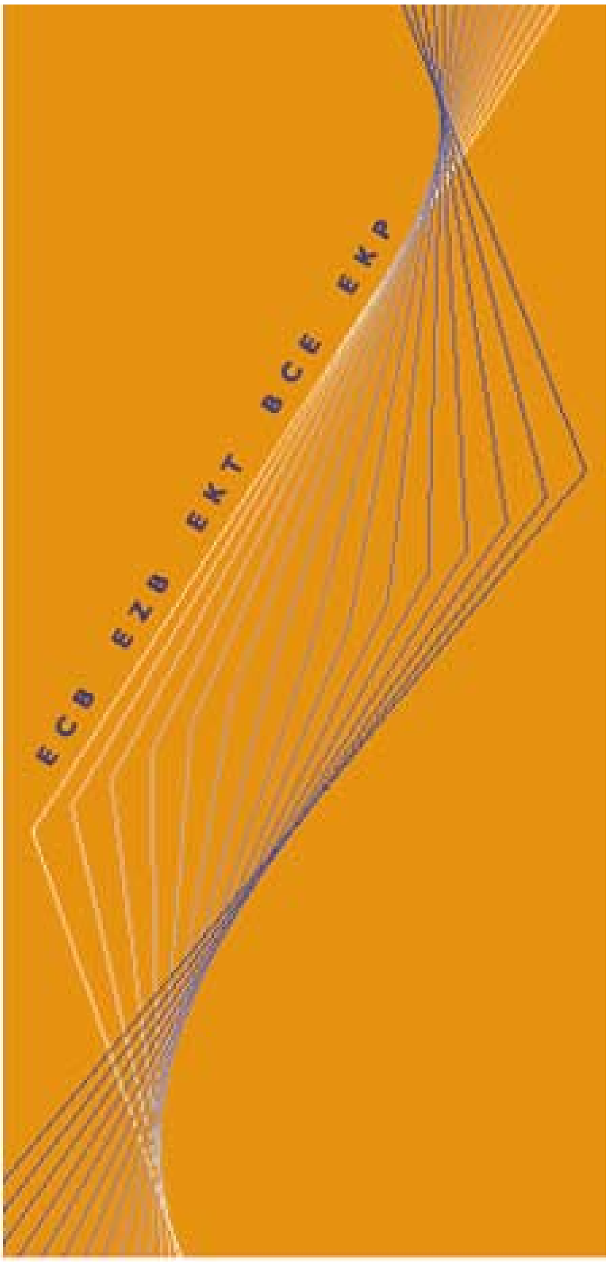
EUROPEAN CENTRAL BANK

WORKING PAPER SERIES



WORKING PAPER NO. 55

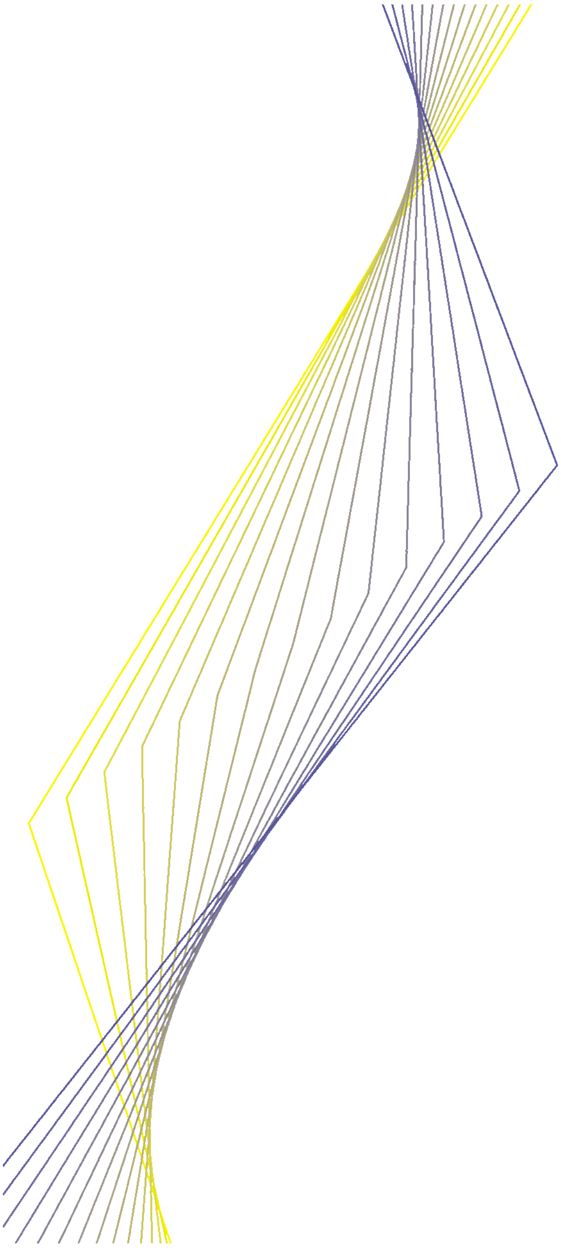
MODELLING THE DEMAND FOR LOANS TO THE PRIVATE SECTOR IN THE EURO AREA

BY A. CALZA
C. GARTNER
AND J. SOUSA

April 2001

EUROPEAN CENTRAL BANK

WORKING PAPER SERIES



WORKING PAPER NO. 55

MODELLING THE DEMAND FOR LOANS TO THE PRIVATE SECTOR IN THE EURO AREA

BY A. CALZA
C. GARTNER
AND J. SOUSA*

April 2001

* European Central Bank, Kaiserstraße 29, 60311 Frankfurt am Main, Germany. E-mail addresses: alessandro.calza@ecb.int, christine.gartner@ecb.int, joao.sousa@ecb.int.
The authors thank the participants in an ECB internal seminar and an anonymous referee for very valuable comments. We are especially grateful to Dieter Gerdesmeier for a number of interesting suggestions. All remaining errors are our own. The opinions expressed are exclusively those of the authors and should not be attributed to the European Central Bank.

Address	**Kaiserstrasse 29**
	D-60311 Frankfurt am Main
	Germany
Postal address	**Postfach 16 03 19**
	D-60066 Frankfurt am Main
	Germany
Telephone	**+49 69 1344 0**
Internet	**http://www.ecb.int**
Fax	**+49 69 1344 6000**
Telex	**411 144 ecb d**

ISSN 1561-0810

Contents

Abstract

This paper studies the determinants of loans to the private sector in the euro area. Using the Johansen methodology, the study identifies one cointegrating relationship linking real loans, GDP and interest rates. This relationship implies that in the long-run real loans are positively related to real GDP and negatively to real short-term and long-term interest rates. Both the signs and the magnitude of the coefficients suggest that the cointegrating vector describes a long-run demand equation. The short-run dynamics of the demand for euro area real loans is subsequently modelled by means of a Vector Error Correction Model (VECM). A number of specification tests performed on the VECM produce satisfactory results, with tests of stability of the model parameters showing no signs of structural breaks during the sample period (1980 Q1 - 1999 Q2). All of this suggests that developments in real loans to the private sector in the euro area can be reasonably explained by the model.

Key words: credit demand, euro area, cointegration, error-correction model.
JEL Codes: C32, C51.

1 Introduction

Credit granted to the private sector is one of the main counterparts to monetary liabilities in the consolidated balance sheet of the Monetary and Financial Institutions (MFI) sector and constitutes an important source of financing for households and corporations in the euro area. Credit developments may thus contain useful information for analysing and forecasting economic activity, prices and monetary developments. Nevertheless, unlike euro area money demand, the developments of credit have received relatively little attention so far and, despite the vast literature on theoretical and empirical aspects of the credit channel, empirical evidence on the determinants of credit demand specifically related to the euro area and/or its member countries remains rather limited.

This paper conducts an econometric investigation of credit demand in the euro area or, more specifically, of the demand for loans to the private sector.[1] Most of the existing empirical studies on demand for credit aggregates assume a distinct behaviour of households and private non-financial corporations (see, for instance, Fase *et al.*, 1992, Focarelli and Rossi, 1998 and Manrique and Sáez, 1998)[2]. However, as in other econometric studies of monetary and financial developments in the euro area, this undertaking is only possible within the limits determined by data availability. Given the lack of sufficiently long historical data on the sectoral breakdown for the euro area, in this paper the analysis refers to total loans to the private sector (as in De Nederlandsche Bank, 2000 and Vega, 1989).[3]

As to the factors influencing credit demand, most studies include an economic activity variable (such as real GDP or industrial production) and financing costs (i.e. interest rates or bank lending rates) as its main determinants. There seems to be no clear consensus in the literature about how economic activity affects credit demand. Some empirical findings point to a *positive* relation between the two variables based on the theoretical grounds that strong economic growth would have a positive effect on expected income and profits and, thus, on the overall financial conditions of households and corporations. According to this argument, robust economic growth enables private agents to support higher levels of indebtedness and, consequently, to finance higher consumption and investments through credit (see Kashyap, Stein and Wilcox, 1993). An additional point would be that expectations of higher activity and productivity can lead to a larger number of projects becoming profitable in terms of expected net present value and, hence, to a higher demand for credit to fund them.

By contrast, other studies focusing on the US economy question the existence of a stable relationship between credit and economic activity. Some go even further and argue that, if any such relationship existed, it might actually turn out to be *negative* (e.g. Bernanke and Gertler, 1995 and Friedman and Kuttner, 1993). The main line of argument is that an increase in contemporary productivity (as opposed to expected productivity) leads to a rise in output and, ultimately, profits. Following this reasoning, during expansionary phases, companies might prefer to rely more on internal sources of finance and reduce the relative proportion of external financing (i.e. loans from banks or recourse to capital markets). Similarly, households may want to take advantage of higher

1 The ECB definition of credit to the private sector is a broad concept. In addition to loans, it includes financing provided through purchases of debt securities (such as corporate bonds) and of shares and other equity issued by non-banks. Given the lack of historical data on euro area MFI holdings of private sector securities, in this paper it was necessary to restrict the analysis to data on loans to the private sector, which are available from 1980 onwards, instead of the broader credit aggregate which is only available from 1997 onwards. Loans should, nonetheless, constitute a reasonable proxy as they account for over 90% of credit to the private sector in the euro area.

2 Fase et al. (1992) provide equations for credit (distinguishing between short-term and long-term) to households and firms in the Netherlands; Focarelli and Rossi (1998) focus on demand for credit to firms in Italy; Manrique and Sáez (1998) refer to credit to households and firms in Spain.

3 De Nederlandsche Bank (2000) estimates national equations for bank loans to the private sector in several EU countries, Japan and the USA; Vega (1989) focuses on aggregate credit demand in Spain.

income in expansionary phases to reduce their debt levels. On the other hand, in recessions, when both disposable income of households and the profitability of firms are likely to decline, households and corporations may increase their demand for bank credit in order to smooth out the impact of lower income and profits.

Most empirical studies also include a measure of the cost of loans as an explanatory variable. The negative relationship between the demand for loans and their cost (i.e. bank lending interest rates) appears to be more consensual, though some studies have pointed out that the price of loans should be adjusted to reflect the opportunity cost of bank loans (i.e. the cost of alternative sources of finance should be netted out as in Friedman and Kuttner, 1993). The underlying argument is that the demand for loans will depend not only on the own price of the borrowed funds, but also on their *relative* price (that is relative to the cost of funds obtained from other internal or external sources). This issue is more relevant for non-financial corporations than for households since the latter have limited access to financing from sources other than the banking sector.

As noted above, due to constraints in the availability of data, this study focuses on total loans to the private sector instead of their sectoral breakdown. We therefore implicitly assume that the demand for credit by corporations and households responds in the same direction to an improvement in economic activity or to changes in the level of interest rates. Based on the limited number of empirical studies for individual euro area countries, we can conclude that this assumption is not overly restrictive, particularly regarding the investigation of long run relationships. We acknowledge, however, that the availability of sectoral data would no doubt allow for a more refined modelling of the behaviour of loan demand.

An empirical investigation of the long-run determinants of demand for credit to households could, for instance, include scale variables such as consumption and residential investment or disposable income rather than total GDP. More precise measures of the cost of loans such as bank interest rates on mortgage credit and on credit for consumption purposes could be used, together with other explanatory variables such as asset prices (see *e.g.* Fase *et al.*, 1992 and Manrique and Sáez, 1998). As for loans to non-financial corporations, an empirical analysis could include investment as the appropriate scale variable (as in Focarelli and Rossi, 1998 and Manrique and Sáez, 1998) and specific interest rates on loans to corporations (see De Bandt and Jacquinot, 1992), while also considering additional explanatory variables such as profitability measures (e.g. Focarelli and Rossi, 1998) and inventory stocks (see De Nederlandsche Bank, 2000). Mergers and acquisitions activity, changes in regulatory and institutional arrangements (in particular in taxation and subsidies), market capitalisation of firms and structural evolution towards "securitisation" may also be considered as influencing the demand for bank loans to non-financial corporations.

It should be mentioned that the study is based on the assumption that what is being modelled is loan demand, even though the observed loan developments result from the interaction of both supply and demand. Therefore, it cannot be excluded that supply factors also influenced credit developments. However, at the current stage it is not possible to model the supply of loans effectively due to the lack of sufficiently long and harmonised data for the euro area on the determinants of the supply of bank loans (such as interest rate margins, bank's profitability measures, measures of competition in banking markets, etc.) that would allow such identification. If supply factors played a determinant role this might diminish the reliability of the results.

2 The model

The empirical model

For the reasons discussed above, the analysis of the demand for loans to the private sector in the euro area is limited to a relatively small set of explanatory variables representing general economic activity and the cost of loans.

The empirical model is based on the following long-run relationship specified in semi log-linear form:

$$LOANS = \alpha + \beta_1 \cdot GDP + \beta_2 \cdot ST + \beta_3 \cdot LT + \varepsilon \qquad (1)$$

where *LOANS* and *GDP* stand for logarithms of loans to the private sector and GDP both in real terms; while *ST* and *LT* denote the real short-term and long-term interest rates respectively.

This specification attempts to circumvent the constraints imposed by the relatively limited availability of historical data for the euro area. In particular, because of the lack of sufficiently long series for euro area retail interest rates, we assume that the cost of loans can be approximated by the short-term market interest rates and the long-term bond yield. We do not consider this assumption as being very restrictive. While market interest rates may be less than optimal proxies of retail lending interest rates in the short-run, they should share the same longer-term trend as retail interest rates. Besides, the fact that we do not allow for alternative sources of finance might not be critical given that external sources of finance in the euro area have traditionally been significantly less important than total bank credit in the euro area (see ECB, 2000).

Data issues

In this study, we analyse quarterly data for the euro area (based on the original 11 member countries) over the period 1980 Q1 – 1999 Q2. Real loans are measured by the logs of quarterly averages of end-of-month outstanding amounts of loans to the private sector (seasonally adjusted) deflated by the GDP deflator. Until Q3 1997 the series for loans is based on stock data, from Q4 1997 it is based on flow statistics. More detailed information about the computation of the historical data on loans to the private sector can be found in the Data Annex. The nominal and real GDP series are constructed up to the fourth quarter of 1994 by aggregating logs of seasonally-adjusted national accounts data from the BIS and the European Commission converted into euro using the irrevocably fixed rates announced on 31 December 1998; from the first quarter of 1995 onwards, the aggregate series has been extended using quarter-on-quarter growth rates derived from the ESA95-compliant series for seasonally-adjusted euro area GDP from Eurostat.

Real market interest rates are weighted averages of national short-term and long-term market interest rates, deflated by contemporaneous inflation as measured by annual percentage changes in the GDP deflator. In particular, the nominal short-term market interest rate is a weighted average (based on GDP-weights at 1995 purchasing power parities PPP) of the three-month interbank interest rates until 29 December 1998; thereafter, it corresponds to the three-month EURIBOR interest rate. Similarly, the nominal long-term interest rate is a GDP-weighted average of yields on national ten-year government bonds or their closest substitutes. Quarterly interest rates are period averages expressed in percentage points per annum.

The choice of the deflator for the computation of real interest rates raises some questions. In principle, *ex-ante* real rates (i.e. nominal interest rates deflated by expected inflation) would be more appropriate. However, since inflation expectations are not observable and there are several difficulties in their estimation, one simple alternative approach is the use of current inflation to deflate the nominal interest rate. This may work well for short-term maturities, as current inflation is unlikely to differ significantly from the expected inflation rate over a short period of time. In the case of long-term real interest rates inflationary expectations cannot be proxied so accurately by current inflation. In such case, models of inflation may be estimated in order to construct series of long-term inflation expectations or data from surveys on inflationary expectations can be used. Albeit imperfect, the approach followed in this paper is in line with that of other studies, in that current inflation is used to compute both the short-term and the long-term real rate. This procedure therefore assumes that during the sample period expectations are, on average, in line with the actual out-turns.

Like in all studies using reconstructed historical series for the euro area, one important issue concerning the database is the choice of the method for the aggregation of the national data for the period prior to the adoption of the single currency on 1 January 1999. This issue has received a significant amount of attention in the literature on money demand in the euro area (see, for instance, Browne *et al*., 1997 and Fagan and Henry, 1999). There are discordant views regarding the merits of the different aggregation methods (conversion at current exchange rates, at exchange rates fixed at some base period or at PPP exchange rates). For the purpose of this paper, which is not meant to deal with this issue, it is sufficient to point out that using irrevocable fixed rates to aggregate national contributions corresponds to the methodology used by the ECB for the computation of historical series on loans to the private sector. By contrast, the advantage of using GDP weights (measured at PPP weights) is that, unlike irrevocably fixed exchange rates, they can be applied also to series that are not based on nominal stocks such as interest rates. Thus, this second alternative ensures consistency in the way all variables are aggregated.

In this paper, the estimates are based on a set of variables computed using the following aggregation methods: (a) the irrevocable conversion rates announced on 31 December 1998 for nominal loans and real GDP (as well as for the nominal GDP series used for the computation of the GDP deflator); and (b) GDP weights at 1995 PPP exchange rates for the short-term and long-term market interest rates. However, in order to test for the robustness of the results to the aggregation method chosen, in Section 5 we re-estimate the model using an alternative database in which all the variables are consistently aggregated using GDP weights.

3 Stylised facts about loans to the private sector in the euro area

Figure 1 shows long time series for the annual growth rate of loans and GDP, both expressed in real terms. For most of the 1980s, loans to the private sector grew at a similar pace to GDP. This link was weaker around 1988-1990, when growth in loans to the private sector was well above that of GDP. Thereafter the growth of loans to the private sector seemed to follow the decline in economic activity over the period 1991-1993. However, it did not immediately follow the pick-up in growth in 1994, presumably because of the temporary rise in real long-term interest rates in that year. The annual growth rate of real loans to the private sector showed an upward trend over the rest of the sample period, whereas this did not seem to be the case for developments in GDP. This suggests that factors other than GDP growth might have contributed to the stronger growth of credit to the private sector over this period.

The rapid acceleration in real credit growth over the second half of the 1990s was accompanied by a decline in inflation. This is confirmed by Figure 2 where two alternative measures of inflation – annual percentage changes in the GDP deflator and consumer prices (as measured by the CPI) – are included. As the chart shows, the two alternative measures of inflation followed broadly the same pattern over the sample period, with one notable exception between the end of 1985 and the first half of 1987. During this period, there was a strong decline in CPI inflation. However, this was not accompanied by a corresponding decline in growth in the GDP deflator, that even rose somewhat at the beginning of 1986. The gap between the two inflation rates during this period might have been related to the impact on import prices of the combination of lower oil prices and a very strong appreciation of the Deutsche Mark and other currencies between 1985 and 1986.[4]

Figure 3 provides evidence of the relationship between credit developments and real interest rates. The chart suggests that over recent years an inverse relationship between real credit growth and real market interest rates has existed. This has been particularly significant over the last five years, when growth in loans to the private sector increased significantly at a time of declining real interest rates.

Tables 1 and 2 report some detailed data about the composition of loans to the private sector in the euro area. Although the data refer only to a relatively short period, they nevertheless provide an overview of the relative importance of loans by sector and of the maturity structure of loans that may be helpful in the interpretation of the empirical results. As can be seen in Table 1, euro area loans to the private sector are divided almost equally between loans to households and loans to corporations. Within the household sector, which accounts for 49% of the total, loans for house purchase are the most important (30%), followed by lending for purposes other than consumption or house purchasing (11%) and by consumer credit (8%). Within the corporation sector, loans to non-financial corporations are the most important accounting for 44-45% of all loans while loans to non-monetary financial corporations amount to around 7% of the total. Non-profit institutions serving households have a negligible share in total loans (less than 1%).

As regards the structure of loans to the private sector by original maturity (see Table 2), most loans (over 60%) are of a long-term nature (i.e. over 5 years). About a quarter of total loans are of a short-term maturity (i.e. up to 1 year), with the remaining share accounted for by loans with an original maturity between 1 and 5 years. It should be noted that no information is available on the residual maturity of these loans or on whether the interest rate charged on the loans is fixed or varies with market conditions. Such information would be helpful in order to more accurately assess the relative importance of short-term and long-term interest rates for the demand for loans.

4 Econometric analysis

Testing the integration properties of time series

Table 3 reports the results of two distinct unit root tests: the Augmented Dickey-Fuller and the Phillips-Perron tests. The results show that the null hypothesis of a unit root (non-stationarity) in the levels of *LOANS, GDP, ST* and *LT* could not be rejected. However, when the tests are performed on the first differences of the same variables the null hypothesis of an unit root is rejected for all the variables, suggesting that they can be treated as integrated of order 1 (i.e. I(1)).

In order to confirm the results of these traditional unit root tests, the variables are also subjected to further examination by means of the stationarity test suggested by Kwiatkowski et al. (1992).[5]

4 *The GDP deflator was less affected than the consumer price index by this development as by definition the former relates only to the prices of domestic production which are not as directly affected by foreign influences as some of the components of the CPI. It might be worth bearing this point in mind as it may contribute to explain one specific empirical finding of the study.*

As Table 4 shows, the null hypothesis of stationarity can be rejected for the levels of *LOANS, GDP, LT* (with constant and no trend in the auxiliary test regressions) and ST (with both constant and a trend) but not for their first differences, which confirms that these variables can be modelled as I(1).

Cointegration analysis

In this section the cointegration properties of the data are investigated making use of the Johansen procedure.[6] Accordingly, we estimate a Vector AutoRegression (VAR) model for *LOANS, GDP, ST* and *LT* over the period 1980 Q1 - 1999 Q2. The criterion for selecting the optimal lag length consists of choosing the number of lags that are needed to eliminate the vector autocorrelation in the residuals. This procedure suggests that the inclusion of 4 lags is appropriate. The model includes an unrestricted constant and allows for a linear trend in the variables but not in the cointegration relationship. The test results in Table 5 reveal that only one cointegrating vector is present in the data (asymptotic standard errors are shown in brackets):

$$LOANS = k + \underset{(0.04)}{1.339} \cdot GDP - \underset{(0.39)}{1.008} \cdot ST - \underset{(0.65)}{1.788} \cdot LT \qquad (2)$$

The above relation implies that in the long-run real loans are positively related to real GDP and negatively related to both real short-term and long-term interest rates. On the basis of the signs of the coefficients, we interpret the cointegrating relation as describing the long-run demand for loans. Formal exclusion tests show that none of the system's variables can be excluded from the cointegrating vector.[7]

As regards the estimated coefficients, the long-run elasticity of real loans and real GDP is above unity, which is consistent with the findings of several empirical investigations, including a recent study by Kakes (2000) for the Netherlands. One possible explanation for this result is that GDP might capture the effect of omitted variables, such as wealth, which are also relevant to explain credit demand. As regards the coefficients on real interest rates, the above relation implies that loans seem to be relatively more affected by changes in long-term real interest rates than by changes in short-term real interest rates. In fact the estimated interest rate semi-elasticities are consistent with a share of loans sensitive to short-term rates of around one third of the total. This is slightly higher than what was found in Table 2 for recent years (one-fourth of total loans). Nevertheless, it should be borne in mind that the relative share of fixed and variable rate loans is not accurately known for the time being.[8]

Figure 4 illustrates the error correction term corresponding to the cointegration relation (2) used in the modelling of the short-run dynamics of the system. The error correction term is scaled so that the deviations from the long-term equilibrium relationship average zero over the sample period.[9] Deviations from the zero horizontal line may therefore be interpreted as deviations from

5 *Stationarity tests are useful in that they allow to explicitly test the null hypothesis of stationarity and also assess to what extent the non-rejection of non-stationarity in unit root tests may be related to the lack of power of these tests (see, for instance, Schwert, 1987, and De Jong et al., 1992a, 1992b).*

6 *See Johansen (1995). This procedure is also used by Focarelli and Rossi (1998), while other studies on credit demand in individual euro area countries (e.g. Vega, 1989, and Manrique and Sáez, 1998) use alternative cointegrating techniques.*

7 *As suggested by Johansen (1988, 1991), the restriction tests performed consist of likelihood-ratio tests of zero restrictions on the coefficient of each variable in the long-run relation.*

8 *See ECB (1999).*

9 *More precisely the error correction term (ECT) is defined as ECT= LOANS-* $\bar{k}$*-1.339 GDP+1.008 ST + 1.788 LT, where* $\bar{k}$ *is computed so that the average of ECT is zero.*

the long-run equilibrium so that when the error correction term is above (below) the horizontal line, the level of real loans to the private sector is above (below) the equilibrium level implied by the model.

The deviations from equilibrium are generally relatively small with the main exception of the four quarters of 1986, during which real loans fall below their equilibrium level. A possible explanation for this deviation from equilibrium relates to the earlier-mentioned price developments between 1986 and 1987. In fact, the measure of real loans based on the GDP deflator used in this study could be "over-deflated" during this specific period due to the lower decline in the annual change in the GDP deflator relative to that in consumer prices.

Regarding the most recent period, the data suggest that the level of loans to the private sector was somewhat above the long-run equilibrium level at the beginning of 1999, even though the deviation is not significantly higher than in other periods within the sample. On the grounds of this empirical model, this "overhang" would be expected to contribute to slower loan growth in the future as the level of real loans to the private sector moves closer to the long-run equilibrium. However, this could depend, inter alia, on the nature of the process by which real loans adjust to deviations from equilibrium. In fact, given the characteristics of the model adopted, namely the possibility of the endogeneity of the determinants of loans, the return to equilibrium could also be induced by adjustments in variables other than loans. Therefore, it seems useful to investigate the properties of the model in a VECM format and to test whether there is any evidence that some of the variables may be (weakly) exogenous.

A dynamic model for loans to the private sector

The use of a VECM allows to specify both the long-run and the short-run dynamics of the model, while also capturing potential endogeneity of the determinants of credit demand. In particular, while the cointegrating vector is generally interpreted as a long-run equilibrium relationship, the estimates of the short-term dynamics help to characterise the process of adjustment towards this equilibrium.

The model is estimated in a VECM form over the period 1980 Q1 – 1999 Q2 (reported in Table 6) and subject to a number of standard misspecification tests. The coefficient of the error correction term in the equation for loans is statistically significant from zero, confirming the existence of a long run relationship linking real loans to real GDP and real interest rates. The sign of the coefficient also seems to suggest that the equation may be describing a demand behavioural relationship. The magnitude of the coefficient is rather small suggesting that in case of deviation of the stock of loans from their equilibrium level, this should be corrected only slowly. This coefficient is lower than the adjustment coefficient found in money demand studies (see Coenen and Vega, 1999 and Brand and Cassola, 2000). This probably reflects the fact that the adjustment of the stock of loans to the equilibrium level implies stronger frictions and transaction costs (for instance redemption penalties) than is the case with monetary instruments. The results of the misspecification tests (see Table 7) are fairly satisfactory. In particular, both the tests performed on the residuals of the individual equations and their multivariate variants show no evidence of autocorrelation, heteroscedasticity or non-normality. Following this assessment, weak exogeneity tests are performed on the equations for *GDP, ST* and *LT* in order to determine whether, in the spirit of a general-to-specific approach, it would be legitimate to specify the demand for loans as a single equation model instead of a system. The test is performed by assessing the statistical significance of the coefficient of the error correction term in each of the equations of the system other than the equation for loans. If the error correction term is found not to be significant in a specific equation, this implies that there is no information loss from excluding that equation from the system.

The tests show that while the null hypothesis of weak exogeneity cannot be rejected for the equation of real GDP, it can be clearly rejected for the real short-term and the real long-term interest rate equations (see Table 8). This implies that the VECM approach cannot be reduced to a single equation. Although on the basis of the weak exogeneity of GDP it would be possible to exclude this variable from the system and proceed with a smaller VECM conditioned on GDP, we choose to continue to retain the full system. One implication of the test result is that, in order to describe the dynamics of the adjustment of real loans to its equilibrium level, it cannot be assumed that in case real loans deviate from equilibrium the return to it will necessarily be prompted only by adjustments in loans themselves. In fact, deviations from equilibrium may lead to movements also in real short-term and long-term interest rates.

One important property of any econometric model is the stability of its parameters over the sample period. This is assessed using Chow's 1-step ahead, break-point and predictive failure tests. The first type of test is mainly an indicator of the existence of outliers. The other two types of tests are sequences of 1-step Chow tests and are more appropriate to test for the existence of structural breaks as they provide formal statistical criteria to distinguish outliers from more fundamental structural changes.[10] The breakpoint Chow test is done by first estimating the model over the whole sample and then testing whether there is evidence of a structural change in the parameters when the sample period is progressively reduced. The predictive failure Chow test is performed by first estimating the model using only the initial observations and then testing whether the parameters change as the sample period is progressively increased. As can be seen from Figure 5, both the individual equations and the system seem broadly stable over the sample period, notwithstanding an outlier in the long-term interest rate equation (also reflected by the multivariate test statistic) in 1994 Q2. The stability of the model is further confirmed by the one-step ahead recursive residuals shown in Figure 6.

5 Testing the sensitivity of the results to the aggregation method

When studying the behaviour of monetary and credit variables in the euro area, significant attention should be paid to the aggregation method used to construct euro area time series data. In order to test the robustness of the results to different aggregation methods, the model is re-estimated using GDP weighted time series for all the variables. Again, the cointegration tests show that only one cointegrating vector can be found:

$$LOANS = k + \underset{(0.04)}{1.465} \cdot GDP - \underset{(0.57)}{0.416} \cdot ST - \underset{(1.03)}{3.084} \cdot LT \qquad (3)$$

The estimated cointegrating vector is qualitatively similar to that obtained using irrevocably fixed conversion rates. However, the real short-term interest rate is no longer significant. In addition, the estimates for the coefficient on real GDP and the long-term real interest rate are much larger than in the previous case. Thus, on the basis of GDP weighted series, it seems possible to establish a long-run relation only between real loans, real GDP and the long-term real interest rate.

10 If a model fails the one-step Chow test in a specific quarter, this may be due to the presence of an outlier, without necessarily implying the occurrence of a structural break. A repeated failure of 1-step Chow tests or the case in which 1-Step Chow statistics reaches significant high levels would be a more compelling evidence that there is a structural break.

6 Conclusions

An econometric investigation of the determinants of loans to the private sector in the euro area suggests that the behaviour of real loans can be related mainly to the developments of domestic factors such as real GDP and short-term and long-term real interest rates. The error correction term identified through the cointegration test appears to be stationary. In the cointegration equation, the coefficients of real short-term interest rates and long-term interest rates show negative signs, which suggests that the model employed is describing a demand phenomenon. The coefficient of the long-term interest rate variable is significantly higher than that of the short-term interest rate, which is consistent with available evidence on the maturity structure of loans to the private sector in the euro area. Notwithstanding a temporary perturbation in 1986, the long-run model shows good statistical properties in terms of the stability of its parameters. The empirical results show that the level of real loans was somewhat above its equilibrium level in the first half of 1999, and therefore some convergence towards the long-run equilibrium level may be expected. The model is subsequently estimated in a VECM form and subject to a number of standard misspecification and stability tests, with satisfactory results. The coefficient of the error correction term in the equation for loans is statistically significant from zero, confirming the existence of a long run relationship linking real loans to real GDP and real interest rates. The sign of the coefficient seems to further confirm that the equation may be describing a demand behavioural relationship.

Follow-up studies should make use of more detailed data, possibly including a breakdown of loans by sector and purpose as well as by maturity. Furthermore, it might be fruitful to include other variables such as asset prices, bank lending rates, corporate profits and household wealth in the estimations as these data become available in the course of time.

References

Bernanke, B. and **M. Gertler** (1995) Inside the black box: the credit channel of monetary policy transmission, NBER working paper No. 5146.

Brand, C. and **Cassola, N.** (2000) A money demand system for euro area M3, ECB Working Paper No. 39, European Central Bank, Frankfurt.

Browne, F.X., G. Fagan and **J. Henry** (1997) Money demand in EU countries: a survey, European Monetary Institute Staff Paper No. 7.

Coenen, G. and **J.-L. Vega** (1999) The demand of M3 in the euro area, ECB Working Paper No 6, European Central Bank, Frankfurt.

De Bandt, O. and **P. Jaquinot** (1992) The financing of corporate firms in France – An econometric model, Economic Modelling, 9(3), pp. 253-69.

De Jong, D.N., J.C. Nankervis, N.E. Savin and **C.H. Whiteman** (1992a) The power problems of unit root tests in time series with autoregressive errors, Journal of Econometrics, 53, pp. 323-343.

De Jong, D.N., J.C. Nankervis, N.E. Savin and **C.H. Whiteman** (1992b) Integration versus trend stationarity in time series, Econometrica, 60, pp. 423-433.

De Nederlandsche Bank (2000) EUROMON: The Nederlandsche Bank's multi-country model for policy analysis in Europe, Amsterdam, pp. 83-85.

Dickey, D.A. and **W.A. Fuller** (1981) Likelihood ratio statistics for autoregressive time series with a unit root, Econometrica, 49, 1057-1072.

Doornik, J.A. and **Hansen, H. (1994)** An omnibus test for univariate and multivariate normality, Discussion Paper No. W4 & 91, Nuffield College, Oxford.

ECB (1999) The balance sheets of the monetary financial institutions of the euro area in early 1999, ECB Monthly Bulletin, August, pp. 56-70.

ECB (2000) The euro area one year after the introduction of the euro: key characteristics and changes in the financial structure, ECB Monthly Bulletin, January, pp. 35-49.

Engle, R.F. (1982) Autoregressive conditional heteroscedasticity, with estimates of the variance of United Kingdom inflation, Econometrica, 50, pp. 987-1007.

Fagan, G. and **J. Henry** (1999) Long run money demand in the EU: evidence for area-wide aggregates, in Money Demand in Europe (Eds.) Lütkepohl, H. and J. Wolters, Physica-Verlag, Heidelberg, pp.241-258.

Fase M.M.G., Kramer P. and **W.C. Boeschoten** (1992) MORKMON II: The Nederlandsche Bank's quarterly model of the Netherlands economy, Economic Modelling, 9(2), pp. 146-204.

Focarelli , D. and **P. Rossi** (1998) La domanda di finanziamenti in Italia e nelle diverse aree del Paese (1984-1996), Temi di discussione del Servizio Studi di Banca d'Italia No. 333.

Friedman, B. and **K. Kuttner** (1993) Economic activity and the short-term credit markets: an analysis of prices and quantities, Brookings Papers on Economic Activity, 2, pp. 193-283.

Godfrey, L.G. (1978) Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables, Econometrica, 46, pp. 1293-1301.

Johansen, S. (1988) Statistical analysis of cointegrating vectors, Journal of Economic Dynamics and Control, 12, pp. 231-254.

Johansen, S. (1991) Estimation and hypothesis testing of cointegration vectors in gaussian vector autoregressive models, Econometrica, 59, pp. 1551-1580.

Johansen, S. (1995) Likelihood-based Inference in cointegrated vector autoregressive models, Oxford University Press, Oxford.

Kakes, J. (2000) Identifying the mechanism: is there a bank lending channel of monetary transmission in the Netherlands, Applied Economics Letters, 7, pp. 63-67.

Kashyap, A., J. Stein and **D. Wilcox** (1993) Monetary policy and credit conditions: evidence from the composition of external finance, American Economic Review, 83, pp. 8-98.

Kwiatkowski, D., P. C. B. Phillips, P. Schmidt and **Y. Shin** (1992) Testing the null hypothesis of stationarity against the alternative of a unit root, Journal of Econometrics, 54, pp. 159-178.

Manrique M. and **F.J. Sáez** (1998) Un analisis desagregado de la demanda de activos líquidos y de la demanda de crédito de las familias y de las empresas no financieras, Banco de España, Boletín Económico, January 1998.

McKinnon, J.G. (1991) Critical values for cointegration tests, Chapter 13 in Long-run economic relationships: readings in cointegration (Eds.) R.F. Engle and C.W. J. Granger, Oxford University Press, Oxford.

Phillips, P.C.B. and **P. Perron** (1988) Testing for a unit root in time series regression, Biometrika, 75, pp. 335-346.

Schwert, G.W. (1987) Effects of model specification on tests for unit roots, Journal of Monetary Economics, 20, pp. 73-103.

Vega, J.L. (1989) Las variables de crédito en el mecanismo de transmisión de la política monetaria: el caso español, Documento de trabajo del Banco de España No. 8902.

White, H. (1980) A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity, Econometrica, 48, pp. 817-838.

Data Annex

This annex describes the methodology applied for the computation of the historical data on loans to the private sector used in the study. The ECB publishes two historical series for loans to the private sector: (1) one seasonally adjusted (using X-12-ARIMA) starting from January 1991; and (2) one non-seasonally-adjusted starting from December 1982. We have extended the former backwards to January 1980 by using the annual percentage changes extracted from the non-seasonally adjusted figures to compute a series starting in December 1983. We have then used non-harmonised data from national sources for the euro-area countries (excluding Luxembourg) to extend the series back to January 1980. From the third quarter of 1997, the data on loan stocks are adjusted for the effects of reclassifications, other revaluations, exchange rate changes, write-offs/write-downs and any other changes that do not arise from transactions.

Tables and Figures

Table 1

Structure of loans to the private sector by sub-sector

		Households				Non-profit institutions serving households	Non-financial corporations	Non-monetary financial corporations
		Consumer credit	House purchase	Other lending	Total			
1997	*Q3*	8.1	29.3	11.6	49.0	0.7	45.4	4.8
	Q4	8.0	29.3	11.4	48.7	0.8	45.2	5.3
1998	*Q1*	7.9	29.2	11.3	48.5	0.8	45.2	5.5
	Q2	8.0	29.1	11.5	48.6	0.8	45.1	5.5
	Q3	8.1	29.3	11.3	48.8	0.7	44.8	5.7
	Q4	8.1	29.2	11.3	48.7	0.7	44.9	5.7
1999	*Q1*	8.2	30.0	10.8	49.0	0.7	43.8	6.5
	Q2	8.2	30.1	10.7	48.9	0.7	43.9	6.5

Data: ECB.

Table 2

Structure of loans to the private sector by maturity

		Up to 1 year	Over 1 and up to 5 years	Over 5 years
1997	*Q3*	24.0	12.9	63.1
	Q4	24.1	12.9	63.0
1998	*Q1*	24.1	13.0	62.9
	Q2	24.2	12.9	62.9
	Q3	23.7	13.0	63.3
	Q4	24.1	12.3	63.6
1999	*Q1*	24.7	13.9	61.5
	Q2	24.8	13.7	61.5

Source: ECB
Note: The breakdown by maturity is not available for loans to non-profit institutions serving households.

Table 3

Testing for unit roots

	Null hypothesis	Alternative hypothesis	Test statistics	
			ADF[a, b]	PP[a, b]
LOANS	I(1)	Stationary	1.048	1.984
	I(2)	I(1)	-3.309*	-3.074*
GDP	I(1)	Stationary	0.144	-2.272
	I(2)	I(1)	-6.906**	-6.925**
ST	I(1)	Stationary	-1.688	-1.468
	I(2)	I(1)	-7.067**	-7.136**
LT	I(1)	Stationary	-2.361	-3.118
	I(2)	I(1)	-6.033**	-6.415**

a *ADF is the Augmented Dickey Fuller (1981) test (including up to the highest lag statistically significant at the 5% level); PP is the Phillips Perron (1988) test (with 3 truncation lags, as suggested by the Newey West criterion).*

b *Constant included in all the auxiliary test regressions, deterministic trend only if statistically significant at the 5% level.*

** *Rejection of null at 1% significance level based on McKinnon (1991) values.*

* *Rejection of null at 5% significance level based on McKinnon (1991) values.*

Table 4
Testing for stationarity

	Null hypothesis	Alternative hypothesis	KPSS test statistic (l=8)[a]	
			Constant, no trend	Constant and trend
LOANS	Stationary	I(1)	0.977**	0.082
	I(1)	I(2)	0.246	0.090
GDP	Stationary	I(1)	0.960**	0.118
	I(1)	I(2)	0.160	0.140
ST	Stationary	I(1)	0.418	0.155*
	I(1)	I(2)	0.197	0.089
LT	Stationary	I(1)	0.513*	0.102
	I(1)	I(2)	0.147	0.063

a *KPSS is the stationarity test proposed by Kwiatlowski et al. (1992); l represents the parameter of the Bartlett window and has been set at a value close to the square of the number of observations.*

** *Rejection of null at 1% significance level based on KPSS critical values.*

* *Rejection of null at 5% significance level based on KPSS critical values.*

Table 5
Johansen test for cointegration

H_0: rank = p	Maximum eigenvalue test-statistic	95% critical value	Trace test-statistic	95% critical value
$p = 0$	28.36*	27.1	53.21*	47.2
$p \leq 1$	15.12	21.0	24.85	29.7
$p \leq 2$	7.378	14.1	9.74	15.4
$p \leq 3$	2.358	3.8	2.36	3.8

* Existence of cointegration at 5% significance level.

Table 6

Estimating the VECM

(a) Cointegrating Equation	*LOANS*	*GDP*	*ST*	*LT*	*k*
	1.0000	-1.339	1.008	1.788	20.792
		(-33.9734)	(2.5524)	(2.7406)	

(b) Single equation estimates	D(*LOANS*)	D(*GDP*)	D(*ST*)	D(*LT*)
Error correction term (-1)	-0.072	-0.050	-0.113	-0.100
	(-3.3907)	(-1.4764)	(-3.8195)	(-3.2511)
D(*LOANS(-1)*)	0.335	-0.160	-0.119	-0.281
	(2.6012)	(-0.7892)	(-0.6717)	(-1.5251)
D(*LOANS(-2)*)	0.451	0.360	0.123	0.072
	(3.3686)	(1.7060)	(0.6634)	(0.3759)
D(*LOANS(-3)*)	0.259	0.195	0.281	0.427
	(1.8408)	(0.8779)	(1.4440)	(2.1167)
D(*GDP(-1)*)	-0.081	0.016	-0.069	-0.027
	(-0.9081)	(0.1151)	(-0.5589)	(-0.2143)
D(*GDP(-2)*)	-0.038	0.001	-0.076	-0.172
	(-0.4479)	(0.0104)	(-0.6404)	(-1.4012)
D(*GDP(-3)*)	-0.014	0.045	0.071	-0.074
	(-0.1686)	(0.3305)	(0.5987)	(-0.6022)
D(*ST(-1)*)	-0.041	-0.034	0.212	-0.125
	(-0.3587)	(-0.1921)	(1.3515)	(-0.7684)
D(*ST(-2)*)	-0.024	-0.161	-0.063	0.127
	(-0.2097)	(-0.8932)	(-0.3965)	(0.7743)
D(*ST(-3)*)	-0.106	-0.198	-0.291	-0.178
	(-1.0338)	(-1.2296)	(-2.0646)	(-1.2139)
D(*LT(-1)*)	0.070	0.197	0.365	0.652
	(0.5889)	(1.0563)	(2.2348)	(3.8472)
D(*LT(-2)*)	-0.026	0.049	-0.121	-0.129
	(-0.2079)	(0.2433)	(-0.6888)	(-0.7065)
D(*LT(-3)*)	0.156	0.343	0.385	0.186
	(1.3231)	(1.8458)	(2.3639)	(1.1023)
C	0.001	0.002	-0.002	-0.000
	(0.9122)	(1.1771)	(-1.6666)	(-0.2309)
R-squared	0.725	0.196	0.446	0.349
Adjusted R-squared	0.661	0.009	0.317	0.198
Sum sq. residuals	0.001	0.001	0.001	0.001
S.E. equation	0.003	0.005	0.005	0.005
F-statistic	11.362	1.047	3.469	2.309

t-statistics in parenthesis.

Table 7
Diagnostics tests

(a) Single equation tests	Autocorrelation (4th order)[a]	Normality[b]	ARCH effects[c]	Heteroscedasticity[d]
LOANS	1.681 [0.1684]	2.2691[0.3215]	0.359 [0.8368]	0.354 [0.9955]
GDP	1.896 [0.1250]	4.350 [0.1136]	1.947 [0.1178]	0.666 [0.8508]
ST	0.742 [0.5679]	1.001 [0.6064]	0.481 [0.7492]	0.467 [0.9735]
LT	2.268 [0.0743]	2.422 [0.2978]	0.593 [0.6691]	0.512 [0.9556]

(b) Multivariate tests

Autocorrelation[a] (4th order)	Vector normality[b]	Heteroscedasticity[d]
1.211 [0.1737]	7.658 [0.4676]	0.589 [1.0000]

a Lagrange multiplier test for autocorrelation by Godfrey (1978).
b Normality test (Doornik and Hansen, 1994).
c Test for ARCH effects based on Engle (1982).
d Heteroscedasticity test suggested by White (1980).
p-value in square brackets: a p-value lower than 0.05 would imply the failure of the test at the 5% significance level.

Table 8
Weak exogeneity test

	LOANS	*GDP*	*ST*	*LT*
Test statistic [a]	11.515**	2.1730	14.581**	10.568**

a Wald test for coefficient restriction.
*** Rejection of null hypothesis of weak exogeneity at 1% significance level.*

Figure 1

Annual percentage changes in real loans to the private sector and real GDP in the euro area, quarterly data, 1981 Q1 –1999 Q2.

Figure 2

Annual percentage changes in real loans to the private sector, the consumer price index and the GDP deflator in the euro area, quarterly data, 1981 Q1 –1999 Q2.

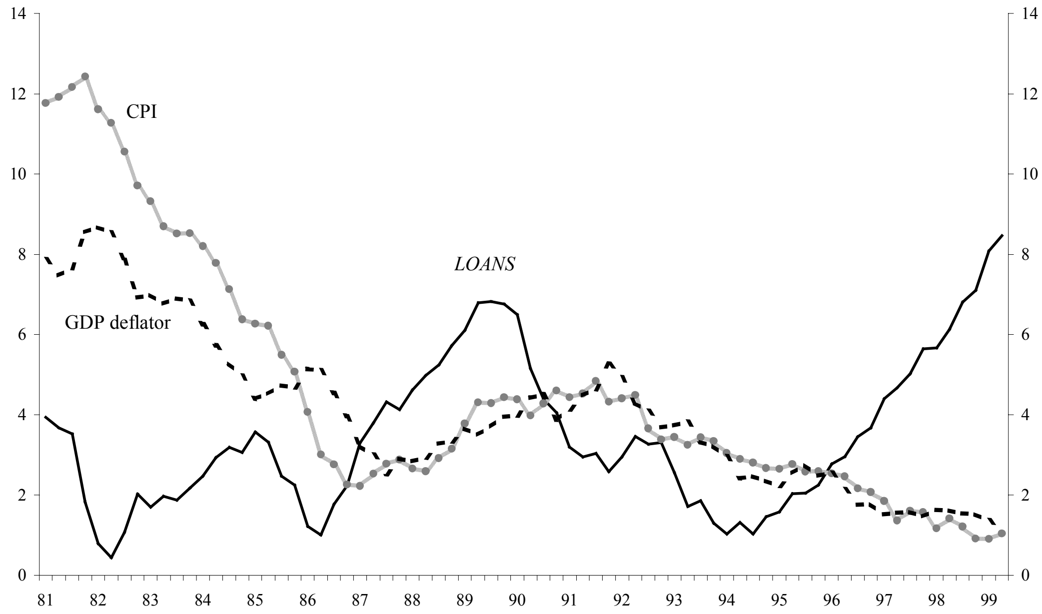


Figure 3

Annual percentage changes in real loans to the private sector and real short-term and long-term market interest rates in the euro area, quarterly data, 1981 Q1 –1999 Q2.

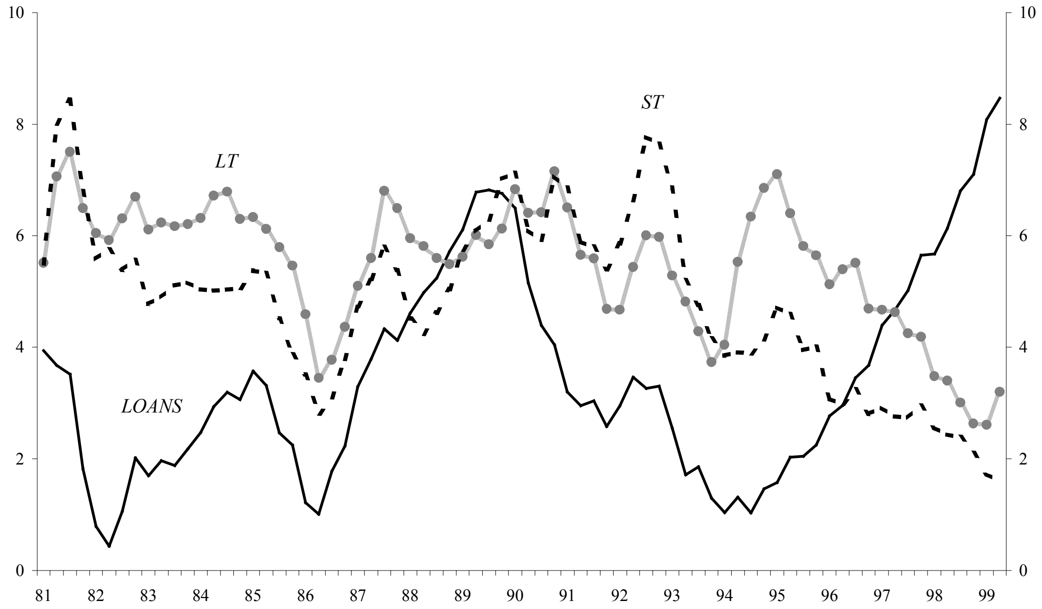


Figure 4

Cointegrating relationship used as the error correction term of the dynamic model (re-scaled to average zero over the sample period).

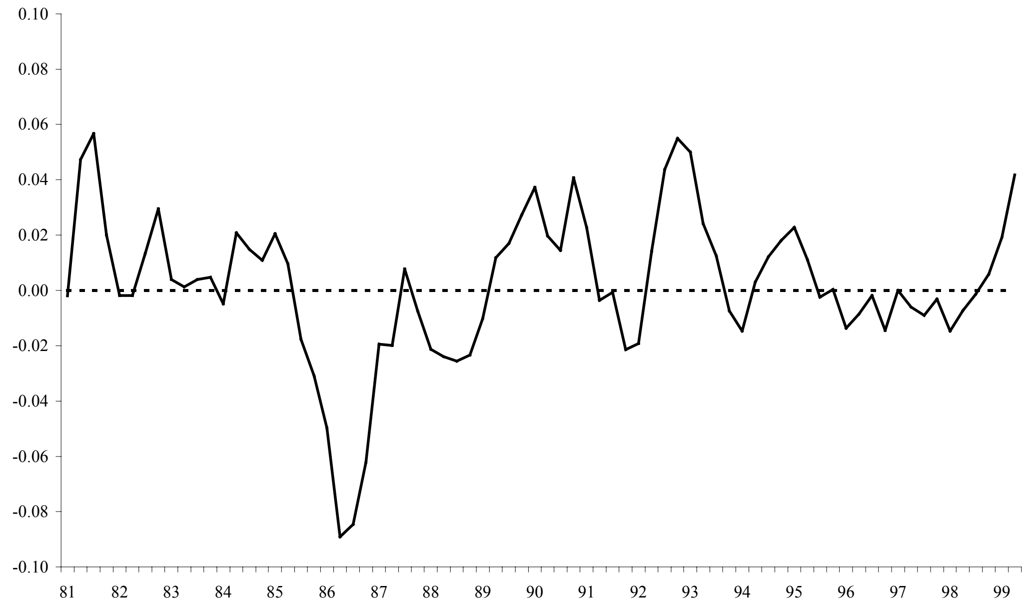
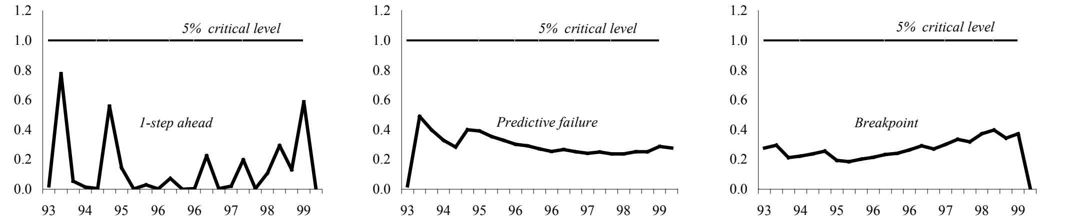


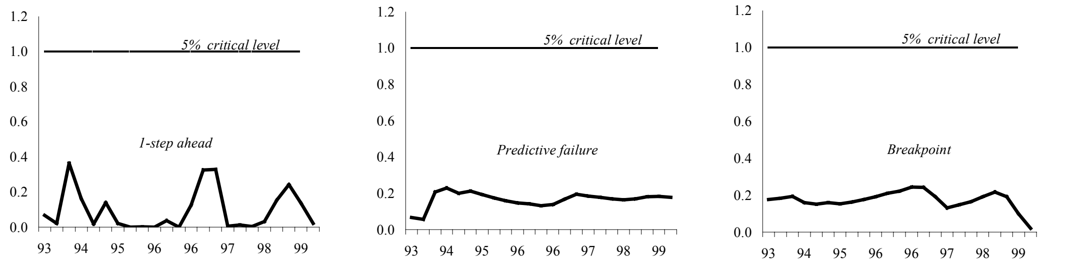
Figure 5

Results of Chow's 1-step ahead, predictive failure and break-point tests (values above the 5% critical value level signal instability of the parameters of the model).

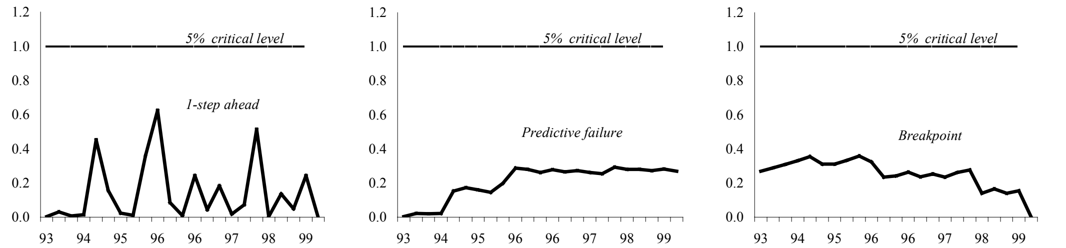
Equation d(LOANS)



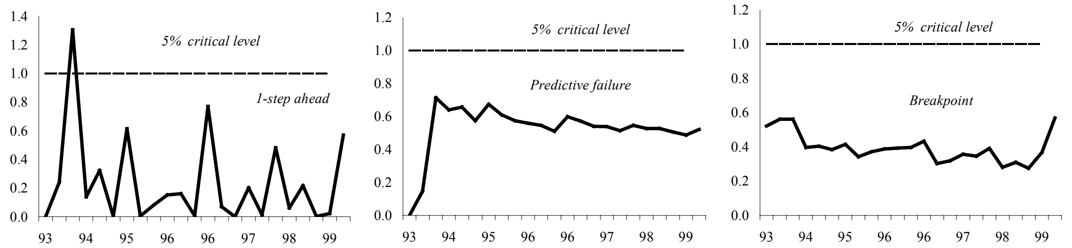
Equation d(GDP)



Equation d(ST)



Equation d(LT)



System

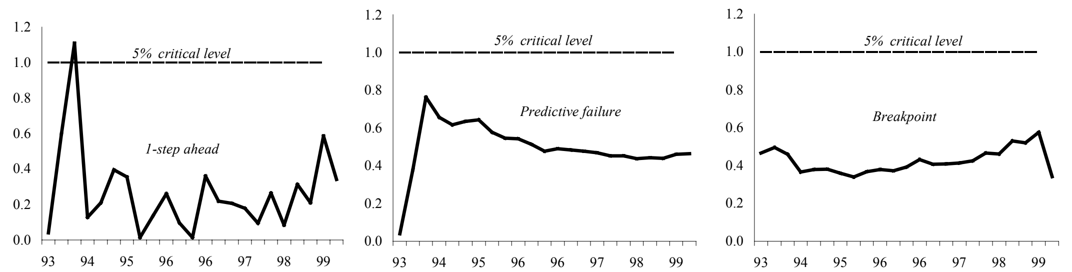
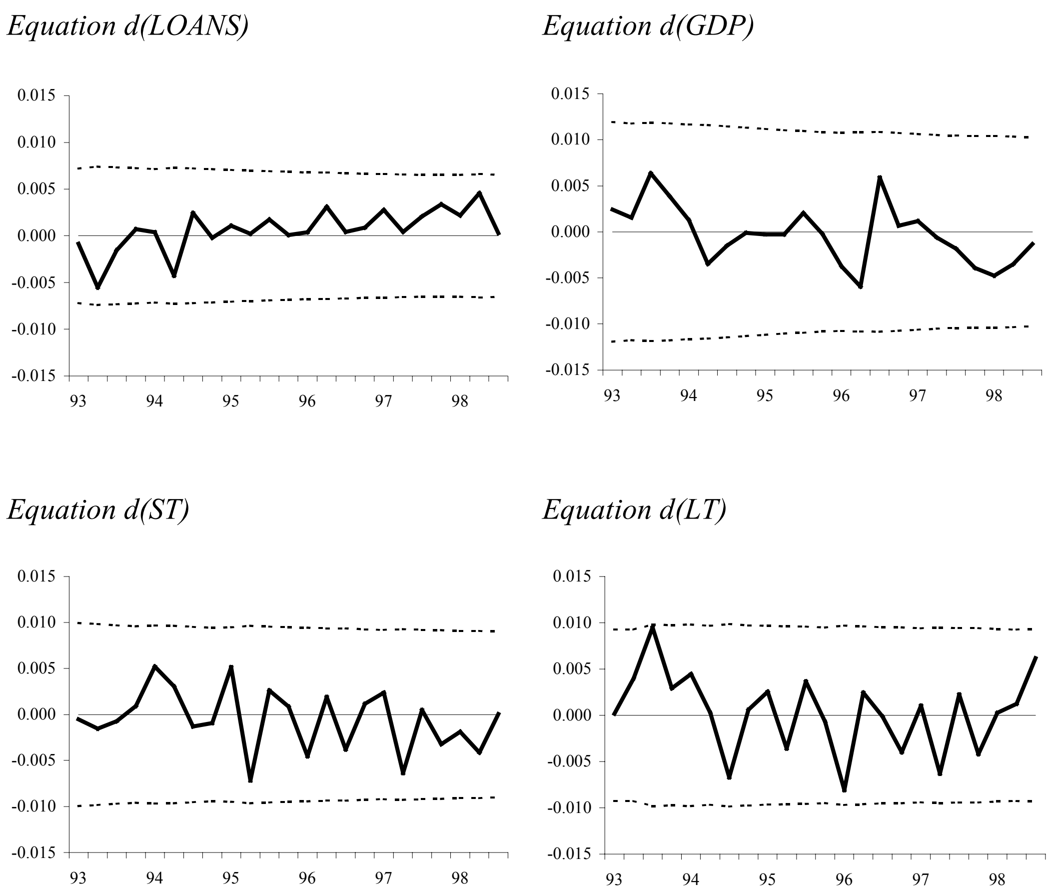


Figure 6

Results of 1-step ahead recursive residuals (dotted lines indicate ± 2 standard errors).



European Central Bank Working Paper Series

1 "A global hazard index for the world foreign exchange markets" by V. Brousseau and F. Scacciavillani, May 1999.

2 "What does the single monetary policy do? A SVAR benchmark for the European Central Bank" by C. Monticelli and O. Tristani, May 1999.

3 "Fiscal policy effectiveness and neutrality results in a non-Ricardian world" by C. Detken, May 1999.

4 "From the ERM to the euro: new evidence on economic and policy convergence among EU countries" by I. Angeloni and L. Dedola, May 1999.

5 "Core inflation: a review of some conceptual issues" by M. Wynne, May 1999.

6 "The demand for M3 in the euro area" by G. Coenen and J.-L. Vega, September 1999.

7 "A cross-country comparison of market structures in European banking" by O. de Bandt and E. P. Davis, September 1999.

8 "Inflation zone targeting" by A. Orphanides and V. Wieland, October 1999.

9 "Asymptotic confidence bands for the estimated autocovariance and autocorrelation functions of vector autoregressive models" by G. Coenen, January 2000.

10 "On the effectiveness of sterilized foreign exchange intervention" by R. Fatum, February 2000.

11 "Is the yield curve a useful information variable for the Eurosystem?" by J. M. Berk and P. van Bergeijk, February 2000.

12 "Indicator variables for optimal policy" by L. E. O. Svensson and M. Woodford, February 2000.

13 "Monetary policy with uncertain parameters" by U. Söderström, February 2000.

14 "Assessing nominal income rules for monetary policy with model and data uncertainty" by G. D. Rudebusch, February 2000.

15 "The quest for prosperity without inflation" by A. Orphanides, March 2000.

16 "Estimating the implied distribution of the future short term interest rate using the Longstaff-Schwartz model" by P. Hördahl, March 2000.

17 "Alternative measures of the NAIRU in the euro area: estimates and assessment" by S. Fabiani and R. Mestre, March 2000.

18 "House prices and the macroeconomy in Europe: Results from a structural VAR analysis" by M. Iacoviello, April 2000.

19 "The euro and international capital markets" by C. Detken and P. Hartmann, April 2000.

20 "Convergence of fiscal policies in the euro area" by O. De Bandt and F. P. Mongelli, May 2000.

21 "Firm size and monetary policy transmission: evidence from German business survey data" by M. Ehrmann, May 2000.

22 "Regulating access to international large value payment systems" by C. Holthausen and T. Rønde, June 2000.

23 "Escaping Nash inflation" by In-Koo Cho and T. J. Sargent, June 2000.

24 "What horizon for price stability" by F. Smets, July 2000.

25 "Caution and conservatism in the making of monetary policy" by P. Schellekens, July 2000.

26 "Which kind of transparency? On the need for clarity in monetary policy-making" by B. Winkler, August 2000.

27 "This is what the US leading indicators lead" by M. Camacho and G. Perez-Quiros, August 2000.

28 "Learning, uncertainty and central bank activism in an economy with strategic interactions" by M. Ellison and N. Valla, August 2000.

29 "The sources of unemployment fluctuations: an empirical application to the Italian case" by S. Fabiani, A. Locarno, G. Oneto and P. Sestito, September 2000.

30 "A small estimated euro area model with rational expectations and nominal rigidities" by G. Coenen and V. Wieland, September 2000.

31 "The disappearing tax base: Is foreign direct investment eroding corporate income taxes?" by R. Gropp and K. Kostial, September 2000.

32 "Can indeterminacy explain the short-run non-neutrality of money?" by F. De Fiore, September 2000.

33 "The information content of M3 for future inflation" by C. Trecroci and J. L. Vega, October 2000.

34 "Capital market development, corporate governance and the credibility of exchange rate pegs" by O. Castrén and T. Takalo, October 2000.

35 "Systemic risk: A survey" by O. De Bandt and P. Hartmann, November 2000.

36 "Measuring core inflation in the euro area" by C. Morana, November 2000.

37 "Business fixed investment: Evidence of a financial accelerator in Europe" by P. Vermeulen, November 2000.

38 “The optimal inflation tax when taxes are costly to collect” by F. De Fiore, November 2000.

39 “A money demand system for euro area M3” by C. Brand and N. Cassola, November 2000.

40 “Financial structure and the interest rate channel of ECB monetary policy” by B. Mojon, November 2000.

41 “Why adopt transparency? The publication of central bank forecasts” by P. M. Geraats, January 2001.

42 “An area-wide model (AWM) for the euro area” by G. Fagan, J. Henry and R. Mestre, January 2001.

43 “Sources of economic renewal: from the traditional firm to the knowledge firm” by D. R. Palenzuela, February 2001.

44 “The supply and demand for eurosystem deposits – The first 18 months” by U. Bindseil and F. Seitz, February 2001.

45 “Testing the Rank of the Hankel matrix: a statistical approach” by G. Camba-Mendez and G. Kapetanios, February 2001.

46 “A two-factor model of the German term structure of interest rates” by N. Cassola and J. B. Luís, February 2001.

47 “Deposit insurance and moral hazard: does the counterfactual matter?” by R. Gropp and J. Vesala, February 2001.

48 “Financial market integration in Europe: on the effects of EMU on stock markets” by M. Fratzscher, March 2001.

49 “Business cycle and monetary policy analysis in a structural sticky-price model of the euro area” by M. Casares, March 2001.

50 “Employment and productivity growth in service and manufacturing sectors in France, Germany and the US” by T. von Wachter, March 2001.

51 “The functional form of the demand for euro area M1” by L. Stracca, March 2001.

52 “Are the effects of monetary policy in the euro area greater in recessions than in booms?” by G. Peersman and F. Smets.

53 “An evaluation of some measures of core inflation for the euro area” by J.-L. Vega and M. A. Wynne, April 2001.

54 “Assessment criteria for output gap estimates” by G. Camba-Méndez and D. R. Palenzuela, April 2001.

55 “Modelling the demand for loans to the private sector in the euro area” by A. Calza, G. Gartner and J. Sousa, April 2001.