Three Essays on Lending, Liquidity and Bank Capital

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Outline

1. Stock lending and Market Returns: The Spanish Market
   - Introduction
   - The Data
   - Results

2. Welfare Effects of QE under Optimal Bank Capital Structures
   - Introduction
   - The model
   - Parameter Values and Quantitative Results
   - Welfare Analysis

3. Implied Bond Liquidity Premiums
   - Introduction
   - The Model
   - Data and Estimation Methodology
   - Results
Motivation

Question

What are the determinants of liquidity?
How does it affect price formation?

1. **Liquidity**: Fundamental characteristic of markets that allow participants to sell positions without incurring in further losses.

2. **Liquidity as driver of short run market prices** (Miller 1977): Equity, pure credit assets, Government Bonds.

3. Lending and liquidity: tight relation, to sell an asset first you need to have it or borrow from the holder.

4. Lending and Arbitrage capital: Capital restrictions lead to lending restrictions and those to liquidity restrictions.
Motivation

Three relevant lending markets:

1. Equity lending market: determines equity liquidity
2. Bank Capital (regulation): determines liquidity of pure credit assets
3. Government Bond market: partially determine liquidity of bank capital
Equity Lending Market

1. Lending is the only way to finance holdings in equity portfolios.
2. Big lending patterns could relate to short selling, ¿increases in price efficiency?
3. Market bubbles are less likely to occur in highly liquid markets.
1. Capital restrictions and regulation lead decisions of bank managers, ¿How?
2. Market price of relatively illiquid assets (credit) is highly affected by capital regulation
3. Credit channel is crucial for the transmission of Monetary Policy: Welfare concerns
1. Government Bond Prices and Bank capital exhibit a cointegration pattern: Higher bank capital higher bond prices, higher bond prices higher bank capital

2. Government Bonds essential assets to provide liquidity to bank balances

3. Liquidity of Government Bonds should affect credit spreads, bank equity valuation and cash markets

4. Contagion across countries through the Liquidity Channel
Section 1

Stock lending and Market Returns: The Spanish Market
Introduction

Question

How is equity market liquidity affected by equity lending Market? Does regulation on Short Selling change that relation?

- First attempt to model the effects of short selling due to Miller [1977]
- Empirical studies (Lamont and Jones [2002], D’Avolio [2002], Bris et al [2007]) have illustrated that short selling activities increase the speed at which information is incorporated into prices, reduce volatility and increase price efficiency (representativity)
- Studies on the effect of equity lending are scarce (Diether et al [2005]): equity lending relates to market liquidity as it is the only way to fund equity positions
Introduction (II)

Regarding short selling one has to distinguish between two categories:

- **Naked Short Selling**: forbidden in most developed countries (market manipulation)
- **Non-Naked Short Selling**: stocks have to be borrowed in advance to be sold in the market. Borrowers pay a convenience yield (Lending fee/rebate rate) to lenders in exchange

- **Lending Market is an OTC market**
  - Verification of holding at trade dates is hard due to the existence of asynchronies between trading dates and liquidation dates
  - Not all the operations in lending market relate to short selling activities, tax shield on dividend dates and hedge also motivate equity borrowing
Effect of Dividend on Lending Fees
Legal Framework

- Spanish Stock Market is an electronic market:
  - 3 day gap between trading and settlement: Stocks could be borrowed at any moment between this dates, verification of positions lies within custody banks
  - No fail to deliver exists: whenever a counterparty fails to deliver an stock, BME as clearing house issues a Registry Note (market making) to hedge the naked position and charges a penalty to naked entity

- Typical short selling regulation involves limiting operations during this three day gap: 2008 and 2012 short selling bans, stocks have to be borrowed in advance

- Actual owner of stocks are the one effectively holding those, not the lenders. Issues with political rights and dividend rights

- There is no ruling on collaterals for lending purposes. Legal differences between credit operations and lending operations depending on maturity

- Law in recalls is similar to US: lenders have the possibility to recall the position from borrowers at any date
Modelling Approach

- Estimation of supply and demand equations for the lending market making use of two different datasets and the specification in Diether et al [2005]
  - Definition of supply and demand shifts making use of the errors of previous estimations
  - Construction of a weekly value-weighted index for the whole sample of stocks
  - Computation of company specific abnormal returns through CAPM equation
  - Construction of bubble indicators as the ratio of market to book values between each date and a reference date
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The Data

- **Period:** January 2005 to December 2008
- **Number of companies:** 135 (102)
- **Two datasets on lending:** Official Records from CNMV and Non-official records of Total Supply for Lending from International Dataexplorers
  - CNMV: Aggregate amount of borrowed stocks
  - International Dataexplorers: Total supply of assets available for lending, lending fees
- **Thompson Reuters Datastream:** Trading prices (low, high, open, close), volumes, Balance Sheet data, Right Issuances, Convertibles
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Supply and Demand Equations: Shifts

Following the specification in Diether et al [2005]

Supply equation:

\[ S_{it} = c_i + \alpha Cost_{it} + \delta Cost_{it} \times CNMV_{it} + \sum \beta_j W_{it,-1j} + \sum \delta_j X_{it,j} + u_{it} \]

Demand equation:

\[ D_{it} = \alpha_i + \beta Cost_{it} + \sum \theta_j M_{it-1,j} + \sum \omega_j Z_{it,j} + v_{it} \]

Those are estimated using a simultaneous equations instrumental variables approach where, \( X_{it,j}, Z_{it,j}, M_{it-1,j}, W_{it,-1j} \) are vectors of additional contemporaneous and lagged control variables used as instruments to estimate cost related variables and where the dependent variable is the Lending Interest.

From errors of those regressions I compute SIN, SOUT, DIN and DOUT using a 1.5 standard deviation threshold
Results

Estimates of Supply and Demand

<table>
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<tr>
<th>Dependent variables: Lend Interest</th>
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<td>Past total supply*Regulatory note</td>
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</table>

* significant at 10%; ** significant at 5%; *** significant at 1%

Instrumented in Supply Eq.: Cost, Cost*Regulatory Note, Instruments: Lending t-1, Market Momentum.
Percentile of Lending t-1, Weeks to Dividend, Lending t-1* Regulatory Note

Instrumented in Demand Eq.: Cost, Instruments: Supply t-1, Percentile of Market Capitalisation,
### Stock Lending and Market Returns: The Spanish Market

#### Welfare Effects ofQE under Optimal Bank Capital Structures

#### Implied Bond Liquidity Premiums

## Introduction

## The Data

## Results

### Returns and Abnormal Returns

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Return</th>
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### Alvaro de Santos

Lending, Liquidity and Bank capital
## Abnormal Return Predictability

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<td>0.0014+</td>
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Stock Lending and the 2008 Market Crash: Short and Long Run Evidence

<table>
<thead>
<tr>
<th>Dependent Variable: Market to Bank</th>
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<th>II</th>
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<tr>
<td>SIN &amp; DOUT</td>
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Section 2

Welfare Effects of QE under Optimal Bank Capital Structures
Introduction

- Liquidity of credit markets determined by capital regulation → Capital determines funding costs
- Capital constrained entities follow a deleverage pattern
- Actual crisis started with a banking crisis → Then transformed into a liquidity problem

Question

How does Basel capital regulation affect assets liquidity? Is it possible to reduce the adverse effects of capital regulation?
Introduction

Actual models on bank capital structures (managers decisions) take exogenous assumptions on the liquidity of assets (Estrella [2004], Peura and Keppo [2006], Repullo and Suarez [2013]).

First two references take assumptions on the liquidity of bank equity capital, while the latter assumes perfect illiquidity of equity and perfect liquidity of credit assets paired with a monopolistic environment for borrowers.

Asset liquidity is driven by capital constraints, as illustrated in Kondor [2009] and Acharya and Shin [2013].

To analyze the liquidity effects of capital regulation and the (welfare) effects of actions aimed to increase that, liquidity has to be endogenized.

Basel III has recognized the effect of liquidity imposing a liquidity ratio to be satisfied by regulated entities.
The Set-up

- Discrete time model with two states, $s = \{h, l\}$ and three types of assets:
  - Loans (two period to maturity, subject to capital regulation, managerial costs, $c$, tradable in the intermediate period at a market price, $P_{s,s'} = 1 - \sigma_{s,s'}$, refinanciable, pay an interest rate $r_s$)
  - Government bonds (one period to maturity credit assets, managerial costs, $c$, not subject to capital regulation, no coupon, bought at a price $P^u$)
  - Bank equity capital (subject to capital regulation, managerial costs, $c^e$, acquired either by investors or other regulated entities)

- States evolve according to a Markov chain, probability of going to high default probability state is $q_{i,h}$

- Loans and bonds are subject to default risk
The Set-up

- Default distribution: \( F_s(x) = \Phi \left( \frac{\sqrt{1-\rho_s \phi^{-1}(x)} - \phi^{-1}(p_s)}{\sqrt{\rho_s}} \right) \)
- \( p_s = E(x|s) \)
- \( \rho_s = 0.12 \left( 2 - \frac{1-e^{-50p_s}}{1-e^{-50}} \right) \)
- LGD: \( \lambda \) homogeneous for both credit assets
- Regulatory capital (Basel II): \( \gamma_s = \frac{\lambda}{2} \Phi \left( \frac{\phi^{-1}(p_s) + \sqrt{\rho_s \phi^{-1}(0.999)}}{\sqrt{1-\rho_s}} \right) \)
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- \( \rho_s = 0.12 \left( 2 - \frac{1-e^{-50p_s}}{1-e^{-50}} \right) \)
- LGD: \( \lambda \) homogeneous for both credit assets
- Regulatory capital (Basel II): \( \gamma_s = \frac{\lambda}{2} \Phi \left( \frac{\Phi^{-1}(p_s) + \sqrt{\rho_s} \Phi^{-1}(0.999)}{\sqrt{1-\rho_s}} \right) \)
The Set-up

- Default distribution: \( F_s(x) = \Phi \left( \frac{\sqrt{1-\rho_s} \Phi^{-1}(x) - \Phi^{-1}(p_s)}{\sqrt{\rho_s}} \right) \)
- \( p_s = E(x|s) \)
- \( \rho_s = 0.12 \left( 2 - \frac{1-e^{-50p_s}}{1-e^{-50}} \right) \)
- LGD: \( \lambda \) homogeneous for both credit assets
- Regulatory capital (Basel II): \( \gamma_s = \frac{\lambda}{2} \Phi \left( \frac{\Phi^{-1}(p_s) + \sqrt{\rho_s} \Phi^{-1}(0.999)}{\sqrt{1-\rho_s}} \right) \)
The Set-up

- Credit assets can only be held by regulated entities (banks)
- Bond supply is exogenous
- There is a unit size continuum of banks
- Bank default rates are heterogeneous
- Banks are financed through equity and deposits. Deposit supply is totally elastic at a deposit rate normalized to zero
- Banks could be recapitalized either by investors (capital injection) or other banks (equity acquisition) if capital to loan ratio is above regulatory level, $k > \gamma_s$, otherwise banks can only recapitalize through deleverage or acquisition of new equity by other banks
- Investors are assumed to hold enough money to recapitalize (intertemporal welfare effects of recapitalization)
Evolution of Bank Capital and Loan Portfolio

- Capital and loan evolution are characterized by the following accountancy identity....

\[ K_1^e = \left( r + k + \frac{\Delta n^b (\bar{P}^e_1 - (1+c^e)\bar{P}^e)}{L} - c' + \frac{\chi (1-P)}{1+\chi} - x_1 (r + \lambda') \right) L \]

\[ L_1^e = (1 - x_1) L \cdot 1_{\{\chi = 0\}} \]

...where...

\[ k = \frac{K^e + \Delta n^b P_i^e - \xi (1-P) L^e}{L} \]

\[ L = (1 - \xi) L^e \cdot 1_{\{\xi > 0\}} + (1 + \chi) L^e \cdot 1_{\{\chi > 0\}} + \max \left( \frac{K^e}{k^*}, L^e \right) 1_{\{\chi = \xi = 0\}} \]

\[ L_i^u = \alpha_i L \]

\[ c' = c - \alpha_i (1 - c - P_i^u) \]

\[ \lambda' = (1 + \alpha_i) \lambda \]
The trading decision

Under this set-up, if $P_{s,s'} \geq 1$ the trading decision of banks is:

- Banks holding a capital $1 - P_{s,s'} < k^e < k^\bar{k}_{s',s}$ sell loans and use the money to give new loans.
- Banks holding a capital $k^\bar{k}_{s',s} < k^e$ buy loans until the regulatory constraint is binding.
- Loan Price is given by:
  $\int_{0}^{x_{s'}} (K^e_{s'} - \gamma_{s'} L^e_{s'}) \, dF_{s}(x) = \int_{x_{s'}}^{1 - P_{s,s'}} \gamma_{s'} L^e_{s'} \, dF_{s}(x)$
- Bank value is $K^e - (1 - P_{s,s'}) L^e$

- When $P_{s,s'} < 1$ two scenarios may arise....
The trading decision

If \( P_{s',s} - P_{s',s} \geq \left( \frac{P_{s',s}' - \bar{P}_s}{P_s} \right) - c^e \ldots \)

- Banks holding a capital \( 1 - P_{s,s'} < k^e < \gamma_{s'} \) are indifferent between selling loans and new equity
- Banks holding a capital \( \gamma_{s'} \leq k^e \leq \bar{k}_{s',s}' \) either are recapitalized by shareholders or give new loans
- Banks holding a capital \( \bar{k}_{s',s}' < k^e \) buy loans
- Loan price is given by:

\[
\int_{0}^{1-P_{s,s'}_{s}} (K_{s'}^e - \gamma_{s'}^e L_{s'}^e) dF_s (x) = \gamma_s \int_{0}^{1-P_{s,s'}_{s}} \left( \frac{(\gamma_{s'}^e - k^e)}{\gamma_s - (1 - P_{s,s'}_{s})} L^e \right) dF_s (x)
\]

- Bank value is \( K^e - (1 - P_{s,s'}) L^e \)
The trading decision

...Otherwise

- The decision is like in previous case but:
  - Banks holding a capital $k_{s',s}^3 < k^e$ buy equity
  - Bank value is $K^e - (1 - P_{s,s'}) L^e$
  - Implicit loan value is given by:

$$\int_0^{x_{k}} (K_{s'}^e - \gamma_{s'} L_{s'}^e) dF_{s}(x) = \gamma_{s'} \int_{x_{s'}}^{1-P_{s,s'}} (\gamma_{s'} - k^e) L^e dF_{s}(x)$$
General Solution: Implications

- The problem has one state contingent equilibrium \( \{ r_s^*, k_s^* \} \) when bank managers hold rational, non-myopic, expectations.
- Prices are unique, depend on previous and current state of the economy and are sufficient statistics of the state of the economy (\( P_{s,h} < 1 \) and \( P_{s,l} > 1 \)).
- Some existing borrowers suffer refinanciation constraints, some banks hold excess lending capacity.
- Interest rates (Spreads) lie within the interval
  \[
  \left[ \left( \frac{1-\beta}{\beta} \gamma_l + c + p_l \lambda \right) \frac{1}{1-p_l}, \left( \frac{1-\beta}{\beta} \gamma_h + c + p_h \lambda \right) \frac{1}{1-p_h} \right]
  \]
- Market value of the Bank value is always equal to residual book value, \( K^e - (1 - P_{s,s}') L^e \).
- When \( k_s^* > \gamma_s \) and \( s = h \), there is a mass of banks asking for a capital injection from shareholders.
- If \( \frac{(P_{s,s}' - \bar{P}_s^e)}{P_{s,s}^e} - c^e > P_{s''} L^e - P_{s'\prime} L^e \), capital buffers and spreads are smaller, liquidation losses are bigger.
- In recesions, bond prices and capital are positively correlated.
Effect of Parameter Changes: $r_s^*$

The effect on equilibrium loan rates, $r_s^*$, of changing the value of any parameter $\{\lambda, q_{s,h}, \gamma_i, \gamma_h, \delta, c\}$ is...

\[
\begin{array}{cccccc}
\lambda & q_{s,h} & \gamma_i & \delta & c \\
\hline
\frac{dV_s}{dP_{s,i}} & \frac{dP_{s,i}}{da} & (-) & 0 & (-) & (-) & (-) \\
\frac{dV_s}{da} & (-) & (-) & (-) & (-) & (-) \\
\frac{dr_s^*}{da} & (+) & (+) & (+) & (+) & (+) \\
\end{array}
\]
Effect of Parameter Changes: $k_s^*$

...while being not defined for equilibrium capital, $k_s^*$

<table>
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<tr>
<th>$a = \frac{\partial^2 V}{\partial k \partial a}$</th>
<th>$\lambda$</th>
<th>$q_{s,t}$</th>
<th>$\gamma_i$</th>
<th>$\delta$</th>
<th>$c$</th>
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<td>(+)</td>
<td>(+)</td>
<td>(−)</td>
<td>(+)</td>
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<td>$\frac{\partial^2 V}{\partial k \partial P} \frac{\partial P}{\partial a}$</td>
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<td>$\left( \frac{\partial^2 V}{\partial k \partial r} + \frac{\partial^2 V}{\partial k \partial P} \frac{\partial P}{\partial r} \right) \frac{\partial r}{\partial a}$</td>
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<td>(−)</td>
<td>(−)</td>
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<td>$\frac{dk_s^*}{da}$</td>
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Parameter Values

For simulation results we use the following values for the parameters...

\[
\begin{array}{cccccccccc}
\lambda & q_{l,h} & q_{h,h} & \delta & c & c^e & p_h & p_l & \alpha_i \\
45\% & 20\% & 64\% & 4.85\% & 3.4\% & 32\% & 3.6\% & 1.1\% & 10\%
\end{array}
\]
Simulation Results: $r^*_s$ and $k^*_s$

... and benchmark our results against those in Repullo and Suarez [2013]....

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<th>With Equity Markets</th>
<th>RS</th>
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<td>$r^*_h$</td>
<td>1.7%</td>
<td>1.7%</td>
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<td>$r^*_i$</td>
<td>0.73%</td>
<td>0.69%</td>
<td>1.3%</td>
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<td>$k^*_h$</td>
<td>6.09%</td>
<td>6.09%</td>
<td>6.70%</td>
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<tr>
<td>$k^*_i$</td>
<td>6.81%</td>
<td>5.19%</td>
<td>6.90%</td>
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<tr>
<td>$k^*_h - \gamma_h$</td>
<td>60bps</td>
<td>60bps</td>
<td>120bps</td>
</tr>
<tr>
<td>$k^*_i - \gamma_i$</td>
<td>365bps</td>
<td>203bps</td>
<td>380bps</td>
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</table>
...and price predictions

<table>
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<th>Model without equity</th>
<th>Model with equity</th>
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<td>Loan Prices, $P_{s,s'}$</td>
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<td>State: $h$ after $h$</td>
<td>93.62%</td>
<td>93.62%</td>
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<td>State: $l$ after $h$</td>
<td>96.05%</td>
<td>96.06%</td>
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<tr>
<td>State: $h$ after $l$</td>
<td>90.82%</td>
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<td>State: $l$ after $l$</td>
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<td>Bond Prices, $P^b_{s'}$</td>
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<td>State: $h$</td>
<td>95.26%</td>
<td>95.31%</td>
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<td>State: $l$</td>
<td>96.11%</td>
<td>96.17%</td>
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<td>Market to book value of capital, $\frac{k_{s'} - (1 - P_{s,s'})}{k_{s'}}$</td>
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<td>State: $h$ after $h$</td>
<td>78.98%</td>
<td>78.98%</td>
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<tr>
<td>State: $l$ after $h$</td>
<td>116.9%</td>
<td>122.2%</td>
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<tr>
<td>State: $h$ after $l$</td>
<td>17.07%</td>
<td>69.78%</td>
</tr>
<tr>
<td>State: $l$ after $l$</td>
<td>101.46%</td>
<td>101.15%</td>
</tr>
</tbody>
</table>
With this model we can also analyze the welfare effects of market and regulatory actions aimed to increase price liquidity.

Three actions are considered:

- Short selling regulation
- Bond purchases
- Loan purchases

State contingent welfare is measured with:

$$ W_{s,s'} = (NC_{s,s'} - NR_{s,s'} - R_{s,s'}) (\mu - r^*_s) + \omega BR_{s,s'} $$

Then aggregated using ergodic state transition probabilities.
QE and Welfare

- The effect of short selling bans (reduction in liquidity) depends on the aversion of the government to assume bank losses: High risk aversion $\Rightarrow$ Short Selling bans reduce Welfare
- Bond purchases increase Welfare
- Loan purchases have no effect when market liquidity is low. Otherwise the effect is positive

![Graphs showing the relationship between QE and Welfare](image-url)
Section 3

Implied Bond Liquidity Premiums
Introduction

- Government Bonds are highly traded “liquid” assets banks typically use as collateral for their funding operations in the ECB.
- Since 2008, the European government bond market has faced turbulences, bond prices reduced.
- This leads to a reduction in aggregate bank liquidity (haircuts, downgrades...)

Question

How does government bond liquidity affect other markets?
Is there a liquidity contagion pattern amongst European countries?
Various studies have analyzed the relations between liquidity and credit:

- **Empirical:** Warga [1992], Fontaine [2012], Ericsson and Renault [2006], Longstaff [2005]
- **Theoretical:** Brunnermeier [2008] and Brunnermeier et al. [2009] ⇒ Liquidity and credit quality closely related
- **Acharya and Shin [2013]:** Banking Funding constraints in one country lead to illiquidity in other countries (wealth effect)

Measuring credit liquidity is a difficult task (liquidity non-observable) ⇒ Proxies (Bid-Ask spreads, Traded Volumes...)

- **Fontaine [2012]:** bond age is relevant to understand US bond liquidity ⇒ Violation of non-arbitrage condition
  - Why? Plausible explanation: Bond age is a proxy for funding conditions in previous dates
  - Bonds: Held to maturity portfolios ⇒ Amortizing costs
Affine Model Price Specification

- Christensen et al [2009]: Conditional Nelson Siegel specification ⇔ Arbitrage Free
- Factors evolve according to Orstein-Uhlenbeck processes, and the price incorporates an additional liquidity factor....

\[
\begin{align*}
    dF &= K(\theta - F)dt + \sum dB^Q \\
    F_{i,c,t} - F_{i,c} &= k_{i,c} (F_{i,c,t} - F_{i,c}) + \sigma_{i,c} \epsilon_{i,c,t} \\
    P^*(F_{c,t}, \text{age}_{M,c,t}, L_{c,t}) &= \sum_{m=m_1}^{M} D_{c,t}(m) \times C_{c,t}(m) + \zeta_{c} (L_{c,t}, \text{age}_{M,c,t}) + \Omega_{c} \psi_{c,t}
\end{align*}
\]
Affine Model Price Specification

... where

\[
\begin{align*}
\Sigma &= \begin{pmatrix}
\sigma_1 & 0 & 0 & 0 \\
0 & \sigma_2 & 0 & 0 \\
0 & 0 & \sigma_3 & 0 \\
0 & 0 & 0 & \sigma_4 \\
\end{pmatrix} \\
D_{c,t}(m) &= e^{-\left(a_{c,t}(m) + \sum_{i=1}^{3} F_{i,c,t}(m) \beta_{i,c,t}\right)m} \\
\beta_{1,c,t} &= 1 \\
\beta_{2,c,t} &= \frac{(1-e^{-\lambda_1 m})}{\lambda_1 m} \\
\beta_{3,c,t} &= \frac{(1-e^{-\lambda_1 m})}{\lambda_1 m} - e^{-\lambda_1 m} \\
\zeta_c \left(L_{c,t, ageM,c,t}\right) &= L_{c,t} e^{-\frac{1}{\kappa} ageM,c,t}
\end{align*}
\]
The Data

- 12 European Countries data (5 Core Countries + 5 Non-core countries + Deutschland + Switzerland):
  - Bond Prices
  - Coupon
  - Time to Maturity
  - Age
  - CDS spreads
  - Repo rates
- Market-to-Book Value of Eurostoxx 600 Banking Index
- IRS rates
- Euribor Rates
- Weekly Frequency
- January 2007 to December 2011⇒Abstracting from Central Bank Actions
Estimation Methodology

- Non-Linear State-Space representation $\Rightarrow$ Unscented Kalman Filter

\[
\begin{align*}
F_{c,t} - F_c &= K_c (F_{c,t} - F_c) + \Sigma \epsilon_{c,t} \\
P_t &= \phi (F_{c,t}, C_c,t, age_{c,t}) + \Omega \theta_t
\end{align*}
\]

- Price volatility: $\Omega$ diagonal matrix
- Individual Price volatility $\Omega_i = \omega_0 + \omega_1 m > 0$
- Likelihood function: $L(\omega) = \sum_{t=1}^{T} l(P_t; \omega) = \sum_{t=1}^{T} log (\Phi (P_{t+1,t}, \Omega_{t+1,t}; \omega))$
- Parameter restrictions: $\lambda_1, \kappa > 0$, $k_i \epsilon [-1, 1]$, $D_{c,t} (m) \leq 1$
- Country level estimation
- Multiple Starting Points
- Spillover Liquidity effects across countries $\Rightarrow$ Predictive regressions
- Predictability of excess returns
- Effect of liquidity in other markets $\Rightarrow$ Predictive regressions
Liquidity Factor

- Liquidity factor relevant for all countries but Deutschland
- Decay parameter estimates: Low values for Spain, Italy, Portugal and Greece (on average 0.69) for the others 2.54
- Average liquidity factor:
  - Very negative for France and Belgium $\Rightarrow$ Banking sector highly damaged
  - Low effect for Core countries $\Rightarrow$ 0.29 $ lower price in new issuances
  - Higher effect for Non-Core countries $\Rightarrow$ 0.83 $ lower price in new issuances
Evolution of Liquidity

- Austria
- Netherlands
- Switzerland
- Finland
- Ireland
- France
- Belgium
- Italy
- Spain
- Portugal
- Greece
## Spillover effects

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<td>0.0141***</td>
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<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>L.NL</td>
<td>0.965***</td>
<td>0.0263***</td>
<td>0.0297***</td>
<td>0.0196***</td>
<td>0.0896***</td>
<td>-0.0086***</td>
<td>-0.0124***</td>
<td>0.000***</td>
<td>0.000***</td>
<td>0.000***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.011)</td>
</tr>
</tbody>
</table>

Observations: 2441  2441  2811  2441  2811  2441  2441  2431  2441  2811

*p-values in parentheses

* p < 0.1  ** p < 0.05  *** p < 0.01
Robust (sign) independently of the number of prediction lags
Suggest the following categorization:

<table>
<thead>
<tr>
<th>Core countries</th>
<th>Big Market</th>
<th>Small Market</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>France, Belgium</td>
<td>Austria, Nederlands, Finland</td>
</tr>
<tr>
<td>Non-Core countries</td>
<td>Spain, Italy</td>
<td>Greece, Portugal, Ireland</td>
</tr>
</tbody>
</table>

Spain leads Italy; Belgium leads France
Liquidity increases in big countries leads to liquidity reductions in smaller markets (the opposite is also true) \( \rightarrow \) Flight to liquidity
Liquidity increases in big core countries leads to liquidity increases in non core countries \( \rightarrow \) Wealth effect
### Introduction

**The Model**

**Data and Estimation Methodology**

**Results**

---

### Liquidity and Bond Market Excess Returns

<table>
<thead>
<tr>
<th></th>
<th>1Y Yield</th>
<th>2Y Yield</th>
<th>3Y Yield</th>
<th>4Y Yield</th>
<th>5Y Yield</th>
<th>7Y Yield</th>
<th>10Y Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Months</td>
<td>-0.546***</td>
<td>-0.571***</td>
<td>-0.574***</td>
<td>-0.561***</td>
<td>-0.535***</td>
<td>-0.467***</td>
<td>-0.401***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.001)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>6 Months</td>
<td>-0.556***</td>
<td>-0.557***</td>
<td>-0.547***</td>
<td>-0.526***</td>
<td>-0.498***</td>
<td>-0.431**</td>
<td>-0.343**</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.005)</td>
<td>(0.006)</td>
<td>(0.007)</td>
<td>(0.009)</td>
<td>(0.016)</td>
<td>(0.036)</td>
</tr>
<tr>
<td>12 Months</td>
<td>-0.336*</td>
<td>-0.306</td>
<td>-0.276</td>
<td>-0.247</td>
<td>-0.219</td>
<td>-0.164</td>
<td>-0.0887</td>
</tr>
<tr>
<td></td>
<td>(0.078)</td>
<td>(0.100)</td>
<td>(0.128)</td>
<td>(0.162)</td>
<td>(0.202)</td>
<td>(0.301)</td>
<td>(0.521)</td>
</tr>
</tbody>
</table>

- $R^2$ 3 Months: 0.285 (0.223) 0.308 (0.246) 0.313 (0.254) 0.312 (0.258) 0.310 (0.260) 0.302 (0.260) 0.286 (0.253)
- $R^2$ 6 Months: 0.250 (0.188) 0.263 (0.205) 0.265 (0.213) 0.266 (0.219) 0.267 (0.224) 0.267 (0.232) 0.258 (0.233)
- $R^2$ 12 Months: 0.134 (0.115) 0.149 (0.134) 0.160 (0.148) 0.172 (0.162) 0.186 (0.178) 0.217 (0.212) 0.248 (0.247)

*p-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Introduction

The Model

Data and Estimation Methodology

Results

Liquidity, Repo Market Excess Returns and the CDS market

<table>
<thead>
<tr>
<th></th>
<th>3 Months</th>
<th>6 Months</th>
<th>9 Months</th>
<th>12 Months</th>
<th>24 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIQUIDITY</td>
<td>-0.0991*</td>
<td>-0.126**</td>
<td>-0.155**</td>
<td>-0.172**</td>
<td>-0.209*</td>
</tr>
<tr>
<td></td>
<td>(0.078)</td>
<td>(0.042)</td>
<td>(0.025)</td>
<td>(0.020)</td>
<td>(0.064)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>3 Months</th>
<th>6 Months</th>
<th>9 Months</th>
<th>12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIQUIDITY</td>
<td>-0.433***</td>
<td>-0.385**</td>
<td>-0.284*</td>
<td>-0.211</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.028)</td>
<td>(0.095)</td>
<td>(0.215)</td>
</tr>
<tr>
<td>LEVEL</td>
<td>0.733***</td>
<td>0.835***</td>
<td>0.845***</td>
<td>0.683**</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.002)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>SLOPE</td>
<td>0.381**</td>
<td>0.130</td>
<td>-0.0263</td>
<td>-0.181</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.382)</td>
<td>(0.850)</td>
<td>(0.230)</td>
</tr>
<tr>
<td>CURVATURE</td>
<td>-0.472**</td>
<td>-0.413**</td>
<td>-0.106</td>
<td>0.287**</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.029)</td>
<td>(0.452)</td>
<td>(0.039)</td>
</tr>
</tbody>
</table>

$R^2$: 0.304 (0.252) 0.271 (0.233) 0.174 (0.154) 0.111 (0.098)

$p$-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
<table>
<thead>
<tr>
<th></th>
<th>3 Months</th>
<th>6 Months</th>
<th>9 Months</th>
<th>12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>BELGIUM</td>
<td>-0.150***</td>
<td>-0.158***</td>
<td>-0.169***</td>
<td>-0.125***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>FRANCE</td>
<td>-0.183***</td>
<td>-0.109***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.003)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRELAND</td>
<td>-0.255***</td>
<td>-0.256***</td>
<td>-0.206***</td>
<td>-0.148**</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>ITALY</td>
<td>-0.298***</td>
<td>-0.283***</td>
<td>-0.235***</td>
<td>-0.193***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>PORTUGAL</td>
<td>0.241***</td>
<td>0.167***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.004)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \alpha )</td>
<td>1.277***</td>
<td>1.216***</td>
<td>1.101***</td>
<td>1.084***</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.845</td>
<td>0.827</td>
<td>0.811</td>
<td>0.721</td>
</tr>
</tbody>
</table>

*p-values in parentheses
* \( p < 0.1 \), ** \( p < 0.05 \), *** \( p < 0.01 \)
### Liquidity and the Interbank Cash Market

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AUSTRIA</td>
<td>0.0691**</td>
<td>0.175***</td>
<td>0.0775*</td>
<td>0.115***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.006)</td>
<td>(0.098)</td>
<td>(0.008)</td>
<td></td>
</tr>
<tr>
<td>IRELAND</td>
<td>0.117***</td>
<td>-0.696***</td>
<td>0.164***</td>
<td>0.209***</td>
<td>0.110***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.000)</td>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>BELGIUM</td>
<td>0.0730***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPAIN</td>
<td>0.205**</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.038)</td>
<td></td>
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<tr>
<td>NEDERLANDS</td>
<td>0.418***</td>
<td>-0.276***</td>
<td>-0.118***</td>
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<tr>
<td></td>
<td>(0.000)</td>
<td>(0.001)</td>
<td>(0.008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PORTUGAL</td>
<td>1.992***</td>
<td></td>
<td>-0.188***</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GREECE</td>
<td>0.198***</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITALY</td>
<td></td>
<td>0.244***</td>
<td>0.0678**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000)</td>
<td>(0.043)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.381</td>
<td>0.826</td>
<td>0.578</td>
<td>0.506</td>
<td>0.500</td>
</tr>
</tbody>
</table>

*p-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
THANKS FOR YOUR ATTENTION