# Bank lending to the production sector: credit crunch or extra-credit?

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## Bank Lending to the Production Sector: Credit Crunch or Extra-Credit?

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## Contents

## Abstract

This paper provides empirical evidence to support the theory that, in Italy, over the course of the past two years, even though a considerable slowdown in bank lending has been recorded, there has not been a credit crunch. After a first section dedicated to a descriptive analysis of the data, the paper presents an econometric estimation of the production sector's demand for bank loans. An Error Correction Model (ECM) is used – estimated for the pre-crisis period (1998.Q2 – 2007.Q2) and applied both with the one and two step procedure – which considers lending as a function of the added value of the private sector, of the gross operating margin to nominal added value ratio (a proxy for self-financing) and of the real interest rate applied to loans. To test the robustness of the results obtained in the first specification of the model, we remove the assumption of weak exogeneity of the independent variables of the single equation model and construct a multivariate multi-equation model (VECM). All of the different approaches and methods adopted provided similar results: as expected, the demand for credit increases as real added value increases and decreases as the cost of lending and self-financing increase. The dynamic out-of-sample forecast of the model, relating to the two-year period of economic and financial crisis (2007.Q3 – 2009.Q2), shows that the actual loan stock remained well above the "theoretical" level forecasted on the basis of the functional relationships estimated before the crisis. This delta (which can be defined as "extra-credit") is interpreted as the outcome of a rightward shift of the credit supply curve, rather than a leftward shift as would have happened in a credit crunch scenario.



Keywords: *credit crunch, Italian banks, bank lending, production sector, loan demand, error correction model, cointegration*

JEL Classification: C32, C51, E44

## Non-technical summary

This paper analyses the interaction between the dynamics of bank lending to the production sector and the macroeconomic scenario, in order to verify the hypothesis about the existence of a credit crunch in Italy during the recent financial and economic crisis. According to the definition available in literature, a credit crunch represents a decline in the supply of credit (leftward shift of the curve) of an excessive and anomalous magnitude with respect to the business cycle trend. Even in the presence of a significant slowdown in the growth rate of loans, developments in the credit market have been relatively positive during the crisis, given the severe decline in economic activity. Over the course of 2008, and in the first six months of 2009, the bank credit-to-GDP ratio – namely credit per product unit – has slowed down, but has never fallen, demonstrating a far superior trend than that recorded in previous downturns identified by the International Monetary Fund, which in a recent study established the threshold of annual growth in the bank credit-to-GDP ratio, beyond which we can speak of credit squeeze/crunch, as between -0.6 and -1%. After having provided descriptive evidence, the paper focuses on an analysis of the relationships between credit and economic trends and, using econometric techniques, estimates the demand for credit as a function, inter alia, of the production activity, the levels of private sector self-financing and the real interest rate applied to loans. On the basis of the relationships that have been established between these variables in the pre-crisis period (between the second quarter of 1998 and the second quarter of 2007), we estimate what the outstanding loans would have been in the crisis period if the banks had strictly observed these relationships; we then compare this "theoretical" value with the actual value. Our results show that in Italy, as of the third quarter of 2007 – namely since the beginning of the financial crisis – the outstanding loans figure was significantly superior to that "compatible" with a macroeconomic scenario marked by an exceptional decline. As the crisis worsened, the distance between actual credit and theoretical credit increased, exceeding 80 billion euro (a sort of "extra-credit" corresponding to over 10% of loan stock). If other factors are considered equal and given the difficult economic scenario, the higher propensity to grant credit could be interpreted as an increased attention of the banking industry on all of those aspects – beyond traditional ones – that tend to reinforce medium/long run relationships with customers (higher consideration of the enterprise's income prospects, personal and long lasting relationships with enterprenuers , etc.).

## 1. INTRODUCTION

Economic literature and past experience show that credit and finance play a decisive role in economic growth. The occurrence of an epoch-making financial crisis and of one of the most severe recessions in economic history has therefore led to questions, throughout the world, as to the risk that the generalised process of bank deleveraging and the rapid deterioration of the income conditions of households and enterprise could generate a credit crunch with consequent negative repercussions on production activity. Over the course of the past year, this debate seen the massive involvement of governments and social parties and on many occasions there has been explicit reference, in alarmist tones, to the presence of a credit crunch.

There are different grounds underlying the considerable interest that this topic is arousing: context, structural and empirical. In terms of context, we refer to the exceptional gravity that has characterised the economic recessions which, in Italy, was already showing in average figures for 2008 (-1% the annual GDP growth). The structural grounds are based on the fact that in Italy the weight of bank debt in sources of corporate funding (particularly of small and medium sized enterprises) is higher than elsewhere[1]. Lastly, the empirical grounds are based on the observation that in the past year and a half we have actually seen a significant slowdown in the growth of loans to the production sector.

The rationale, therefore, for this paper is the need to further explore a topic that is extremely important for our economy, in order to verify if there are actually grounds to sustain that there has been a credit crunch in Italy. It contributes to the debate on three fronts: 1) it describes and evaluates credit dynamics using different methods; 2) it estimates a loan demand model for the historic period before the financial crisis; 3) it uses said model and offers proof that would seem to counter the hypothesis of a credit crunch.

The paper is organised as follows: Section 2 provides a brief overview of the development of the credit situation in the past two years; Section 3 provides the economic meaning of credit crunch on the basis of the approach commonly used in literature; Section 4 provides the first descriptive tools to be able to evaluate the presence, or otherwise, of a credit crunch in Italy, correlating credit trends with those of industrial production and GDP; Section 5 econometrically estimates a demand for loans function and uses it to compare the amount of actual loans with that forecasted on the basis of the model estimated in the pre-crisis period; Section 6 summarises the main conclusions.

*[1] At the end of 2003 bank loans corresponded to 71% of corporate indebtedness, against 55% in Germany, 35% in France and 47% in the United States (Casolaro, Eramo and Gambacorta; 2006).*

## 2. THE CREDIT SITUATION

As the economic and financial crisis has unfolded over the past two years, the annual growth rate of loans to the private sector (production sector and consumer households), calculated on seasonally-adjusted data[2], has decreased significantly (Graph 1) falling from +12.9% in October 2007 to +1.5% in August 2009. The economic situation confirms that total loans to the private sector are stagnating: over the past six months, annualised quarterly changes have fluctuated between values of -0.5 and +2% (+0.2% in August 2009).

Looking at loans to households and loans to enterprises separately, we can see that while during the first stage of the crisis the slowdown mainly regarded consumer households, over the course of the past year, it has particularly affected the production sector (both medium-large and small non-financial firms)[3]. Graph 2 shows that the annual growth rate of loans to consumer households, after having dropped to its lowest point last February (+1%), has started to rise in recent months (+4.5% in August); even the annualised quarterly growth does not provide reason for concern. On the other hand, loans to the production sector, which until last September were growing at an annual rate of 10.6%, during this stage appear to be less promising, and showed a significant slowdown (Graph 3); for this aggregate, the economic situation signals a recessionary trend (the annualised quarterly change last August -2.1%; -3.2% in July).

The economic situation therefore suggests further exploration of the dynamics of loans to the production sector, for which there are heightened fears of a credit crunch at this stage. To establish an initial framework, we need to read the dynamics commented on above with relation to what has happened at international level.

At international level, there appears to be a widespread tendency towards the stagnation of loans to enterprises. Within the euro area, the Italian situation appears to the least worrying. As of last April, the annualised quarterly growth rate of loans to non-financial firms (seasonally-adjusted) in Italy was constantly above that recorded in Germany, France, Spain and the euro area as a whole (Graph 4): the last figure for August shows a growth of 0.6% in Italy against a fall of 5% in the euro area (-5.2% in Germany; -3.6% in France; -7.3% in Spain).

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[2] *In all of the calculation in this paper, seasonal adjustments have been carried out using the Tramo/Seats procedure.*

[3] *A recent study by the ECB shows that, overall, analysing credit and GDP trends in the euro area from 1980 to date, average historical regularities suggest that the annual growth of real loans to households slightly leads real GDP growth, while the growth in loans to non-financial corporations clearly lags growth in real GDP (European Central Bank, Monthly Bulletin, October 2009).*

## 3. CREDIT CRUNCH: DEFINITION AND ANALYSIS TOOLS

In order to verify the existence, if any, of a credit crunch, we first have to establish the economic meaning of this term. The definition of credit crunch most commonly used in literature is that of Bernanke and Lown (1991, p.207): "a significant leftward shift in the supply of bank loans, holding constant both the real interest rate and the quality of potential borrowers".

According to this definition, a credit crunch represents a decline in the supply of credit (leftward shift of the curve) of an excessive and anomalous magnitude with respect to the trend of the business cycle[4]; the focal point, therefore, entails valuing the decline in the supply of credit against the performance of the economy, taking for granted the fact that the bank lending tends to normally and physiologically slow down or decline during a period of recession.

This definition suggests two analysis approaches:

a) a more description approach, expanded in section 4, which entails comparing the credit trend with those of the main indicators of the business cycle (industrial production and GDP);

b) a more analytical approach, illustrated in section 5, which is based on the construction of an econometric model, which explains credit trends as a function of its determinants and which emphasises the short and long run statistical relation between credit variables and the macroeconomic scenario.

## 4. CREDIT AND PRODUCTION ACTIVITY DURING THE CRISIS

As highlighted in Section 2, loans to the production sector have shown a marked slowdown in 2008-09. In the same period, the industrial production index (a possible proxy of the firm's credit demand for new investment in industry) collapsed to all intents and purposes, further deteriorating as of September 2008: the annual change of the seasonally-adjusted series fell from +3.2% in July 2007 to -24.9% last March, only partially recovering in recent months. The slowdown in credit was actually fairly modest if compared to industrial production dynamics (Graph 5)[5]: loans continued to rise y-o-y, also in the presence of a downsizing of investment projects by companies[6]. A similar conclusion is reached if the long-run

*[4] For more details on the interpretation and the causes of the credit crunch, see Clair and Tucker (1993).*

*[5] The comparison between the trend of the industrial production index and loan dynamics has a limitation stemming from the fact that we are comparing a nominal aggregate (loans) to an index expressed instead in real terms (industrial production). However, our calculations show that even if loans are deflated with the price index (consumer and production),the same conclusions are reached: the slowdown in loans (in real terms) over the past one and a half years has been decidedly more contained that the collapse of the production index.*

*[6] The significant fall in the demand for loans by enterprises to fund new investment projects is confirmed by the results of a recent survey on bank lending (Bank Lending Survey) conducted by the Bank of Italy and the European Central Bank.*

trend[7] is removed from outstanding loans and the industrial production index (Graph 6).

To what extent can it be claimed that the collapse of industrial production led to the slowdown in lending? Granger's causality test (Granger; 1969) shows that, by using the cyclical components of the two time series analysed in the last decade, this claim could be upheld: the results obtained say, in fact, that the production index causes bank loans and not the contrary (Table 1)[8]. This substantiates the conclusion that lending slowed down during the crisis due to the very high and more than proportional fall in the firm's loans demand for new investments.

However, the analysis conducted above has three critical aspects. Firstly, it was conducted on a relatively limited historic time period: as a longer homogeneous time series for loans was not available, only the last decade was considered; this does not enable us to verify what happened in past recessions (such as for example that of 1992-93).

Furthermore, note that industrial production, unlike loans, is expressed in real terms and, as it does not include services, regards a sector that represents less than 30% of added value.

Lastly – passing to the third critical aspect – only the demand for loans to fund new investment projects has been considered, ignoring for example the fact that the demand for loans may also increase to cover new liquidity requirements that have occurred due to a sudden fall in self-financing.

To circumvent the latter problem, all of the possible determinants of the demand for loans must be considered: the econometric model developed in Section 5 seeks to offer a solution to this aspect.

With regard, on the other hand, to the first two critical aspects, a first improvement of the analysis was made by observing credit dynamics with relation to the trend of nominal GDP, both recently and with regard to Italian recessions in past decades. As a uniform time series for loans for the period prior to 1998 is not available, a recent research conducted by the International Monetary Fund (IMF) was used, which explores the topic of credit crunch, using data for Italy from 1970 onwards (IMF World Economic Outlook, April 2008)[9].

Following Bernanke and Lown's definition, the IMF has defined a bank credit squeeze "as a slowdown in the growth rate of the bank credit-to-GDP ratio sharper than that experienced during a normal business cycle downturn" and a bank credit crunch as "a severe bank credit squeeze driven by a significant decline

*[7] The long-run trend was calculated by applying the Hodrick-Prescott filter. Again, results are similar even if loans are considered in real terms (deflated with the consumer or production price index).*
*[8] This result is obtained by considering both loans in nominal and real terms (deflated with the consumer price index).*
*[9] The time period analysed for Italy in this IMF study is that between the first quarter of 1970 and the second quarter of 2007. Therefore, it does not take the lending trend in the last two years into account.*

in the banking system's supply of credit" (IMF World Economic Outlook, April 2008, pp. 10-11)[10]. Its empirical study shows that, on the basis of the historic evidence considered, in Italy we should talk about a credit squeeze/crunch[11] in the presence of an annual rate of change of the bank credit-to-GDP ratio of between 0.6 and 1%[12].

Calculated on the total amount of loans disbursed to the production sector, the annual rate of change of the bank credit-to-GDP ratio[13] fell in 2008 and in the first half of 2009 (Graph 7), but it has still remained decidedly positive (from +9.1% in the first quarter of last year to +3.8% in the second quarter of this year), showing, in any event, a value that is considerably higher than the -0.6% threshold indicated by the IMF and than the lowest value recorded in the past nine years (+1.4% at the end of 2004).

The analysis of the bank credit-to-GDP ratio would appear to indicate better credit (per unit of GDP) dynamics for the past two years with respect to the trend shown in previous downturns experienced from 1970[14] onwards, and enable us to reject the hypothesis of both credit crunch and credit squeeze.

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*[10] As stated by the IMF, "factors that could limit the banking system's supply of credit,and therefore transform a squeeze into a crunch, include banks' inability to raise core funding or retain them due to a run, as well as banks' inability to raise funds through debt or equity issuance on capital markets".*

*[11] As illustrated in the definitions, the two levels of judgement depend, in addition to the extent of the downturn of the index, also by the degree of involvement of the supply side and on potentially distressed bank conditions (presence of a crisis). On the basis of this observation, if in the last two years we were to encounter a downturn in the bank credit-to-GDP ratio that is higher than the threshold indicated by the IMF, it would automatically be interpreted as a credit crunch, given the gravity and exceptional nature of the recent financial crisis.*

*[12] In its study, the IMF establishes this threshold by identifying the episodes of credit squeeze/crunch in all of those quarters in which the rate of growth of the bank credit-to-GDP index was in the lowest decile of the distribution. Said episodes occurred in Italy between the fourth quarter of 1993 and the second quarter of 1996.*

*[13] The bank credit-to-GDP ratio is calculated as the ratio between the seasonally adjusted good loans (net of the non performing loans) and the four periods mobile sum of nominal GDP.*

*[14] Another interesting study on credit dynamics in recession periods is that published by the Bank of Italy last July (Bassanetti et al; 2009). The outcome of their analysis is that loans to the private sector, if measured in nominal terms, in the current crisis, have demonstrated a profile in line with previous recessions (1974 and 1992-93). In real terms, on the other hand, the slowdown of loans would appear to be more accentuated than in 1992-93 (when, however, it lasted for around ten quarters) and less brusque than that of 1974. In this evaluation, we must, nevertheless, take into account the higher level of intensity of the current recession, which has so far had a predominantly industrial nature. Even the fall in the loans to GDP ratio has been shown in this study to be more severe than in the 1974 recession, with respect to what is happening today, while in the 1992-93 recession, the significant decrease of the loans to GDP ratio occurred with a certain lag and lasted for around four years. These results do not appear to significantly contrast with those obtained in this paper.*

## 5. BANK LENDING AND CREDIT DEMAND: AN ECONOMETRIC ANALYSIS

The comparison between trend of loans and industrial production dynamics would almost appear to point to an excess of credit supply with respect to the demand for loans by companies to fund new investment. This gap could however be explained by the increase in the demand for bank loans to cover the lack of resources that companies are able to draw upon through self-financing. On the other hand, lending dynamics have certainly also been influenced by other factors, the role of which can be understood and measured using an econometric analysis.

In line with a research approach that returned to popularity in the early 90's[15], we therefore constructed and estimated an equation able to summarise the relationships that link credit demand with its main determinants.

This analysis, conducted on the basis of a quarterly database covering the period between the second quarter of 1998 and the second quarter of 2009, breaks down into two stages:

1) in the first (Section 5.1) we estimate an equation for the demand for loans in the pre-crisis period (up until the second quarter of 2007) in order to verify what were the relationships that linked credit to the variables of the scenario under normal conditions, namely before the structural break, caused by the financial crisis, occurred;

2) in the second (Section 5.2) we used the relationships estimated above for the pre-crisis period and we make an out-of-sample dynamic forecast for the last two years (2007.Q3 - 2009.Q2), in order to compare the amount of actual credit with the amount that the model would have predicted on the basis of the evolution of the economic scenario.

### 5.1 A loan demand model in the pre-crisis period

The basic model used is an Error Correction Model (ECM), which links – in the short and long run – loans to the production sector with the cost of lending and with some indicators on production levels and on the self-financing capacity of the private sector (added value and gross operating margin).

This model was applied using three different approaches:

A. The the two-step procedure ECM by Engle and Granger (1987), in which first the long-run equation is estimated and then the short-run relation;

B. The one-step procedure ECM, in which short and long-run equations are estimated simultaneously;

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[15] *See in particular Sorensen, Ibanez e Rossi (2009), Gambacorta and Rossi (2007), Casolaro, Eramo and Gambacorta (2006), Calza, Manrique and Sousa (2006) and Calza, Gartner and Sousa (2003).*

C. The Vector Error Correction Model (VECM), with a multivariate analysis characterised by a system with several simultaneous equations.

In the first two equations, we use the basic assumption of weak exogeneity of the independent variables used in the loans equation, considering the credit trend as the only endogenous variable. The VECM represents an alternative model, which enables us to eliminate the assumption of weak exogeneity of the lending determinants and to consider all of the variables analysed as endogenous.

The variables used are defined as follows:

IMP = loans to the production sector (both medium-large and small non-financial firms) resident in Italy, net of gross non performing loans (end-of-quarter outstandings, seasonally-adjusted data);

VAK = added value of the private sector[16] expressed in real terms (at constant prices, seasonally-adjusted data);

VAN = added value of the private sector expressed in nominal terms (at current prices, seasonally-adjusted data);

MOL = gross operating margin (VAN – total labour cost);

TIMP = average real interest rate[17] on loans to medium-large non-financial firms[18] (calculated on outstanding loans; end-of-quarter data).

The source of the bank variables is the Bank of Italy, while Istat is the source of those relating to gross operating margin and added value.

The first objective of the analysis is to estimate a credit demand function of the following type: $IMP = f(VAK, MOL/VAN, TIMP)$.

The demand for loans, according to economic theory, falls as the interest rate applied to the same rises: from the estimations, we would expect a minus sign for the coefficient associated to the variable TIMP.

In the credit demand equation that we wish to consider, VAK represents the scale variable[19]. Added value is a production indicator: as VAK rises, it would be fair to expect a higher demand for bank loans (we would expect a coefficient with a plus sign).

On the other hand, the gross operating margin represents gross operating profit before amortization and depreciation and corresponds to what remains of added

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*[16] The added value of the private sector was calculated by subtracting the “non market” portion provided by Istat from total added value.*

*[17] The real interest rate was calculated by deflating the nominal interest rate with the annual growth rate of the added value deflator of the private sector.*

*[18] In the calculation of the average real interest rate, loans to smaller firms have not been considered as not available in the data provided by Bank of Italy.*

*[19] In the credit demand function in question, the added value expressed in nominal terms already appears as the denominator of the MOL/VAN ratio. To avoid problems of collinearity between regressors, we therefore decided to use the added value expressed in real terms as the scale variable of firm’s activity.*

value after having deducted labour costs; so it incorporates the level of self-financing generated before any extraordinary charges or income, financial charges and taxes. The MOL is very important for the operating management analysis: it is not influenced by any accounting policies regarding amortizations, depreciations or allowances and shows a company's self-financing capacity. If other factors are equal, an increase of MOL/VAN increases a company's self-financing capacity and should lead to a lower demand for bank lending: we therefore expect the coefficient for this variable to have a minus sign.

A descriptive analysis, over the whole period considered, shows how there is a strong positive correlation between IMP and the added value of the private sector (correlation of 97% with the nominal added value and of 84% if the latter is expressed in real terms). The annual trends of these variables appear to be very closely linked over the past decade: the main stages of upturn (in 2000 and 2006) or downturn (in 2001-2002 and 2008-2009) of credit dynamics occurred at the same time as a higher or lower growth in added value (Graph 8). During the crisis of the past two years, VAK has changed from an annual growth rate of 1.9% in the third quarter of 2007 (+5% for VAN) to an average annual fall of 6.3% in the first six months of this year (-3.2% in nominal terms).

The figures also show a negative correlation (-34%) between IMP and MOL/VAN. In the past decade, the gross operating margin as a percentage of VAN has recorded a highly irregular trend, not always correlated to the real cycle of added value[20]: the trend of these two variables however, has been perfectly correlated for the past year (Graph 9). From the second half of 2008, the economic recession actually caused both a collapse of real added value and a considerable drop in the gross operating margin as a percentage of nominal added value (from 40.8% in the second quarter of 2008 to 38.6% in the second quarter of 2009). In the second quarter of 2009, MOL has shown a y-o-y fall of 8.6% (from +3.4% in the second quarter of 2008); the fall in VAN (from +2.5% y-o-y in the second quarter of 2008 to -3.4% in the second quarter of this year; see Graph 10) has been less marked.

Therefore, the economic crisis appears to have also provoked a reduction in the self-financing capacity of the private sector, particularly in the last stage. This could have made the demand for bank loans by companies rise, partially compensating the lower demand caused by a fall in production activity.

A. *ECM: the Engle and Granger two-steps procedure*

Following Engle and Granger's two step procedure, we initially estimated, using the Ordinary Least Squares method (OLS), the following long-run equation:

$$(1) \qquad \ln(IMP_t) = \lambda_0 + \lambda_1(trend) + \lambda_2 TIMP_t + \lambda_3 \ln(VAK_t) + \lambda_4 \ln\left(\frac{MOL_t}{VAN_t}\right) + \varepsilon_t$$

[20] *The cyclical component of real added value has been found using the long-run trend calculated by applying the Hodrick-Prescott's filter.*

where $\ln(\cdot)$ represents the variable's natural logarithm.

Equation (1) represents the long-run credit demand function. All of the variables considered in this equation are non-stationary[21]: this justifies the use of an error correction model. The residual term $\varepsilon_t = ECM_t$, which represents the disequilibrium error in the long-run equation, is on the other hand stationary (Table 2). The variables in question therefore are cointegrated[22].

Equation (1) therefore explains the cointegrating relationship that links, in the long run, outstanding loans to the production sector with the added value of the private sector, the gross operating margin and the average real interest rate applied to loans[23].

In the second step of the procedure, we estimated the short-run equation, taking into account the disequilibrium error obtained in the long-run relationship at t-1 ($ECM_{t-1}$). The credit demand function thus becomes the following:

$$(2) \qquad \Delta\ln(IMP_t) = \alpha + \beta_1\Delta\ln(IMP_{t-1}) + \beta_2\Delta(TIMP_t) + \beta_3\Delta\ln(VAK_t) + \beta_4\Delta\ln\left(\frac{MOL_t}{VAN_t}\right) + \theta[ECM_{t-1}] + u_t$$

where $\Delta$ indicates the first difference operator.

This model therefore enables us to explain the changes in the dependent variable as a result of the interaction of two components:

- The error correction component ($\theta[ECM_{t-1}]$), where $\theta$ represents the speed of adjustment of loans, namely the fraction of the disequilibrium error at time t-1 that is corrected to time t.
- The short-run component, identified in the first differences of TIMP, ln(VAK), ln(MOL/VAN) and ln($IMP_{t-1}$). The coefficient vector ($\beta_1, \beta_2, \beta_3, \beta_4$) represents the short-run impact on the lending growth rate of a change in said variables.

The estimations of the coefficients of equations (1) and (2), made by taking the pre-crisis period as a sample, are all statistically significant and have the expected sign (Table 3).

The adjustment coefficient $\theta$ is negative and statistically significant, demonstrating the correct specification of the error correction mechanism and satisfying the stability condition: in each period, the growth rate of loans reacts in a

*[21] The unit root tests (Augmented Dickey-Fuller Test), conducted on the entire estimation period, support the non-stationarity hypothesis of ln(IMP), TIMP, ln(VAK) and ln(MOL/VAN). The non-stationarity of the real interest rate on loans is explained by its downward trend within the sample.*

*[22] The variables in question, taken separately, are all non-stationary; however, a linear combination of the same, represented by (1), is stationary. This means that the variables are cointegrated.*

*[23] This relation depends on the values of the long-run coefficients ($\lambda_0, \lambda_1, \lambda_2, \lambda_3, \lambda_4$), also called equilibrium coefficients.*

significant way to the change in the disequilibrium error of the previous period, adjusting itself towards long-run equilibrium.

With reference to the parameters of most interest, we can see a very significant long-run relationship between the demand for loans, TIMP, VAK and MOL/VAN. In the long run, the demand for bank lending by the production sector increases (more than proportionally) as real added value increases, while it decreases as MOL/VAN increases (and therefore as a company's self-financing capacity increases)[24]; the demand for loans also reacts negatively to an increase in the cost of lending[25]. The sign and the statistical significance of said relationships is also confirmed by the short-run estimations (see the coefficients $\beta_2, \beta_3, \beta_4$ represented in Table 3).

The interpretation of these results would indicate that more a company produces, the higher quantity of credit it will need. On the contrary, as self-financing increases, there is a lesser need for external sources of funding: this leads to a lower demand for bank credit. Lastly, as the interest rate on loans rises, there is a lower demand for loans due to the higher cost of funding. These interpretations apply both to long and short-run relationships.

B. *ECM: the one-step procedure*

An alternative procedure entails estimating both the long and short run relationships at the same time in a single equation, (one step single equation procedure)[26].

Combining (1) and (2) we get:

$$(3) \qquad \Delta\ln(IMP_t) = \beta_1\Delta\ln(IMP_{t-1}) + \beta_2\Delta(TIMP_t) + \beta_3\Delta\ln(VAK_t) + \beta_4\Delta\ln\left(\frac{MOL_t}{VAN_t}\right) +$$

$$+\theta\left[\ln(IMP_{t-1}) - \lambda_0 - \lambda_1(trend_{t-1}) - \lambda_2 TIMP_{t-1} - \lambda_3\ln(VAK_{t-1}) - \lambda_4\ln\left(\frac{MOL_{t-1}}{VAN_{t-1}}\right)\right] + u_t$$

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*24 The values of the long-run coefficient of the credit demand equation show that if the VAK rises by 1% we have a rise of almost 2% in IMP, while if the MOL/VAN ratio rises by 1% we have a fall of around 0,3% in IMP.*

*25 The value of the long-run coefficient on the interest rate indicates that a fall of 100 basis points in TIMP would lead to a rise of around 1% in IMP. The use of the interest rate on loans to medium-large non-financial firms, not considering the rate applied to smaller firms, could lead to a distortion in the estimation of the relationship between the loan demand of the production sector and the interest rate applied to loans. As the interest rate on loans to smaller firms is generally higher than that applied to medium-large size companies, this distortion could lead to an overestimation of the demand for loans; said distortion could lead to a higher "theoretical" (forecasted) value of loans. This would further substantiate the conclusions reached in Section 5.2, in which the credit disbursed during the crisis is compared to the theoretical value forecasted by the model on the basis of the pre-crisis functional relationships.*

*26 This approach provides slightly different results to the two-step one, as in the latter the coefficients of the long-run relationship are calculated before and then inserted into the short-run equation as deterministic values (not to be estimated). In the "one step single equation procedure", by simultaneously estimating the long and short run, the equilibrium coefficients of the long-run relationship cannot be established a priori.*

The OLS estimations of equation (3), computed again by taking as reference the sample period 1998-2007, overall provide results similar to those obtained with the two-step procedure (Table 3); the only substantial difference is that the relationship linking credit demand to firm's gross operating margin in the long run is not significant: however, the coefficient still has a minus sign. The inverse relationship between the demand for loans and the firm's self-financing component is instead significant in the short run (at a confidence level of 90%)[27].

C. *VECM: analysis of a multivariate system*

The underlying assumption of the ECM specification is the weak exogeneity of the independent variables in the credit demand equation. From a theoretical perspective, however, it is possible that there may be retroactive effects and simultaneity relationships between loans demand, the dynamics of added value and gross operating margin and the cost of bank lending. For example, it may be that as the credit disbursed rises, its immediate effect is a rise in added value or a rise in MOL; or there could be another equation whose dependent variable is the interest rate on loans (loans supply function).

In order to test the validity and robustness of the results obtained with the ECM specification, we therefore need to verify what would happen without the weak exogeneity assumption.

To do this, we use a vector autoregressive model (VAR), a system of simultaneous equations where each variable is considered endogenous.

The variables considered in the system are ln(IMP), TIMP, ln(VAK), and ln(MOL/VAN), the same analysed in the ECM specification. As suggested by the results obtained in the lag order determination tests (Table 4), we use a VAR with a lag:

(4) $$Y_t = \mu + \sum_{i=0}^{1} \Phi Y_{t-i} + \varepsilon_t$$

$$\varepsilon_t \sim \text{VWN}(0,\Sigma)$$

where $Y_t = [\ln(IMP), TIMP, \ln(VAK), \ln(MOL/VAN)]$.

The variables considered in the model are all non-stationary (Table 2): however, one or more cointegrating relationships may exist that render their linear combination stationary. Johansen's trace test indicates the existence of a cointegrating vector that links IMP, TIMP, VAK and MOL/VAN in the long run (Table 5).

Starting from (4) we therefore construct a four-equation VECM (Vector Error Correction Model), characterised by a cointegrating equation (long-run demand for loans) with intercept and trend and a lag in short-run relationships.

[27] *In regard to the sign, the significance and the interpretation of the other coefficients, we confirm what we said describing the two-stage procedure's results.*

The VECM estimated is as follows:

(5)
$$\begin{bmatrix} \Delta \ln(IMP_t) \\ \Delta(TIMP_t) \\ \Delta \ln(VAK_t) \\ \Delta \ln(MOL_t / VAN_t) \end{bmatrix} = \mathrm{B} \begin{bmatrix} \Delta \ln(IMP_{t-1}) \\ \Delta(TIMP_{t-1}) \\ \Delta \ln(VAK_{t-1}) \\ \Delta \ln(MOL_{t-1} / VAN_{t-1}) \end{bmatrix} +$$
$$+ \begin{bmatrix} \theta_1 \\ \theta_2 \\ \theta_3 \\ \theta_4 \end{bmatrix} \left[ \ln(IMP_{t-1}) - \lambda_0 - \lambda_1 (trend_{t-1}) - \lambda_2 TIMP_{t-1} - \lambda_3 \ln(VAK_{t-1}) - \lambda_4 \ln\left( \frac{MOL_{t-1}}{VAN_{t-1}} \right) \right] + \begin{bmatrix} u_t^{IMP} \\ u_t^{TIMP} \\ u_t^{VAK} \\ u_t^{MOL} \end{bmatrix}$$

where B represents the matrix of short-run coefficients and $(\theta_1, \theta_2, \theta_3, \theta_4)$ the vector of adjustment coefficients.

The estimations of (5) show a long-run relationship that is very similar to that obtained with the ECM (Table 6). The demand for loans increases as real added value increases and falls as the interest rate on loans rises and as self-financing increases; all of the long-run coefficients estimated are also highly statistically significant. Adjustment coefficients $\theta_3$ and $\theta_4$ however, are not significant: VAK and MOL/VAN do not react in a significant manner to the disequilibrium error generated in the long-run relationship of the previous period.

Some of the variables considered endogenous, could in reality be treated as exogenous. Weak exogeneity tests are therefore conducted in order to verify if it is possible to specify the model in a more parsimonious way[28]. As in Sorensen, Ibanez and Rossi (2009) and Casolaro, Eramo and Gambacorta (2006), following Johansen's procedure (1992), restrictions are introduced to the VECM specification and, verifying the statistical significance of the adjustment coefficients, weak exogeneity tests are conducted on each variable.

These tests (Table 7) lead us to accept the hypothesis of weak exogeneity of ln(VAK), ln(MOL/VAN) and TIMP. This implies that the only variable that can be considered endogenous is loans, justifying and confirming the results obtained by the single-equation model (ECM): the test results permit us to rewrite equation (5) in the simpler form expressed by (2) or (3).

The weak exogeneity of TIMP, however, is the most difficult to accept from the tests[29]; furthermore, the joint weak exogeneity test on ln(VAK), ln(MOL/VAN) and TIMP is rejected at a confidence level of 90%, while the joint exogeneity of ln(VAK) and ln(MOL/VAN) is accepted. Therefore, even though the validity of equations (2) and (3) has been demonstrated, we verify how the results would change if only loans and the real interest rate are considered

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*[28] When a variable is weakly exogenous, the model can be rewritten, without any loss of information, in a partial version that excludes the modelling of the same variable. Weakly exogenous variables may in any event continue to appear in long and short-run relationships.*

*[29] Even though the test leads to the acceptance of the null hypothesis of weak exogeneity, it shows a level of significance very close to the 10% threshold (Table 7).*

endogenous; starting from (5), we therefore use a more parsimonious model (reduced form VECM), characterised by a two-equation system:

$$(6) \qquad \begin{bmatrix} \Delta\ln(IMP_t) \\ \Delta(TIMP_t) \end{bmatrix} = B \begin{bmatrix} \Delta\ln(IMP_{t-1}) \\ \Delta(VAK_t) \\ \Delta\ln(VAK_{t-1}) \\ \Delta\ln(MOL_t / VAN_t) \end{bmatrix} +$$

$$+ \begin{bmatrix} \theta_1 \\ \theta_2 \end{bmatrix} \left[ \ln(IMP_{t-1}) - \lambda_0 - \lambda_1(trend_{t-1}) - \lambda_2 TIMP_{t-1} - \lambda_3 \ln(VAK_{t-1}) - \lambda_4 \ln\left(\frac{MOL_{t-1}}{VAN_{t-1}}\right) \right] + \begin{bmatrix} u_t^{IMP} \\ u_t^{TIMP} \end{bmatrix}$$

The estimations in (6) confirm the long-run relationships calculated previously (Table 8): the new cointegrating vector identified is very similar to that identified in (5) and to that obtained by the non-vectorial ECM (equations 2 and 3)[30]. The two adjustment coefficients are also both statistically significant. In addition, the short-run relationships are also significant or coherent with economic theory.

## 5.2 Credit during the crisis: a comparison with the forecasts of the model

In this last part of the paper, using the coefficients estimated with the different techniques described above, we make a dynamic out of sample forecast, starting from the third quarter of 2007, the period in which the financial crisis started. Like in the estimation stage, we look first at the dynamic forecast of the ECM model and then verify how the dynamic forecast of multivariate systems (VECM) diverges from them.

The performance of the ECM in the estimation period (1998:2 – 2007:2) is very good: the one-period ahead static forecast, provides an average forecast error of only 0.4% (around 2.4 billion euro) both with the one and two step procedures (Graphs 11-12). This corroborates the results we obtain with the out-of-sample dynamic forecast.

The results of the dynamic forecast conducted on the last two years diverge considerably from the actual value of loans: as can be seen in Graph 13, the outstanding loans figure is always higher than that forecast by the ECM on the basis of the functional relationships estimated before the crisis. Loans demonstrated a divergent trend with respect to their theoretical level, both with the two-steps and one-step approaches; the difference between actual loans and their forecast value – statistically significant from the third quarter of 2007 onwards – grows as the crisis intensifies. In the fourth quarter of 2008 and in the first three months of this year, the period in which the GDP dropped the most, this sort of "extra-credit" exceeded 80 billion euro on the basis of the one-step approach and 90 billion according to the two step approach; in mid 2009, it was

[30] *Overall, the following relationships emerge from the long-run loan demand equations estimated: if VAK rises by 1%, IMP rises by around 2%; if the MOL/VAN ratio increase by 1%, IMP falls by 0.3%-0.5%; a fall of 100 basis points in TIMP leads to an increase of around 1% in IMP.*

around 100 billion, an additional 12% of loans compared to that justified by the changed macroeconomic scenario[31].

The same forecasting method can be applied to the estimations obtained by the VECM specification, both in its complete form and in the parsimonious model (reduced form model). The dynamic forecast of multivariate systems is performed only using the equation of the model in which lending is a dependent variable[32], in order to verify how bank lending should have behaved in the last two years, given the performance of the determinants of demand and on the basis of the relationships identified by the system.

The results of the forecasting exercise conducted on the multivariate systems lead to the same conclusions reached with the ECM specifications (Graphs 14-15): the positive difference between actual outstanding loans and their forecast value continues to increase during the crisis. This difference materialises – both with the VECM and in the reduced form system – at the end of 2008 and in the first half of 2009 with values of between 80 and 100 billion[33].

So what does this "extra-credit" represent and why did it develop? A possible theoretical explanation can be obtained by using a supply and demand model of bank loans (L = IMP), represented on a Cartesian plan (Graph 16) as a function of the real interest rate (i = TIMP). Starting from a hypothetical market equilibrium $P^*$, in place before the crisis, we see what could have happened in the last two years. The collapse of production activities and the reduction of investment programmes provoked a fall in the credit demand[34]: the result was a leftward shift of the demand curve. Maintaining the pre-crisis relationships and the initial supply curve constant, the theoretical equilibrium $P_1$ identifies the quantity of credit $L_1$ coherent with the new level of added value and the MOL shown during the crisis[35]: $L_1$ therefore represent the outstanding loans forecasted by the model.

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[31] *This result cannot be compared to that obtained in a recent IMF study contained in the October 2009 Global Financial Stability Report and referred to by Onado (2009) in a recent article he wrote for LaVoce.info. This IMF study, which finds a financing gap (excess of demand with respect to the supply of credit) in 2009 of 460 billion, in the first place refers to the whole euro area and not to Italy, where, as we have seen, the credit situation is better; furthermore, in this IMF study, credit demand also includes that of the public sector, which in 2009 was almost double that of the private sector; lastly, unlike the analysis conducted in this paper, the IMF study was conducted using forecasts for 2009 and 2010 and seeks to estimate future credit capacity. There are a number of differences in terms of methodology and objectives with respect to this paper.*

[32] *Therefore the model solution is found only considering the loans equation and excluding the other equations of the system; with the exception of loans, the other variables considered endogenous in the system being estimated, are treated in the forecast (in the solution of the model) as exogenous.*

[33] *This differential obtained by the multivariate systems, slightly lower in the first period with respect to the non-vectorial approaches, rose considerably over the course of 2008 and in the first half of 2009, showing a trend in the last stage very like that obtained with the one-step ECM.*

[34] *This should have more than offset the positive effect on demand resulting from the simultaneous fall in self-financing.*

[35] *This explanation also consider the monetary effects caused by inflation.*

The outstanding loans observed were nevertheless higher than $L_1$: this difference was formed due to a change in pre-crisis relationships and by virtue of a rightward shift of the supply curve, in line with the lower level of interest rates. Equilibrium $P_2$ represents actual market equilibrium and $L_2$ are the outstanding loans actually recorded during the last two years.

The concept of "extra-credit" can therefore be identified as the difference between $L_2$ and $L_1$ and is explained by a rightward shift of the supply curve; instead, if there had been a credit crunch, we would have expected to see a significant leftward shift of the credit supply curve, as indicated in the definition by Bernanke and Lown[36].

## 6. CONCLUSIONS

The empirical evidence presented in this paper supports the theory according to which, in Italy, over the course of the recent economic and financial crisis, despite a considerable slowdown in bank lending, there has not been a credit crunch.

The paper moves from an analysis of credit trends in the production sector, first demonstrating how the dynamics of the same were much more positive than those recorded for important economic variables such as, for example, industrial production. In the period between September 2008 and August 2009, the average annual growth rate of loans (seasonally-adjusted) was 4.5% compared to a corresponding average fall in industrial output of 16.8%. This aspect is particularly important in the light of the causality link between the two variables, which, conducted on a time series appropriately cleaned of trends, and using Granger's casuality test, demonstrated that bank lending is determined (caused) by industrial production and not vice versa.

Given that industrial production today represents a minor part of economic activity, the paper then focused on credit related to the output produced as a whole. From the analyses, it appears that over the course of 2008 and in the first six months of 2009, the bank credit-to-GDP ratio (credit per unit of GDP) slowed down but never fell; furthermore, the annual trend was far higher than that experienced in previous downturns identified by the International Monetary Fund, which in a recent report identified the threshold for the change in the bank credit-to-GDP ratio beyond which we can speak of credit squeeze/crunch as between -0.6 and -1%.

In the paper, in order to take the whole series of determinants of credit demand into account, an error correction econometric model (ECM) was constructed – estimated on the pre-crisis period (1998.Q2 – 2007.Q2) and applied using both the one-step and two-step procedure – which considers loans as a function of the added value of the private sector, of the gross operating margin to nominal added value ratio (a proxy for self-financing) and of the real interest rate on loans. To test

[36] *See Section 3.*

the robustness of the results obtained, we then removed the assumption of weak exogeneity of the independent variables of the single-equation model and constructed a multivariate multi-equation system (VECM).

All of the different approaches and methods used provided similar results: as expected, credit demand increases as the real added value increases and falls as the cost of lending and self-financing increase. Weak exogeneity tests would also appear to indicate that the only variable that can certainly be considered endogenous in the multivariate system is loans, confirming the results obtained with the single-equation non-vectorial model (ECM).

The dynamic out-of-sample forecast of the model, relating to the two year period of economic and financial crisis (2007.Q3 – 2009.Q2), shows that the actual loan stock was far higher than the "theoretical" level forecasted on the basis of the functional relationships estimated before the crisis. This delta, a sort of "extra-credit", estimated to be over 80 billion euro (10-13% of loans) at the end of the first half of 2009, can be interpreted as the result of a rightward shift of the credit supply curve and not a leftward one as should have happened in the case of a credit crunch.

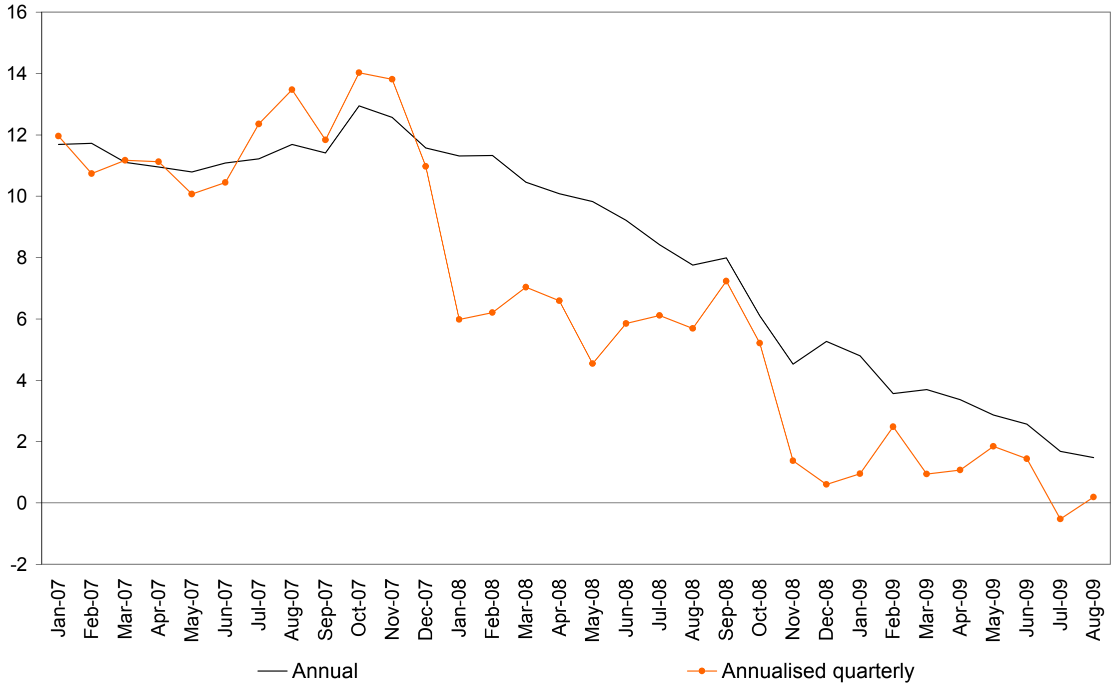
If other factors are considered stable, and given the difficult economic scenario, the higher propensity to grant credit could be the result of the increased awareness of the banking industry of all of those aspects – beyond traditional ones – that tend to reinforce medium/long run relationships with customers (higher consideration of firm's income prospects, personal and long-lasting relationships with entrepreneurs etc.).

These conclusions have been drawn from macroeconomic data. It would be interesting to conduct further exploration, conducting some disaggregation, to test any asymmetries in the results from a territorial, sector-related or dimensional perspective. A further development could be to extend the research to the main countries of the euro area.

**Graphs and Tables**

**Graph 1**

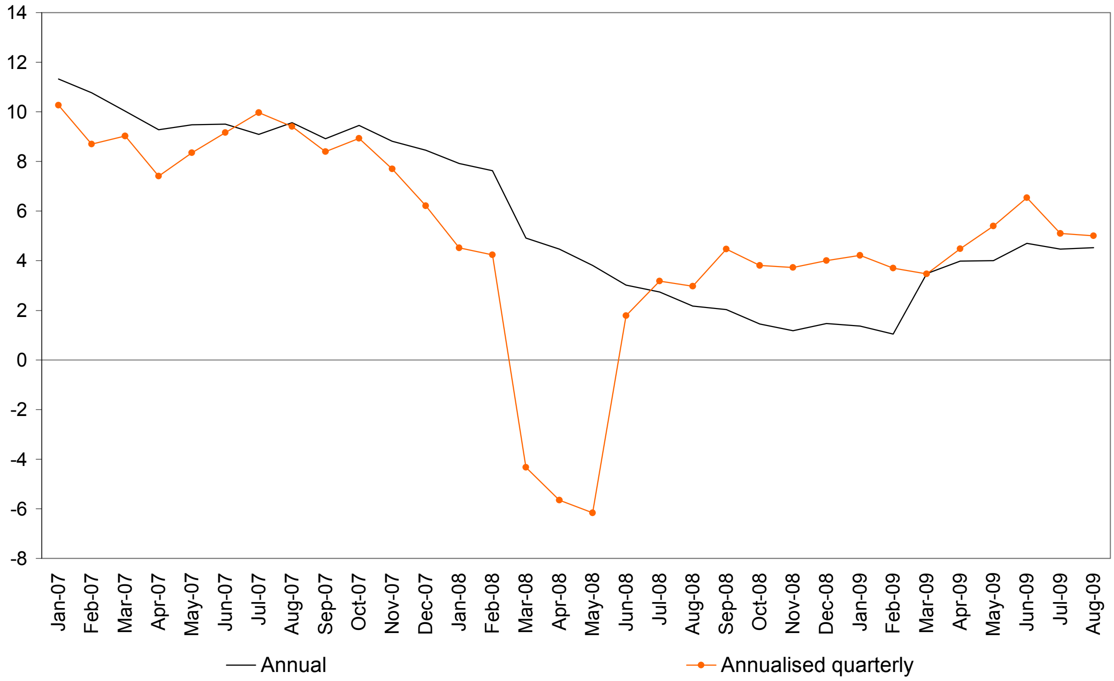
***Growth rate of loans to the private sector***
***(seasonally-adjusted data; % val.)***




*Source: our calculations on Bank of Italy data*

**Graph 2**

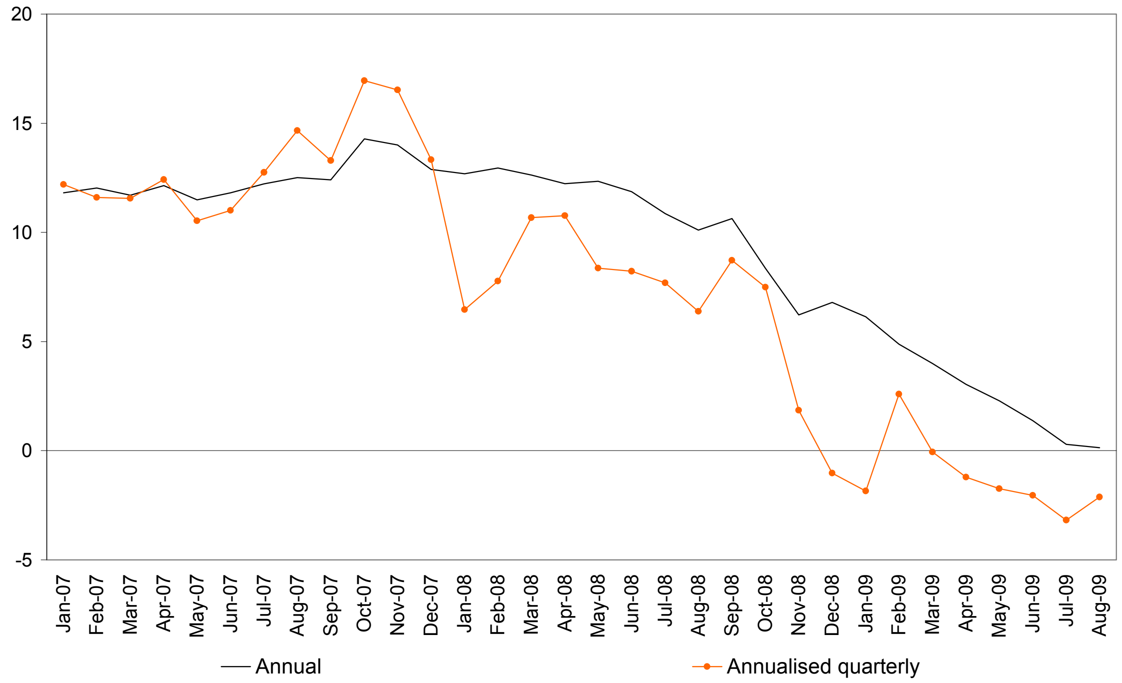
***Growth rate of loans to consumer households***
***(seasonally-adjusted data; % val.)***




*Source: our calculations on Bank of Italy data*

**Graph 3**

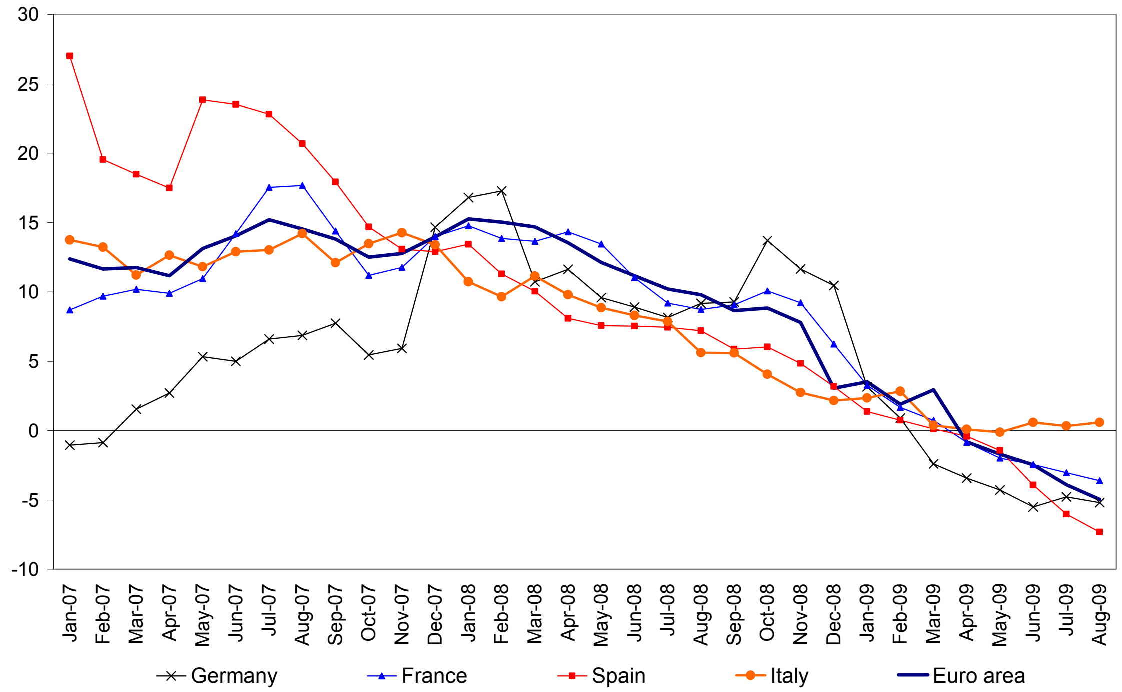
***Growth rate of loans to the production sector***
***(seasonally-adjusted data; % val.)***




*Source: our calculations on Bank of Italy data*

**Graph 4**

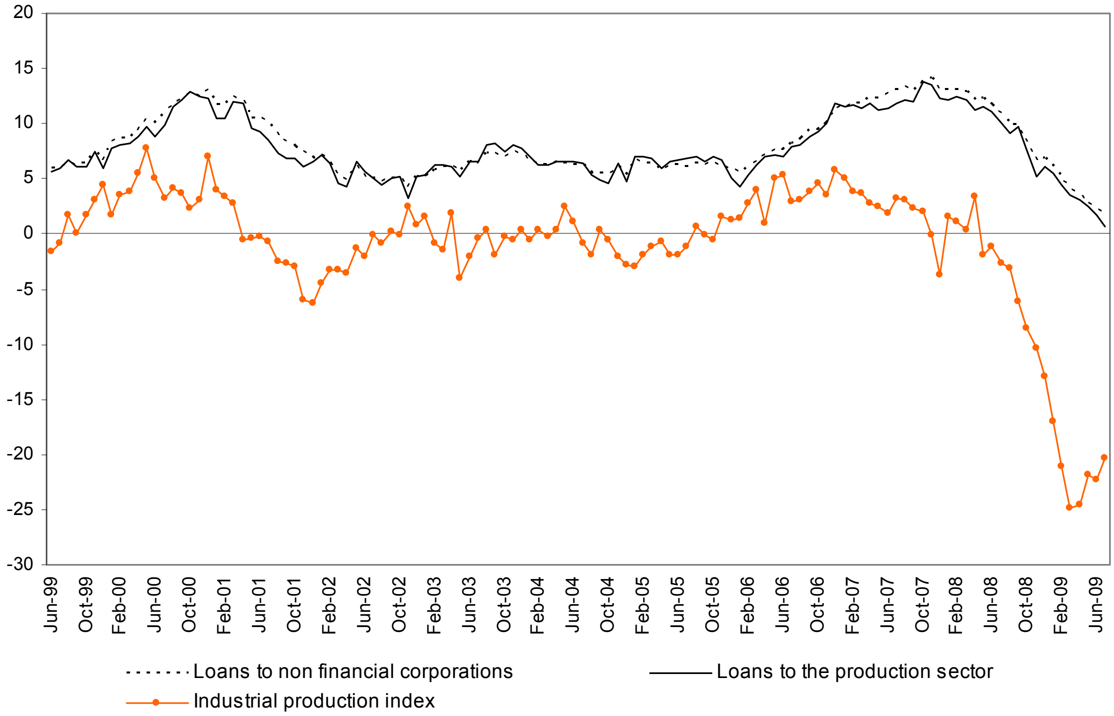
***Growth rate of loans to non-financial firms: an international comparison***
***(annualised quarterly % change; seasonally-adjusted data)***




*Source: our calculations on European Central Bank data*

**Graph 5**

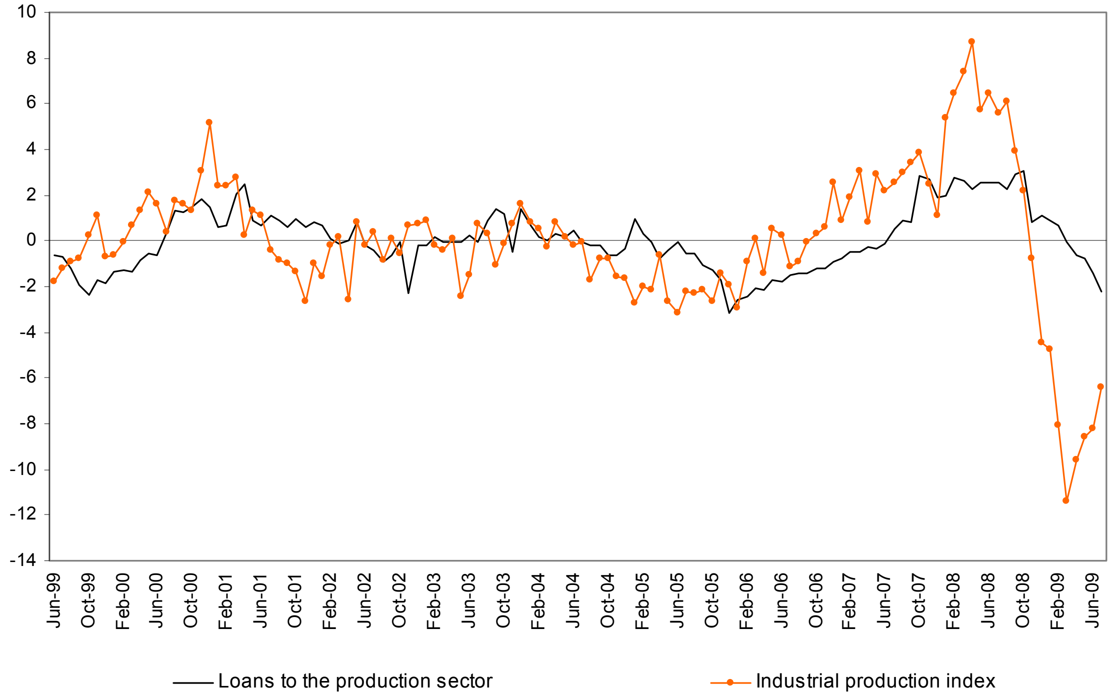
***Credit and industrial production: annual growth rates***
***(% change; on seasonally-adjusted data)***




*Source: our calculations on Bank of Italy data e Istat*

**Graph 6**

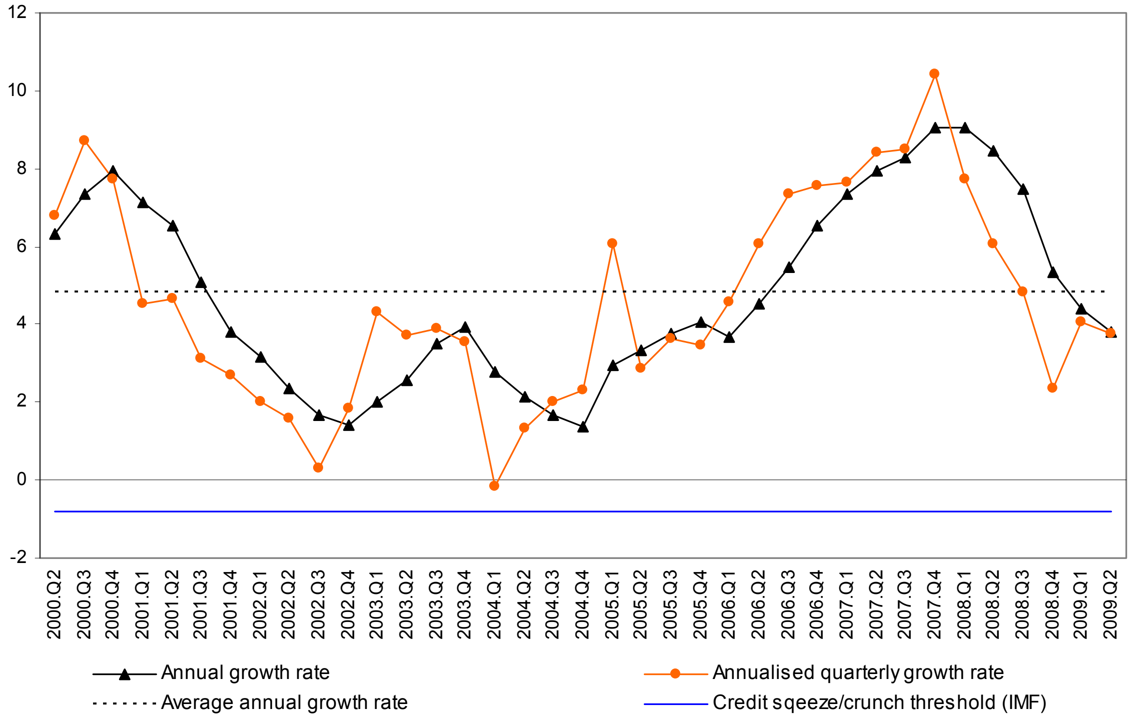
***Credit and industrial production: the cyclical component***
***(percentage gap with respect to the long-run trend)***




*Source: our calculations on Bank of Italy data e Istat*

**Graph 7**

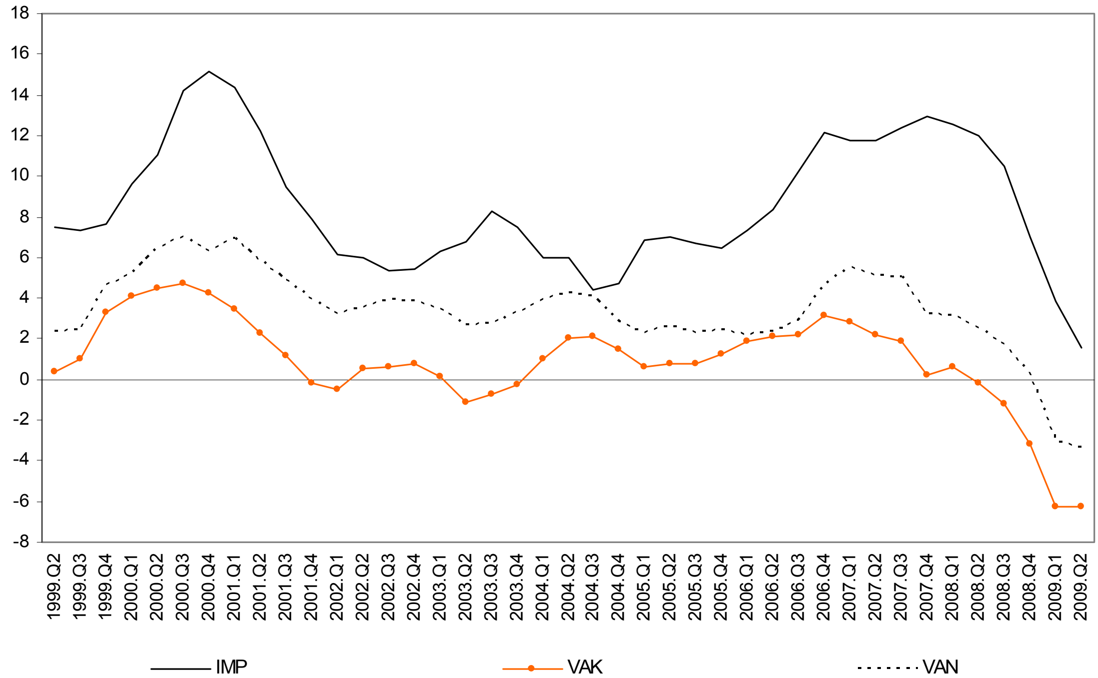
***Dynamics of the bank credit-to-GDP ratio of the production sector***
***(% change; quarterly data 2000:2 - 2009:2)***




*Source: our calculations on Bank of Italy data e Istat*

**Graph 8**

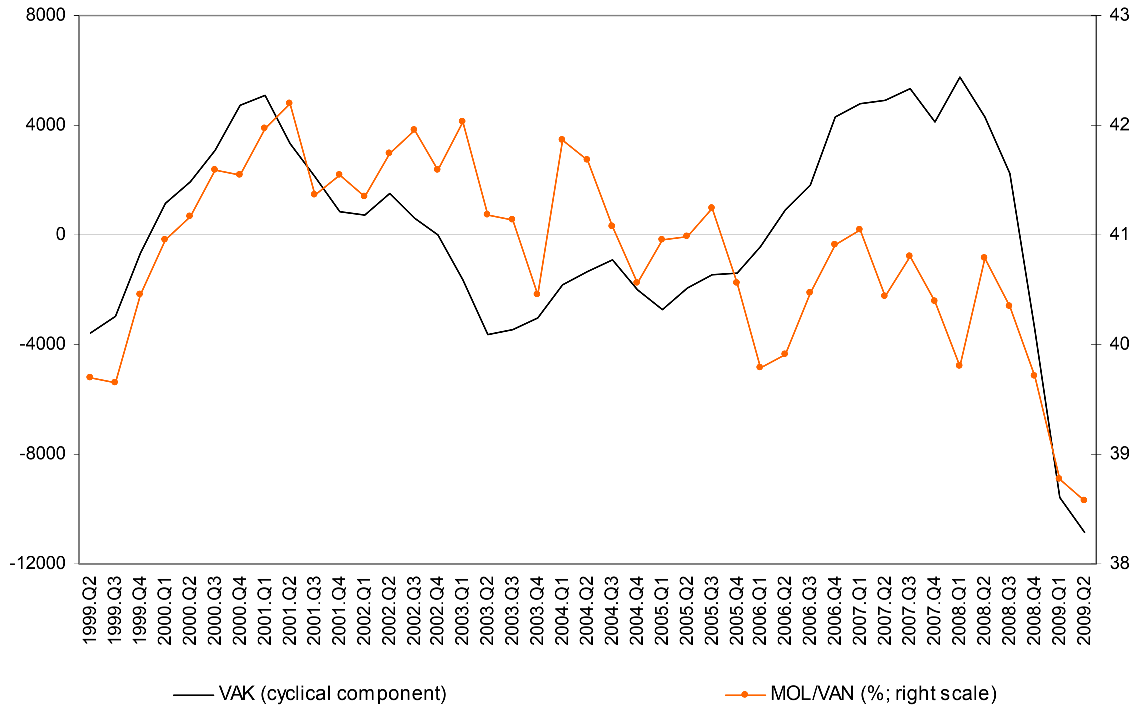
***Loans and Added value of the private sector: annual growth rates***
***(quarterly data; % change)***




*Source: our calculations on Bank of Italy data e Istat*

**Graph 9**

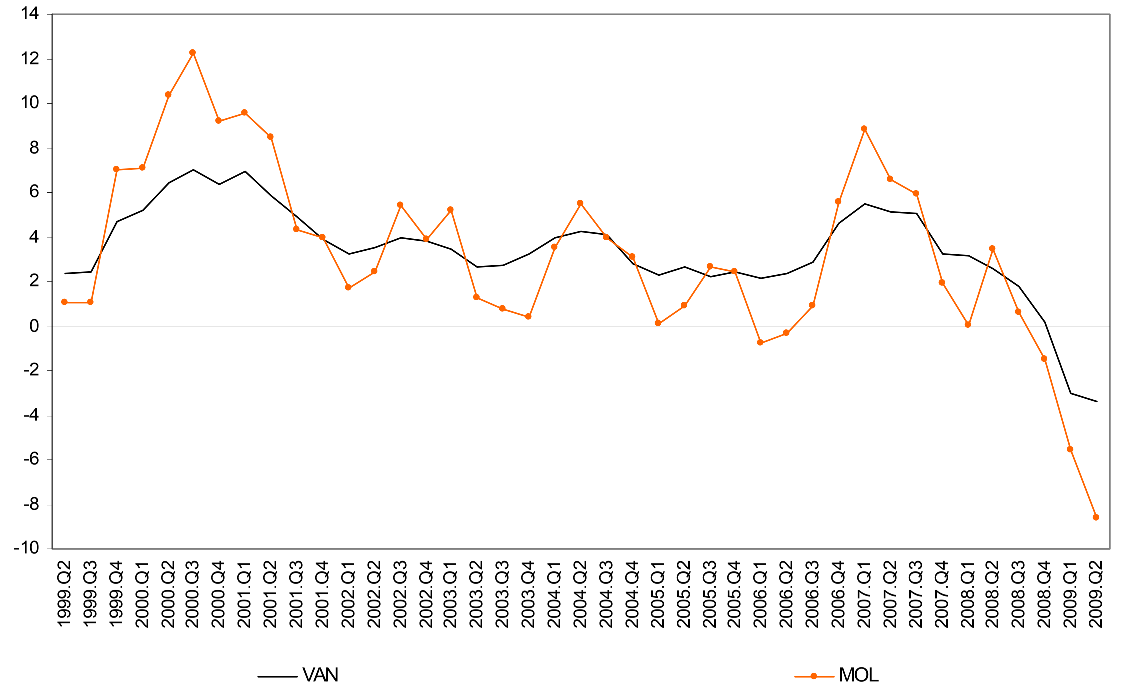
***Added value and gross operating margin (quarterly data)***




*Source: our calculations on Istat data*

**Graph 10**

***Gross operating margin and nominal added value: annual growth rates (quarterly data; % change)***




*Source: our calculations on Istat data*

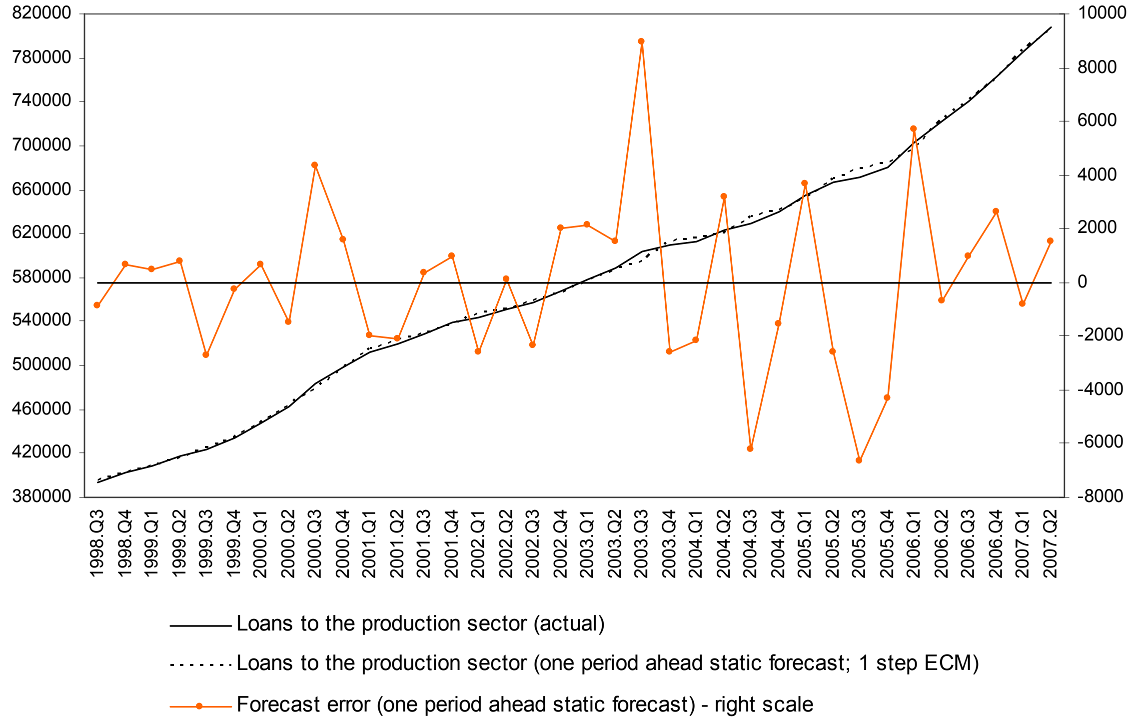
**Graph 11**

***The performance of the 2-step ECM in 1998-2007***
***(figures in euro millions)***


*Source: our calculations on Bank of Italy and Istat data*

**Graph 12**

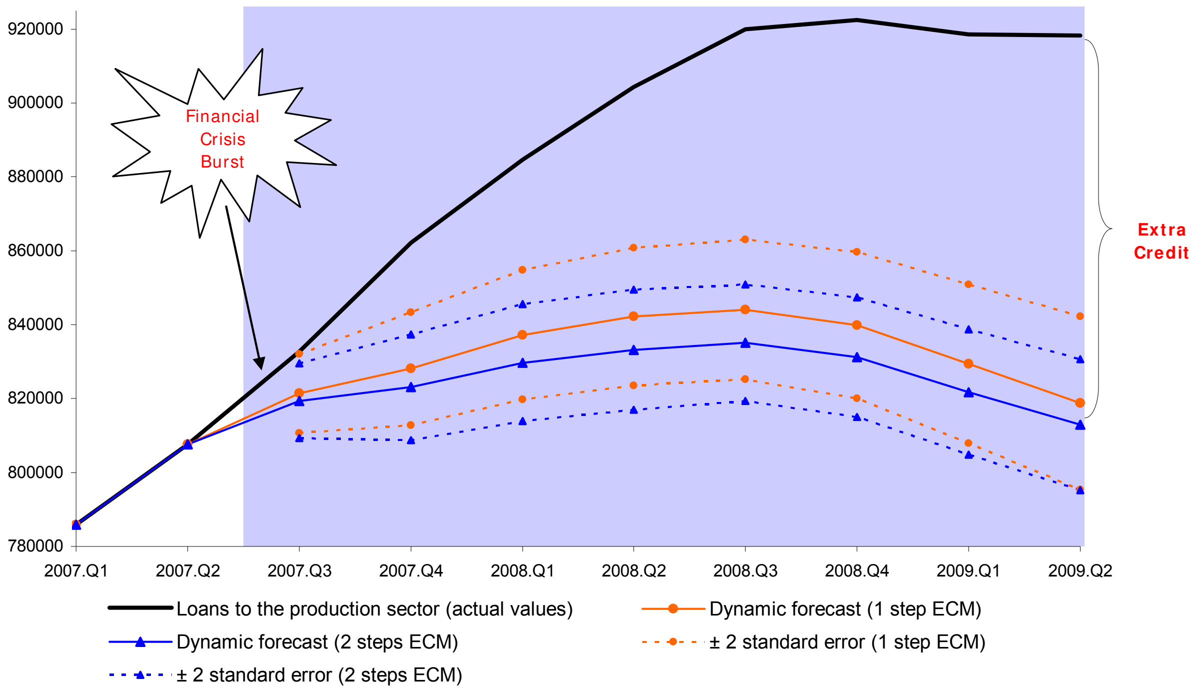
***The performance of the 1-step ECM in 1998-2007***
***(figures in euro millions)***




*Source: our calculations on Bank of Italy and Istat data*

**Graph 13**

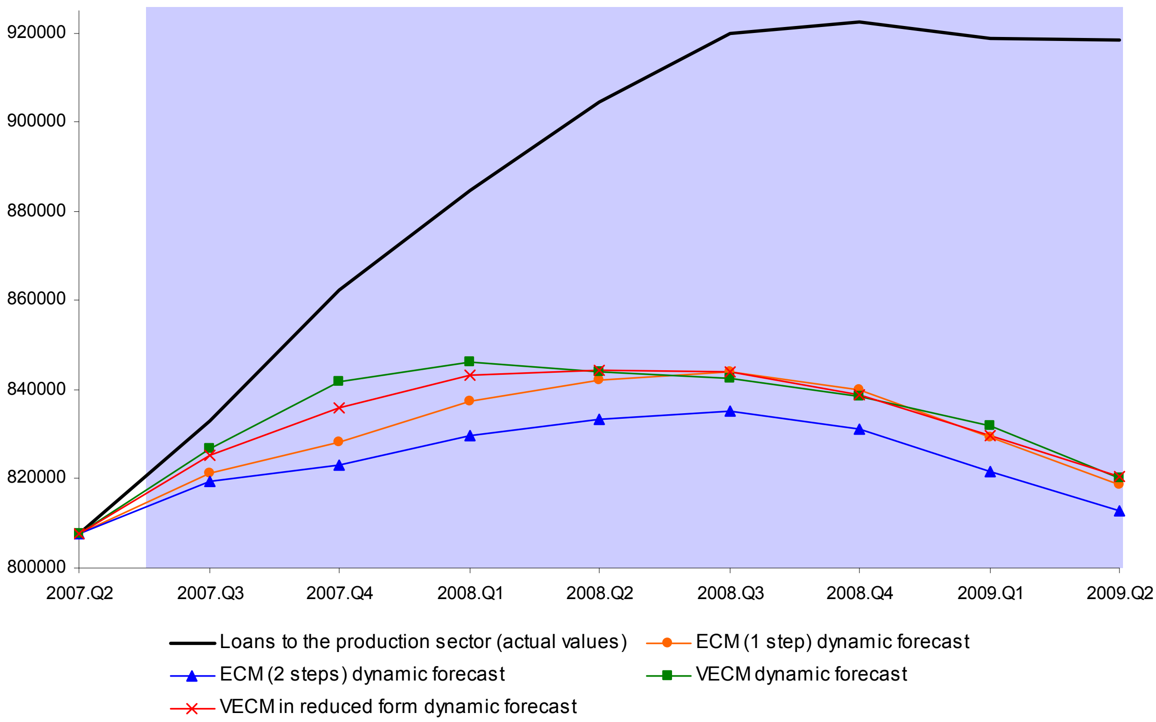
***Bank lending during the crisis and dynamic forecast of the ECM (figures in euro millions)***




*Source: our calculations on Bank of Italy and Istat data*

**Graph 14**

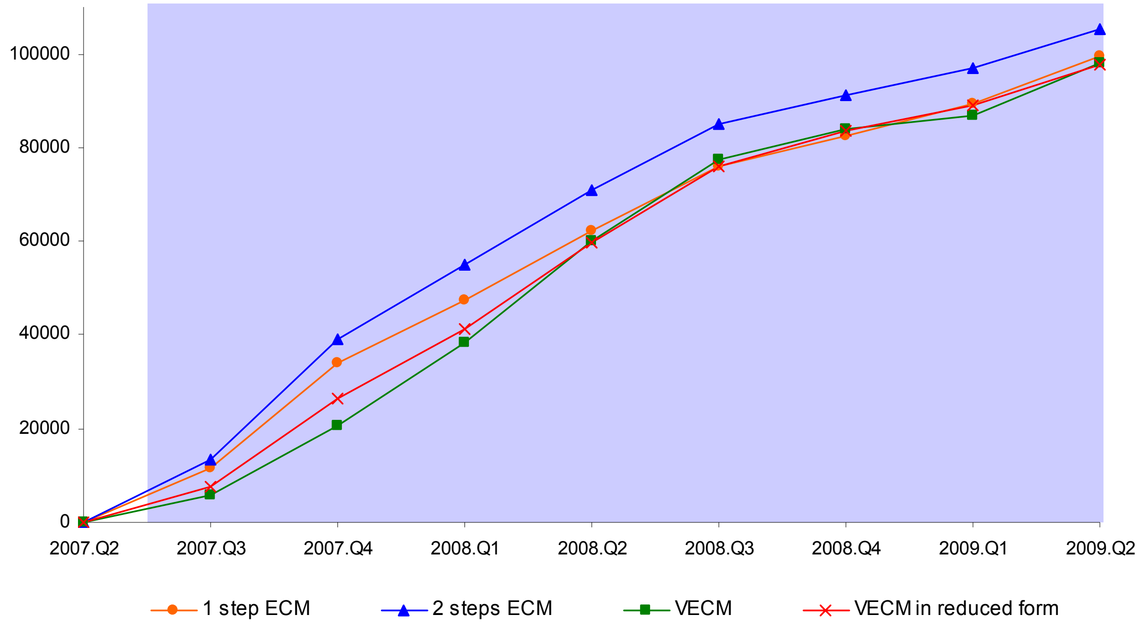
***Bank lending during the crisis and dynamic forecasts of the models: A comparison between ECM and VECM (figures in euro millions)***




*Source: our calculations on Bank of Italy and Istat data*

## Graph 15

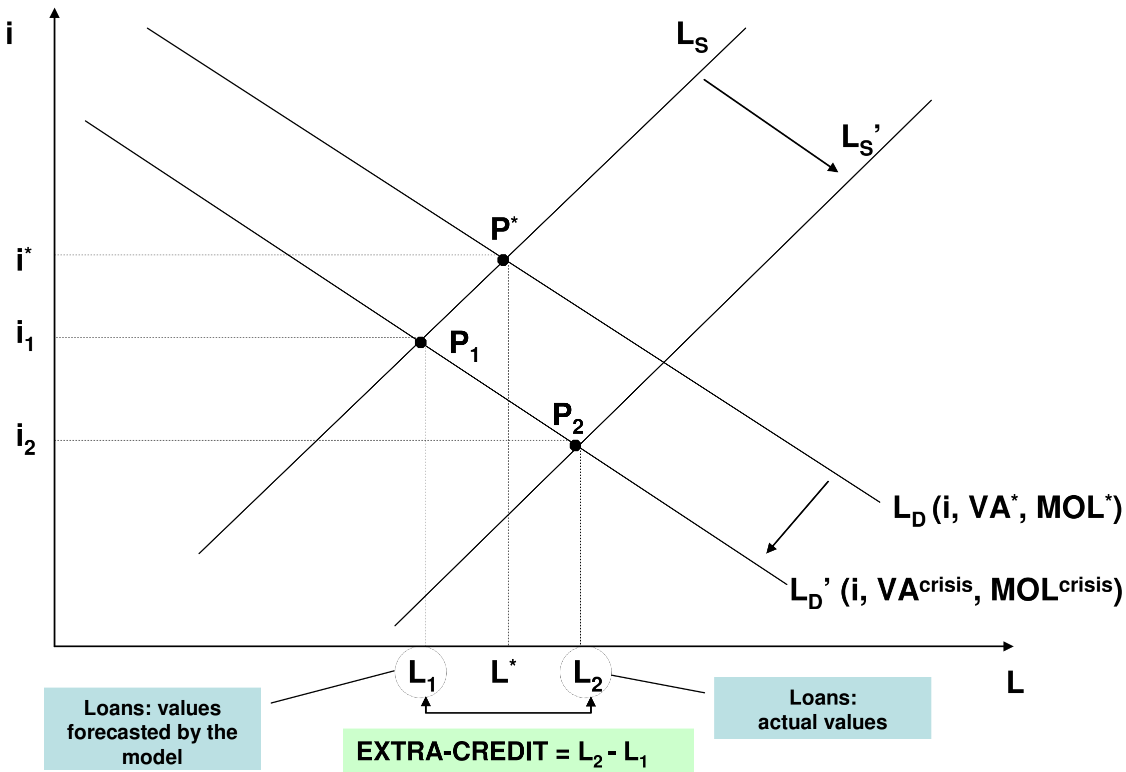
***Credit during the crisis: the difference between actual values and forecast values (figures in euro millions)***




*Source: our calculations on Bank of Italy data e Istat*

## Graph 16

***"Extra-Credit": a theoretical explanation***




*Source: our elaborations*

**Table 1**

***Credit and industrial production: Pairwise Granger Causality Tests***

Sample period: 06:1999 - 07:2009 (monthly data)

| Null Hypothesis: | F-Statistic | Probability |
|---|---|---|
| Industrial production does not Granger cause Loans to the production sector | 8.911 | 0.000 |
| Loans to the production sector do not Granger cause Industrial production | 1.291 | 0.279 |

Lags: 2
The test considers the variables' cyclical components, obtained removing the long period components (computed using the Hodrick-Prescott filter).

**Table 2**

***Stationarity test: Augmented Dickey-Fuller Unit Root Test***

Sample period: 1998:Q1 - 2007:Q2 (quarterly data)

*Null hypothesis: unit root (non-stationarity)*

| Variable | Test statistic | Prob [1] | Test Critical Values | | |
|---|---|---|---|---|---|
| | | | *1%* | *5%* | *10%* |
| **ln(IMP)** | -0.019 | 0.951 | -3.627 | -2.946 | -2.612 |
| **TIMP** | -1.991 | 0.289 | -3.679 | -2.968 | -2.623 |
| **ln(VAK)** | -0.946 | 0.762 | -3.627 | -2.946 | -2.612 |
| **ln(MOL/VAN)** | -2.243 | 0.195 | -3.621 | -2.943 | -2.610 |
| ***ε = ECM*** | -3,383 ** | 0.018 | -3.627 | -2.946 | -2.612 |

[1] MacKinnon (1996) one-sided p-values.

** We can reject the null hypothesis at a significance level of 5%.

## Table 3

### *Error Correction Model estimates*

Sample period: 1998:Q2 - 2007:Q2 (quarterly data)

| | Coefficients | Regressors | *(1) - (2)* | *(3)* |
|---|---|---|---|---|
| | | Estimation procedure: | ***Two steps*** *(Engle and Granger procedure)* | ***One step*** *(single equation procedure)* |
| *adjustment coefficient* | $\theta$ | *equazione di lungo periodo* | -0.548 *** (0,157) | -0.492 *** (0,129) |
| *long-run coefficients* | $\lambda_1$ | *trend* | 0.012 *** (0,001) | 0.012 *** (0,001) |
| | $\lambda_2$ | *TIMP* | -1.145 *** (0,192) | -0.959 *** (0,304) |
| | $\lambda_3$ | *ln(VAK)* | 1.858 *** (0,170) | 1.942 *** (0,333) |
| | $\lambda_4$ | *ln(MOL/VAN)* | -0.320 ** (0,136) | -0.375 (0,293) |
| *short-run coefficients* | $\beta_1$ | *Δln(IMP$_{t-1}$)* | 0.482 *** (0,109) | 0.406 *** (0,143) |
| | $\beta_2$ | *Δ(TIMP$_t$)* | -0.682 *** (0,204) | -0.591 ** (0,224) |
| | $\beta_3$ | *Δln(VAK$_t$)* | 0.763 *** (0,224) | 0.707 *** (0,248) |
| | $\beta_4$ | *Δln(MOL$_t$/VAN$_t$)* | -0.196 ** (0,086) | -0.189 * (0,109) |

Estimation method: Ordinary Least Squares (OLS).

Standard errors in brackets.

The symbols ***, ** and * represent statistical significance at the 1, 5 and 10 per cent level.

## Table 4

### *VAR: lag order determination tests*

Endogenous variables: ln(IMP), TIMP, ln(VAK), e ln(MOL/VAN)

Sample period: 1999:Q1 - 2007:Q2

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 335.5149 | NA | 2.21E-14 | -20.09181 | -19.91042 | -20.03078 |
| 1 | 505.3535 | 288,2110* | 1,99e-18* | -29.41537 | -28,50839* | -29,11020* |
| 2 | 518.5723 | 19.22725 | 2.47E-18 | -29.2468 | -27.61425 | -28.6975 |
| 3 | 533.8397 | 18.50596 | 2.92E-18 | -29.20241 | -26.84427 | -28.40897 |
| 4 | 560.112 | 25.47614 | 2.03E-18 | -29,82497* | -26.74125 | -28.78739 |

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

## Table 5

***Johansen's cointegration test***

Variables: ln(IMP), TIMP, ln(VAK), ln(MOL/VAN)

Sample period: 1999:Q1 - 2007:Q2

Unrestricted Cointegration Rank Test (Trace)

Trend assumption: Intercept and Trend in Cointegrating equation (Linear deterministic trend, restricted)

| Null hypothesis: No. of Cointegrating Equations (R) | Trace Statistic | 5% Critical Value | Prob.** |
|---|---|---|---|
| R=0 * | 69,098 | 63,876 | 0,017 |
| R≤1 | 40,998 | 42,915 | 0,077 |
| R≤2 | 18,321 | 25,872 | 0,323 |
| R≤3 | 7,260 | 12,518 | 0,318 |

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

## Table 6

***Vector Error Correction Model estimates***

Sample Period: 1998:Q2 - 2007Q:2 (quarterly data)

*(Standard errors in brackets)*

**Cointegrating Vector (long-run equation):**

$$\ln(IMP) = -12{,}105 + \underset{(0{,}001)}{0{,}012^{***}}(trend) - \underset{(0{,}172)}{1{,}428^{***}}(TIMP) + \underset{(0{,}157)}{2{,}002^{***}}\ln(VAK) - \underset{(0{,}139)}{0{,}455^{***}}\ln(MOL/VAN)$$

**Adjustment coefficients:**

| Coefficient | $\theta_1$ | $\theta_2$ | $\theta_3$ | $\theta_4$ |
|---|---|---|---|---|
| Dependent variable | $\Delta ln(IMP_t)$ | $\Delta(TIMP_t)$ | $\Delta ln(VAK_t)$ | $\Delta ln(MOL_t/VAN_t)$ |
| | -0,556 ***<br>(0,214) | -0,344 **<br>(0,148) | 0.041<br>(0,147) | 0.139<br>(0,403) |

The symbols ***, ** and * represent statistical significance at the 1, 5 and 10 per cent level.

## Table 7

### *VECM: weak exogeneity tests*

*(LR test)*

| Dependent variable | $\Delta ln(IMP_t)$ | $\Delta(TIMP_t)$ | $\Delta ln(VAK_t)$ | $\Delta ln(MOL_t/VAN_t)$ |
|---|---|---|---|---|
| Null hypothesis: | $\theta_1 = 0$ | $\theta_2 = 0$ | $\theta_3 = 0$ | $\theta_4 = 0$ |
| Weak exogeneity of: | *ln(IMP)* | *TIMP* | *ln(VAK)* | *ln(MOL/VAN)* |
| $\chi^2$ | 5.090 | 2.138 | 0.028 | 0.067 |
| p-value | 0.024 | 0.144 | 0.866 | 0.796 |

*joint tests*

| Null hypothesis: | $\theta_3 = 0$<br>$\theta_4 = 0$ | $\theta_2 = 0$<br>$\theta_3 = 0$<br>$\theta_4 = 0$ |
|---|---|---|
| $\chi^2$ | 0.067 | 7.237 |
| p-value | 0.967 | 0.065 |

Weak exogeneity is accepted, at a confidence level of 95 (90) per cent, when the p-value is larger than 5 (10) per cent.

## Table 8

### *Estimates of the VECM in reduced form*

*(VAK and MOL/VAN exogenous)*

Sample period: 1998:Q2 - 2007:Q2 (quarterly data)

**Cointegrating Vector (long-run equation):**

$$\ln(IMP) = -10{,}787 + \underset{(0{,}001)}{0{,}013^{***}}(trend) - \underset{(0{,}185)}{0{,}985^{***}}(TIMP) + \underset{(0{,}203)}{1{,}906^{***}}\ln(VAK) - \underset{(0{,}172)}{0{,}299^{*}}\ln(MOL/VAN)$$

| | Dependent variable: | $\Delta ln(IMP_t)$ | $\Delta(TIMP_t)$ |
|---|---|---|---|
| *Adjustment coefficients* | $\theta_i$ *(con i=1,2)* | -0,497***<br>(0,114) | -0,247***<br>(0,083) |
| | *Regressors:* | | |
| *short-run coefficients* | $\Delta ln(IMP_{t-1})$ | 0,725***<br>(0,119) | -0,282***<br>(0,071) |
| | $\Delta ln(VAK_t)$ | 0.387<br>(0,232) | 0,851***<br>(0,178) |
| | $\Delta ln(VAK_{t-1})$ | -0.354<br>(0,237) | -0,313*<br>(0,183) |
| | $\Delta ln(MOL_t/VAN_t)$ | -0.119<br>(0,084) | -0.098<br>(0,063) |

Estimation method: *Seemingly Unrelated Regression* (*SUR*)

Standard errors in brackets.

The symbols ***, ** and * represent statistical significance at the 1, 5 and 10 per cent level.

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