478**	
		(0.274)		(0.458)	(0.843)	(1.143)	
					8.618***		
					(2.427)		
Auc lags	$a_{2,11}$	0.592***	0.525***	−0.436**	−0.604***	0.478**	−0.326***
		(0.14)	(0.127)	(0.174)	(0.187)	(0.223)	(0.123)
	$a_{3,11}$	0.299*	0.236	−0.013	−0.155	0.169	−0.333**
		(0.157)	(0.151)	(0.234)	(0.218)	(0.265)	(0.152)
	$a_{4,11}$	0.194	0.048	0.602**	−0.573**	−0.498	−0.422**
		(0.139)	(0.046)	(0.191)	(0.216)	(0.306)	(0.138)
Repo(t)	$a_{1,12}$	−0.091**		0.127**	−0.002	−0.037	
		(0.037)		(0.064)	(0.057)	(0.113)	
Repo lags	$a_{2,12}$	0.061	−0.032	−0.044	−0.115**	−0.096	−0.102*
		(0.045)	(0.034)	(0.053)	(0.052)	(0.059)	(0.061)
	$a_{3,12}$	−0.006	−0.033	0.107**	−0.054	0.274	−0.118**
		(0.029)	(0.025)	(0.039)	(0.042)	(0.212)	(0.041)
	$a_{4,12}$	0.011	0.007	−0.03	−0.198**	−0.023	0.056
		(0.022)	(0.014)	(0.04)	(0.09)	(0.12)	(0.065)

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Auction outcome caused-by Repo

- There is evidence of substitution but it is immediate
- The end-of-year effect is strong
- Some evidence of LTR being a substitute for MRO
- End-of-maintenance period is different

Dependent Variable: Q_t^{repo}

	Within	*Across*	*Last*	*EOY*$_{(a,b)}$	*LTR*	*LTRL*
$a_{0,2}$	-1.33		$4.173^{\bar{*}}$	$-10.932^{\bar{*}}$	$4.339^{\bar{*}}$	
	(1.016)		(2.061)	(4.916)	(2.13)	
				$29.572^{\bar{*}}$		
				(11.272)		
$a_{2,21}$	$0.682^{\bar{*}}$	0.353	-0.196	-0.273	-0.619	-0.426^{*}
	(0.274)	(0.35)	(0.517)	(0.8)	(0.432)	(0.254)
$a_{3,21}$	0.151	0.076	0.77	$-3.002^{\bar{*}}$	0.277	-0.848
	(0.368)	(0.368)	(0.746)	(0.787)	(0.439)	(0.662)
$a_{4,21}$	-0.168	-0.424	-0.526	$1.956^{\bar{*}}$	0.247	-0.192
	(0.37)	(0.277)	(0.675)	(0.964)	(0.582)	(0.728)
$a_{2,22}$	-0.062	-0.224	-0.136	0.173	-0.129	$0.579^{\bar{*}}$
	(0.179)	(0.199)	(0.235)	(0.21)	(0.191)	(0.214)
$a_{3,22}$	-0.028	-0.102	0.437	-0.391	-0.138	-0.283
	(0.08)	(0.122)	(0.301)	(0.283)	(0.409)	(0.313)
$a_{4,22}$	0.173^{*}	0.083	-0.327	0.41	0.384	-1.07^{*}
	(0.102)	(0.066)	(0.215)	(0.594)	(0.415)	(0.587)

Auc lags: $a_{2,21}$, $a_{3,21}$, $a_{4,21}$

Repo lags: $a_{2,22}$, $a_{3,22}$, $a_{4,22}$

Dependent Variable: Q_t^{repo}

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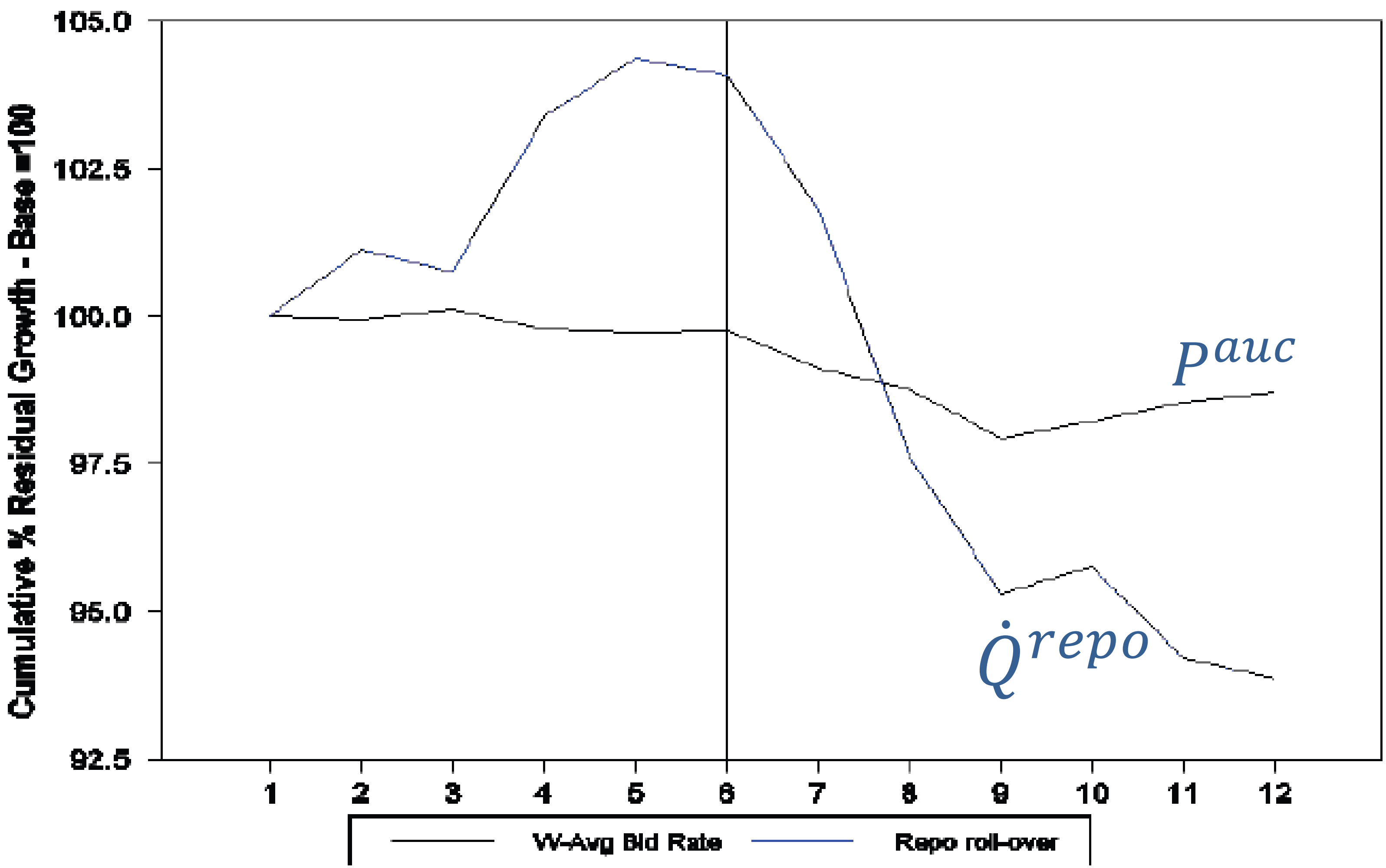
Auction outcome causes repo

- More aggressive bidding in auction leads to more post-auction repo activity
- Cross MP effects not significant
- End-of-year very significant
- Repo roll-over not persistent

Discussion of Rate-Event CARR

- This is the cumulative average unexplained growth in bidding aggressiveness in auctions and interbank repo roll-over.
- Index set to 100 at start
- 5 auctions either side of event!
- This is just an indication…std error bounds need to be added

Cumulative average residual growth around target interest rate changes



Pre-Lehman Crisis

- Allotment, Q(auc), and weighted average settlement rate, P(auc), non-stationary
  - Willingness to allot more if necessary to balance satisfying demand and staying relatively close to target rate.
- Repo volume non-stationary and repo roll-over stationary
  - But much more volatile than in the pre-crisis period
- We show now that a plausible behavioural model gives rise to an empirical model that will identify policy contribution to easing interbank market tensions.

Empirical strategy for identification of effects due to auction & mon policy

$$
\begin{aligned}
\text{Auction equation: } y_t &= a_0 - a_1(x_t - b_0 - Z_{t-1}) + W_t \\
&\quad + (a_1 + a_2)(\zeta_t + \eta_t) \\
\text{Interbank equation: } x_t &= b_0 - b_1 W_{t-1} + \eta_t + Z_t \\
\text{Common random walk: } W_t &= W_{t-1} + \omega_t \\
\text{Idiosyncratic random walk: } Z_t &= Z_{t-1} + \zeta_t \\
\text{where, } \omega_t &\sim iid(0, \sigma_\omega^2) \\
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Policy effect

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Counterparty risk
Collateral quality

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Interbank shocks have transitory impact because policy eventually accommodates, or the problem subsides

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\text{Interbank equation: } x_t &= b_0 - b_1 W_{t-1} + \eta_t + Z_t \\
\text{Common random walk: } W_t &= W_{t-1} + \omega_t \\
\text{Idiosyncratic random walk: } Z_t &= Z_{t-1} + \zeta_t \\
\text{where, } \omega_t &\sim iid(0, \sigma^2_\omega) \\
\zeta_t &\sim iid(0, \sigma^2_\zeta) \\
\eta_t &\sim iid(0, \sigma^2_\eta)
\end{aligned}
$$

This allows for different weight on transitory that is included in x

Model has a VMA(1) standard form

$$\begin{aligned}\text{Auction difference equation: } \dot{y}_t &= -a_1\dot{x}_{t-1} + \omega_t \\ &\quad +(a_1 + a_2)(\zeta_t + \eta_t) - a_2\eta_{t-1} \\ \text{Interbank difference equation: } \dot{x}_t &= -b_1\omega_{t-1} + \eta_t - \eta_{t-1} + \zeta_t.\end{aligned}$$

Auction MA…: $e_t + \phi e_{t-1} \approx \omega_t + (a_1 + a_2)(\zeta_t + \eta_t) - a_2\eta_{t-1}$

This can be lagged and inserted into the estimation of the interbank equation.

When lagged it only contains one term besides ω_{t-1} correlated with $\dot{x}_t$

This can be counteracted by control variables more directly related to repo volume.

Steps of approach.

1. Regress P(auc) and Q(auc) on repo rollover and include MA terms.
2. Collect the lagged residuals from each of these two models.
3. Regress repo roll-over on the lagged residuals from above steps and include controls for changes in counterparty risk and collateral quality
4. Measure the incremental contribution of the lagged auction residuals to the fit. Use these increments to calculate the cumulative impact of policy.

Results from 1st Crisis Period

Dependent:	Repo Roll-Over		
N	96	Degrees_Freedom	90
R_Sqr	0.319	R_Bar_Sqr	0.281
Log_Like	-310.6	Q(24-1)	13.31
D-W	1.99	Signif_Q	0.944

	Coeff	T-Stat
PAUCRES{1}	0.313	3.512
QAUCRES{1}	-0.044	-1.143
PRINBANKCDS(1)	8.055	2.246
PRINSPREAD(1)	7.253	1.447
DEURIBOROIS	-30.443	-3.448
RHO	0.133	1.25

Results from 2nd Crisis Period

Dependent: Repo Roll-Over

N	328	Degrees_Freedom	320
R_Sqr	0.034	R_Bar_Sqr	0.014
Log_Like	-1211.6	Q(36-1)	31.70
D-W	2.01	Signif_Q	0.627

	Coeff	T-Stat
QAUCRES{1}	-0.008	-0.32
PRINSPREAD2(1)	16.167	2.04
PRINDEPTH2(1)	14.585	1.642
DEURIBOROIS	20.673	1.972
RHO	0.034	0.594

Policy contribution to Interbank

- Positive in the 1st Crisis Period
  - Resids from 1st step remain significant in supplementary regression
  - MA(1) in supplementary reg looses significance when controls added
  - Controls are significant

- No effect in the 2nd Crisis Period
  - Resids from 1st step are insignificant in supplementary regression
  - MA(1) in supplementary reg never significant
  - Controls are significant

Conclusion

- In pre-crisis period interest rate was initially too low and repo volume increased
- Not clear that auctions provide a strong constraint on interbank activity
- Interest rate effect does affect volume of activity despite efficiencies in interbank
- In crisis 1: Policy was effective in easing conditions
- In crisis 2: Separation in type of participants implies no effects between the two venues

Conclude

- Return to normality?
  - Order of unpacking
    - 1. Improve counterparty risk by some type of insurance
    - 2. As collateral quality improves make more of it circulate in the interbank market
    - 3. Raise the fixed-rate at auctions
      - Forcing more banks to use the interbank market
    - 4. Return to variable rate auctions at the front-end of MP
      - Eventually re-introduce VRAs throughout MP
    - 5. Monitor flows of interbank funding
      - If persistent core-to-periphery then worry!