

## I. Introduction

The issue of modelling bank credit has been investigated by a significant body of empirical work which complements the extensive literature that models the behaviour of monetary aggregates. The empirical research devoted to the determination of credit frequently employs cointegration techniques to estimate mainly demand relationships (e.g. Hofmann, 2001; Calza et al., 2003). However, very few studies estimate separate loan demand and loan supply relationships (e.g. Kakes, 2000). Moreover, the modelling of consumer credit alone is practically not covered

at all by the literature that uses aggregate credit data, while it is quite common in studies that use micro-level data. The identification of loan demand and loan supply relationships implies, inter alia, the existence of a bank lending channel (Bernanke and Blinder, 1988). This channel seems to function well in markets that are not fully developed and in which frictions are still present. In our article, we aim to contribute to the empirical literature on consumer credit and investigate separately the demand and supply factors that determine the evolution of this aggregate in Greece. Our analysis covers the period 1990–2008, aiming to account for the effects of the liberalization of

credit in Greece. We did not extend our empirical work to more recent years (post-2008), during which the impact from the global financial crisis and the sovereign debt crisis in Greece on the domestic real economy and on deposits, credit and asset prices was particularly large.

The sample period that we examine includes a rapid acceleration of consumer credit growth, following its liberalization and the adoption of the euro in 2001, which partly reflects the changing behaviour of economic agents. The associated shifts in the impact of factors that determine credit render standard econometric methods of estimation less applicable. This is more generally the case in the empirical literature that focuses on developing economies. The same issue is also encountered in the literature which models the demand for money in advanced economies that went through financial liberalization earlier, in the 1980s. We address this matter through the use of dummy and time trend variables to capture liberalization effects and help establish cointegrating relationships, in the Johansen testing framework, which otherwise would have not been identified. We aim to test the validity of the theoretical restrictions for identifying separate long-run demand for and supply of consumer loan relationships by estimating a VECM.

The rest of the article is structured as follows. Section 2 includes an overview of the empirical work on modelling bank loans. Section 3 provides the stylized facts of the consumer loan market in Greece, namely the liberalization process and evolution of consumer credit. Section 4 presents our empirical methodology and estimation results. Finally, Section 5 provides the concluding comments.

## II. Empirical Literature

The issue of modelling bank credit within a changing environment is re-emerging in view of the recent financial crisis, which raised a number of questions regarding the financing of the economy. The empirical literature that investigates the determination of credit aggregates is still growing although it remains relatively limited compared to the rich body of work that has been devoted to the modelling of monetary aggregates. The empirical methodologies applied for modelling bank loans by including both loan demand and loan supply determinants can be broadly distinguished into error correction models (e.g. Calza et al., 2003), reduced-form equations (e.g. European Central Bank (ECB), 2007; Giannone et al., 2010) and structural models (structural VAR, e.g. Chrystal and Mizen, 2005 or the financial block of a national macro-econometric model, see e.g. Fase et al., 1992; Jeanfils, 2000, presenting central bank models for Belgium and the Netherlands, respectively). Alternatively, approaches based on micro-data entail the

estimation of single equations that use information from bank lending surveys (see e.g. De Bondt et al., 2010; Hempell and Sorensen, 2010, both of which use panel data), survey data from samples of individual households (Fernandez-Corugedo and Muellbauer, 2006) or published data from a panel of individual banks (Kashyap and Stein, 2000). Finally, micro-founded dynamic stochastic general equilibrium (DSGE) models have been developed (e.g. Darracq Paries et al., 2010; Rubaszek and Serwa, 2012) that model the banking sector with credit frictions. Most of the empirical work encountered in the literature investigates the determinants of credit to the private sector as a whole. Furthermore, due to the differences in behaviour and in financing constraints among the different sectors, one strand of the credit literature focuses on explaining loans to businesses (e.g. Sorensen et al., 2009) separately from loans to households (e.g. Fitzer and Reiss, 2008; Rubaszek and Serwa, 2012).

The development of credit to the private sector is explained both by demand and supply-related variables. On the demand side, loan decisions by firms and households are based on their own balance sheet condition and available sources of external funds. The key factors in all demand specifications include the cost of credit (loan interest rate) and a measure of the level of transactions of households and/or businesses, captured by an economic activity variable, normally real GDP. On the supply side, the ability and willingness of banks to extend loans is related to factors that influence their own funding conditions (relevant variables include bank equity, total assets, deposits and the cost of external financing), their capital position, the cost of alternative bank portfolio choices (e.g. the spread between the loan rate and the T-bill rate), competition from other banks and their perceptions of risk (macroeconomic variables, nonperforming loans). In the empirical literature, loans to the private sector are conventionally modelled as a demand function (e.g. Hofmann, 2001; Calza et al., 2003). The simultaneous estimation of a separate supply curve for loans is not deemed necessary in most studies when demand effects are likely, or simply assumed, to dominate supply effects. More importantly, the identification of a separate demand and supply curve is not always feasible, depending on data availability, the choice of variables and the theoretical model. Kakes (2000), Hulsewig et al. (2004) and Sorensen et al. (2009) are all studies which impose theoretical restrictions on a VECM in order to identify a loan demand and a loan supply function for the Netherlands, Germany and the euro area, respectively. The determination of separate loan supply and/or loan demand curves supports the existence of a bank lending channel, notably as stated in the Bernanke–Blinder model (1998). The Bernanke–Blinder framework suggests that the channel operates well in economies in which market frictions exist (e.g. emerging markets),

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which render borrowers more bank-dependent, for example in countries which are in the process of credit liberalization.<sup>1</sup> By contrast, the advancement of financial deregulation and financial innovation (that creates new products replacing bank loans or promotes, for example, the expansion of true-sale securitization activity and the sale of loans by banks to nonbanks) explains why empirical studies using data from the more developed economies (mainly the United States and the United Kingdom) find conflicting evidence regarding the existence of the lending channel. However, in the case of household loans, the bank lending channel may almost be taken for granted, since household borrowing is mainly bank-based, more than in the case of firms, at least in the euro area and to some extent in the United States, where households are more widely funded from nonbank sources (such as government-sponsored enterprises, private issuers of asset-backed securities and microfinance institutions).<sup>2</sup>

While the more advanced economies had completed financial deregulation by the end of the 1980s, other economies only recently went through or are still undergoing this process. Thus, studies that are based on samples that include a period of credit liberalization often make use of methods found in the emerging market literature. Furthermore, in the case of more advanced economies and samples that are long enough to include earlier periods of transformation, the demand for money literature also offers empirical approaches to help model these changes (e.g. see Baba et al., 1992). Therefore, many studies use dummy variables, e.g. in the long-run relationships or in the short-run dynamics of a model (e.g. Kakes, 2000), to account for shifts in the parameters. Other studies incorporate time trends in the long-run relationship to proxy for the effects of credit liberalization or financial innovation (e.g. Arrau et al., 1995; Kakes, 2000; Hulsewig et al., 2004; Brissimis and Vlassopoulos, 2009). Alternative approaches in this literature focus on the construction of indices that measure the degree of liberalization through the use of 'institutional' variables (Cottarelli et al., 2005; Fernandez-Corugedo and Muellbauer, 2006). Finally, the strand of the econometric literature that deals with structural changes offers a variety of methods that can be used

to model time-varying or shifting parameters (e.g. in the money demand literature, see the time-varying parameter model in Brissimis et al. (2003)).

### III. Stylized Facts

In the 1990s, lending to the private sector in Greece was rising very strongly with consumer loans being one of the faster growing components. The average growth rate of consumer loans in the period 1991 to 1999 stood at 41.4%, reflecting, inter alia, the very low starting base. In the 10-year period starting in 2000, the average growth rate decreased, albeit remaining as high as 27.1%, and in 2010, a negative rate of change was recorded due to the effects of the financial crisis. The surging consumer loan growth rates observed in this period were initially driven by the growth in credit card loans which represented 41.5% of consumer credit in 2000. This share declined, however, in subsequent years (to 24% in 2010), not only due to the very high interest rates that these loans carried compared to the remaining consumer loans, which were associated with a lower operational cost and risk of default, but also due to the growing need of households to fund purchases of consumer durables or their small businesses, as the liberalization of consumer credit progressed. Following this fast expansion, consumer loans increased their share in total credit at the end of this period. In 1990, consumer loans constituted only 1.3% of the total credit to the private sector, rising to 8.3% in 1999 and 13.7% at the end of 2010 (compared to 4.8% for the euro area as a whole in 2010). Similarly, the ratio of consumer loans to GDP increased significantly over this interval, from 0.5% in 1990 to 4.1% in 2000 and 15.2% in 2010.<sup>3</sup>

The credit boom observed in consumer loans since the mid-1990s is mainly attributed to three factors: (i) the liberalization of the Greek financial sector and the removal of consumer credit restrictions in particular; (ii) the environment of falling interest rates, reflecting the process of convergence towards the levels of EU interest rates and the disinflation process in Greece; and (iii) the formation of expectations by banks, consumers and firms of higher

<sup>1</sup>The Bernanke–Blinder model assumes that market frictions and imperfect information cause bonds and loans to be imperfect substitutes, both from the perspective of banks (which consider these two alternative investment choices) and from the perspective of firms (which focus their financing choices on banks and markets, as alternative sources of financing). Conversely, when loans and bonds are perfect substitutes, the model implies that the bank lending channel fails to operate and the estimation of a loan supply function is not possible at all.

<sup>2</sup>Naturally, household current income and their accumulated savings are important alternative sources of financing to bank loans. In the United States, the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Association (Freddie Mac) benefit from government-guaranteed funding in order to purchase, guarantee and securitize mortgages. A thorough comparison between the euro area and the United States regarding the external financing of households and nonfinancial corporations is to be found in ECB (2009).

<sup>3</sup>The results of the household finance surveys in Greece (conducted on behalf of the Bank of Greece in 2003, 2005 and 2007) indicate that considering the distribution of a sample of all households that have some type of loan, the median ratio of the outstanding amount of loans to disposable income (debt-to-income ratio) increased consistently from 22.8% in the survey of 2003 to 50.4% in the survey of 2007.

future incomes, associated with the benefits from the adoption of the euro in Greece, which led to fast growth in consumption and greater willingness to lend and borrow.

The liberalization process of the Greek financial sector began slowly during the 1980s and gathered momentum after 1987 and the beginning of the 1990s. In the period until 1994, the Greek financial system was heavily regulated as interest rates were set at administered levels and credit was channelled to the economy through investment requirements imposed on banks as regards the financing, mainly of the public sector and a complicated reserve/rebate system as regards the financing of the private sector. As a result of the latter, the loan interest rates received by banks were different from the rates charged to borrowers but also it was more profitable for banks to extend loans to enterprises than to households (mainly through mortgages).

The process of liberalization entailed the relaxation of the above administrative arrangements mainly in the period 1994 to 2003. These developments directly influenced the supply side of loans, enabling banks to extend credit freely. At the same time, given that, in the past, firms and households were effectively credit-constrained, the abolition of these restrictions unleashed the demand for loans, leading to the observed surge of private sector credit and of consumer loans in particular.

Considering first the changes that influenced the demand side of consumer credit (illustrated also in Fig. 1), Greek households could borrow more easily

after the ceiling on consumer loans was first raised in 1994.

<sup>4</sup> However, consumer credit was completely liberalized only after mid-2003, when the ceiling (of 25 000 euros per borrower and bank) on consumer loans and the corresponding limits for the subcategories of consumer loans were all abolished. This development partly contributed to the fast increase in consumer loan growth rates and the corresponding loan-to-GDP ratio (see Fig. 1).

Regarding developments that influenced the supply of consumer loans by banks, the liberalization of credit began in the end of 1988 with the abolition of the reserve/rebate system, which was inhibiting the efficient allocation of credit to the economy by altering the relative loan interest rates for different sectors. Considering the investment requirements and the primary reserve requirement, at the beginning of the 1990s, banks were still left with only a fraction of their deposits that they could freely manage. The process of liberalization then continued in the period 1991 to 1993 with the gradual reduction and eventual complete withdrawal of the requirement for banks to invest specified percentages of their new deposits in short-term government paper and in loans to small-scale enterprises and state enterprises. Following that, the liberalization of the capital account in 1994 allowed banks to attract deposits from nonresidents. Moreover, bank liquidity was further enhanced through reduction in the primary reserve requirement by the Bank of Greece from 12% to the euro area level of 2% in mid-2000 and the abolition at the end of 2000 of the requirement for banks to re-deposit at the Bank of Greece or surrender, at a notional exchange

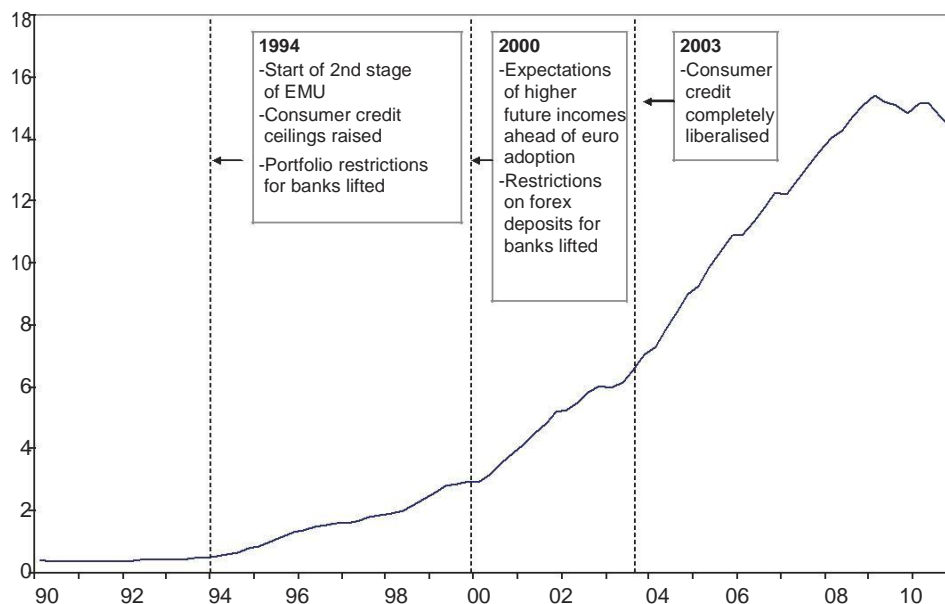


Fig. 1. Consumer loans to GDP ratio (s.a., %)

<sup>4</sup> See Voridis et al. 2003.

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rate, customer deposits in foreign exchange.<sup>5</sup> Thus, in the years that followed, banks were better able to channel funds to the private sector and to households in particular, due to the withdrawal of all these restrictions and those concerning consumer credit. Finally, as the liberalization of the Greek banking system progressed, Greek banks improved their access to external funds by tapping international capital markets (through interbank borrowing and bond issuance) and securitizing their loan portfolios.

The decline in both real and nominal interest rates also contributed to the rapid expansion of credit to the private sector. This decrease followed the liberalization of loan interest rates in 1987<sup>6</sup> and was brought about by the macroeconomic policies which were adopted in the second half of the 1990s and promoted the convergence of Greek interest rates to lower euro area levels (see Fig. 2). The falling trend in interest rates also reflected disinflation and, following Greece's entry to the euro area, greater monetary stability, which lowered risk premia. Furthermore, intensifying competition and the rising size of Greek banks also contributed to the

fall in loan interest rates. Looking at the different categories of interest rates, since the start of the 1990s, the interest rate on consumer loans was consistently exceeding all other loan rates, as illustrated in Fig. 2. This is attributed to the fact that consumer loans carry lower collateral compared to business and mortgage loans. Following the decrease in the level of all interest rates by 2002, the interest rate on new business loans moved close to the consumer loan rate, until the end of 2008. These two rates are both short-term<sup>7</sup> and, to some extent, track changes in the 3-month Euro Interbank Offered Rate (EURIBOR). Moreover, Greek banks were pricing consumer and enterprise loans at higher rates, at the time, in response to the strong demand by customers who were seeking to finance their small businesses through either consumer or enterprise loans.<sup>8</sup> In the period 2009 to 2010, lower ECB policy rates passed through to both business and mortgage loan rates; however, the consumer loan rate did not follow suit. In this loan category, the higher importance attached by banks to credit risk and the rising ratio of

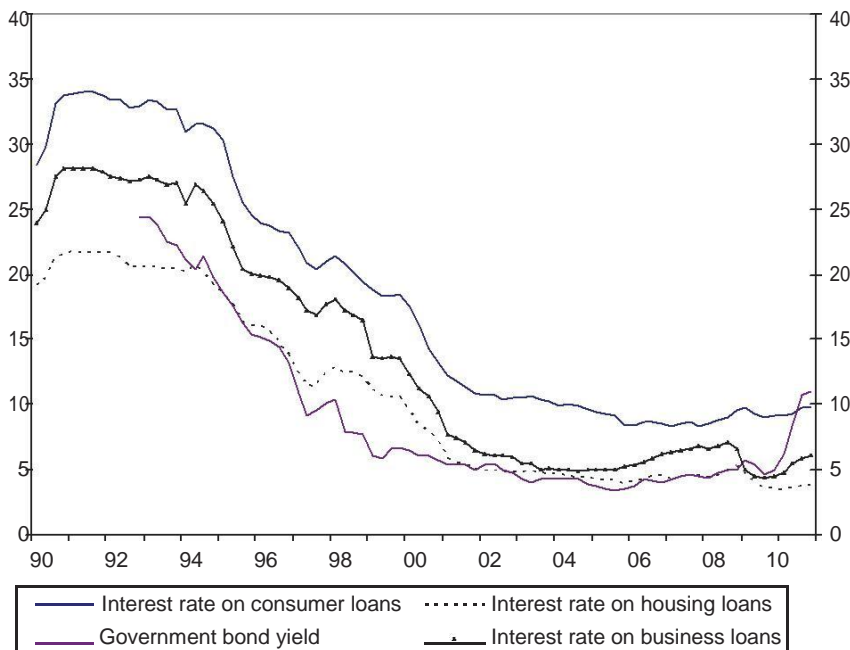


Fig. 2. Interest rates on bank loans and government bond yield (in %)

<sup>5</sup> Banks' reserves were gradually freed up by July 2002.

<sup>6</sup> In November 1987, interest rates on time deposits and on most categories of loans to the private sector were deregulated. In 1989, interest rates on savings deposits were also liberalized although they were still subject to a minimum rate administered by the Bank of Greece, which was finally abolished in March 1993.

<sup>7</sup> The business loan rate referred to here is the rate on new loans with interest rate fixation period of less than 1 year and amounts of loan up to 1 million euro.

<sup>8</sup> In addition, mortgage loans extended for the purpose of home improvements were also traditionally used for the funding of small businesses.



nonperforming loans led to an overall tightening of credit terms and conditions, including interest rates. The rise in consumer credit risk premia was considerable, though not as extensive as that for risk premia incorporated in the government bond yield.

A very significant development that led to the surge in growth rates of credit to the private sector and to consumers in particular, was the prospect of and eventually the adoption of the euro in Greece. In the period leading up to and following the adoption of the euro, in January 2001, both banks and households formed expectations of higher future incomes, owing to the benefits of joining the euro area. Banks followed more generous lending policies as they expected borrowers to earn higher incomes in the future. At the same time, these expectations led households to increase their consumption spending,<sup>9</sup> manifested in the very low household saving ratios and the high annual growth rates in real consumer expenditure, over the period 2000 to 2008. In the 1990s, the savings ratio of the private sector recorded a considerable fall, which largely reflected the decrease in the household savings ratio (and was, to a large extent, responsible for the savings–investment imbalances that were associated with a deterioration in the current account deficit, see Brissimis et al., 2010). Gross saving of the private sector fell from an average level of 24.6% of GDP in the period 1992 to 1996 to 14.5% in the period 1997 to 2001 and 12.0% in the period 2002 to 2010.

<sup>10</sup> More generally, decreases in the savings rate following credit liberalization were previously observed in other euro area countries (e.g. in Italy, see Casolaro et al., 2006). Considering household balance sheets, this fall can be interpreted as reflecting a disparity between rising liabilities, as households borrowed more from banks, and financial assets, which did not rise accordingly (household deposits, which constitute a significant part of household financial wealth, grew annually on average by 9.5% in the period 2001 to 2008 compared to the corresponding average growth rate for household credit of 29.2%). This discrepancy between the

rise in assets and liabilities is equal, *ceteris paribus*, to a decrease in households' net financial assets, i.e. their financial wealth, which in turn suggests that households were running down their savings. These trends were reversed in the period 2009 to 2011, during which the rates of growth in consumer spending and consumer credit declined substantially and turned negative. Overall, in the sample period, the liberalization of credit induced households to borrow more and to increase their spending to levels which implied a decrease in savings.

#### IV. Empirical Analysis

We model consumer credit through the identification of long-run loan demand and supply relationships and the specification of short-run loan dynamics, in a VECM setting. The demand for consumer loans in real terms is normally modelled as a function of real income ( $y$ ) and the real loan interest rate ( $r$ ), i.e.  $l = f(y, r)$ , where  $l$  represents real consumer loans. Consumer loans demanded are expected to depend positively on income and negatively on loan interest rates. In the case of consumer loans, there are usually no alternative sources to substitute financing from banks, hence other cost of financing variables are not normally considered. As to supply factors, we include real bank deposits ( $d$ ) as a scale variable, aiming to measure the influence of bank's own external funding on their ability to supply loans. Alternative scale variables considered in the literature but not included in our model are real total bank assets or equity.<sup>11</sup> Concerning the rate-of-return variables, we include the differential between the consumer loan rate and the business loan rate ( $se = r - r^*$ ).<sup>12</sup> The two rates correspond to types of loans that are fairly close substitutes, for the purpose of financing consumption or small business needs.<sup>13</sup> We expect to find a positive relationship between the volume of loans supplied and this differential, which expresses the relative earnings for the bank from granting

<sup>9</sup> Furthermore, it was the liberalization of credit which permitted this influence from higher future income expectations. According to consumption theory, the lifting of credit constraints has the effect of allowing consumers to base their spending decisions on future as well as current income. On the other hand, the consumption behaviour of credit-constrained households is highly sensitive to current income.

<sup>10</sup> In the period 2002 to 2010, the ratio of household savings to disposable income was fluctuating around a very low average level of 0.5%, taking sometimes even negative values, according to data from the National Accounts. The low savings ratio over this period is consistent with the degree of financial pressure implied by the debt service ratio found in the surveys of household finance. The surveys indicate that, considering the distribution of a sample of all households that have some type of loan (in urban and semi-urban areas in Greece), the median ratio of debt service costs to income rose from 15.6% in 2003 to 16.4% in 2007. This implies that 50% of households in this sample spend almost one-sixth of their income on servicing their debt; accounting also for consumption spending on basic needs, this leaves only a small portion of their income for saving purposes.

<sup>11</sup> We believe that the variable of deposits is a better proxy for the funding constraints of Greek banks. Credit was, to a large extent, funded by bank deposits, which constituted a significant share of total bank assets (which subsequently fell, albeit remaining high, from 60.7% in December 2008 to 54.5% in December 2010).

<sup>12</sup> Note that in the interest rate differential variable, the real rate differential coincides with the nominal rate differential.

<sup>13</sup> The business loan rate applies to new loans of less than 1 million euro with the interest rate fixed for less than 1 year. Other interest rate differentials, such as the differential against the bond yield or the mortgage rate, were not considered, since the corresponding assets, each for different reasons, are not as close substitutes for consumer loans.

consumer loans against the alternative portfolio option of supplying credit to businesses. It should be noted that by including this interest rate differential, we assume that the loan portfolio decisions of banks are governed by the property of rate-of-return homogeneity. This property implies that when the rates of return on alternative bank portfolio assets rise by the same amount, banks do not alter the structure of their portfolio. The loan supply is then specified as a positive function of bank deposits and the interest rate differential,  $l = g(d, se)$ .

Based on the discussion in the previous section, we also consider variables that help capture the effects of financial liberalization. These variables are assumed to influence the long-run relationships of the model. Thus, we include dummy variables that would allow shifts in parameters, associated with key dates linked to the liberalization of credit. We also add trend terms to take into account structural changes in credit demand or supply due to liberalization. This is consistent with the approach usually followed in the empirical literature when modelling similar changes, where it is assumed that a trend term may proxy these effects, or, for example, the impact of financial innovation (see for example Arrau et al., 1995; Kakes, 2000; Hulsewig et al., 2004; Brissimis and Vlassopoulos, 2009). Another interesting example, that we do not follow here, is the approach taken by Arrau and De Gregorio (1993) who use a sample for Chile and Mexico and assume a time-varying constant term in the long-run money demand relationship, modelled as a random walk process. In all, we use five constant-term or slope dummy variables and a trend, associated with either demand or supply changes (for details see data appendix). These mainly capture the effects from the first round of liberalization during which consumer credit ceilings were raised (after the first quarter of 1994) (see Fig. 1 and Section 3), the subsequent influence of optimism and rising consumer spending prior to euro adoption (after the first quarter of 2000) and the effects from the last stage of consumer credit liberalization (after the third quarter of 2003).

For estimation, we use a sample of quarterly data for the period between 1990Q1 and 2008Q4. All variables are seasonally adjusted and expressed in logs, except for the

interest rates. The definition of the variables and sources of data are given in the appendix. Looking, first, at the time series properties of all variables ( $l$ ,  $r$ ,  $y$ ,  $se$  and  $d$ ), unit root tests (the ADF test) and the pattern of autocorrelations of the levels and first differences of the variables suggests that we can model all the time series examined as integrated of order one,  $I(1)$ . We then proceed to establish the existence of cointegrating relationships using the procedure suggested by Johansen (1988, 1991, 1995). In order to perform the Johansen test for the number of cointegrating vectors, we estimate an unrestricted VAR model in which all the variables are in levels. The vector of endogenous variables ( $X$ ), is defined as  $(l, r, se)$ , the vector of exogenous variables ( $Z$ ) includes  $(y, d)$  and finally the vector of deterministic variables ( $V$ ) includes the constant term, dummy variables and the time trend. Regarding exogeneity, we assume that income and deposits are exogenous with respect to loans.<sup>14</sup>

To select the lag order of the VAR model, we first consider the values of the Akaike and Schwartz information criteria, which suggest a lag order of three and one, respectively. However, since the diagnostic tests of the VAR residuals suggest that serial correlation is only eliminated when three lags are included, we estimate a VAR(3) model. Residuals also pass the Jarque–Bera normality test for this model.

We then consider the trace and maximum eigenvalue tests, the values of which are reported in Table 1. The tests indicate that there are two cointegrating vectors.

So far, the estimated VAR model includes both demand and supply variables. Once the number of cointegrating vectors has been determined, the natural next step would be to test for overidentifying restrictions in a restricted VECM. However, this model would be too complex to be estimated by a fully efficient method such as Full Information Maximum Likelihood (FIML), as the set of dummy variables included in each cointegrating vector differs. For this reason, we follow a two-step procedure to estimate the restricted model. In the first step, we estimate separately the two cointegrating relationships in which the theoretical restrictions pertaining to the demand for or supply of credit have been imposed. The equations are

Table 1. Trace and maximum eigenvalue tests for cointegration rank

Rank	Trace test	Critical value (5% level)	p-Value**	Maximum eigenvalue test	Critical value (5% level)	p-Value**
0	68.87	29.80	0.000*	44.57	21.13	0.000*
1	24.30	15.49	0.002*	24.30	14.26	0.001*
2	0.00	3.84	0.955	0.00	3.84	0.955

Notes: \* denotes rejection of the null of rank 0 or 1 respectively, at the 5% level. \*\* MacKinnon, Haug, and Michelis (1999) p-values.

<sup>14</sup> The assumption of exogeneity of these two variables does not influence our final estimates of the loan demand and supply relationships. This is due to the two-step estimation procedure that we eventually adopt, as described later in this section.

estimated by Fully Modified OLS (FMOLS; Phillips and Hansen, 1990) rather than simple OLS. In the second step, we estimate by maximum likelihood a VECM including as error correction terms (ECT), the residuals of the cointegrating equations estimated in the first step.<sup>15, 16</sup> The validity of the overidentifying restrictions in this VECM was tested by a log-likelihood ratio test comparing the restricted VECM to an exactly identified model.<sup>17</sup> The latter was similarly estimated in two steps.

The estimated demand and supply relationships are shown in Table 2. These relationships embody different demand and supply-related shifts in parameters through the inclusion of the relevant dummy variables. Moreover, we first normalize with respect to loans, the dependent variable, in the two equations and restrict both the coefficient of real economic activity in the demand equation and that of real deposits in the supply equation to equal 1 in the cointegrating vectors. Imposing theoretically a unit coefficient rather than estimating helps us avoid the typical bias associated with estimates of coefficients of exogenous variables in small samples. Exclusion restrictions then suggest that the two cointegration relationships represent candidate demand and supply functions (of the form described at the start of this section).

Table 3 presents the results of the likelihood ratio test for the validity of the over-identifying restrictions of the VECM.

The test statistic from the two models, which has a  $\chi^2(8)$  distribution, suggests that we cannot reject the validity of the theoretical supply and demand restrictions, implied by the relationships reported in Table 2.

Table 2. FMOLS estimation of the loan demand and supply relationships

Demand equation dependent variable: $l - y$		Supply equation dependent variable: $l - d$	
Variables	Parameter estimates (SEs)	Variables	Parameter estimates (SEs)
Constant	-8.532 (0.074)	Constant	-5.260 (0.049)
r	-0.039 (0.005)	DU4*se	0.062 (0.014)
DU1*t	0.027 (0.002)	DU5	0.185 (0.050)
t	0.035 (0.002)	t	0.044 (0.001)
DU2	0.918 (0.094)		
DU3	1.011 (0.133)		
Adj. R <sup>2</sup>	0.997	Adj. R <sup>2</sup>	0.983

<sup>15</sup> Note that tests of the residual terms confirm that they are stationary. Stationarity of these terms is already established by the Johansen test of the unrestricted VAR in levels, which indicates the existence of two cointegrating vectors, as presented in Table 1.

<sup>16</sup> We estimate the model by maximum likelihood; however, the parameters of the long-run relationships are essentially held fixed at their FMOLS values, unlike estimation that is typically carried out in the Johansen setting, in which the parameters of the long-run as well as the short-run relationships would have been estimated simultaneously, in one round. This procedure is basically the Engle and Granger (1987) methodology, generalized to a multi-equation setting.

<sup>17</sup> For this model to be estimated, four arbitrary restrictions were required by the order condition (see Pesaran and Shin, 1994).

<sup>18</sup> For example, Kakes (2000) finds a value of 1.757 for this coefficient.

Table 3. Likelihood ratio test: restricted versus unrestricted VECM

Log-likelihood ratio	16.08
Critical value at the 1% level	20.09
Degrees of freedom	8

Considering the estimated long-run cointegrating demand and supply relationships, the results in Table 2 indicate that all coefficients carry the signs expected from theory. Thus, the semi-elasticity of the demand for loans with respect to the loan interest rate is estimated at  $-0.039$ , a value that lies within the usual range found in the literature. For example, Fitzer and Reiss (2008) find a corresponding coefficient of  $-0.060$  for loans to households in the Austrian economy, which they consider to be high. Regarding the Greek loan market, Brissimis and Vlassopoulos (2009) also estimate the interest semi-elasticity for a mortgage loan demand curve at  $-0.039$ . Regarding the coefficient on income, the same authors find an almost unit elasticity of loans demanded with respect to income. More generally, this coefficient is found to be at least 1 in the literature, reaching values up to 2.5.<sup>18</sup> Most authors note that this coefficient seems to capture the effects of the omitted wealth variable that should also influence demand. Sorensen et al. (2009) also restrict this coefficient to a value of 1.

The positive signs of the coefficients of the two constant-term dummy variables indicate two upward shifts in the loan demand curve in the more advanced stages of liberalization of credit. The size of the coefficient on the trend suggests that the boost provided due to liberalization effects accounts for a significant part of the long-run dynamics of the demand for loans. As in the case of the interest rate, this coefficient (0.035) is also of equal size to that estimated by Brissimis and Vlassopoulos (2009) for the demand for housing loans in Greece (0.034). However, in the period of the first round of consumer credit liberalization, we find that this effect was considerably higher, almost double, as indicated by the coefficient of the relevant slope dummy (DU1\*t).

Turning to the supply equation, the liberalization effect estimated for the whole sample period is quite considerable, with a coefficient of 0.044 on the trend term. The estimated positive coefficient of the constant-term dummy



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variable (0.185), suggests that the effects of the liberalization are moderated by supply constraints. These constraints perhaps partly reflect the enforcement of anti-inflation restrictive measures for private sector credit, and consumer credit in particular, by the Bank of Greece. We find an estimate for the semi-elasticity of loan supply with respect to the interest rate differential (se) of 0.062. This differential is multiplied by a dummy variable which excludes observations at the start of the sample as price incentives did not influence the supply of credit in the period until the first round of liberalization. Hulsewig et al. (2004) find a close coefficient estimate of 0.054 in their estimated loan supply curve for an interest differential between the loan rate and the monetary policy variable. Looking also at our restricted unit coefficient of deposits, Hulsewig et al. (2004) use equity as a scale variable and find a coefficient of 0.658.

Considering the full VECM (not presented here, see Table 4 results from the final 'general to specific approach model'), the loading factors that apply to these two long-run equations carry the correct signs and are found to be statistically significant. However, in the third equation of the model, which explains the change in se (the interest differential) as a dependent variable, the loading factors for both the demand and the supply ECT were statistically insignificant, indicating that the interest differential is weakly exogenous. We then dropped the third equation and estimated a two-equation VECM for the change in loans and the change in the interest rate. Table 4 presents the results for this model, whereby we have gradually

eliminated the statistically insignificant variables in the context of the general-to-specific approach. We used the SURE.<sup>19</sup>

In the first equation for the change in loans, the loading factor for the demand-related ECT (−0.118) suggests a moderately fast adjustment speed of consumer loans to departures from the long-run demand relationship, which is higher than that of the adjustment to the long-run supply relationship (−0.072). In the same equation, short-run dynamics indicate that loans display some degree of inertia. Finally, in the second equation that explains the change in loan rates, it is important to note that the two ECT are found to be statistically significant.

We then checked the stability of the coefficients, first of the long-run equations estimated recursively by FMOLS under the assumption that the short-run dynamic coefficients remain constant and, second, of the two VECM equations estimated recursively by OLS, holding the long-run parameters fixed in the ECT. The coefficients for the short-run dynamics are highly stable and are not reported here. The two panels in Fig. 3 present the results from recursive FMOLS estimation of the long-run parameters. The relative stability of the dummy and trend variables coefficients until the end of 2008 suggests that these variables seem to capture well the shifting effects of the liberalization during the sample period. We note, however, that further estimation of these equations until 2010 reveals that the estimated coefficients of most of the variables showed signs of instability in the period 2009 to 2010, associated with the crisis-related effects of the significant deceleration in credit growth and the decrease in deposits. The semi-elasticity of the demand for loans with respect to the interest rate becomes smaller in absolute value during this period, suggesting that households might be less willing to assume new debt burdens, responding less to changes in interest rates.

Finally, we calculated the individual contributions of the explanatory variables in our VECM to the growth of real credit over the sample period. We then disentangled demand from supply-side contributions. For this purpose, we solved dynamically<sup>20</sup> the VECM, using the estimated coefficients in Tables 2 and 4, which remain fixed, and the actual historical values of all the explanatory variables. In order to find the contribution of an individual variable, we compared the actual historical values of loans to those predicted by the model under the assumption that the variable remains fixed, throughout the whole sample period, at its initial value (at the start of the sample). We thus found the contribution, which includes both short-run and long-run effects, of deposits, income and the interest rate

Table 4. Estimation with the seemingly unrelated regressions estimator (SURE) of the two-equation VECM

	Equation 1: $l_t$	Equation 2: $r_t$
Variables	Parameter estimates (SEs)	Parameter estimates (SEs)
Constant	0.019 (0.005)	0.104 (0.111)
$l_{t-1}$	0.379 (0.097)	–
$l_{t-2}$	0.285 (0.097)	–
$r_{t-1}$	−0.011 (0.003)	0.294 (0.107)
$Y_t$	–	−17.903 (8.428)
ECT1 $_{t-1}$	−0.118 (0.056)	−7.065 (1.905)
ECT2 $_{t-1}$	−0.072 (0.027)	2.944 (0.984)
Adj. $R^2$	0.73	0.22
Diagnostic tests		
Normality: Jarque–Bera statistic	0.414 (0.813)*	5.387 (0.068)*
Serial correlation: Portmanteau statistic (1 to 4 lags)	6.810 (0.146)*	4.001 (0.406)*

Note: \* probability values.

<sup>19</sup>We tried FIML, but convergence was not achieved by the numerical methods used by Eviews.

<sup>20</sup>Note that to what concerns the lagged endogenous variables in the model, solving dynamically essentially requires substituting out recursively the earlier model forecasts of the endogenous variable.

Panel A

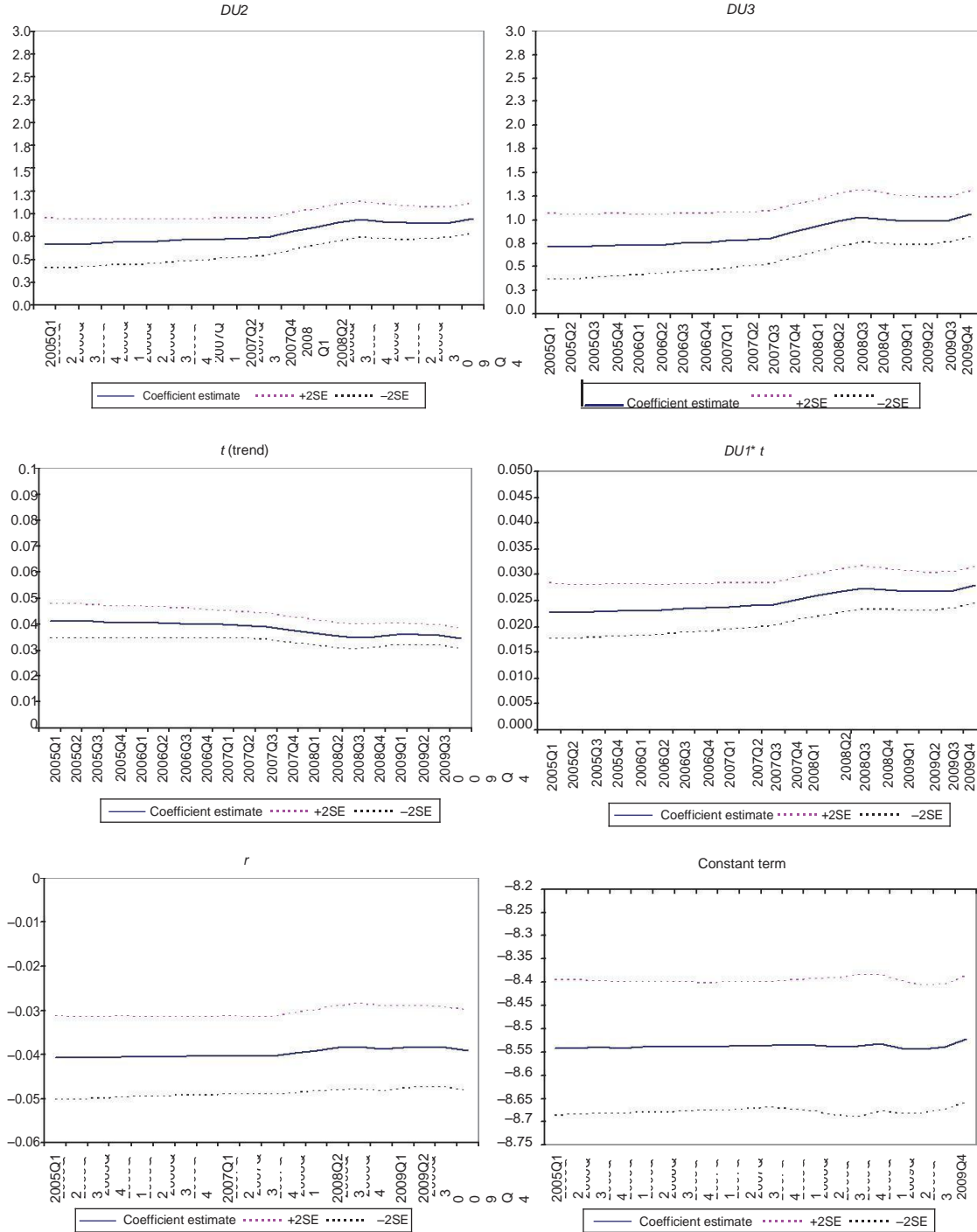


Fig. 3. Recursive FMOLS coefficient estimates of the long-run demand and supply equations. Panel A: Demand relationship; Panel B: Supply relationship

spread. Similarly, to find the individual contributions of the trend and each of the dummy variables, we set them separately equal to zero. The results are presented in Figs 4 and 5. In Fig. 4, the effects related to the liberalization of credit are approximated by the sum of contributions of the trend and of the dummy variables. The

contribution of credit liberalization remains positive and, perhaps not surprisingly, is the largest contribution. However, one must note that the sizeable contribution of the trend and the dummy variables perhaps also captures the effects attributed to factors that have not been allowed for in this specification, particularly factors

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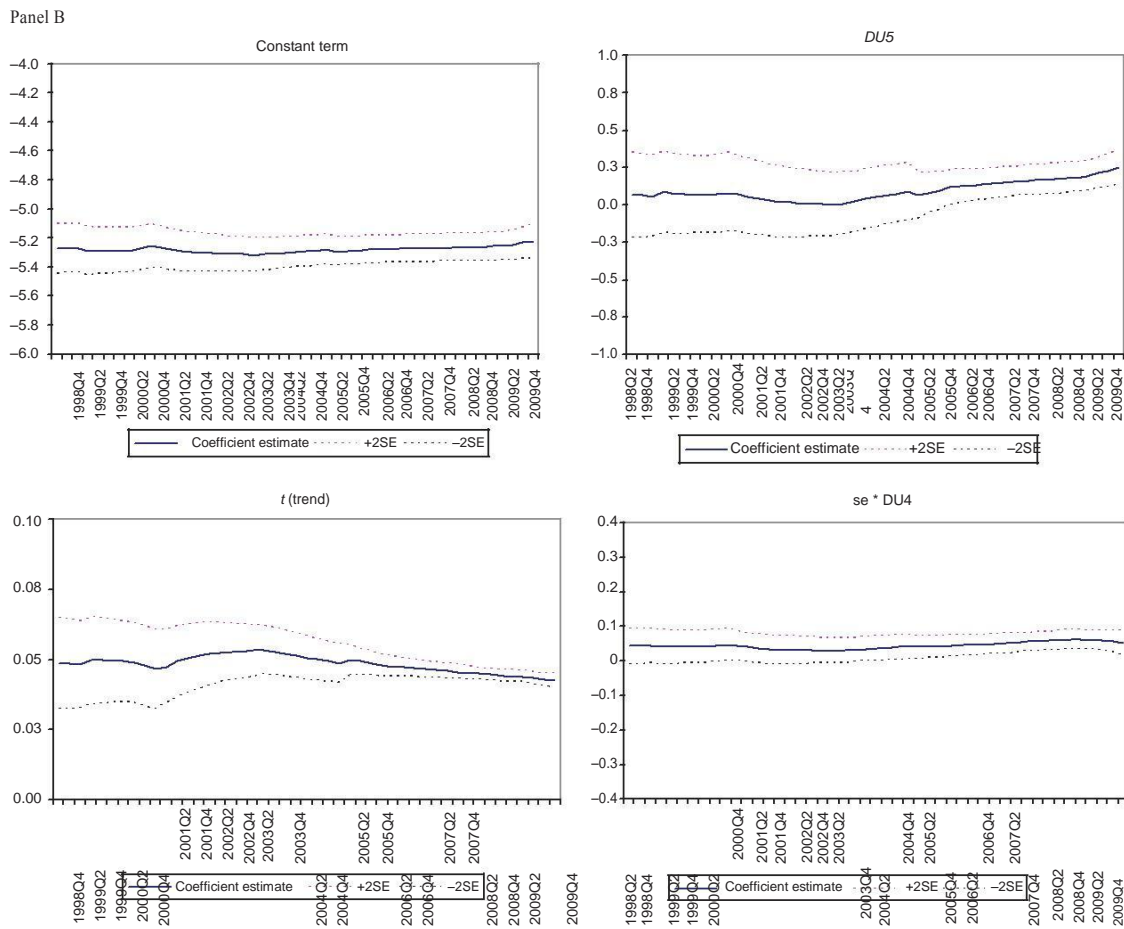


Fig. 3. Continued

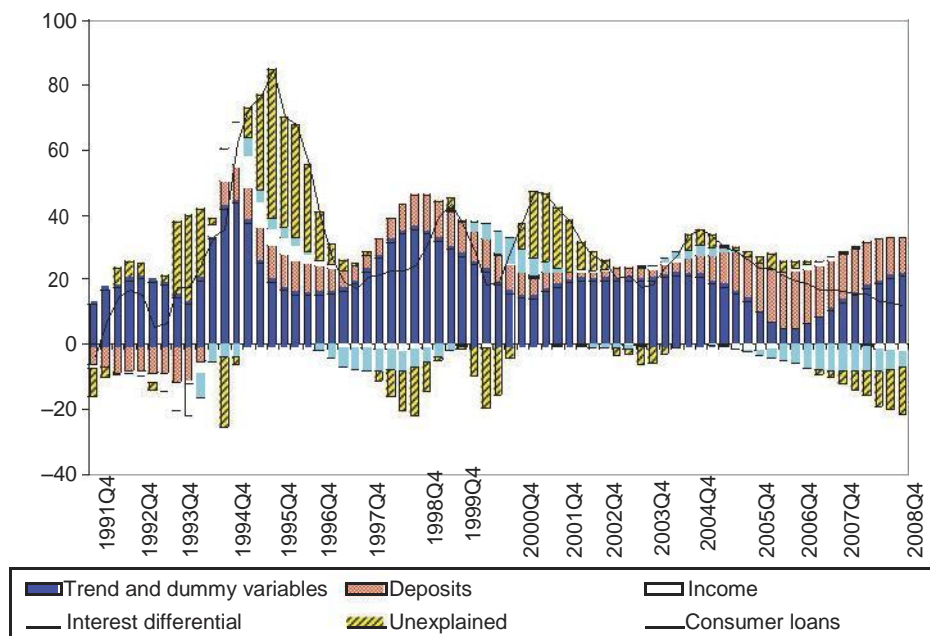


Fig. 4. Total contribution to the annual growth rate of consumer loans of: deposits, income, interest differential, trend and dummy variables (%)

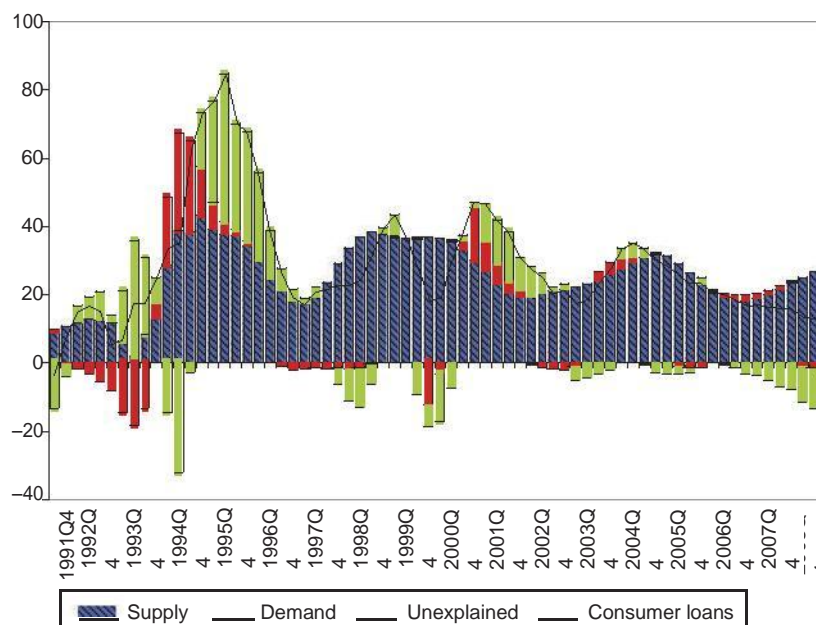


Fig. 5. Total contribution to the annual growth rate of consumer loans of demand and supply (%)

related to the benefits from entry into the euro area. On the demand side, these benefits are associated with household expectations regarding the favourable growth prospects of the economy and a rising standard of living. On the supply side, the expectations of banks were influenced by the prospects for greater expansion of the market for loans and the improved creditworthiness of potential borrowers. The low level of household indebtedness perhaps also contributed to the acceleration of credit growth.

Deposits made the second largest contribution on average, on account of strong deposit growth after 1994. This reflects the fact that Greek banks traditionally used their growing deposit base to fund loans. However, a broader measure of bank funding perhaps would have better captured the effects of the increasing availability of market funding, particularly in the period after the adoption of the euro. Looking at the interest rate spread, the contribution to loan growth is quite sizeable, though not always positive. For example, the negative contribution recorded after 2005 is due to the narrowing gap between the consumer and the business loan rate (see also Fig. 2). Finally, GDP made the smallest contribution to the growth rate of loans, which was negative in some periods. This result is in contrast with that found in other studies, where income had the largest effect on loan growth. The difference may be explained not only by the fact that these studies rely on a loan demand relationship only and hence they leave out, sometimes important, supply effects but also by the observation that credit liberalization during this period had a large impact on loan growth, mainly through the supply side. This is suggested in Fig. 5, which decomposes loan

growth into demand and supply effects. Supply effects always remain positive and impressively dominate demand effects, which are sometimes negative, especially at the start of the sample period during which demand was still repressed.

## V. Conclusions

In our article, we aimed to model consumer credit in Greece and identify long-run demand and supply relationships. We employed multivariate cointegration techniques and established that two cointegrating relationships exist. We partly deviated from the typical Johansen procedure and estimated the model in two steps. In the first step, we imposed theoretical restrictions and estimated separate demand and supply-related cointegrating relationships by FMOLS. Following the estimation of the full VECM subject to these restrictions, in the second step we found that the overidentifying restrictions are valid.

Overall, our results suggest that the introduction of variables related to shifts reflecting financial liberalization effects helps isolate these effects and estimate the key demand and supply relationships that hold in the long run. Recursive OLS estimates support the stability of the short-run parameters of the VECM. The parameters of the long-run cointegrating relationships were estimated recursively by FMOLS and are relatively stable, indicating that the variables modelling structural changes capture well liberalization effects; we note, however, that in the post-2008 period, which corresponds to the recent financial crisis, the parameters of the long-run relationships show

signs of instability; the interest rate semi-elasticity in the long-run demand equation seems to fall, suggesting perhaps that the crisis-related pressure reduces the willingness of borrowers to assume more debt and their responsiveness to price changes. Finally, the identification of a separate demand and supply function for consumer credit, in the full sample period, is consistent with the existence of a bank lending channel in Greece. Considering the recent financial crisis, the sharp fall in credit, driven by consumer credit, and the particularly pronounced rise in nonperforming consumer loans recorded in the crisis period would call for a thorough study of the behaviour of consumer credit during this period.

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## Data Appendix: Definitions and Sources

The sample period is 1990Q1–2008Q4. All variables, except for the interest rates, are seasonally adjusted and expressed in logs. The following variables were used.

l: consumer loans, including securitized loans, at Monetary Financial Institutions (MFIs), end of quarter (source: Bank of Greece). Deflated by the CPI (source: Hellenic Statistical Authority).

d: deposits of non-MFIs at MFIs (excluding Bank of Greece), end of quarter (source: Bank of Greece). Deflated by the CPI.

y: gross domestic product at constant 2000 prices (source: Hellenic Statistical Authority).

r: real interest rate on new consumer loans (source: Bank of Greece). The nominal rate is a weighted average of the following loan rates: a) variable rate or rate fixed for less than 1 year b) rate fixed for more than 1 year and less than 5 years c) rate fixed for more than 5 years. This rate is

expressed in real terms by subtracting from the nominal rate, the annual growth rate of the CPI.

se: difference between the consumer loan rate and the business loan rate. The latter is the rate on new business loans with interest rate fixation period up to 1 year, for loans up to EUR 1 million (source: Bank of Greece).

DU1 to DU3 are dummy variables in the demand equation corresponding to the different phases of consumer credit liberalization. DU1 takes the value of 1 in the period 1994Q1 to 1999Q4 and 0 elsewhere, DU2 the value of 1 in the period 2000Q1 to 2003Q2 and 0 elsewhere and DU3 the value of 1 in the period 2003Q3 to 2008Q4 and 0 elsewhere.

DU4 and DU5 are dummy variables in the supply equation corresponding to the phasing out of bank supply constraints. DU4 takes the value of 1 in the period 1994Q1 to 2008Q4 and 0 elsewhere and DU5 the value of 1 between 1997Q1 and 2004Q4 and 0 elsewhere.