

Money, credit, monetary policy and the business cycle in the euro area

Domenico Giannone, Université Libre de Bruxelles, ECARES and CEPR
Michele Lenza, European Central Bank
Lucrezia Reichlin, London Business School and CEPR

This version: 22 February 2012

Abstract

This paper uses a data-set including time series data on macroeconomic variables, loans, deposits and interest rates for the euro area in order to study the features of financial intermediation over the business cycle. We find that stylized facts for aggregate monetary and real variables are remarkably similar to what has been found for the US by many studies while we uncover new facts on disaggregated loans and deposits. During the crisis the cyclical behavior of short term interest rates, loans and deposits remain stable but we identify unusual dynamics of longer term loans, deposits and longer term interest rates.

JEL Classification: E32, E51, E52, C32, C51.

Keywords: Money, loans, non-financial corporations, monetary policy, euro area

The authors wish to thank Antonello D'Agostino, Marco Del Negro, Björn Fischer, Fabio Fornari, Romain Houssa, Alberto Musso, Huw Pill, Giorgio Primiceri and Julian Von Landesberger. The views expressed are those of the authors and do not necessarily reflect those of the European Central Bank or the Eurosystem.

1 Introduction

Several simplified assumptions at the core of empirical macroeconomic models have been called into question after the experience of the recent financial crisis. For example, we have observed that, in exceptional circumstances, the stance of monetary policy is not characterized by one interest rate only and there might be large wedges between different rates which disrupt the transmission of monetary policy; that balance sheets adjustments to financial stress lead to non standard dynamics of assets and liabilities and that portfolio choices are affected by large swings in risk premia which, in turn, may lead to non-standard dynamics in deposits and loans.

These observations, among others, call for empirical research on financial intermediation in relation to the macro-economy. This research requires a more detailed analysis of credit variables, interest rates and deposits than what is standard in time series studies.

This paper is a contribution in this direction. We study the interaction between money, credit and the business cycle, in normal times and during the financial crisis, and focus on the euro area. The analysis is of particular value because for the euro area there is very little empirical work documenting these features even before the crisis. This makes the understanding of the financial turmoil particularly problematic.

Our database contains thirty nine variables including disaggregated monthly information for credit, deposits and interest rates for a relative long sample, from 1992 until 2010, spanning three recessions: the early nineties, the slowdown of the early millennium and the 2008-2009 great recession (see www.CEPR.org for the euro area business cycle chronology produced by the CEPR dating committee). The database allows an analysis of the link between financial intermediation and the business cycle, since it covers the most important elements of assets and liabilities of the banking sector, which in the euro area captures the bulk of financial intermediation.¹

Our analysis is based on a semi-structural time series model which considers a richer level of information on financial intermediaries than it is customary in empirical macroeconomics. Although we do not have time-series information on all items in the financial institutions' balance sheets, by considering disaggregated deposits and loans, we can characterize a large component of their liabilities and their assets and provide some information on how they evolve in relation to the business cycle and interest rates in normal and exceptional times. Our study is less detailed on the cross-sectional dimension than micro studies based on individual banks balance sheets (see for example Ioannidou, Ongena, and Peydro, 2009). However, the time-series dimension allows us to study issues related to the dynamics of key variables, as well as the transmission mechanism of monetary policy which cannot be addressed with cross-sectional data only.

Our approach is agnostic and empirical, more aimed at digging out facts than at giving them a fully structural interpretation. We adopt a very flexible and general empirical model, a Vector Auto Regression (VAR), which is rich enough to allow us to analyze the joint dynamics of a large set of data. The high flexibility and generality of the Vector Autoregressive model come at the cost of a high number of unknown parameters when more than a handful of variables are considered. As a consequence, Maximum Likelihood estimation is not viable in our context because of the high estimation uncertainty due to the proliferation of parameters ("curse of dimensionality"). We address this problem by using Bayesian shrinkage as suggested in De Mol, Giannone, and Reichlin (2008) and Banbura, Giannone, and Reichlin (2010) who show that, if the data are collinear, as it is the case of macroeconomic variables, then the relevant sample information is not lost when over-fitting is controlled for by shrinkage via the imposition of priors on the parameters of the model to be estimated.

¹For evidence on this point and a comparison with the US, see ECB (2008).

Given that the emphasis of our paper is on the identification of robust facts, we take model validation very seriously. For this purpose we put our model under the tough test of an out-of-sample forecasting evaluation for all the variables we are considering. Since out-of-sample forecasting performance reflects both parameter uncertainty and model fit, a satisfactory evaluation would suggest that, although our data-set includes many variables and the model is very flexible and general, the estimates capture the most prominent features of the data and are not affected by the issue of over-fitting.

Our analysis is composed of two parts. In the first part, we analyze the pre-crisis period, from January 1992 to July 2007. For this sample, our main aim is to uncover the relationship between credit, money markets and the business cycle in normal times; that is, over the typical business cycle. Hence, rather than focusing on a specific shock, we look at the response of our variables to the linear combination of shocks explaining the bulk of the cyclical variation of variables capturing real economic activity. The latter can be interpreted as a business cycle shock. We compare the responses to this shock with those to a non anticipated change in the policy rate (monetary policy shock, which we identify using a recursive identification scheme) that generates a counter-cyclical behavior of the interest rate. The comparison is informative since, over the typical cycle, systematic monetary policy induces a positive correlation between the policy rate and the business cycle, contrary to the monetary policy shock which is negatively correlated to the cycle. Hence, by distinguishing between movements of the policy rate caused by unexpected changes in monetary policy and those caused by systematic changes, we can assess the sign and the magnitude of interest rates versus pure real effects (for a similar analysis on US data, using a different technical approach, see den Haan, Sumner, and Yamashiro, 2007).

For the subset of impulse responses which correspond to those estimated in VAR models of the US economy (see, for example, Sims, 1980; Christiano, Eichenbaum, and Evans, 1999; Stock and Watson, 2001), we find that results based on euro area data are remarkably similar to those based on US data. For disaggregated deposits and loans, which have been typically disregarded in the macroeconomic literature, we uncover new facts. Specifically, we find that deposits (excluding overnight deposits), contrary to loans, are not clearly correlated with the business cycle while they are very sensitive to changes in the yield curve.

In the second part of the paper we aim at assessing whether and how the characteristics established in the first part have changed during the financial turmoil. Our objective is to identify the extent of their anomaly, compared to historical regularities uncovered in the first part. The analysis is conducted with the same model but by means of a counter-factual exercise. We compare the realized path of the variables of interest with that expected conditionally on the past and the observed indicators of business cycle conditions during the financial turmoil.

We find that, conditionally on the exceptional loss of output during the Great Recession, loans to non financial corporations, especially short term, have been in line with historical regularities but this is not true for household loans and, in particular, for long-term deposits (i.e., other than overnight). We partly relate the instability in deposits to the exceptional steepness of the yield curve.

To our knowledge, this is the first paper studying business cycle properties of credit markets, monetary variables and interest rates at this level of detail for the euro area. Other papers have studied the monetary transmission mechanism on euro area data before the crisis. In particular, the European Central Bank promoted a set of studies on this issue providing many interesting results (see the collection of studies in Angeloni, Kashyap, and Mojon, 2003). However, those studies were based on a sample that included only a few years into the existence of the monetary union and none of the time series studies considered our level of detailed information (in particular, see the chapters by Peersman and Smets and Mojon and Peersman). More recently, Boivin, Giannoni, and Mojon (2009) have considered multi-country models but the focus has not been on financial intermediation and Peersman (2011) has studied the features of credit shocks and unconventional monetary policy in a much less detailed framework than ours.

For the US, the closer to our study are the papers by Bernanke and Blinder (1992); Bernanke and Gertler (1995); Christiano, Eichenbaum, and Evans (1996); den Haan, Sumner, and Yamashiro (2007). These authors build on the literature following the financial crisis of the early nineties and used data on disaggregated loans and some components of flow of funds data in order to characterize the credit cycle and shed some light on the “credit channel” of monetary policy. Our study, however, is broader and contains a specific analysis of the crisis as well as more information on disaggregated deposits which allows us to focus on banks’ balance sheet behavior. The analysis of deposits also helps to understand the behavior of monetary aggregates over the cycle. This is of a specific interest, given the importance that the ECB attributes to these variables both as indicators of inflationary pressures and of financial risk (see, for example, Ferrero, Nobili, and Passiglia, 2007; Fischer, Lenza, Pill, and Reichlin, 2009; Stark and Papademos, 2010).²

The structure of the paper is as follows. Section 2 describes the database and the model. Section 3 describes the pre-crisis characteristics of the data by looking at the responses to monetary policy and cyclical shocks. Section 4 deals with the analysis of the crisis based on counterfactuals. Section 5 concludes.

2 Data and model specification

2.1 Data

The data-set includes 39 monthly variables. The sample ranges from January 1992 to August 2010. The data include macroeconomic variables, financial variables, monetary and credit variables. We also include selected variables for the US to capture international linkages. Since, as mentioned in the introduction, the euro area financial system is mainly based on banks (see, for example, ECB, 2008), bank deposits and loans represent the bulk of financial intermediation and they are particularly informative about the role of the financial sector in the transmission of shocks.

The three-months Euribor and the FED funds rates are our proxies for the policy rate in the euro area and the US, respectively. The rest of the financial block includes interest rates on government bonds at different maturities, euro area stock prices and the US dollar/euro exchange rate.

The monetary block is quite rich. The database includes the three main euro area monetary aggregates. The narrowest aggregate, M1, includes currency in circulation and overnight deposits. M2 consists of M1 plus time deposits (i.e. deposits with an agreed maturity of up to 2 years) and saving deposits (i.e. deposits redeemable with a notice of up to 3 months). We also include (see the last eight variables in the table) a disaggregation of the time and saving deposits by holding category, i.e. we distinguish among saving and time deposits held by households, non-financial corporations (NFC), insurance companies and pension funds (ICPF) and other financial institutions (OFI). Finally, M3 consists of M2 plus repurchase agreements (repo), money market funds shares and debt securities issued with a maturity of up to 2 years.

For what concerns loans, we consider the finest disaggregation available. In particular, loans to the private sector are decomposed into loans to non-financial corporations and to households. Moreover, we distinguish between loans to non-financial corporations up to one year and above one year. Loans to households, instead, are further decomposed according to their purpose: consumer loans, loans for house purchases and other loans. Whenever available, we also include the lending rates for different types of loans.³

²The model developed in this paper is the basis of regular policy briefing at the European Central Bank and has been part of a project for the enhancing of monetary analysis in that institution.

³We thank Christoffer Kok Sorensen for sharing with us the data on the lending rates used in Kok Sorensen and

Table 1 in the next section provides precise variables definition.

2.2 The model

Let X_t be the vector including the n variables defined in Table 1 (all variables are in log-levels, except for variables expressed in rates or with negative levels that are in levels). We estimate a VAR model with p ($=13$) lags:

$$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} \dots + A_p X_{t-p} + \epsilon_t$$

The large dimension ($n = 39$ and $p = 13$) of our VAR model implies that we face an issue of over-fitting. We address it by shrinking the model's coefficients toward a prior model that is parsimonious but naive (see De Mol, Giannone, and Reichlin, 2008; Banbura, Giannone, and Reichlin, 2010). In practice, we use the Minnesota (random walk) and the sum of coefficients priors originally proposed by Litterman (1980) and Doan, Litterman, and Sims (1984). For details on the implementation, see Banbura, Giannone, and Reichlin (2010). As suggested in Giannone, Lenza, and Primiceri (2012), we select the degree of informativeness of the two prior distributions by maximizing the marginal likelihood.

2.3 Model performance: forecast evaluation

Before presenting our main empirical results, we run a recursive out-of-sample forecasting evaluation exercise. This step should be understood as aimed at model validation. Since the size of our model is very large, we want to make sure that we are not over-fitting the data. In that case, forecasting performance would be poor.

We start by estimating the model from January 1992 to December 1998, produce a forecast and then we iterate the procedure by recursively updating our estimation sample by one month until the end of the sample, August 2010. We consider two horizons: three and twelve months for which the evaluation samples are, respectively, March 1999 - August 2010 and December 1999 - August 2010.

Results are reported in terms of ratio of the Mean Squared Forecast Errors (MSFE) of the VAR model versus the MSFE of the prior model, which is the random walk model in levels with drift. Numbers smaller than one imply that our model improves over the prior, showing that our procedure is able to extract information from the sample.

Table 1 below reports, in each column, variable definition, transformations and the MSFEs ratios for the forecast horizon of three and twelve months ahead.

Werner (2006).

Table 1. Database

Variables	Transformation	Ratio vs RW	
		3 months ahead	1 year ahead
1 Industrial Production	log-levels	0.66	0.90
2 HICP	log-levels	1.12	1.96
3 Unemployment rate	levels	0.26	0.44
4 Producer Prices Index	log-levels	0.81	1.41
5 US Industrial Production	log-levels	0.48	0.53
6 US Consumer Prices Index	log-levels	1.16	1.49
7 US Federal Funds rate	levels	0.63	0.75
8 Euribor 3 months	levels	0.60	0.91
9 Consumer Confidence	levels	0.78	0.85
10 World price of raw materials	log-levels	1.07	1.31
11 Oil price	log-levels	1.08	1.33
12 US/Euro exchange rate	log-levels	1.34	1.61
13 Stock Prices	log-levels	1.02	0.96
14 2 years bond rate	levels	0.93	1.11
15 3 years bond rate	levels	0.97	1.16
16 5 years bond rate	levels	1.07	1.31
17 7 years bond rate	levels	1.15	1.49
18 10 years bond rate	levels	1.20	1.63
19 M1	log-levels	1.16	1.51
20 M2	log-levels	0.78	0.89
21 M3	log-levels	0.66	0.78
22 Own rate of return, M1	levels	0.27	0.77
23 Own rate of return, M3	levels	0.32	0.63
24 Loans to non-financial corporations up to 1 year	log-levels	0.35	0.25
25 Loans to non-financial corporations over 1 year	log-levels	0.35	0.37
26 Consumer loans	log-levels	0.67	0.66
27 Loans for house purchases	log-levels	0.34	0.54
28 Other loans	log-levels	1.38	1.28
29 Lending rate, loans to NFC up to 1 year	levels	0.47	0.98
30 Lending rate, consumer loans	levels	0.58	0.67
31 Lending rate, loans for house purchases	levels	0.63	1.02
32 Saving deposits of households	log-levels	0.48	0.58
33 Saving deposits of NFC	log-levels	0.53	1.16
34 Saving deposits of ICPF	log-levels	1.03	1.17
35 Saving deposits of OFI	log-levels	0.54	0.93
36 Time deposits of households	log-levels	0.85	0.60
37 Time deposits of NFC	log-levels	0.75	0.83
38 Time deposits of ICPF	log-levels	0.70	0.67
39 Time deposits of OFI	log-levels	0.79	1.58

Overall, the model performs quite well suggesting that, by means of Bayesian shrinkage, we have been able to control for over-fitting and, at the same time, to extract the relevant information from the data at our disposal. In particular, it improves on the random walk with drift for all real variables, loans, deposits, the Euribor and lending rates. For consumer prices, commodity prices, exchange rates and financial prices (i.e. the yield curve and stock prices) the random walk forecasts are more difficult to outperform. This is not surprising, given the wide empirical evidence on the unpredictability of these variables (see, among others, Campbell, Lo, and MacKinlay, 1997; Kilian and Taylor, 2003; D’Agostino, Giannone, and Surico, 2006; Stock and Watson, 2006; Fischer, Lenza, Pill, and Reichlin, 2009).

The good out-of-sample results give support to our approach of modeling the variables simultaneously within a single large model. This is in contrast with existing studies that resort to a “marginal strategy”, that is, a strategy where one starts from a small core model and then compares results from different models estimated by Maximum Likelihood, each model including the core and a few different additional variables (see, for example, Christiano, Eichenbaum, and Evans, 1996; den Haan, Sumner, and Yamashiro, 2007).

2.4 Empirical exercises

The VAR model is used to establish stylized facts for the period prior to the last crisis and, then, to identify anomalies during the crisis. The pre-crisis sample is January 1992 - July 2007.

Pre-crisis stylized facts

Stylized facts are established by the estimation of impulse response functions to two sets of identified shocks. We aim at assessing and interpreting business cycle features of key monetary and credit

aggregates.

In order to describe the business cycle features of key monetary and credit aggregates, we study the impulse response functions to a business cycle shock. This is the shock that accounts for the bulk of business cycle fluctuations. More precisely, we define the business cycle shock as the linear combination of orthogonal shocks that captures the maximum variance of unemployment at business cycle frequencies (a period of length between two and eight years).⁴

The impulse response functions to this shock describe the unconditional correlations along the “typical” business cycle. This is a “statistical identification”, a device for extracting information on the cross correlation of the series of interest at business cycle frequency which also preserves information on lead-lag relations.

Due to the systematic monetary policy, short term interest rates are generally highly pro-cyclical. Hence, in order to assess the sign and the magnitude of interest rates versus pure real effects, we will need to contrast the cyclical correlations with the responses to a shock that generates a-cyclical or counter-cyclical behavior of the interest rate. The monetary policy shock will serve our purpose since an exogenous monetary policy tightening is expected to have a contractionary effect on the economy. The monetary policy shock is identified by assuming a recursive (Choleski) structure (see Christiano, Eichenbaum, and Evans, 1999, for a discussion of this identification scheme). The ordering is reported in Table 1 in the previous sub-section. The indicators of economic activity and prices, ordered above the Euribor, are assumed to react to the monetary policy shock only after one month. Financial variables, ordered under the Euribor, are allowed to react instantaneously to the monetary policy shock. Systematic policy is assumed to react to financial markets only after one month, while no delay is imposed to the response to prices and economic activity.

The crisis

After having established the pre-crisis facts, we proceed to ask whether the crisis has induced changes in the structure of correlations among the variables in our system. To this end, we perform a counterfactual scenario analysis for the period ranging from August 2007 until August 2010. Then, we compare the observed developments in monetary and credit markets with those implied by pre-crisis correlations and real economic developments.

The counterfactuals are constructed as follows:

1. We use the same model’s coefficients estimated in the previous section, i.e. using the sample January 1992 - July 2007.
2. We assume that the euro area industrial production and unemployment and US industrial production are known for the whole sample, while all other variables are only observed until July 2007.
3. We compute the conditional expectations for all the variables in the sample August 2007 - September 2010 based on the pre-crisis VAR coefficients (see step 1) and the knowledge of euro area and US real activity developments in the whole sample (see step 2).⁵

⁴See Di Cecio and Owyang (2010) for details on the implementation. Other popular procedures to identify business cycle shocks as those in Uhlig (2004) and Giannone, Reichlin, and Sala (2005) can be seen as special cases of our procedure in that they pick those shocks that maximize the explainable variance at *all* frequencies.

⁵The conditional expectations are computed by the Kalman filter method described in Banbura, Giannone, and Lenza (2011).

Since the model's coefficients are kept fixed at the pre-crisis value, by conditioning on the observed real economic activity behavior during the crisis, we are identifying the most likely shocks that could have generated the great recession under the assumption of no substantial change neither in the average characteristic of the shocks (this is because the covariance matrix of the forecast errors is kept fixed) nor in the dynamic interdependence, as captured by the autoregressive coefficients. If the crisis had induced substantial structural changes or it had been generated by shocks with unprecedented nature, we would identify a large difference between observed and counterfactual dynamics.

3 Results

3.1 Stylized facts before the crisis: 1992-2007

In this section we analyze the impulse response functions to the cyclical and monetary shock for the period preceding the 2008-2009 recession.

Results are reported for the log-levels or, for the variables expressed in rates, for levels and refer to one standard deviation shocks. Our normalization corresponds to a cyclical contraction and a monetary policy tightening. We report the median (solid line), the 16% and 84% quantiles of the distribution of the impulse responses. We report all the impulse response functions until 24 months after the shocks.

Figures 1 and 2 report the complete set of results for impulse responses to the business cycle and monetary policy shocks. The subset of the impulse responses to the monetary policy shock can be compared with existing studies on US data.

INSERT FIGURE 1 and 2 HERE

Perhaps surprisingly, Figure 2 shows that the well known features of those responses found on US data are confirmed on euro area data. In response to a monetary contraction, we identify a humped shaped response of production variables, a decline in consumer confidence, a strong liquidity effect and a sticky response of interest rates at longer maturity (for early findings on some of these features, see Peersman and Smets, 2003). Moreover, the euro appreciates with respect to the dollar, while stock prices decline. Turning to prices, we find that consumer prices (HICP) hardly move, while production prices (PPI) decline after a few months. Responses to the cyclical shock cannot be directly compared with any study on the US, but results for macro-economic variables, interest rates, exchange rates and stock prices correspond to what it could be expected: industrial production is pro-cyclical and so are consumer confidence, interest rates, production prices and stock prices. Unemployment is anti-cyclical and so is the exchange rate (the euro depreciates in response to a cyclical contraction). HICP inflation responds downward with a delay.

Our VAR allows to uncover stylized facts for many other variables capturing financial intermediation: several types of loans, interest rates and deposits. For these variables, we produce novel information and we comment them in details. To facilitate the reader, in what follows, we zoom some of the plots in Figure 1 and 2 by focusing on three blocks.

The first block is that subset of plots which corresponds to a small monetary VAR. We have the short end of bank liabilities, represented by narrow money (M1), whose developments mainly reflect those in

overnight deposits), the three-months euribor, our proxy for the policy rate, and industrial production, our proxies for the euro area business cycle.

The second block focuses on the banks' liabilities at longer maturity included in M2 and M3 and longer term interest rates. The analysis of broader monetary aggregates is interesting because it helps understanding the behavior of banks' liabilities over the business cycle, but also because the European Central Bank (ECB) pays particular attention to M3, under the second pillar of its monetary policy strategy. In particular, we focus on the differences between M3 and M1 and that between M2 and M1. The former includes saving and time deposits, repos, money market funds shares and debt securities with maturity up to two years. The latter only includes saving and time deposits, an important component of the deposits of financial institutions. The two quantities are similar in magnitude since saving and time deposits (M2-M1) account for between 40 and 48 % of the whole M3 while the M3-M2 component is smaller, i.e. between 11 and 15% of M3. Time and saving deposits are part of the more stable funding for banks. Here we also examine the responses of the entire yield curve to the two shocks so as to study the interaction between the latter and deposits at different maturity. Finally, in the third block, we look at the asset side of banks' balance sheet and focus on loans and their own lending rates.

Money, output and interest rates

Our first zoom is on M1, the most liquid of the monetary aggregates, industrial production and the three month Euribor which we use as a proxy of the policy rate.

INSERT FIGURE 3 HERE

In response to an exogenous increase of the short term interest rate (monetary contraction), industrial production declines. In response to a cyclical contraction, we observe a negative and slightly lagged response of the Euribor, reflecting the systematic response of monetary policy to the decline in industrial production and other economic activity variables.

Notice that both shocks generate a recession, but with an opposite behavior of the policy rate. This fact helps understanding the relative importance of interest rates and economic activity in shaping the dynamic of monetary and credit aggregates along the business cycle. If the dynamic of a given variable is mainly driven by real economic developments, then we should expect this variable to respond in the same way to the cyclical and the monetary policy shocks. Conversely, if interest rate effects dominate, we should expect the opposite response to the two shocks. Intermediate situations indicate that both effects are relevant.

The response of narrow money, M1, is not the same for the two shocks, indicating that interest rate effects dominate cyclical effects in determining its behavior. In anticipation of a cyclical contraction, M1 contracts but after few months it becomes counter-cyclical. In response to a monetary contraction, we observe a persistent decline. As a consequence, in the medium run, M1 is negatively correlated with the policy rate, conditionally on both shocks. This suggests that narrow money is mainly driven by interest rate changes with a strong liquidity effect. These results shed light on the otherwise puzzling fact that the unconditional correlation between the growth rate of M1 and that of industrial production is negative (see figure 4). When economic activity weakens, the short interest rate responds negatively and with a lag. Contemporaneously to that negative response, we have an increase in M1 growth due to a strong liquidity effect and, since the effect of the slow-down in activity on M1 is small, unconditionally we observe a negative correlation between activity and M1 growth.

INSERT FIGURE 4 HERE

Monetary aggregates, deposits and the yield curve

Here we analyze the rest of the components of the monetary aggregates and the yield curve.

INSERT FIGURE 5 HERE

Interestingly, the cyclical behavior of M3-M1 and M2-M1 is very different from M1. Their response to a cyclical contraction is almost muted in the first 10 months and then becomes negative. The correlation with economic activity is negative in response to a monetary contraction, while the correlation with the interest rate is always positive, independently from the nature of the shock. These results indicate that interest rate effects and portfolio considerations are the main drivers of broad money.

In order to understand which components of broad monetary aggregates explain this behavior and to interpret the findings, we extend our analysis to a higher degree of granularity and look at saving (figure 6) and time deposits (figure 7), and, later, at the main determinants of their holdings.⁶

INSERT FIGURES 6 AND 7 HERE

Results show that the behavior of M3-M1 and M2-M1 mainly reflects the dynamics of time deposits for all holders. In fact, as M3-M1 and M2-M1, time-deposits are positively correlated with the short-term interest rates. Saving deposits, instead, are mainly characterized by the liquidity effect. This is explained by the fact that saving deposits have shorter maturity than time-deposits and, hence, behave very similarly to the overnight deposits in M1. Conversely, the decision of holding time deposits, which have longer maturities than saving deposits, are dominated by portfolio considerations: higher short-term rates imply higher returns for time deposits which, everything else equal, should induce substitution from other, non-monetary, asset holdings. We now turn to the study of the yield curve, in order to shed further light on some of the possible determinants of the portfolio shifts characterizing the dynamics of time-deposits and, in turn, of M3-M1 and M2-M1.

Turning to the yield curve (figure 8), we can see that, after a monetary contraction, long term rates move in the same direction as the policy rate, but considerably less, given the anticipated temporary nature of the increase in interest rates.

INSERT FIGURE 8 HERE

⁶Saving deposits and time deposits have more or less equal share in M2-M1 and saving deposits are more liquid. In terms of holding sectors, the most sizable components are deposits to households and non-financial corporations which account for 90-95% of total deposits in M2-M1.

Although the short-term rate we consider, the three-months Euribor, is only an imperfect proxy for the returns on deposits⁷, the positive spread opening up between short-term rates and longer-term bond rates, implies that short-term monetary assets (especially time-deposits) tend to earn a higher return than longer-term non-monetary assets (e.g. government bonds) in the aftermath of a monetary tightening. This finding helps to explain why time-deposits increase in response to a monetary tightening.

In response to a cyclical contraction, we also have a decline in bond rates. The shape of the yield curve is not affected, since the magnitude of the decline is the same across maturities and matches the reduction of the Euribor. Hence, compared to a monetary contraction, in the typical cyclical contraction, holding short-term monetary assets does not become more attractive compared to alternative, longer term investments and this explains the cyclical behavior of monetary aggregates described above.

The implication of our finding is that unlike M1, which is counter-cyclical, M3 and M2 are not very correlated with the cycle while they are inversely related to the term spreads (see figure 9).

INSERT FIGURE 9 HERE

Loans and lending rates

We now turn to the asset side of the balance sheet, and focus on loans.

INSERT FIGURE 10 HERE

All loans are pro-cyclical. However, although they all respond negatively to a cyclical contraction, short term corporate loans show a delayed response. This explains why loans to non financial corporations lag the business cycle (see figure 11). This result has important implications for the current discussion on banking regulation. Some of the leading proposals on financial reforms suggesting to use quantities based on loans as early warning for financial stability risks are likely to be ineffective, since loans provide a delayed signal for those risks (for a discussion on these issues, see Repullo and Saurina, 2011).

INSERT FIGURE 11 HERE

For what concerns a monetary contraction, we notice some relevant differences compared to the response to the cyclical shock of short-term corporate loans, which correlate negatively rather than positively with economic activity. The result indicates that interest rate effects dominate the behavior of short term loans to non-financial corporations. This feature has also been found in US data by Gertler and Gilchrist (1995) and more recently by den Haan, Sumner, and Yamashiro (2007). One possible interpretation of this finding, in line with the discussion in den Haan, Sumner, and Yamashiro (2007), is that the decline of interest rates induces a shift of bank portfolios in favor of business loans.

⁷Deposit rates are not available for the full sample we consider.

INSERT FIGURE 12 HERE

Figure 12 reports the impulse responses of lending rates. Not surprisingly, they have similar shape to what found for the Euribor but they are stickier, in particular those for consumer loans.⁸

4 The crisis

In this section, we use counterfactual exercises in order to assess whether and how the typical functioning of the euro area economy has changed during the financial turmoil.

The cyclical contraction experienced by the euro area in 2008 and 2009 is exceptional in our sample. The crisis has seen a large contraction in real activity, but also major disruption in financial markets. An important question is whether the size and nature of the crisis have broken historical correlations between real and financial variables or else, what we have experienced in the behavior of loans, deposits and interest rates just reflects the exceptional drop in real activity rather than a change in the relation with it.

One way to answer this question is to use the facts we established in the previous section and assess whether they remain robust, once we control for the unprecedented size of business cycle shocks. More precisely, we compute conditional expectations of the variables of interest on the basis of historical correlations and the realized path of variables representing business cycle conditions. This amounts to perform the counterfactual exercises described in Section 2.⁹ Conditioning on real economy variables we make sure that we capture the size of the shocks that would have caused the recent recession *if it were due to the shocks that have typically generated recessions in the euro area*. For example, if exogenous shocks to the supply of credit were traditionally associated to a recession in the euro area, we would be implicitly conditioning also on those shocks. Then, we compare the conditional expectations of the variables of interest with their actual developments from August 2007 onward, in order to assess whether such variables have behaved in line with the historical regularities. Significant differences between expected and observed developments may signal that either different shocks from those traditionally prevailing to explain the dynamics of the variables of interest have materialized, or the relationships between the latter variables and the conditioning set has changed during the crisis.

In the text we present a subset of results concerning loans, deposits, interest rates and some key macroeconomic variables.¹⁰

Monetary policy: Euribor (from here on careful with figures numbers)

Interestingly, the counterfactual path of the 3-months Euribor is not significantly different from the observed path (Figure 13a). Notice that the Euribor is our proxy for the policy rate. In normal times, the policy rate itself (main refinancing operations, MRO, rate) and the Euribor are closely tied and so is the overnight interest rate in the interbank market, the EONIA. In the crisis period, as shown in Figure 13b, we have observed sizable spreads between the Euribor and the MRO and the Eonia and the MRO. From August 2007 to the end of 2008 this has reflected the tensions in the money markets (large positive spreads of Euribor versus MRO rate) while, after 2008, and particularly in 2010, the large

⁸For a survey of studies on the stickiness of lending rates, see Kok Sorensen and Werner (2006)

⁹See Giannone, Lenza, and Reichlin (2010) for an application of this idea for identifying the effect of the inception of the euro on comovement of GDP across countries.

¹⁰The complete set of results is available upon request.

amount of liquidity created by non-standard ECB policies explains the negative spreads of EONIA and Euribor rates versus MRO (on this point, see Lenza, Pill, and Reichlin, 2010).

INSERT FIGURE 13 HERE

Our results suggest that the interbank market rates (in particular, the Euribor), have behaved according to historical regularities with respect to the business cycle. However, unprecedented spreads have opened up with respect to the MRO rate. Considering that markets rates reflect both standard and non-standard monetary policy, a reasonable interpretation of our finding is that the ECB (non-standard) liquidity policy during the crisis, by creating ample liquidity in the market, has managed to keep market rates where they have always been in relation to the cycle. This interpretation is backed by the observation that, during this period, we have seen an unusual wedge between the market rates and the policy rate. For a detailed analysis of this point, see Lenza, Pill, and Reichlin (2010); Giannone, Lenza, Pill, and Reichlin (2010).

Loans

Short-term loans to non-financial corporations also behaved in line with past regularities. Loans to consumers and for housing, on the other hand, show an exceptional decline. This may suggest that banks, during the recent crisis, have shown even more risk-aversion than usual by restricting riskier and less profitable credit (such as long-term loans and loans to households) more than in the usual cyclical experience.

INSERT FIGURE 14 HERE

Monetary aggregates

The counterfactual on monetary aggregates shows no exceptional behavior of M1 and an unusual decline of M2 and M3.

INSERT FIGURE 15 HERE

This finding is particularly interesting and, again, may reflect the exceptional measures taken by the ECB which, by replacing the interbank market and acting as an “intermediary of last resort” has avoided a run on overnight deposits. This point is discussed in details by Lenza, Pill, and Reichlin (2010) and Giannone, Lenza, Pill, and Reichlin (2010).

Figure 16, showing saving and time deposits, indicates that the collapse in M2 and M3 is mainly explained by the time deposits component for both households and non-financial corporations.

INSERT FIGURE 16 HERE

Bond rates

Uncertainty around bond rates is quite large. However, at all maturities, rates have been less reactive to cyclical conditions than what has been historically observed.

INSERT FIGURE 17 HERE

This evidence is in line with the stickiness of long-term rates, observed also in other countries. The stickiness of long-term rates and the sharp decline in the Euribor imply an unusually steep yield curve which, at least partly, can be related to the unusual collapse in time deposits. In fact, as highlighted in the previous section, the holdings of time-deposits are tightly linked to portfolio considerations. Exceptionally higher bond rates compared to returns on short-term monetary assets can partly explain the large dismissals of the latter, including time-deposits. Along this line ECB (2010), provides a set of estimates of the impact of yield curve dynamics on the developments in broad monetary aggregates and shows that the impact of the unusual steepness of the yield curve on monetary aggregates is sizable¹¹, although it cannot account for the full extent of the unusual reduction in broad monetary aggregates.

The crisis, bank intermediation and central bank policy

Summing up, the recent crisis has been exceptional in its depth, length and disruption of the financial system. However, some of the features of the financial intermediation in the euro area have remained stable.

Remarkably, short-term loans to firms, the three-months Euribor, overnight and, to a smaller extent, saving deposits have behaved in line with historical regularities. Our conjecture is that this is partly endogenous to ECB policy, which stabilized money market rates with the aim of supporting overnight interbank lending and, in turn, lending to the private sector. The stabilization of short-term market rates is also associated with the stability of overnight and saving deposits, which are important components of bank liabilities.

In contrast, time deposits and therefore (M2-M1 and M3-M1) showed a decline in growth rates which is unusual given business cycle conditions. This break is, in part, associated with stickier than usual long-term bond rates and, hence, with a steeper than usual yield curve.

These facts suggest that the ECB non-standard policies are likely to have helped to a great extent to stabilize the short-end of bank balance sheets. However, bank funding of a longer term nature, was unusually weak; the part of such funding we analyze here (time deposits) consists in holdings of short-term monetary assets whose attractiveness depends also on the returns of competing assets of a non-monetary nature (for example, government bonds). In situations in which standard term structure relations do not hold, monetary policy cannot control the transmission mechanism from money market rates to a wider set of financial prices and this impairs the funding of financial intermediaries at maturities longer than overnight.

5 Conclusions

This paper is the first comprehensive analysis of business cycle characteristics of deposits, loans and interest rates over the business cycle in the euro area. Our Bayesian VAR model includes about

¹¹The growth rates of M3 would have been between 2 and 3% higher in 2010, had the steepness of the yield curve behaved in line with past regularities.

forty variables, and it is designed to handle a large data-set while controlling instability due to over-parametrization.

The characterization of the data from 1992 to 2007, the year preceding the financial crisis, shows heterogenous behavior of loans, depending on maturity and destination, and deposits, depending on maturity, therefore providing some elements for the understanding of financial intermediation in a bank based system over the cycle. Other features related to the macro-economy and interest rates are remarkably similar to what the literature had found for the US economy.

Some of the features characterizing the dynamic interrelationships between the real economy and financial intermediation have remained stable also during the financial crisis. This is true in particular for short-term loans to non financial corporations, short-term deposits and the three-months Euribor. In turn, this fact is possibly related to the effects of the unconventional ECB liquidity policy, which has limited the transmission of the financial turmoil. Longer term deposits and the yield curve, on the other hand, show abnormal behavior and suggest that the monetary transmission mechanism during that period, by breaking relations between interest rates at different maturities, induced changes in the structure of banks' liabilities.

References

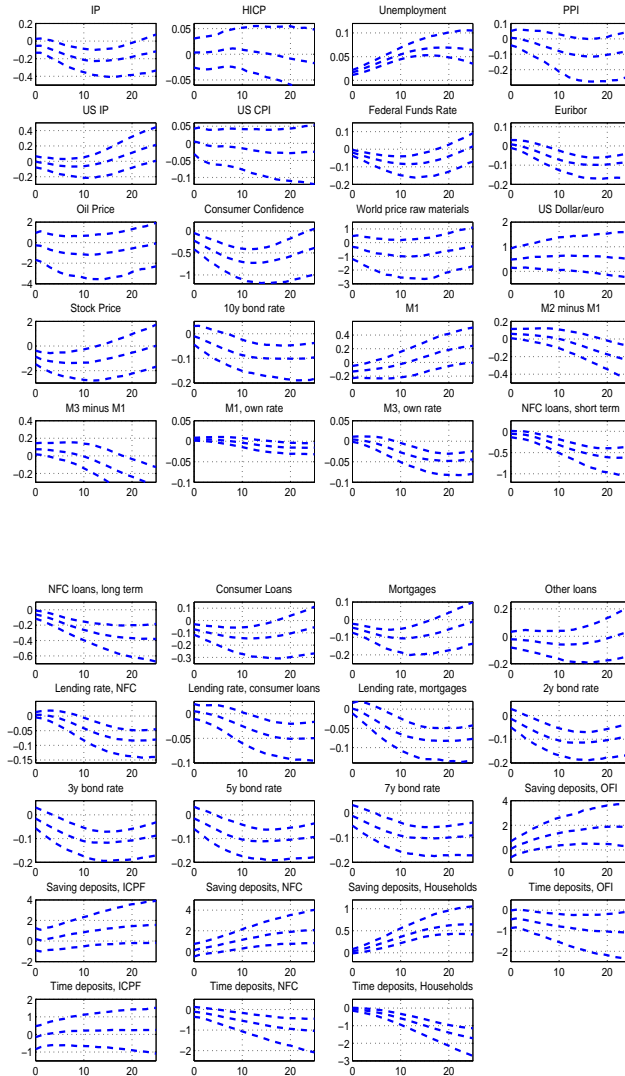
- ANGELONI, I., K. A. KASHYAP, AND B. MOJON (eds.) (2003): *Monetary Policy Transmission in the Euro Area. A Study by the Eurosystem Monetary Transmission Network*. Cambridge University Press.
- BANBURA, M., D. GIANNONE, AND M. LENZA (2011): "A Large Vector Autoregressive Model for the Euro Area," Discussion paper, ECB mimeo.
- BANBURA, M., D. GIANNONE, AND L. REICHLIN (2010): "Large Bayesian vector auto regressions," *Journal of Applied Econometrics*, 25(1), 71–92.
- BERNANKE, B. S., AND A. S. BLINDER (1992): "The Federal Funds Rate and the Channels of Monetary Transmission," *American Economic Review*, 82(4), 901–21.
- BERNANKE, B. S., AND M. GERTLER (1995): "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," *Journal of Economic Perspectives*, 9(4), 27–48.
- BOIVIN, J., M. P. GIANNONI, AND B. MOJON (2009): "How Has the Euro Changed the Monetary Transmission?," in *NBER Macroeconomics Annual 2008, Volume 23*, NBER Chapters, pp. 77–125. National Bureau of Economic Research, Inc.
- CAMPBELL, J. Y., A. W. LO, AND A. C. MACKINLAY (eds.) (1997): *The Econometrics of Financial Markets*. Princeton University Press.
- CHRISTIANO, L. J., M. EICHENBAUM, AND C. EVANS (1996): "The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds," *The Review of Economics and Statistics*, 78(1), 16–34.
- (1999): "Monetary policy shocks: What have we learned and to what end?," in *Handbook of Macroeconomics*, ed. by J. B. Taylor, and M. Woodford, vol. 1 of *Handbook of Macroeconomics*, chap. 2, pp. 65–148. Elsevier.
- D'AGOSTINO, A., D. GIANNONE, AND P. SURICO (2006): "(Un)Predictability and macroeconomic stability," Working Paper Series 605, European Central Bank.

- DE MOL, C., D. GIANNONE, AND L. REICHLIN (2008): “Forecasting using a large number of predictors: Is Bayesian shrinkage a valid alternative to principal components?,” *Journal of Econometrics*, 146(2), 318–328.
- DEN HAAN, W. J., S. W. SUMNER, AND G. M. YAMASHIRO (2007): “Bank loan portfolios and the monetary transmission mechanism,” *Journal of Monetary Economics*, 54(3), 904–924.
- DI CECIO, R., AND M. T. OWYANG (2010): “Identifying technology shocks in the frequency domain,” Working papers, Federal Reserve Bank of St. Louis.
- DOAN, T., R. LITTERMAN, AND C. A. SIMS (1984): “Forecasting and Conditional Projection Using Realistic Prior Distributions,” *Econometric Reviews*, 3, 1–100.
- ECB (2008): “The role of banks in the monetary policy transmission mechanism,” in *ECB Monthly Bulletin*, August, pp. 85–98.
- (2010): “Box 2: The impact of the yield curve on recent developments in monetary aggregates,” in *ECB Monthly Bulletin*, December, pp. 20–23.
- FERRERO, G., A. NOBILI, AND P. PASSIGLIA (2007): “The sectoral distribution of money supply in the Euro area,” Temi di discussione (Economic working papers) 627, Bank of Italy, Economic Research Department.
- FISCHER, B., M. LENZA, H. PILL, AND L. REICHLIN (2009): “Monetary analysis and monetary policy in the euro area 1999-2006,” *Journal of International Money and Finance*, 28(7), 1138–1164.
- GERTLER, M., AND S. GILCHRIST (1995): “The role of credit market imperfections in the monetary transmission mechanism: arguments and evidence,” *Scandinavian Journal of Economics*, (1), 43–64.
- GIANNONE, D., M. LENZA, H. PILL, AND L. REICHLIN (2010): “Non-standard monetary policy measures and monetary developments,” in *Lessons for Monetary Policy from the Financial Crisis*, ed. by J. Chadha, and S. Holly. Cambridge University Press.
- GIANNONE, D., M. LENZA, AND G. PRIMICERI (2012): “Priors for Vector Autoregressions,” Cepr discussion paper 8755.
- GIANNONE, D., M. LENZA, AND L. REICHLIN (2010): “Business Cycles in the Euro Area,” in *Europe and the Euro*, ed. by A. Alesina, and F. Giavazzi, pp. 141–167. National Bureau of Economic Research, Inc.
- GIANNONE, D., L. REICHLIN, AND L. SALA (2005): “Monetary Policy in Real Time,” in *NBER Macroeconomics Annual 2004, Volume 19*, NBER Chapters, pp. 161–224. National Bureau of Economic Research, Inc.
- IOANNIDOU, V., S. ONGENA, AND J. PEYDRO (2009): “Monetary Policy, Risk-Taking, and Pricing: Evidence from a Quasi-Natural Experiment,” Discussion Paper 2009-31 S, Tilburg University, Center for Economic Research.
- KILIAN, L., AND M. P. TAYLOR (2003): “Why is it so difficult to beat the random walk forecast of exchange rates?,” *Journal of International Economics*, 60(1), 85–107.
- KOK SORENSEN, C., AND T. WERNER (2006): “Bank interest rate pass-through in the euro area: a cross country comparison,” Working Paper Series 580, European Central Bank.
- LENZA, M., H. PILL, AND L. REICHLIN (2010): “Monetary policy in exceptional times,” *Economic Policy*, 25, 295–339.

- LITTERMAN, R. B. (1980): “A Bayesian Procedure for Forecasting with Vector Autoregression.,” Working paper, Massachusetts Institute of Technology, Department of Economics.
- PEERSMAN, G. (2011): “Macroeconomic Effects of Unconventional Monetary Policy in the Euro Area,” CEPR Discussion Papers 8348, C.E.P.R. Discussion Papers.
- PEERSMAN, G., AND F. SMETS (2003): “The monetary transmission mechanism in the Euro area: more evidence from VAR analysis,” in *Monetary Policy Transmission in the Euro Area. A Study by the Eurosystem Monetary Transmission Network*, ed. by I. Angeloni, K. A. Kashyap, and B. Mojon. Cambridge University Press.
- REPULLO, R., AND J. SAURINA (2011): “The Countercyclical Capital Buffer of Basel III: A Critical Assessment,” CEPR Discussion Papers 8304, C.E.P.R. Discussion Papers.
- SIMS, C. A. (1980): “Macroeconomics and Reality,” *Econometrica*, 48(1), 1–48.
- STARK, J., AND L. PAPADEMOS (eds.) (2010): *Enhancing Monetary Analysis*. European Central Bank.
- STOCK, J. H., AND M. W. WATSON (2001): “Vector Autoregressions,” *Journal of Economic Perspectives*, 15(4), 101–115.
- (2006): “Why Has U.S. Inflation Become Harder to Forecast?,” NBER Working Papers 12324, National Bureau of Economic Research, Inc.
- UHLIG, H. (2004): “What moves GNP?,” Econometric Society 2004 North American Winter Meetings 636, Econometric Society.

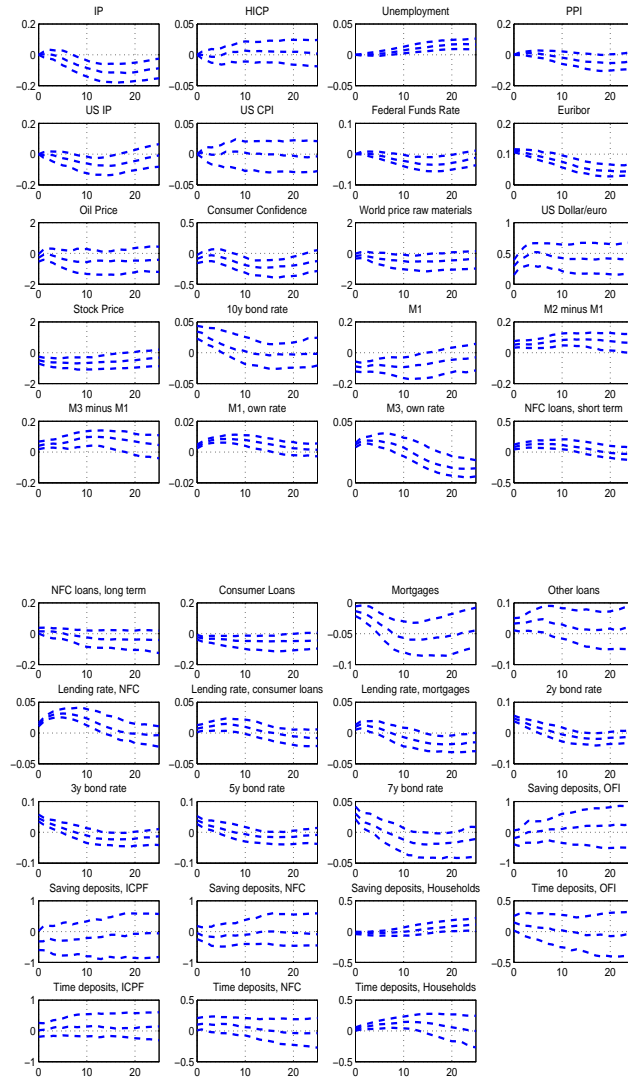
Appendix 1: Figures

Figure 1: Impulse responses of all variables - Cyclical Shock



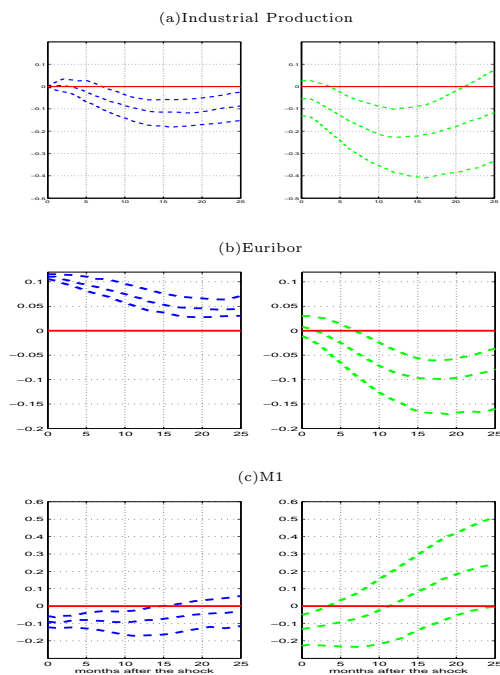
Note: Impulse responses to one standard deviation cyclical shock (trough of IP response in the full sample is normalized to be equal to trough in pre-crisis sample). We report the median and the 16th and 84th quantiles of the distribution of impulse response functions estimated on the pre-crisis sample (dashed lines) and the median of the impulse responses estimated on the full sample (solid line)

Figure 2: Impulse responses of all variables - Monetary Policy Shock



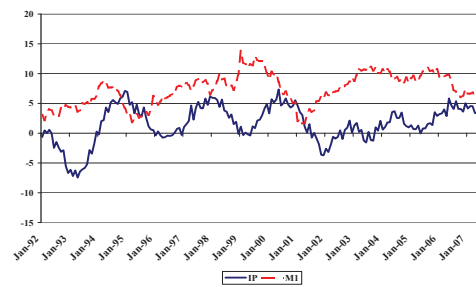
Note: Impulse responses to one standard deviation monetary policy shock. We report the median and the 16th and 84th quantiles of the distribution of impulse response functions estimated on the pre-crisis sample (dashed lines) and the median of the impulse responses estimated on the full sample (solid line)

Figure 3: Industrial Production, Euribor and M1



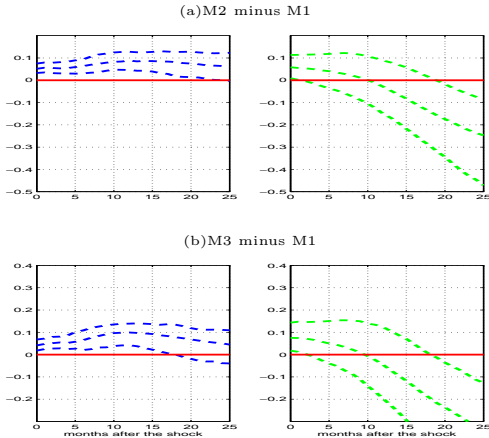
Note: Left panel, monetary policy shock. Right panel, cyclical shock. We report the median and the 16th and 84th quantiles of the distribution of impulse response functions of the (log)-levels.

Figure 4: M1 and Industrial Production



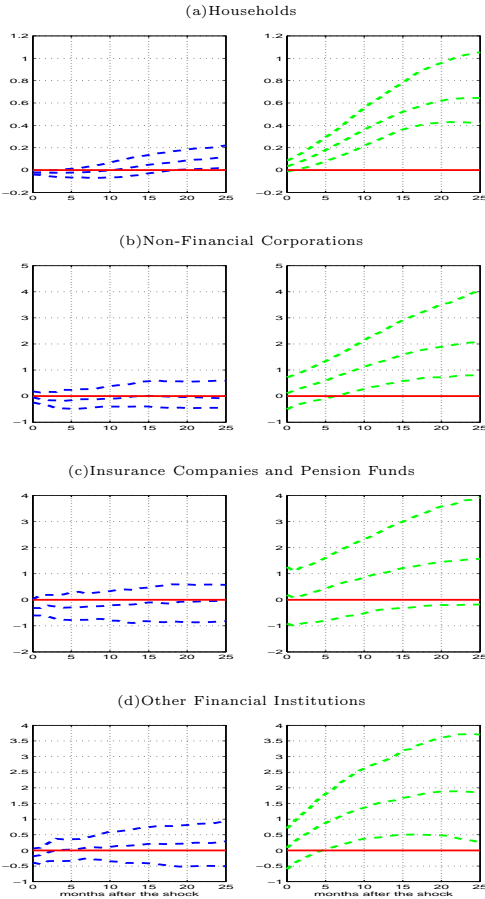
Note: Both variables are expressed in terms of annual growth rates

Figure 5: Monetary Aggregates: M2-M1 and M3-M1



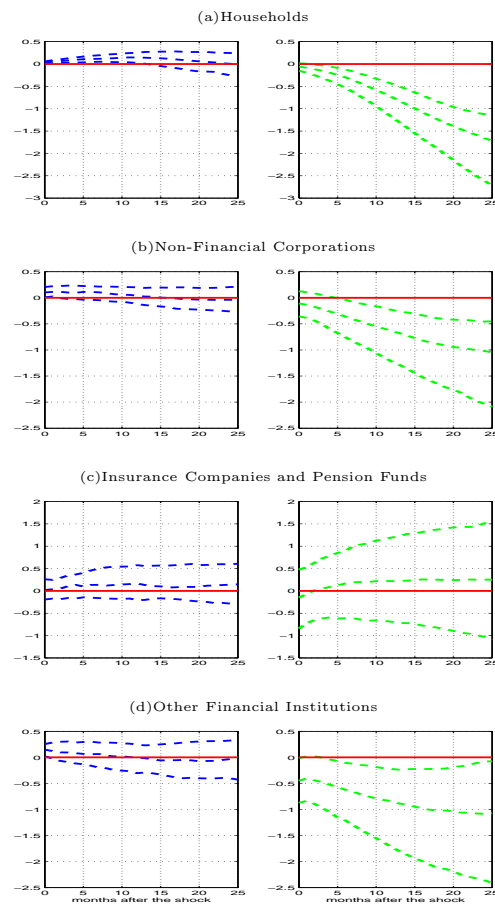
Note: Left panel, monetary policy shock. Right panel, cyclical shock. We report the median and the 16th and 84th quantiles of the distribution of impulse response functions of the (log)-levels.

Figure 6: Saving Deposits



Note: Left panel, monetary policy shock. Right panel, cyclical shock. We report the median and the 16th and 84th quantiles of the distribution of impulse response functions of the (log)-levels.

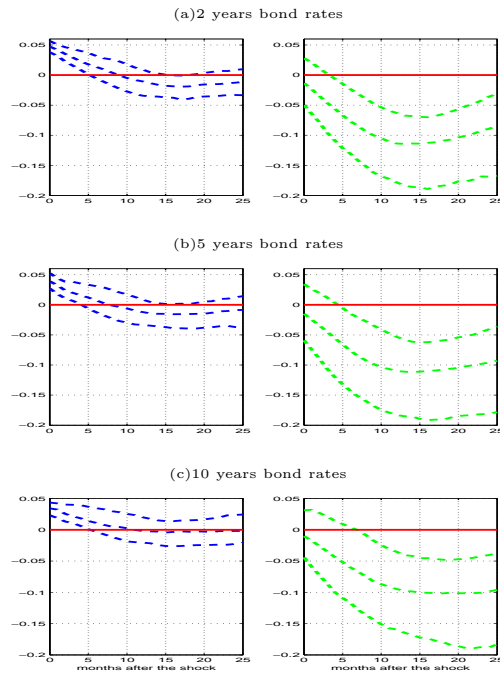
Figure 7: Time Deposits



Note: Left panel, monetary policy shock. Right panel, cyclical shock.

We report the median and the 16th and 84th quantiles of the distribution of impulse response functions of the (log)-levels.

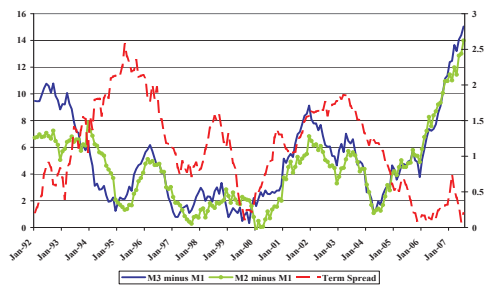
Figure 8: Bond rates



Note: Left panel, monetary policy shock. Right panel, cyclical shock.

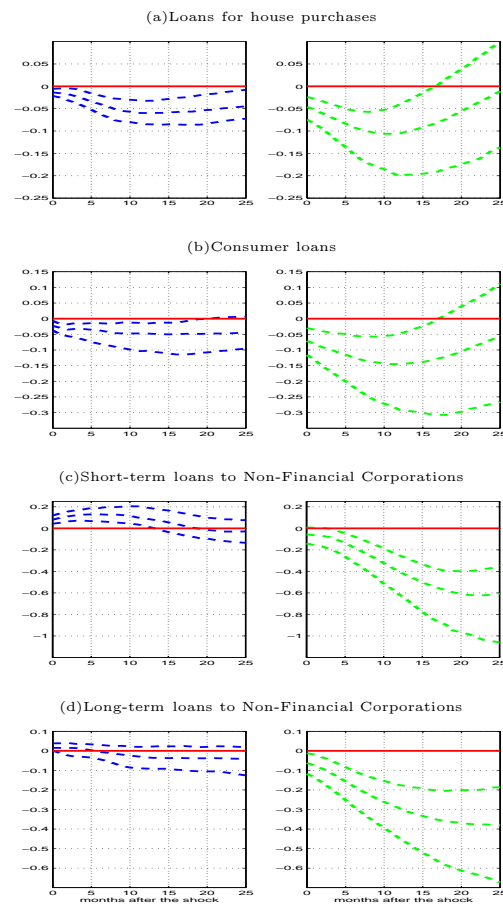
We report the median and the 16th and 84th quantiles of the distribution of impulse response functions of the (log)-levels.

Figure 9: M2 minus M1, M3 minus M1 and term spread (10 minus 2 years bond rates)



Note: M2 minus M1 and M3 minus M1 are expressed in terms of annual growth rates, while the term-spread is defined as the level of 10 years bond rates minus that of two years bond rates. Left scale: M2 minus M1 and M3 minus M1; right scale: term-spread.

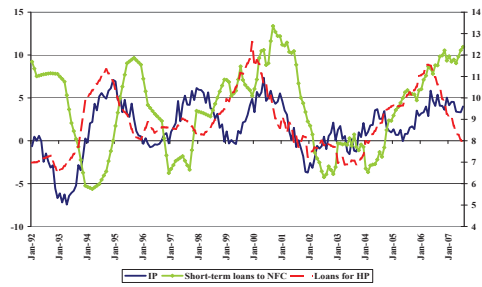
Figure 10: Loans



Note: Left panel, monetary policy shock. Right panel, cyclical shock.

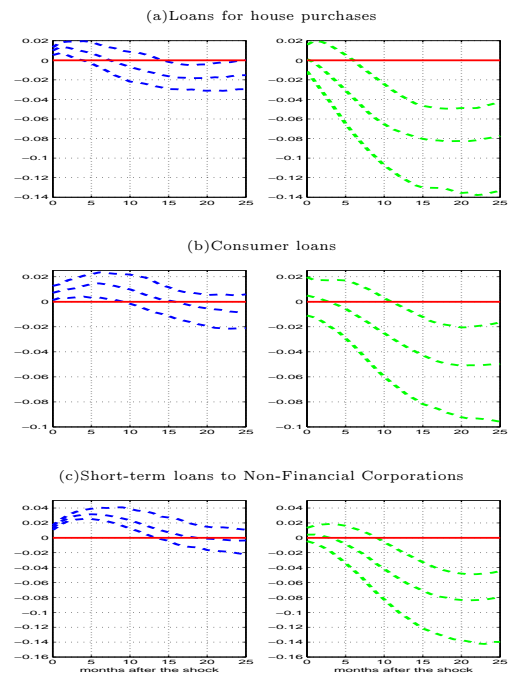
We report the median and the 16th and 84th quantiles of the distribution of impulse response functions of the (log)-levels.

Figure 11: Loans to non financial corporations and industrial production



Note: The variables are expressed in annual growth rates. IP and Loans to Non-Financial Corporations (NFC): left scale; Loans for house purchases (HP): right scale.

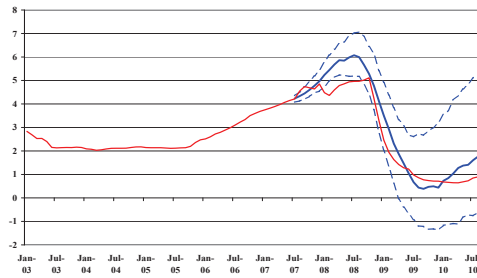
Figure 12: Lending rates



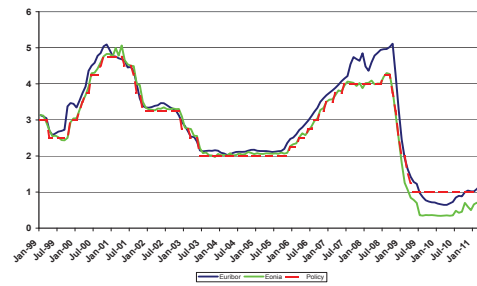
Note: Left panel, monetary policy shock. Right panel, cyclical shock. We report the median and the 16th and 84th quantiles of the distribution of impulse response functions of the (log)-levels.

Figure 13: Counterfactual exercises on 3 months Euribor

(a) Counterfactual exercises on Euribor



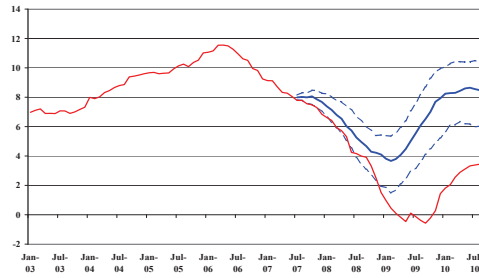
(b) 3 months Euribor, EONIA and ECB policy rate



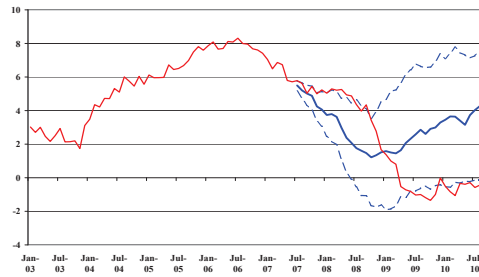
Note: In the top panel with the counterfactual exercises we report the actual level of the 3 months euribor (red solid line) and the median (blue solid line) and the 16th and 84th quantiles of the distribution of the conditional forecasts (blue dashed lines).

Figure 14: Counterfactual exercises on Loans

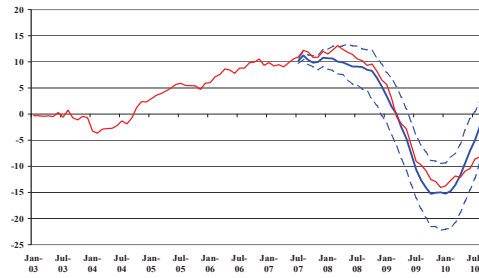
(a) Loans for house purchases



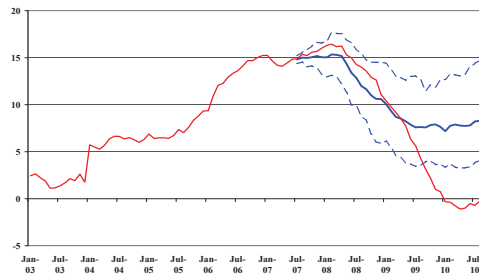
(b) Consumer loans



(c) Short-term loans to Non-Financial Corporations



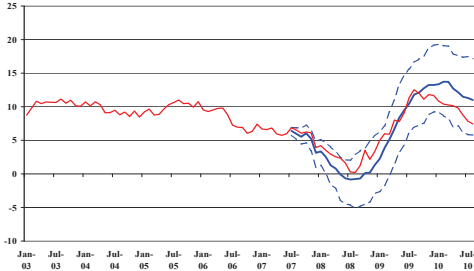
(d) Long-term loans to Non-Financial Corporations



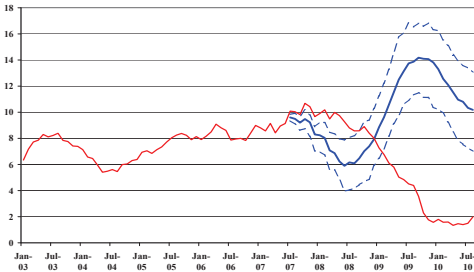
Note: In the counterfactual exercises we report the actual annual growth rates of the variables (red solid line) and the median (blue solid line) and the 16th and 84th quantiles of the distribution of the conditional forecasts (blue dashed lines).

Figure 15: Counterfactual exercises on monetary aggregates

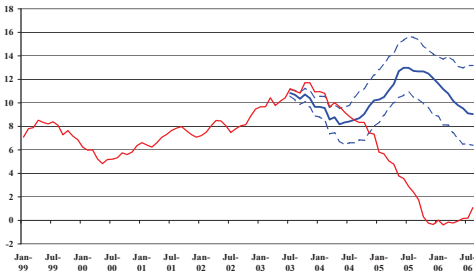
(a)M1



(b)M2



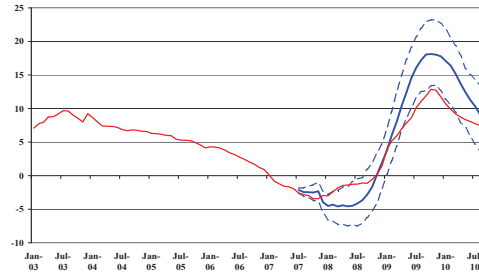
(c)M3



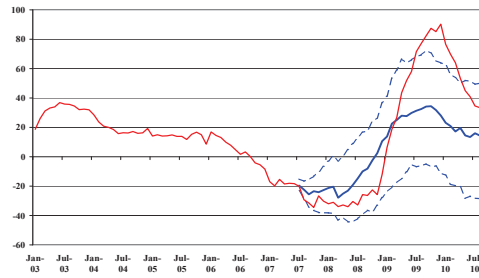
Note: In the counterfactual exercises we report the actual annual growth rates of the variables (red solid line) and the median (blue solid line) and the 16th and 84th quantiles of the distribution of the conditional forecasts (blue dashed lines).

Figure 16: Counterfactual exercises on deposits in M2 minus M1

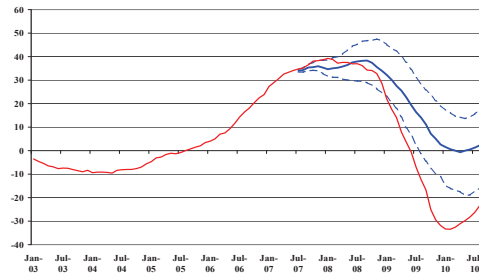
(a) Saving deposits, households



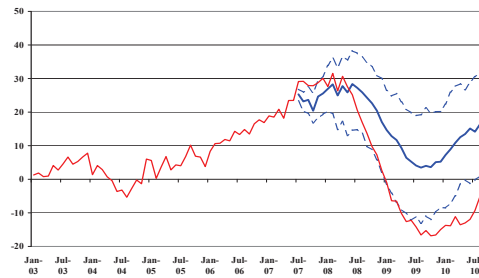
(b) Saving deposits, NFC



(c) Time deposits, households

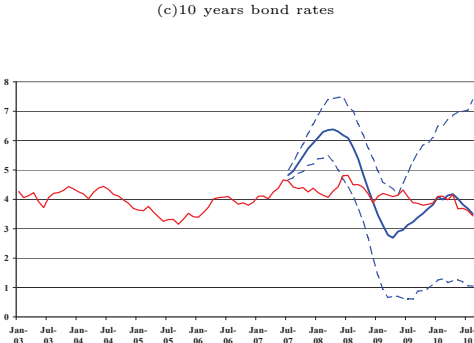
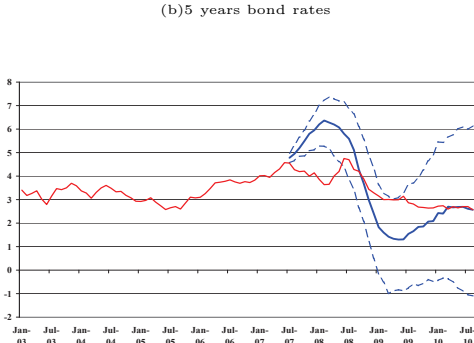
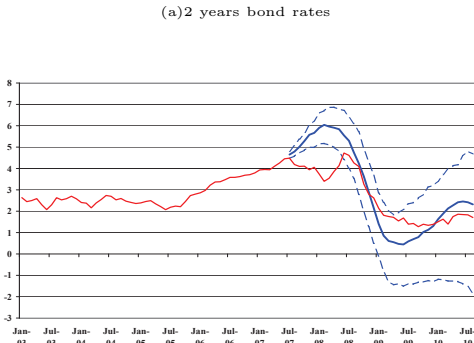


(d) Time deposits, NFC



Note: In the counterfactual exercises we report the actual annual growth rates of the variables (red solid line) and the median (blue solid line) and the 16th and 84th quantiles of the distribution of the conditional forecasts (blue dashed lines).

Figure 17: Counterfactual exercises on bond rates



Note: In the counterfactual exercises we report the actual levels of the variables (red solid line) and the median (blue solid line) and the 16th and 84th quantiles of the distribution of the conditional forecasts (blue dashed lines).