Liquidity matters: Money Non-Redundancy in the Euro Area Business Cycle

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"The US FED, ECB and central banks in the UK, Canada and Switzerland will inject billions of dollars into money markets: the injection of more than $200 bn is aimed at easing the credit crunch on the wider economy" (BBC News, March 11, 2008)

"Coordinated liquidity injections have played an effective role in easing tensions at the short-term end of the global money markets" (J.M. González-Paramo, ECB Executive Board, Madrid, September 30, 2008)

"For most of the last 25 years, the quantity theory of money has been sleeping, but during the last year, unprecedented growth in leading central banks balance sheets has prompted some of us to worry because the quantity theory has slept before, only to reawaken" (Sargent and Surico, 2010).
Introduction

Why could money matter?

- Money stock may influence marginal cost and thus inflation (mrs between consumption and leisure)
- Money alters the intertemporal rate of substitution of output at different points in time
- Money provides central bank with an additional level to react to inflation (Canova and Menz, 2009)
- Balance sheets channel (Bernanke and Gertler, 1995; Adrian and Shin, 2009)
**Introduction**

*Money in the NEK model*

- Theoretical prediction by NEK models: liquidity does not affect the economy (Woodford, 2003)
- Empirical support for this finding in DSGE estimation (Woodford, 2003; Ireland, 2004; Andrés et al., 2006)
- Monetary transmission only through interest-rate channel ⇒ money demand *redundancy* in shaping business cycle

<table>
<thead>
<tr>
<th></th>
<th>New Keynesian Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>Money demand needed to obtain inflation and output path?</td>
<td>NO</td>
</tr>
<tr>
<td>Non-zero impulse responses of output and inflation to money demand shocks?</td>
<td>NO</td>
</tr>
<tr>
<td>Information content of money about real shocks not contained in the scale variable?</td>
<td>NO</td>
</tr>
</tbody>
</table>

*Table: Money’s role in the Transmission Mechanism*
Theoretical underpinnings: non separable money (Andres, Lopez-Salido and Valles, 2009)

\[ y_t = \alpha_1 y_{t-1} + \alpha_2 E_t y_{t+1} - \alpha_3 E_t y_{t+2} - \alpha_4 (s_t - E_t \pi_{t+1}) + \]
\[ + \alpha_5 (m_t - e_t) - \alpha_6 E_t (m_{t+1} - e_{t+1}) + \alpha_7 E_t (m_{t+2} - e_{t+2}) + \alpha_8 a_t \] (1)

\[ m_t = \gamma_1 y_t - \gamma_2 s_t - \gamma_3 y_{t-1} - \gamma_4 E_t y_{t+1} + \]
\[ + \gamma_5 E_t m_{t+1} - \gamma_6 a_t + \gamma_7 e_t \] (2)

\[ s_t = \rho s s_{t-1} + (1 - \rho) \rho y y_t + (1 - \rho) \rho \pi \pi_t + (1 - \rho) \rho \mu \mu_t + \varepsilon_s \] (3)

\[ \mu_t = m_t - m_{t-1} + \pi_t \] (4)

\[ \pi_t = \beta_f E_t \pi_{t+1} + \beta_b \pi_{t-1} + \lambda m c_t \] (5)

\[ m c_t = \theta_1 y_t + \theta_2 y_{t-1} + \theta_3 E_t y_{t+1} + \theta_4 (m_t - e_t) + \theta_5 E_t (m_{t+1} - e_{t+1}) - \theta_6 a_t + \theta_7 z_t \] (6)

\[ a_t = \rho a a_{t-1} + \varepsilon^a_t \] (7)

\[ e_t = \rho e e_{t-1} + \varepsilon^e_t \] (8)

\[ z_t = \rho z z_{t-1} + \varepsilon^z_t \] (9)

- coefficients of interest ⇒ \( \alpha_5, \alpha_6, \alpha_7, \theta_4, \theta_5, \rho_\mu \)
- only \( \rho_\mu \)
Empirical counterintuitive evidence on money’s role

Does money matter?

Many empirical papers raise doubts on the redundancy result ⇒ two different strands:

1. Money matters for properly identifying monetary policy shocks sign and size (Leeper and Roush, 2003; Poilly, 2010)
2. Monetary aggregates have predictive content for output and output-gap (Hafer, Haslag and Jones, 2007; Hafer and Jones, 2008) and prices (Gerlach, 2004; Hofmann, 2009), even when controlling for NEK variables

More: after financial crisis increasing literature on direct role for money

1. shocks to broad monetary aggregates significantly affect US output, prices and interest rates (Favara and Giordani, 2009)
2. real balances play a role in shaping domestic business cycle (Canova and Menz, 2009)
Paper aimed contribution

- Analyze dynamic effects of liquidity shocks in the Euro Area using Structural VAR models and adopting an \textit{agnostic} approach \(\Rightarrow\) looks like a natural way of testing for money redundancy

- We extend Favara and Giordani (2009) results in a three-ways perspective:
  1. simultaneity between money and interest rate (not allowed in Cholesky identification)
  2. full identification \(\Rightarrow\) comparison between liquidity shocks to other sources of business cycle (supply, demand and monetary policy)
  3. structuralization by means of sign restrictions: \textit{agnostic} approach on money’s role
The standard SVAR framework can be summarized

\[ Y_t = c + A(L)Y_{t-1} + u_t, \quad u_t \sim i.i.d.(0, \Sigma) \quad (10) \]

\[ u_t = B\varepsilon_t, \quad \varepsilon_t \sim i.i.d.(0, I_k) \quad (11) \]

- \( Y_t \) - vector of endogenous variables, \( k \times 1 \)
- \( u_t \) - reduced form residuals, \( k \times 1 \)
- \( \varepsilon_t \) - structural shocks, \( k \times 1 \)
- \( c \) - vector of deterministic components, \( k \times 1 \)
- \( A(L) \) - matrix polynomial in the lag operator, \( k \times k \)
- \( B, k \times k \)
Redundancy is testable via impulse responses analysis
if money is redundant, then $\Rightarrow$ flat irf of $y_t, p_t, s_t$ to a liquidity shock

Cholesky is the main tool employed (Adalid and Detken, 2007; Favara and Giordani, 2009)
$\Rightarrow$ this does not allow for simultaneity between monetary aggregates and interest rate

We adopt Uhlig (2005) sign restrictions to overcome this problem. Three advantages:
1. simultaneity
2. reasonable and economic meaningful set of restrictions
3. agnostic approach about money demand effects on output and prices
**Sign restrictions**

*Bayesian estimation*

Estimation and inference is carried out as follows:

- Normal-Wishart prior in \((B(L), \Sigma)\)
- Impulse matrix \([a^{(1)}, a^{(2)}, a^{(3)}, a^{(4)}]\) characterized by economically motivated sign restrictions jointly to orthogonality among structural shocks
- If all of the impulses responses satisfy the above restrictions, the joint draw is retained
- Repeat procedure up to 1000 draws satisfying imposed sign restrictions
Sign restrictions
Agnostic approach on liquidity shocks

\[
\begin{array}{ccccc}
 y_t & p_t & s_t & m_t \\
\hline
 Supply & + & - & \text{unrestricted} & \text{unrestricted} \\
 Demand & + & + & \text{unrestricted} & \text{unrestricted} \\
 Mon.Policy & + & + & - & \text{unrestricted} \\
 Liquidity & \text{unrestricted} & \text{unrestricted} & \text{unrestricted} & + \\
\end{array}
\]

Alternative schemes:

- \( + \) for \( m_t \) in response to a demand shock
- \( + \) for \( m_t \) in response to a monetary policy shock (but not so clear behaviour, see Giannone et al., 2010)
- \( unr \) for \( y_t \) to a monetary policy shock
Agnostic approach: Liquidity shock

Impulse Responses

Impulse Responses for real GDP

Impulse Responses for GDP price defl

Impulse Responses for Policy rate

Impulse Responses for Monetary aggregate M3
## Agnostic approach

*Contribution of liquidity shock to the Forecast Error Variance*

<table>
<thead>
<tr>
<th></th>
<th>1 year</th>
<th>2 years</th>
<th>3 years</th>
<th>5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>10.86</td>
<td>19.19</td>
<td>15.38</td>
<td>18.22</td>
</tr>
<tr>
<td>Prices</td>
<td>1.79</td>
<td>10.38</td>
<td>19.97</td>
<td>37.92</td>
</tr>
<tr>
<td>Interest rate</td>
<td>5.18</td>
<td>22.29</td>
<td>36.24</td>
<td>45.91</td>
</tr>
<tr>
<td>Money</td>
<td>94.41</td>
<td>88.68</td>
<td>84.54</td>
<td>76.39</td>
</tr>
</tbody>
</table>
Agnostic approach: Other sources of business cycle

Monetary policy shock

**Impulse Responses for real GDP**

**Impulse Responses for Policy rate**

**Impulse Responses for GDP price defl**

**Impulse Responses for Monetary aggregate M3**
Agnostic approach: Other sources of business cycle

Supply shock

Impulse Responses for real GDP

Impulse Responses for Policy rate

Impulse Responses for GDP price defl

Impulse Responses for Monetary aggregate M3
Agnostic approach: Other sources of business cycle

Demand shock

Impulse Responses for real GDP

Impulse Responses for Policy rate

Impulse Responses for GDP price defl

Impulse Responses for Monetary aggregate M3
Robustness checks

Overview

Five different types of robustness checks
1. Liquidity measures
2. Sample stability
3. Adding variables (commodity price index, long term interest rate, exchange rate)
4. Alternative identifying assumptions (Gali, 1992)
5. Block exogeneity test

Here I show 1, 2, 4 and 5

3 does not alter results, provides interesting insights on commodity prices and housing (IN PROGRESS!)
Alternative liquidity measures

$M_1$

Impulse Responses for real GDP

Impulse Responses for Policy rate

Impulse Responses for GDP price defl

Impulse Responses for Monetary aggregate M3

Liquidity shock
Credit demand shocks

Loans

Impulse Responses for real GDP

Impulse Responses for Policy rate

Impulse Responses for GDP price defl

Impulse Responses for Monetary aggregate M3

Credit demand shock
Sample stability
1985-2008

Impulse Responses for real GDP

Impulse Responses for Policy rate

Impulse Responses for GDP price defl

Impulse Responses for Monetary aggregate M3

Liquidity shock, 1985-2008
Sample stability
1991-2008

Liquidity shock, 1991-2008

Impulse Responses for real GDP

Impulse Responses for Policy rate

Impulse Responses for GDP price defl

Impulse Responses for Monetary aggregate M3

Liquidity matters
Recursive identification

Impulse Responses to a liquidity shock

Response to Cholesky One S.D. Innovations – 2 S.E.

Response of OGAP to M

Response of Y to M

Response of P to M

Response of STN to M

Response of M to M

Liquidity matters
Recursive identification

*Impulse Responses to a monetary policy shock*

Response to Cholesky One S.D. Innovations – 2 S.E.

- Response of OGAP to STN
- Response of Y to STN
- Response of P to STN
- Response of STN to STN
- Response of M to STN

Liquidity matters
Recursive identification

Discussion and Summary

- No flat impulse responses
- Relevant contribution to variance decomposition
- Hence, liquidity matters for Euro Area business cycle

- By product result: very persistent price puzzle (consistent with Weber et al., 2009)
- Robust across different sample and specifications
- Giordani (2004) solution is not validated by Euro Area data
  ⇒ we can drop output-gap from $Y_t$ vector
## Mix of short and long-run restrictions

*Galí (1992)*

<table>
<thead>
<tr>
<th>years</th>
<th>Supply</th>
<th>Demand</th>
<th>Mon. Policy</th>
<th>Liquidity</th>
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<tr>
<td>0</td>
<td>76.55</td>
<td>0.00</td>
<td>0.00</td>
<td>23.45</td>
</tr>
<tr>
<td>1</td>
<td>76.45</td>
<td>0.80</td>
<td>0.10</td>
<td>22.65</td>
</tr>
<tr>
<td>5</td>
<td>69.21</td>
<td>2.96</td>
<td>4.10</td>
<td>21.73</td>
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</table>

<table>
<thead>
<tr>
<th>Δyₜ</th>
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<tr>
<td>0</td>
<td>8.84</td>
<td>76.58</td>
<td>14.37</td>
<td>0.22</td>
</tr>
<tr>
<td>1</td>
<td>7.77</td>
<td>66.04</td>
<td>20.20</td>
<td>5.99</td>
</tr>
<tr>
<td>5</td>
<td>19.58</td>
<td>51.57</td>
<td>16.30</td>
<td>12.55</td>
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<table>
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<td>9.07</td>
<td>0.71</td>
<td>43.39</td>
<td>46.83</td>
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<tr>
<td>1</td>
<td>31.02</td>
<td>2.64</td>
<td>25.44</td>
<td>40.89</td>
</tr>
<tr>
<td>5</td>
<td>34.47</td>
<td>3.36</td>
<td>26.28</td>
<td>35.88</td>
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<table>
<thead>
<tr>
<th>sₜ</th>
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<tbody>
<tr>
<td>0</td>
<td>2.76</td>
<td>12.21</td>
<td>59.03</td>
<td>25.98</td>
</tr>
<tr>
<td>1</td>
<td>3.92</td>
<td>12.43</td>
<td>52.58</td>
<td>31.06</td>
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<tr>
<td>5</td>
<td>15.32</td>
<td>14.88</td>
<td>35.16</td>
<td>34.64</td>
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<table>
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<tr>
<th>Δmₜ</th>
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<tr>
<td>1</td>
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</tr>
<tr>
<td>5</td>
<td></td>
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</table>
## Block exogeneity test

<table>
<thead>
<tr>
<th>Sample period</th>
<th>1970Q1-2008Q4</th>
<th>1995Q1-2008Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark VAR</td>
<td>0.002</td>
<td>0.004</td>
</tr>
<tr>
<td>Levels and diff.</td>
<td>0.008</td>
<td>0.047</td>
</tr>
<tr>
<td>Benchmark+ LTN</td>
<td>0.003</td>
<td>0.041</td>
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<tr>
<td>Levels and diff.</td>
<td>0.020</td>
<td>0.113</td>
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<tr>
<td>Benchmark+ EQUITY</td>
<td>0.054</td>
<td>0.206</td>
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<td>Levels and diff.</td>
<td>0.028</td>
<td>0.095</td>
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<tr>
<td>Benchmark+ Pr. Earn.RATIO</td>
<td>0.155</td>
<td>0.002</td>
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<tr>
<td>Levels and diff.</td>
<td>0.123</td>
<td>0.014</td>
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<tr>
<td>Benchmark+ CPIX</td>
<td>0.017</td>
<td>0.007</td>
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<td>Levels and diff.</td>
<td>0.033</td>
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<tr>
<td>Benchmark+ NEER</td>
<td>0.000</td>
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<tr>
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<tr>
<td>Benchmark+ REER</td>
<td>0.000</td>
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<td>Levels and diff.</td>
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<tr>
<td>Benchmark+ ULC</td>
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<tr>
<td>Levels and diff.</td>
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<tr>
<td>Benchmark+ UNR</td>
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<td>0.000</td>
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<tr>
<td>Levels and diff.</td>
<td>0.029</td>
<td>0.004</td>
</tr>
</tbody>
</table>
Some comments

- Gali (1992) confirms evidence of a role for money and money demand shocks.

- Block exogeneity test validates this results, with the only slight exception stemming from joint consideration of:
  1. 1995Q1-2007Q4
  2. labour markets variables
     ⇒ it may be explained by a precautionary motive in money demand (De Bondt, 2009)
  3. Needs further investigation
Summary and final remarks

- This paper tests money demand redundancy in the business cycle through SVAR models.
- We adopt an *agnostic* approach to let data speak freely.
- Results from impulse responses and variance decompositions show unambiguously that liquidity shocks persistently affect prices and output.
- Liquidity is a non negligible source of Euro Area business cycle.
- Rationale for ECB monetary pillar?
THANK YOU!