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**Bank efficiency, market concentration and economic
growth in the European Union**

WP 38/2012/DE/UECE

WORKING PAPERS

ISSN Nº 0874-4548



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Abstract

Well-functioning financial markets and banking institutions are usually considered to be a condition favourable to economic growth. The importance of bank efficiency and bank market concentration has also been the object of discussion, with the general belief that while they are of particular relevance in the context of the European Union, there is no consensus on their specific roles.

This paper aims to study the effects on economic growth of the efficiency of the banking institutions, measured through Data Envelopment Analysis (DEA), and also of the concentration of the bank markets, measured by the percentage share of the total assets held by the three largest banking institutions (C3) and the Herfindahl-Hirschman Index (HHI). Considering a panel of all 27 EU countries for the time period between 1996 and 2008, the study analyses the influence of these bank and market conditions not only on the Gross Domestic Product (GDP) but also on its components: the final consumption expenditure, the gross fixed capital formation, the export of goods and services and the import of goods and services.

The main findings point to the generally positive influence of bank cost efficiency on economic growth. More precisely, this influence is statistically significant for GDP and particularly with respect to the gross fixed capital formation. With regard to the bank market concentration, a generally negative influence is revealed, not only on GDP, but also on its components and is statistically more significant for the gross fixed capital formation, as well as for the export and import of goods and services.

Keywords: Bank efficiency, market concentration, economic growth, European Union.

JEL Classification: G21; F43; D4; L11

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1. Introduction

Recently, the extent to which well-developed and accessible credit markets and institutions may be an important condition to economic growth has become clearer. Banks and other financial institutions are supposed to guarantee the financing of productive investments and activities, as they mobilise and allocate financial resources and also by means of their specific money-creation processes through bank credit. At the same time, well-functioning markets and financial institutions may decrease the transaction costs and asymmetric information problems. In addition, they are supposed to play an important role in identifying investment opportunities, selecting the most profitable projects, mobilising savings, facilitating trading and the diversification of risk, as well as improving corporate governance mechanisms.

There is a large strand of literature that analyses theoretically and empirically the link between economic growth and the development of the financial systems (represented among many others, by such authors as King and Levine (1993), Levine and Zervos (1998), Guiso et. al. (2004) and Hassan et al. (2011). On the other hand, the study of the importance of bank efficiency and bank market concentration has also been the object of discussion and it is generally accepted that they are of particular relevance in the context of the European Union, although their roles still remain controversial (see Goddard *et al.*, 2007; Molyneux, 2009; among others).

This paper is a contribution to the study of the link between financial intermediation and economic growth in the context of the European Union. We take into account that in our society, economic growth depends on capital accumulation and most particularly, on bank credit

financing; furthermore, we have in mind the mechanisms through which savings are channelled to productive investments that contribute to economic growth. These mechanisms involve both financial intermediaries (mostly banking institutions, for indirect financing) and financial markets (for the direct financing). Thus, we analyse the importance to economic growth of the performance of the banking institutions (particularly of bank efficiency) and of market conditions (more precisely, of the market concentration).

In this context, our study contributes to the literature mostly in the following ways.

First, like Cetorelli and Gambera (2001), we test the importance to economic growth of the concentration of bank markets, here measured by the percentage share of the total assets held by the three largest banking institutions (C3) and the Herfindahl-Hirschman Index (HHI). However, in contrast to these authors (and among others, Rajan and Zingales, 1998; Claessens and Laeven, 2005; Maudos and Fernandez de Guevara, 2009), we do not consider the influence of the external financial dependence, but instead we analyse the effect of the efficiency of the banking institutions, measured through Data Envelopment Analysis (DEA).

Second, we analyse the influence of these bank and market conditions not only on the Gross Domestic Product (GDP), but also on its components: final consumption expenditure, gross fixed capital formation, the export of goods and services and the import of goods and services.

Third, we consider a panel of all 27 EU member states for a relatively long time period: between 1996 and 2008. By the middle of the 1990s, Europe was preparing for the implementation of the single currency and many of the actual member states were adapting to new market conditions, whereas 2008 may be considered to mark the onset of the current financial crisis. We will not analyse the consequences of this crisis, but rather the situation during the 12 years preceding it, and in all 27 current members of the European Union.

Our main findings point to the general positive influence of the bank cost efficiency on economic growth. More precisely, this influence is statistically significant for GDP, above all for the gross

fixed capital formation. In relation to the bank market concentration, our results are in line with those obtained by, for instance, Cetorelli and Gambera (2001), as concentration has a general negative influence not only on GDP, but also on its components and is statistically more significant for the gross fixed capital formation and also for the export and import of goods and services.

The remainder of the paper is organised as follows: Section 2 presents a brief literature review; Section 3 explains the methodological framework and the data used; Section 4 reports the main results of our estimations; and Section 5 concludes.

2. Brief literature review

During recent decades, and particularly since the renowned King and Levine (1993) paper, there has been an increase of empirical studies at the aggregate level which explain output variables with financial ratios and variables such as liquid liabilities, bank loans to the private sector, or stock market capitalisation, which may be representative of the development of the financial systems and institutions.

In one such study, Levine and Zervos (1998), using data for 49 countries for the period 1976-1990, conclude that there is a strong correlation between the rates of real per-capita output growth and stock market liquidity.

Demirgüç-Kunt and Levine (1999), with data for 150 countries during the 1990s, conclude that the wealthy countries have more developed financial systems, characterising this development by the size and efficiency of the financial sector, measured by the assets, liabilities, overhead costs and interest margins.

A few years later, Beck et al. (2004) used the ratio of the value of credit from financial intermediaries to the private sector, divided by GDP as a proxy to capture the depth and breadth of the financial intermediation in a panel of 52 countries over the period 1960 to 1999. They conclude that financial development is not only clearly pro-growth but also pro-poor, that is, in countries with better-developed financial intermediation, income inequality declines more rapidly.

Analysing these studies, we agree with Khan and Senhadji (2000), who, in providing a review of the literature and empirical evidence of the relationship between financial development and economic growth, concluded that the results of these studies indicate that while the general effects of financial development on the outputs are positive, the size of these effects varies with the different variables considered, with the indicators of financial development and with the estimation method, data frequency or the defined functional form of the relationship.

Furthermore, Rajan and Zingales (1998) argued that there is no clear causality between financial development and economic growth and proposed further tests to analyse the mechanism through which financial development may promote economic growth taking into account both country and sectoral effects. Rather than adhering to the traditional explanation of economic growth by proxies of the financial development, Rajan and Zingales (1998) test the hypothesis that financial markets and banking institutions not only reduce the cost of financing, but also help to combat the problems provoked by asymmetrical information, assuming in their test that the sectors most dependent on external financing will be the ones that grow faster and in line with the development of the financial markets and institutions to which these sectors have access.

At the same time, and particularly with the global trend of bank consolidation, there has been an increase of theoretical debates and empirical analysis of the relationship between bank market concentration and bank performance.

Until the 1990s, there was a general belief that mergers did not clearly contribute to bank performance improvements and several empirical findings were consistent with the traditional structure conduct performance statements, in particular with the “quiet life hypothesis” (e.g. Berger and Hannan, 1989, 1998; Hannan and Berger, 1991; Houston and Ryngaert, 1994; Pilloff, 1996).

From the year 2000, this general consensus was broken when particular attention was paid to such specific characteristics of the banking markets as the presence of asymmetric information, contagion phenomena and imperfect competition, or the specific impacts of bank concentration, competition and regulation on bank performance (among others, De Brand and Davis, 2000; Bikker and Haaf, 2002; Berger *et al.*, 2004; Hasan *et al.*, 2009; Schaeck *et al.*, 2009).

With regard to the empirical tests of the relationship between the bank market structure (represented by the market share or concentration indices) and bank efficiency (measured either by parametric methods, like the Stochastic Frontier Analysis, or by non-parametric methods, like the Data Envelopment Analysis), several papers tend to support the efficient structure hypothesis, underlining the importance of the relationship between bank cost efficiency and bank concentration or market share (for instance, Goldberg and Rai, 1996; Punt and Van Rooij, 2003; Maudos and Fernandez de Guevara, 2007).

However, it is generally recognised that not many works have addressed the possible relationship between banking market structure, bank performance (particularly bank efficiency) and economic growth.

In one of these studies, Carbó Valverde *et al.* (2003) analyse the relationship between financial market competition and economic growth in five large regions in Spain and, using Granger causality tests, conclude that the differences in competition are not associated with improved regional growth.

Comparing the financial systems of different countries and regions, Allen and Gale (2001) conclude that there is inherent inefficiency within the monopolistic power of banks, which may also adopt an excessively conservative approach while the competitive nature of markets tends to encourage innovation and growth-enhancing activities.

At the same time, and following Rajan and Zangales' (1998) contribution, there is a stand of empirical studies that use industry-level and firm-level data to analyse the channels through which financial development contributes to economic growth.

In one such study, Cetorelli and Gambera (2001) develop the Rajan and Zangales (1998) model and, considering a sample of 41 countries and 36 economic sectors, for the time period 1980-1990, conclude that there is empirical evidence of a general depressing effect on growth associated with a concentrated banking industry, which impacts all sectors and all firms indiscriminately.

More recently, Maudos and Fernandez de Guevara (2009) used different measures of bank market competition for a sample of 21 countries and 53 economic sectors during the time period 1993-2003, concluding not only that there is a positive effect of financial development on the economic growth of the sectors most dependent on external finance, but also that the exercise of bank market power promotes economic growth.

Different conclusions are obtained by Claessens and Laeven (2005) using industry-specific and country-specific data for 16 countries (mostly for the time period 1980-90, but also for the period 1980-97) to estimate a measure of banking competition based on industrial organisation theory and then relating this competition measure to the growth of the industries. Their findings point to the evidence that greater competition in the countries' banking systems will contribute to the faster growth of the financially-dependent industries and so there is no support for the hypothesis that market power is good for access to financing and promoting economic growth.

At the same time, and specifically with regard to the measurement of the quality of the financial development and its possible influence on economic growth, Hasan et al. (2009) use a sample of 147 regions in 11 European countries, between 1996 and 2004, finding that regional economic growth benefits significantly from more efficient banks.

3. Methodological framework and data used

We will take into account the model specification of Rajan and Zingales (1998) and the contributions of Claessens and Laeven (2004, 2005) to analyse the influence of market structure and banking competition on economic growth and the more recent contribution of Maudos and Fernandez de Guevara (2009), who used market concentration measures and banking competition measures to explain the growth of 53 economic sectors in 21 countries.

We will not consider the growth of economic sectors here, but rather we will test the influence of bank efficiency and bank market concentration on GDP growth and on its components: final consumption, investment, exports and imports.

The basic model to be estimated will be:

$$\text{Growth}_{i,t} = \alpha_0 + \alpha_1 \text{year dummies}_i + \alpha_2 \text{country dummies}_t + \alpha_3 \text{lag1 growth}_{i,t-1} + \alpha_4 \text{bank efficiency}_{i,t} + \alpha_5 \text{bank market concentration}_{i,t} + \alpha_6 \text{control variables}_{i,t} \quad (1)$$

Where:

Growth = natural logarithm of the GDP (at market prices), or of one of its components: final consumption, gross fixed capital formation, exports or imports;

i = EU country ($i = 1, \dots, 27$);

t = year ($t = 1996, \dots, 2008$);

lag1 growth = first lag ($t-1$) of the growth endogenous variable;

bank efficiency = natural logarithm of the Data Envelopment Analysis (DEA)
bank cost efficiency;
bank market concentration = natural logarithm of the percentage share of the
total assets held by the three largest banking institutions (C3) or natural logarithm of the
Herfindahl-Hirschman Index (HHI);
control variables = return on assets (ROA) or return on equity (ROE).

The inclusion of the year and country dummies aims to capture the influence of the considered
specific time period (between 1996 and 2008) and also the influence of the country-specific
factors that affect the economic growth of the 27 EU member states.

In the next pages, before presenting the results of the estimated model, we need to present the
explanatory variables of our model and particularly to specify how we measure bank efficiency
and bank market concentration.

3.1. Bank efficiency

The research into efficiency is usually based on the estimation of efficiency frontiers with the
best combinations of the different inputs and outputs of the production process and then on the
analysis of the deviations from the frontier that correspond to the losses of efficiency.

Most of the empirical studies on the measurement of bank efficiency adopt either parametric
methods, like the Stochastic Frontier Analysis (SFA), or non-parametric methods, in particular
the Data Envelopment Analysis (DEA).

Here, we will adopt the DEA methodology (developed by, among others, Coelli *et al.*, 1998;
Thanassoulis *et al.*, 2007) and we will follow the intermediation approach, considering that the

banks' total costs will depend on three bank outputs: total loans, total securities and other earning assets; and also on three bank inputs: borrowed funds, physical capital and labour (see Appendix A for a presentation of the DEA methodology and the chosen bank outputs and inputs).

Our data are sourced from the IBCA-BankScope 2008 CD. The sample comprises annual data from consolidated accounts of the commercial and saving banks of all 27 EU countries between 1996 and 2008. Appendix B presents the annual number of banks for each country that are available in the BankScope CD and included in our sample.

Using the available data, the DEA frontier will be defined by the piecewise linear segments that represent the combinations of the best-practice observations, the measurement of efficiency being relative to the particular frontier obtained. If the actual production of one decision-making unit (DMU) lies on the frontier, this production unit will be considered perfectly efficient, whereas if it is situated below the frontier, the DMU will be inefficient; the distance of the actual to the potential level of production will define the level of efficiency of any individual DMU.

Thus, with the DEA approach, the efficiency score for any DMU is not defined absolutely in comparison with a universal efficiency standard; rather, it is always defined as the distance to the particular production frontier, that is, in relation to the other DMUs that are included in the specific data set. As a consequence, DEA provides efficiency scores even in the presence of relatively few observations, which represents a great advantage in comparison with the parametric approaches (like the SFA), as the latter require the availability of sufficient observations to allow the estimation of specific production functions.

Appendix C reports the obtained DEA yearly bank cost efficiency results of the EU countries for the time period between 1996 and 2008.

In spite of the year-on-year oscillations, there is a clear trend in many EU countries to the decrease of bank cost efficiency (particularly for some large countries like Germany and France,

and other, smaller countries including Belgium, Denmark, Finland, Luxembourg, Sweden and the Netherlands). On the other hand, for some of the new EU member states, there is a trend to the increase of bank cost efficiency (particularly evident for Bulgaria and Romania).

3.2. *Bank market concentration*

Among the possible concepts and measures of market concentration, we opt to use two of the most popular indicators: the percentage share of the total assets held by the three largest banking institutions (C3) of each EU member-state and the Herfindahl-Hirschman Index (HHI), which, also in terms of each member-state's total bank assets, is calculated as the sum of the squares of the market shares of each of the country's banking institutions.

For the interpretation of the HHI, we follow the general rule that considers the presence of low concentration if $HHI < 1000$; if $HHI > 1800$, there is high concentration; and if $1000 < HHI < 1800$, the market will be moderately concentrated.

To obtain the concentration measures C3 and HHI, we continue to use data sourced from the IBCA-BankScope 2008 CD: annual data from the consolidated accounts of the commercial and savings banks of all EU countries between 1996 and 2008.

The C3 and HHI results are presented in Appendix D and clearly show that, with some exceptions, there is a general increase in the bank market concentration. The exceptions are to be found in the Netherlands and Greece and most particularly in certain new EU member states, like Bulgaria, Romania and Poland, and also in the Czech Republic, Ireland, Latvia, Lithuania, Malta and Slovakia, although less strongly.

On the other hand, and in spite of the general increase in EU bank market concentration between 1996 and 2008, the levels of concentration continue to be relatively low in the five most important EU countries: France, Germany, Spain, the United Kingdom and Italy (the latter only

up to 2005), countries that clearly account for the majority of the banks included in our panel (see Appendix B).

3.3. *Control variables*

In our estimations, we will also consider the influence on economic growth (and on its main components) of two variables that are commonly used to analyse the performance of the banking sector: the return on assets (ROA) and the return on equity (ROE).

The ROA is the ratio of the net income to the total assets of the banks and is useful in the assessment of the use of the banks' resources and their financial strength. However, for the banking industry, most analysts prefer to use the ROE, that is, the ratio of the net income to the banks' equity, to judge the performance not only of an individual bank, but also of the entire bank sector.

The bank net income gives, by itself, a good idea of the bank's performance, but it suffers from an important drawback: it does not take into account the bank's size and it makes difficult the comparisons among different banking institutions and/or during different time periods. However, the use of the above-mentioned ratios corrects for the size of the banks and makes possible the comparisons among institutions for the same or for different time periods.

Thus, the ROA is a simple measure of bank profitability that gives a good idea of how well the bank administration is doing its job, that is, how well the bank's assets are being used to generate profits. This is a clear bank performance measure, but not the most relevant for the bank's shareholders. The bank's shareholders are particularly interested in the relationship between the bank's earning and their equity investment, which can be measured by the ROE.

Appendix E presents the ROA and ROE obtained for our sample of banking institutions of all EU countries between 1996 and 2008.

Both ratios reveal the clear difficulties of the banking institutions of some important EU countries in 2008. With regard to the ROA, for the years before 2008, there are few negative results and only for some new EU member states and some critical years of Germany's reunification process. Nevertheless, generally speaking, during the time period between 1996 and 2007, the ROA results obtained reveal a general tendency to the increase of the profits generated from the banks' assets in most of the EU countries.

The ROE results confirm the negative situations in 2008 and the few negative values for the banking institutions of some new EU members and of the reunited Germany. However, for the years before 2008 there is no clear trend to the increase or decrease of the ROE results. On the contrary, the ROE results reveal clear oscillations in the ratio of the banks' earnings and the equity investment of their shareholders in all EU countries.

3.4. Sources of data and series used

As was mentioned before, our sample includes yearly data from all 27 EU countries, for the time period between 1996 and 2008. All financial and bank performance variables are sourced from the IBCA-BankScope 2008 CD (annual data from the consolidated accounts of the commercial and saving banks, all in nominal values and in euros).

The macroeconomic data are sourced from the Eurostat statistical database and include: the Gross Domestic Product (GDP), the final consumption expenditure, the gross fixed capital formation, the exports of goods and services and also the imports of goods and services. All these series are at market prices (as are also the financial variables), in millions of ECUs up to 31.12.1998 and millions of euros from 1.1.1999.

Before proceeding with the estimations of the presented equation, we test the stationarity of the series, using the Levin, Lin and Chu (2002) panel unit root test, which may be viewed as a

pooled Dickey-Fuller test, or as an augmented Dickey-Fuller test, when lags are included and the null hypothesis is the existence of non-stationarity. This test is adequate for heterogeneous panels of moderate size, like the panels used in this paper, and it assumes that there is a common unit root process. The main results obtained are reported in Appendix F and clearly allow us to reject the existence of the null hypothesis, although for the macroeconomic variables, only of their first differences (and since these variables are expressed in logarithms, their differences can then be interpreted as growth rates).

Appendix G presents the summary statistics and the correlation matrix of the series of data used in the estimation of the equation (1).

4. Empirical results

The results of the estimation of equation (1) with robust OLS regressions are presented in Appendix H, where the different tables (from Table H1 to Table H5) report the results for the GDP and for its components. In all situations, four models are estimated, all including the first lag of the correspondent dependent variable, the year and the country dummies (whose specific results are not reported, but are available on request) and the constant; the four models differ by the combinations of the two measures of bank market concentration (HHI or C3) and the two control variables (ROA or ROE).

In relation to the GDP (Table H1), the obtained F statistics and the relatively high values of the R-squares for panel estimates, in general, allow us to accept the validity of the estimation results. The results obtained for equation 1, concerning GDP, are also summarised in Table 1 below.

In the four models, the growth (natural logarithm) of the DEA bank cost efficiency is statistically significant and contributes positively to the increase of the variation (first difference) of the GDP

growth (natural logarithm). The same applies to the ROA and ROE ratios and they clearly contribute to the positive variation of the GDP growth. These results are in line with the empirical studies that conclude that financial development, or the good performance of the banking sector, facilitates economic growth (for example King and Levine, 1993; Levine and Zervos, 1998; Hassan et al., 2011).

Table 1 – Summary of the results obtained for GDP

Explanatory variables (model 1)	Effect	Explanatory variables (model 2)	Effect
Lag1 GDP	- *	Lag1 GDP	- *
DEA bank cost efficiency	+ **	DEA bank cost efficiency	+ **
Bank market concentration (HHI) measure	-	Bank market concentration (C3) measure	-
Return on assets (ROA) ratio	+ *	Return on assets (ROA) ratio	+ *
Constant	+ *	Constant	+ *
Explanatory variables (model 3)	Effect	Explanatory variables (model 4)	Effect
Lag1 GDP	- **	Lag1 GDP	- **
DEA bank cost efficiency	+ *	DEA bank cost efficiency	+ *
Bank market concentration (HHI) measure	-	Bank market concentration (C3) measure	-
Return on equity (ROE) ratio	+ ***	Return on equity (ROE) ratio	+ ***
Constant	+ *	Constant	+ *

+ Positive effect; - negative effect. * Statistically significant at 10%; ** statistically significant at 5%; *** statistically significant at 1%.

Source: Estimation results of equation 1 reported in Table H1 of Appendix H.

Regarding the bank market concentration measures (the growth of the HHI and C3, measured by the respective natural logarithms), the results obtained, although statistically less strong, reveal their negative influence on the differences of the GDP growth. A similar conclusion was previously obtained by Centorelli and Gamberra (2001) who, using information on 41 countries and 36 manufacturing sectors in the 1980s, found a negative general effect of market concentration on economic growth for all sectors and firms.

The results obtained for the final consumption expenditure are reported in Table H2 of Appendix H and also summarised in Table 2 below. Although statistically less relevant, these

results are completely in line with those obtained for GDP, revealing that the variation of the growth of the final consumption expenditure represents an important part of the aggregate GDP, whereas consumption has its own specific dynamics and is less dependent on the evolution of the explanatory financial variables than GDP.

Table 2 – Summary of the results obtained for final consumption expenditure

Explanatory variables (model 1)	Effect	Explanatory variables (model 2)	Effect
Lag1 Final consumption	-	Lag1 Final consumption	-
DEA bank cost efficiency	+	DEA bank cost efficiency	+
Bank market concentration (HHI) measure	-	Bank market concentration (C3) measure	-
Return on assets (ROA) ratio	+	Return on assets (ROA) ratio	+
Constant	+	Constant	+
Explanatory variables (model 3)	Effect	Explanatory variables (model 4)	Effect
Lag1 Final consumption	-	Lag1 Final consumption	-
DEA bank cost efficiency	+	DEA bank cost efficiency	+
Bank market concentration (HHI) measure	-	Bank market concentration (C3) measure	-
Return on equity (ROE) ratio	+	Return on equity (ROE) ratio	+
Constant	+	Constant	+

+ Positive effect; - negative effect. * Statistically significant at 10%; ** statistically significant at 5%; *** statistically significant at 1%.

Source: Estimation results of equation 1 reported in Table H2 of Appendix H.

It is expected that well-functioning banking institutions play an important role not only in the saving mobilisation, but also in the diversification of risk, the identification of investment opportunities and the contribution to the gross fixed capital formation.

Table H3 of Appendix H reports the results obtained for the gross fixed capital formation and the results are also summarised in Table 3 below. The important role of the banking institutions to the gross fixed capital formation is well supported by the very clear positive influence of the DEA bank cost efficiency, reinforcing the idea that efficient banking institutions will surely contribute to the increase of the gross capital formation.

At the same time, and in line with the results already obtained for the GDP and the final consumption expenditure, the bank market concentration measures show a clear negative influence, particularly of the HHI, supporting the hypothesis that bank market concentration could be associated to less competition (defended, among others, by Bikker and Haaf, 2002 and Schaeck and Cihak, 2008) and also to lesser efforts in the selection of the most profitable projects.

Now, and contrary to our previous results for GDP and final consumption, the influences of ROA and ROE ratios are not only statistically irrelevant, but also negative. The explanation may be connected to the fact that the application of the financial resources in the gross fixed capital formation is an alternative to the other possible applications of these financial resources and also to the recognised increasing role of the non-traditional activities to explain the banking returns.

Table 3 – Summary of the results obtained for gross fixed capital formation

Explanatory variables (model 1)	Effect	Explanatory variables (model 2)	Effect
Lag1 Gross fixed capital formation	-	Lag1 Gross fixed capital formation	-
DEA bank cost efficiency	+ ***	DEA bank cost efficiency	+ ***
Bank market concentration (HHI) measure	- **	Bank market concentration (C3) measure	-
Return on assets (ROA) ratio	-	Return on assets (ROA) ratio	-
Constant	+ **	Constant	+ **
Explanatory variables (model 3)	Effect	Explanatory variables (model 4)	Effect
Lag1 Gross fixed capital formation	-	Lag1 Gross fixed capital formation	-
DEA bank cost efficiency	+ ***	DEA bank cost efficiency	+ ***
Bank market concentration (HHI) measure	- **	Bank market concentration (C3) measure	-
Return on equity (ROE) ratio	-	Return on equity (ROE) ratio	-
Constant	+ **	Constant	+

+ Positive effect; - negative effect. * Statistically significant at 10%; ** statistically significant at 5%; *** statistically significant at 1%.

Source: Estimation results of equation 1 reported in Table H3 of Appendix H.

The results obtained for the exports of goods and services are presented in Table H4 of Appendix H and summarised below in Table 4. The results confirm that exports have their own dynamics (their “lags” are statistically significant) and mostly depend on other factors like the decisions of the rest of the world (here represented by the “constants”, which are also statistically significant).

With reference to the influence of our explanatory variables, in general, they are not statistically significant, although their influences are in line with the results obtained for GDP (with the exception of the DEA cost efficiency, although this is clearly statistically not significant). However, in three of the considered models, the growth of bank market concentration, particularly when it is measured through the HHI, clearly has a negative influence on the growth rate of the exports of goods and services.

Table 4 – Summary of the results obtained for exports of goods and services

Explanatory variables (model 1)	Effect	Explanatory variables (model 2)	Effect
Lag1 Exports	- *	Lag1 Exports	- *
DEA bank cost efficiency	-	DEA bank cost efficiency	-
Bank market concentration (HHI) measure	- *	Bank market concentration (C3) measure	-
Return on assets (ROA) ratio	+	Return on assets (ROA) ratio	+
Constant	+ **	Constant	+ **
Explanatory variables (model 3)	Effect	Explanatory variables (model 4)	Effect
Lag1 Exports	+ *	Lag1 Exports	- *
DEA bank cost efficiency	-	DEA bank cost efficiency	-
Bank market concentration (HHI) measure	- *	Bank market concentration (C3) measure	- *
Return on equity (ROE) ratio	+	Return on equity (ROE) ratio	+
Constant	+ **	Constant	+ **

+ Positive effect; - negative effect. * Statistically significant at 10%; ** statistically significant at 5%; *** statistically significant at 1%.

Source: Estimation results of equation 1 reported in Table H4 of Appendix H.

The results obtained for the imports of goods and services (presented in Table H5 of Appendix H and summarised in Table 5 below) are very similar to those already reported for the gross fixed capital formation, revealing that the dynamics of the imports of goods and services reflect the business and production cycle (when usually gross fixed capital formation also increases). The DEA bank cost efficiency reveals its positive influence on the growth of imports of goods and services, although it is not statistically significant. At the same time, and confirming all the previous results, the growth of bank market concentration has a negative influence on the growth

of the imports of goods and services, and now this influence is clearly statistically significant, both for the HHI and C3 concentration measures.

Table 5 – Summary of the results obtained for imports of goods and services

Explanatory variables (model 1)	Effect	Explanatory variables (model 2)	Effect
Lag1 Imports	- (*)	Lag1 Imports	- (**)
DEA bank cost efficiency	+	DEA bank cost efficiency	+
Bank market concentration (HHI) measure	- (**)	Bank market concentration (C3) measure	- (**)
Return on assets (ROA) ratio	-	Return on assets (ROA) ratio	-
Constant	+ (**)	Constant	+ (**)
Explanatory variables (model 3)	Effect	Explanatory variables (model 4)	Effect
Lag1 Imports	- (**)	Lag1 Imports	- (**)
DEA bank cost efficiency	+	DEA bank cost efficiency	+
Bank market concentration (HHI) measure	- (**)	Bank market concentration (C3) measure	- (*)
Return on equity (ROE) ratio	-	Return on equity (ROE) ratio	-
Constant	+ (**)	Constant	+ (**)

+ Positive effect; - negative effect. * Statistically significant at 10%; ** statistically significant at 5%; *** statistically significant at 1%.

Source: Estimation results of equation 1 reported in Table H5 of Appendix H.

5. Summary and conclusions

This paper aims to provide empirical evidence of the importance to economic growth of the performance of the banking institutions, particularly of bank efficiency, measured through Data Envelopment Analysis (DEA), bank cost efficiency and bank market concentration, measured both by the percentage share of the total assets held by the three largest banking institutions (C3) and the Herfindahl-Hirschman Index (HHI). The influence of these bank and market conditions, including also as control variables, the return on assets (ROA) and the return on equity (ROE), is tested not only on the Gross Domestic Product (GDP) but also on its components: the final

consumption expenditure, the gross fixed capital formation, goods and services exports and goods and services imports.

We consider a panel of all 27 EU member states for the time period between 1996 and 2008. The macroeconomic data are sourced from the Eurostat statistical database, and all financial and bank performance variables are sourced from the IBCA-BankScope 2008 CD, including the available annual data from consolidated accounts of the commercial and saving banks.

Our results confirm the assumption that well-functioning financial institutions will contribute positively to economic growth (empirically confirmed by the large strand of literature mostly following the pioneering contribution of King and Levine, 1993). During the considered 12 years, a period when all EU member states were preparing either for the new market conditions of the European Monetary Union, or to become a new EU member, or indeed to confront all of these changes and challenges, just before the current financial crisis, there is clear evidence of a generally positive influence of bank cost efficiency on economic growth. However, this influence is statistically more significant for GDP and particularly for the gross fixed capital formation. Regarding the bank market concentration, our results are in line with those obtained by Cetorelli and Gambera (2001), among others, since concentration has a generally negative influence on GDP and on its components, this influence being statistically more significant for the gross fixed capital formation, for the export and import of goods and services.

A more careful analysis of the results obtained for the GDP and its components, considering the estimation of four models, all of them including the first lag of the correspondent dependent variable, the year and the country dummies (the specific results for which are not reported, but are available on request) and the constant, as well as the different combinations of the two measures of bank market concentration (HHI or C3) and of the two control variables (ROA or ROE), allow us to conclude that:

- In all models, the obtained F statistics and the relatively high (for panel data) R-squares point to the validity of the estimation results for GDP. Furthermore, there is clear and statistically significant evidence of the positive influence of the growth of the DEA bank cost efficiency, as well as on the ROA and the ROE ratios on the GDP growth rate.
- For the final consumption expenditure, the obtained results, although completely in line with those obtained for GDP, are now statistically less relevant, revealing that the final consumption expenditure may be an important part of the GDP aggregate expenditure but the growth rate of the final consumption has its own dynamics and is less dependent on the market and bank cost efficiency conditions than the other components of GDP.
- With regard to the growth rate of the gross fixed capital formation, there is statistically strong evidence of the positive influence of the growth of the DEA bank cost efficiency, confirming the important role of well-functioning banking institutions in increasing the gross capital formation. Moreover, the negative effect of the bank market concentration growth is also clear and statistically highly significant when concentration is measured through the Helfindahl-Hirschman Index.
- The results obtained for the exports of goods and services, although mostly in line with those reported for GDP and final consumption, are now statistically less relevant, confirming that the exports growth rate mainly depends on its own dynamics and most particularly on “other factors”, like the decisions of the rest of the world.
- The particular inertia of the growth rate of the imports of goods and services is also clear, but there is evidence that imports go in line with the business cycle, together with the gross fixed capital and GDP growth rates. There is also statistical evidence of the negative effect of bank market concentration, considering both the HHI and the C3 concentration measures.

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Appendix A - Data Envelopment Analysis (DEA)

DEA was originally presented in Charnes *et al.* (1978), assuming constant returns to scale, which can be accepted as optimal but only in the long run. Later, Banker *et al.* (1984) introduced an additional convexity constraint (λ) and allowed for variable returns to scale. Following also Coelli *et al.* (1998), Thanassoulis (2001) and Thanassoulis *et al.* (2007), we can assume that at any time t , there are N decision-making units (DMUs) that use a set of X inputs ($X = x_1, x_2, \dots, x_k$) to produce a set of Y outputs ($Y = y_1, y_2, \dots, y_m$), thus obtaining the DEA input-oriented efficiency measure of every i DMU, solving the following optimisation problem:

$$\begin{aligned} & \min_{\theta, \lambda} \theta_i \\ & s.t. \quad \sum_{r=1}^N y_{mr}^t \lambda_r^t \geq y_{mi}^t \\ & \quad \sum_{r=1}^N x_{kr}^t \lambda_r^t \leq \theta_i x_{ki}^t \\ & \quad \lambda_r^t \geq 0 \\ & \quad \sum_{r=1}^N \lambda_r^t = 1 \end{aligned}$$

The DEA approach provides, for every i decision-making unit (DMU, here every country's banking sector), a scalar efficiency score ($\theta_i \leq 1$). If $\theta_i = 1$, the DMU lies on the efficient frontier and will be considered an efficient unit. On the contrary, if $\theta_i < 1$, the DMU lies below the efficient frontier and will be considered an inefficient unit; moreover, $(1 - \theta_i)$ will always be the measure of its inefficiency.

In the present study, the data are sourced from the IBCA-BankScope 2008 CD and the sample comprises annual data from the consolidated accounts of the commercial and savings banks of all EU countries between 1996 and 2008.

For the DEA estimates, we define the outputs and the input prices of the cost function, using the following variables:

Outputs:

1. **Total loans** = natural logarithm of the loans
2. **Total securities** = natural logarithm of the total securities
3. **Other earning assets** = natural logarithm of the difference between the total earning assets and the total loans

Inputs:

1. **Price of borrowed funds** = natural logarithm of the ratio interest expenses over the sum of deposits
2. **Price of physical capital** = natural logarithm of the ratio non-interest expenses over fixed asset
3. **Price of labour** = natural logarithm of the ratio personnel expenses over the number of employees

Appendix B – Yearly number of banks by EU country

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	72	122	124	124	129	140	142	146	154	153	162	162	147
Belgium	97	91	75	73	68	69	72	73	72	71	58	47	34
Bulgaria	16	19	22	21	25	27	28	29	30	30	29	22	21
Cyprus	17	23	25	21	23	23	24	18	17	16	11	11	9
Czech Rep.	28	28	25	25	27	28	27	26	31	27	25	25	20
Denmark	113	113	117	118	123	116	113	112	129	120	123	121	109
Estonia	16	18	8	8	10	10	11	11	12	11	11	12	10
Finland	11	12	12	12	14	13	12	14	19	16	11	11	12
France	345	323	312	306	308	305	295	283	292	283	256	237	204
Germany	827	830	818	791	771	737	708	682	675	677	685	675	593
Greece	29	35	33	30	26	26	31	34	55	35	33	30	29
Hungary	34	33	34	37	39	35	37	33	33	36	35	31	26
Ireland	34	36	40	40	42	44	46	47	63	51	50	47	40
Italy	200	219	219	228	216	229	232	240	363	304	226	222	199
Latvia	21	25	24	24	25	26	27	30	33	36	36	36	33
Lithuania	11	13	13	14	16	16	16	17	17	17	18	18	15
Luxembourg	122	123	117	123	112	100	96	92	93	91	92	105	80
Malta	9	9	10	8	10	9	9	14	16	17	18	17	14
Netherlands	64	58	57	55	50	55	61	60	77	58	57	54	41
Poland	47	51	47	49	50	45	48	52	73	56	45	43	37
Portugal	41	44	44	43	37	36	33	32	44	34	31	31	25
Romania	8	11	27	30	31	30	31	29	32	29	29	28	27
Slovakia	19	23	24	20	22	20	21	19	19	25	17	17	16
Slovenia	29	29	24	26	25	23	20	20	23	29	23	22	21
Spain	206	216	207	198	204	213	211	208	256	192	184	151	136
Sweden	16	15	17	21	22	104	103	103	101	103	99	92	78
UK	191	196	200	195	195	197	204	206	257	203	190	170	148

This Appendix presents the annual number of banks (commercial and saving banks) for each EU country included in our sample. All data are sourced from the IBCA-BankScope 2008 CD and include all the available data.

Appendix C – Yearly Data Envelopment Analysis (DEA) cost efficiency measures of the EU member states

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	0.702	0.629	0.595	0.760	0.720	0.616	0.643	0.694	0.676	0.707	0.662	0.678	0.715
Belgium	0.950	0.887	0.903	0.983	0.826	0.911	0.793	0.958	0.594	0.819	0.672	0.463	0.478
Bulgaria	0.149	0.270	1.000	1.000	1.000	1.000	1.000	0.970	0.937	0.832	1.000	1.000	0.915
Cyprus	1.000	1.000	1.000	1.000	1.000	1.000	0.914	0.725	0.695	0.679	0.837	0.800	0.937
Czech Rep.	0.945	0.803	0.579	0.632	0.859	0.741	0.681	0.716	0.838	0.897	1.000	1.000	1.000
Denmark	0.926	0.853	0.830	0.785	0.668	0.525	0.607	0.776	0.780	0.734	0.928	0.722	0.536
Estonia	1.000	0.864	0.730	0.647	0.717	0.765	0.621	0.587	0.760	0.777	0.893	0.711	0.669
Finland	0.783	1.000	1.000	1.000	0.737	1.000	0.687	0.677	1.000	0.905	1.000	0.845	0.579
France	0.818	0.699	0.687	0.739	0.552	0.547	0.578	0.576	0.531	0.577	0.606	0.597	0.712
Germany	0.948	0.889	1.000	0.981	0.772	0.762	0.887	0.934	0.956	0.776	0.821	0.699	0.606
Greece	0.754	0.685	0.643	0.604	0.734	0.781	0.949	1.000	1.000	1.000	1.000	0.967	0.991
Hungary	0.334	0.298	0.365	0.367	0.539	0.504	0.402	0.485	0.434	0.433	0.523	0.500	0.495
Ireland	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.951	1.000	1.000	0.849	0.959
Italy	1.000	0.872	1.000	1.000	0.975	0.802	0.921	0.924	1.000	0.958	0.984	0.741	0.740
Latvia	1.000	1.000	0.990	1.000	1.000	0.947	0.885	0.910	0.991	0.827	0.839	0.721	0.729
Lithuania	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.778
Luxembourg	0.879	0.690	0.730	0.696	0.654	0.508	0.564	0.697	0.673	0.757	0.523	0.544	0.524
Malta	1.000	0.911	0.953	0.888	0.932	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Netherlands	1.000	1.000	1.000	0.874	0.764	0.759	0.748	0.852	0.822	0.779	0.821	0.882	0.564
Poland	0.700	0.591	0.708	0.596	0.597	0.604	0.528	0.593	0.616	0.605	0.985	1.000	0.928
Portugal	0.894	0.808	0.836	1.000	0.824	0.638	0.538	0.438	0.512	0.562	0.641	0.599	0.584
Romania	0.612	0.596	1.000	1.000	1.000	1.000	1.000	1.000	0.986	0.925	0.886	0.998	0.855
Slovakia	1.000	0.823	0.596	0.613	0.639	0.658	0.715	0.753	0.833	0.839	0.953	0.902	1.000
Slovenia	0.803	0.732	0.712	0.868	0.856	0.842	0.675	0.620	0.585	0.808	0.855	0.873	0.809
Spain	1.000	1.000	1.000	1.000	1.000	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Sweden	0.632	0.675	0.708	0.724	0.514	0.638	0.677	0.695	0.589	0.626	0.695	0.509	0.440
UK	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

This Appendix presents the cost efficiency results obtained with DEA, considering three outputs (total loans, total securities, and other earning assets) and three inputs (price of borrowed funds, price of physical capital and price of labour).

Appendix D – Concentration measures: C3 and Herfindahl-Hirschman Index (HHI)

C3

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	42.28	46.12	58.71	59.64	54.26	56.40	50.14	50.14	42.84	50.12	45.57	49.84	45.05
Belgium	32.40	31.41	44.75	58.77	58.84	59.38	59.38	54.00	54.92	44.92	54.87	56.82	57.25
Bulgaria	78.59	62.84	55.10	52.88	52.88	48.57	42.49	38.37	34.01	33.38	31.14	32.59	30.37
Cyprus	64.73	61.49	60.84	61.36	52.08	50.55	53.64	66.62	65.92	72.44	77.36	72.89	71.89
Czech Rep.	50.68	49.99	46.33	51.33	55.75	54.63	53.71	54.17	41.63	42.47	41.77	42.13	40.58
Denmark	52.80	46.74	46.88	43.11	50.00	56.01	57.17	58.36	52.60	59.80	59.06	60.89	60.38
Estonia	42.25	40.39	75.83	77.06	77.98	80.54	80.58	80.69	86.99	87.11	88.17	84.99	89.29
Finland	73.67	76.35	78.06	74.08	76.14	83.78	87.60	80.54	74.51	74.69	79.52	79.45	79.4
France	24.56	27.77	28.93	34.96	34.19	35.79	31.35	31.81	30.29	32.87	33.90	35.05	36.61
Germany	18.74	16.03	21.75	22.68	24.83	24.08	21.11	21.96	22.08	25.51	27.97	32.78	36.08
Greece	48.29	45.19	43.02	39.71	41.20	41.11	39.4	38.41	24.02	36.59	35.58	38.19	37.67
Hungary	39.21	45.94	33.60	32.49	30.37	32.20	33.96	39.03	39.66	37.64	39.25	37.67	35.26
Ireland	57.68	58.00	48.35	50.95	50.64	45.96	49.87	47.69	35.84	42.16	43.44	43.03	43.95
Italy	19.05	20.26	23.80	24.24	25.55	27.97	25.55	25.28	24.51	34.25	44.09	49.38	48.47
Latvia	41.90	41.55	49.77	46.27	39.28	35.97	36.38	32.79	30.43	32.67	35.76	33.60	35.30
Lithuania	51.37	51.09	58.95	70.92	69.44	66.43	64.76	56.17	53.25	51.23	50.49	47.70	46.58
Luxembourg	17.05	16.64	17.92	17.34	18.06	19.44	22.29	22.03	21.28	21.13	20.71	16.78	18.9

Malta	91.28	91.48	90.80	96.41	89.93	92.27	91.18	80.82	79.05	78.00	68.85	81.26	80.51
Netherlands	72.29	78.75	81.86	81.28	80.50	81.86	85.40	78.45	65.99	73.22	80.55	71.67	64.27
Poland	47.46	39.18	39.03	39.15	33.09	36.22	33.49	30.49	20.03	31.27	30.79	33.42	28.4
Portugal	32.46	28.90	30.56	31.00	45.10	42.92	46.01	48.25	41.15	54.49	56.48	54.00	53.78
Romania	96.56	85.88	60.93	63.28	58.69	55.34	53.98	58.79	50.89	50.86	49.44	52.14	47.75
Slovakia	71.20	62.95	50.94	57.74	57.72	56.66	56.80	57.34	62.12	45.87	56.82	52.38	55.02
Slovenia	41.63	44.77	45.80	42.42	45.54	51.81	51.97	59.51	56.74	52.77	49.06	50.93	48.18
Spain	31.36	33.82	33.63	38.46	38.21	36.51	32.81	31.89	31.44	36.11	32.98	33.15	32.72
Sweden	43.01	47.21	46.17	46.31	47.48	47.18	49.58	48.51	56.27	58.03	57.67	56.75	54.78
UK	28.24	26.96	22.32	25.46	24.59	24.95	27.95	28.14	23.46	30.85	29.10	33.09	35.57

Herfindahl-Hirschman Index (HHI)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	913	1023	1281	1564	1622	1626	1419	1229	941	1221	1049	1311	1084
Belgium	758	733	1035	1659	1628	1900	1638	1336	1375	978	1445	1499	1499
Bulgaria	2487	1972	1395	1394	1242	1040	846	827	745	741	690	756	673
Cyprus	1799	1613	1560	1608	1356	1278	1315	1837	1899	2199	2719	2242	2308
Czech Rep.	1182	1160	1113	1289	1366	1321	1282	1296	935	1015	1018	1004	1004
Denmark	1209	1106	1106	1017	1268	1479	1519	1511	1194	1577	1542	1615	1570
Estonia	1014	997	2274	2411	2516	2867	2828	2849	3720	4025	4218	3378	3378
Finland	2237	2335	2375	2236	2386	3767	4311	2877	1947	2511	2758	2793	2857
France	420	455	472	595	581	601	513	537	519	586	626	649	682
Germany	283	262	344	355	385	376	320	341	336	390	392	535	624
Greece	1099	981	914	792	896	899	869	856	485	870	812	853	845
Hungary	806	869	665	643	589	645	660	796	835	821	885	857	798
Ireland	1375	1410	1071	1171	1172	1023	1129	1081	815	886	963	1006	1065
Italy	333	326	397	412	431	469	437	411	401	591	807	1051	1025
Latvia	907	822	1028	932	847	865	828	744	660	716	750	697	735
Lithuania	1368	1329	1500	1944	1823	1696	1613	1362	1265	1256	1174	1079	1057
Luxembourg	301	299	333	330	346	371	398	392	366	381	365	276	318
Malta	3731	3759	3699	4156	3578	3680	3706	2683	2437	2370	1938	2639	2606
Netherlands	2061	2541	2647	2569	2543	2581	3232	2620	1597	2110	2418	1895	1701
Poland	962	714	794	687	597	731	668	583	377	612	613	645	550
Portugal	663	584	624	629	1025	997	1103	1158	1036	1273	1393	1310	1327
Romania	4249	2626	1733	1582	1388	1324	1254	1408	1160	1150	1102	1103	972
Slovakia	2127	1766	1240	1486	1443	1308	1301	1330	1437	978	1306	1202	1253
Slovenia	927	1032	1043	901	1017	1195	1218	1338	1234	1080	1130	1195	1087
Spain	464	502	507	600	645	600	515	500	482	654	565	561	563
Sweden	1148	1255	1243	1239	1253	1225	1298	1281	1575	1632	1598	1605	1563
UK	502	493	423	463	466	480	514	517	397	542	529	612	654

This Appendix presents the obtained yearly EU countries' concentration measures with the **C3** (that is, the percentage share of the total assets held by the three largest banking institutions) and the **Herfindahl-Hirschman Index** (also for the total assets, the HHI is calculated as the sum of the squares of all of the country's banking institutions' market shares).

Appendix E – Return on assets (ROA) and return on equity (ROE)

ROA

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	0.0026	0.00345	0.00286	0.00403	0.00419	0.00325	0.00252	0.00348	0.00375	0.00462	0.00902	0.00586	-0.00142
Belgium	0.00302	0.00302	0.00287	0.00468	0.0057	0.00555	0.00387	0.00456	0.00431	0.00461	0.00684	0.00334	-0.01741
Bulgaria	0.05388	0.0967	0.00694	0.01875	0.02756	0.0168	0.01766	0.02099	0.01911	0.02024	0.01917	0.02198	0.02267
Cyprus	0.00389	0.00377	0.00541	0.01176	0.01105	0.00705	-0.00211	-0.0002	0.00202	0.00476	0.00888	0.01536	0.0116
Czech Rep.	0.00324	-0.00751	-0.00996	-0.00912	0.00383	0.00149	0.01318	0.01391	0.01344	0.01442	0.01357	0.0137	0.01222
Denmark	0.00834	0.00804	0.0072	0.00615	0.00603	0.00511	0.00455	0.00656	0.00565	0.00669	0.00719	0.00557	-0.00063
Estonia	0.02395	0.02263	-0.01593	0.01879	0.0171	0.02385	0.02386	0.02296	0.02127	0.01772	0.01719	0.02002	0.01383
Finland	0.00365	0.00862	0.00448	0.00815	0.01414	0.01517	0.00474	0.01658	0.00773	0.00868	0.00884	0.00965	0.00502
France	0.00073	0.00165	0.00269	0.00314	0.00481	0.00388	0.00349	0.00386	0.00497	0.00443	0.00571	0.00282	-0.00105
Germany	0.00231	0.00222	0.00377	0.00219	0.00399	-0.00018	-0.0019	-0.00203	0.00051	0.00269	0.00359	0.00388	-0.00223
Greece	0.00559	0.00606	0.00721	0.02243	0.0131	0.00954	0.00489	0.00747	0.00536	0.00921	0.00834	0.01075	0.0043
Hungary	0.01177	0.01083	-0.00029	0.00374	0.0114	0.0136	0.01482	0.01735	0.02394	0.01839	0.01721	0.01623	0.01344
Ireland	0.00687	0.00695	0.00766	0.00733	0.006	0.00464	0.00439	0.00522	0.00548	0.00551	0.0063	0.00611	0.0008
Italy	0.00201	0.00071	0.00462	0.00634	0.00728	0.00536	0.00433	0.00505	0.00608	0.00727	0.00775	0.00641	0.00419
Latvia	0.03149	0.02642	-0.06331	0.00926	0.01632	0.01551	0.01397	0.01374	0.01609	0.01839	0.01712	0.01735	0.00019
Lithuania	-0.00612	0.00592	0.01042	0.01309	0.00778	0.00381	0.00829	0.01133	0.00999	0.00874	0.01178	0.01446	0.00947
Luxembourg	0.00426	0.00419	0.00543	0.00405	0.00469	0.00505	0.00516	0.00544	0.00493	0.00574	0.00857	0.00627	0.00262
Malta	0.00857	0.00941	0.00772	0.00757	0.01091	0.00818	0.00659	0.00876	0.01008	0.01233	0.01164	0.00941	-0.00227
Netherlands	0.00689	0.00675	0.00682	0.0067	0.00834	0.00707	0.00453	0.0061	0.00509	0.00688	0.00686	0.00805	-0.00883
Poland	0.0217	0.01648	0.00751	0.0107	0.01053	0.00763	0.00429	0.00355	0.01339	0.01722	0.0171	0.01973	0.016
Portugal	0.00586	0.00756	0.0075	0.0079	0.00914	0.00725	0.00654	0.00683	0.00509	0.00652	0.00755	0.00721	0.00288
Romania	0.00241	0.00074	-0.009	0.02758	0.02114	0.02552	0.01705	0.01196	0.02172	0.01683	0.01594	0.0131	0.0202
Slovakia	0.00182	-0.00696	-0.02133	0.01443	0.0153	0.01043	0.01232	0.0131	0.01082	0.00999	0.01105	0.0115	0.00873
Slovenia	0.01058	0.00956	0.01151	0.00645	0.01095	0.00511	0.00706	0.00615	0.00767	0.0073	0.00899	0.00929	0.00439
Spain	0.00619	0.00698	0.00783	0.00803	0.00826	0.00808	0.00764	0.00773	0.00747	0.00773	0.0089	0.00978	0.0069
Sweden	0.00945	0.00487	0.00717	0.00674	0.00756	0.00888	0.0045	0.00582	0.00885	0.00683	0.00677	0.00658	0.00454
UK	0.00674	0.00597	0.00834	0.00793	0.00794	0.0071	0.00622	0.00761	0.00744	0.00537	0.00547	0.00592	-0.00009

ROE

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	0.07012	0.08268	0.0717	0.10285	0.1149	0.08425	0.06325	0.07434	0.08538	0.09875	0.16321	0.09107	-0.02699
Belgium	0.10145	0.09688	0.08235	0.13048	0.1604	0.17411	0.10844	0.13201	0.13042	0.15421	0.21715	0.07971	-0.52826
Bulgaria	0.43574	0.64501	0.04117	0.10237	0.15356	0.11381	0.12309	0.14553	0.16157	0.17414	0.17626	0.19653	0.18565
Cyprus	0.06761	0.0682	0.0941	0.15086	0.11837	0.08053	-0.02424	-0.00296	0.03704	0.09008	0.11125	0.15764	0.13239
Czech Rep.	0.04608	-0.11873	-0.15207	-0.14085	0.05733	0.02374	0.18834	0.18377	0.16247	0.17876	0.17501	0.20417	0.14958
Denmark	0.13266	0.14013	0.12551	0.11145	0.11017	0.10189	0.09585	0.13581	0.12381	0.13881	0.13917	0.11885	-0.01584
Estonia	0.26234	0.25425	-0.10693	0.12701	0.12888	0.18962	0.18476	0.18313	0.20602	0.20292	0.22375	0.25453	0.14777
Finland	0.07584	0.1886	0.09463	0.16671	0.22149	0.23956	0.07312	0.17018	0.08563	0.1005	0.0965	0.13678	0.09833
France	0.02058	0.0491	0.07574	0.08075	0.12459	0.10213	0.08729	0.09581	0.13134	0.12659	0.15251	0.08743	-0.03695
Germany	0.0647	0.06262	0.10468	0.06207	0.10063	-0.00403	-0.0478	-0.05344	0.0154	0.07803	0.10829	0.11397	-0.07949
Greece	0.12395	0.12592	0.12222	0.21942	0.15107	0.12468	0.07597	0.11189	0.08771	0.13803	0.11176	0.1466	0.0771
Hungary	0.20067	0.14938	-0.00464	0.05168	0.14947	0.17457	0.17517	0.19713	0.2474	0.21231	0.189	0.18294	0.16369
Ireland	0.10778	0.11656	0.12663	0.12916	0.09938	0.09332	0.10073	0.13648	0.13956	0.1512	0.1691	0.16367	0.0252
Italy	0.03248	0.01212	0.07539	0.10621	0.12109	0.08584	0.06809	0.07376	0.09107	0.09731	0.11052	0.07958	0.05588
Latvia	0.2347	0.21165	-0.79227	0.09451	0.18878	0.16992	0.15678	0.15339	0.18947	0.22583	0.21638	0.20573	0.0024
Lithuania	-0.0944	0.06697	0.08455	0.10784	0.06946	0.03556	0.07332	0.1123	0.11137	0.11295	0.16206	0.19346	0.11498
Luxembourg	0.13237	0.13567	0.15398	0.11146	0.12008	0.12174	0.11354	0.12027	0.10508	0.12224	0.17984	0.13193	0.05362
Malta	0.15712	0.16442	0.10927	0.10722	0.1479	0.1102	0.08934	0.05892	0.07043	0.09368	0.08918	0.08777	-0.02371
Netherlands	0.1077	0.11702	0.12257	0.13324	0.14828	0.13617	0.0971	0.13562	0.15143	0.16493	0.166	0.16065	-0.25869
Poland	0.24709	0.1869	0.08864	0.12328	0.11412	0.08001	0.04391	0.03965	0.12701	0.16575	0.16663	0.19204	0.17613
Portugal	0.09731	0.12965	0.11553	0.12514	0.16528	0.13154	0.10931	0.10743	0.08646	0.11704	0.11874	0.11894	0.05323
Romania	0.03886	0.00847	-0.07063	0.17422	0.12891	0.14468	0.10438	0.08074	0.1699	0.15345	0.16463	0.15455	0.22711
Slovakia	0.03798	-0.14916	-0.82112	0.23768	0.21061	0.13332	0.13958	0.14107	0.12162	0.12898	0.15206	0.15506	0.11975
Slovenia	0.09374	0.08089	0.11398	0.06774	0.11554	0.05954	0.08655	0.07417	0.09183	0.09395	0.11265	0.11967	0.05467
Spain	0.10724	0.1181	0.12561	0.12915	0.11746	0.1159	0.1095	0.11587	0.10342	0.11944	0.13925	0.15256	0.11552
Sweden	0.23566	0.12267	0.19192	0.16768	0.20256	0.22153	0.115	0.13852	0.20442	0.16303	0.16075	0.16533	0.1289
UK	0.14577	0.12942	0.16932	0.14853	0.14254	0.12455	0.11284	0.13373	0.15684	0.14866	0.15404	0.15892	-0.00381

This Appendix presents the obtained yearly EU countries' bank performance measures: the return on assets (ROA = net income/assets) and the return on equity (ROE = net income/equity).

Appendix F – Panel unit root tests

Levin, Lin and Chu (2002) (LEVINLIN) tests:

Variables	coefficient	t-star	P > t
First difference of the natural logarithm of the GDP	-0.91877	-12.12891	0.0000
First difference of the natural logarithm of the final consumption	-0.89094	-11.08223	0.0000
First difference of the natural logarithm of the gross fixed capital formation	-0.87761	-9.74921	0.0000
First difference of the natural logarithm of the exports	-0.98552	-13.34454	0.0000
First difference of the natural logarithm of the imports	-0.79163	-9.83498	0.0000
Natural logarithm of DEA bank cost efficiency	-0.43473	-4.25875	0.0000
Natural logarithm of bank market concentration (C3) measure	-0.25417	-5.02867	0.0000
Natural logarithm of bank market concentration (HHI) measure	-0.28545	-6.12162	0.0000
Return on assets (ROA) ratio	-0.80155	-9.52113	0.0000
Return on equity (ROE) ratio	-0.70968	-6.57430	0.0000

Appendix G – Summary statistics and correlations of the used series

Summary statistics

Variables ^(*)	Mean	Stand. Dev.	Min	Max	Observations
GDP					
OVERALL	.0730185	.0562873	-.1317225	.2970152	N =324
BETWEEN		.0349147	.0210996	.1360545	i = 27
WITHIN		.0446177	-.1524267	.2422771	T = 12
Final consumption					
OVERALL	.0705547	.0528931	-.1204023	.2857208	N =324
BETWEEN		.0341886	.017408	.1296475	i = 27
WITHIN		.0408487	-.1574834	.228831	T = 12
Gross fixed capital formation					
OVERALL	.0824035	.0969665	-.2301245	.4663296	N =324
BETWEEN		.0477779	.0098286	.2006463	i = 27
WITHIN		.0848381	-.2398363	.3632473	T = 12
Exports					
OVERALL	.0924583	.081342	-.129406	.5417948	N =324
BETWEEN		.0344537	.0488713	.1500353	i = 27
WITHIN		.0739588	-.1836856	.5052467	T = 12
Imports					
OVERALL	.0960796	.082196	-.1556988	.4779053	N =324
BETWEEN		.0342585	.0574718	.1627179	i = 27
WITHIN		.0749834	-.1747626	.411267	T = 12
DEA bank cost efficiency					
OVERALL	-.2407343	.263962	-1.903809	0	N =351
BETWEEN		.1907762	-.8439925	0	i = 27
WITHIN		.1858178	-1.869049	.1695398	T = 13
C3 concentration measure					
OVERALL	3.806431	.3997409	2.774462	4.570165	N =351

BETWEEN		.3719245	2.949454	4.444684	i = 27
WITHIN		.1618877	3.198322	4.393741	T = 13
HHI concentration measure					
OVERALL	6.949937	.6210185	5.568116	8.368878	N =351
BETWEEN		.5865469	5.836045	8.030219	i = 27
WITHIN		.2311326	5.996883	8.00785	T = 13
ROA					
OVERALL	.0082816	.0094148	-.06331	.0967	N =351
BETWEEN		.0053291	.0014469	.0278808	i = 27
WITHIN		.0078239	-.0652238	.0771008	T = 13
ROE					
OVERALL	.1105632	.1080092	-.82112	.64501	N =351
BETWEEN		.037707	.0404331	.2041869	i = 27
WITHIN		.101454	-.7784199	.5513863	T = 13

Correlation matrix

Variables (*)	GDP	Final consumption	Gross fixed capital formation	Exports	Imports	DEA	C3	HHI	ROA	ROE
GDP	1.000									
Final consumption	0.9457	1.000								
Gross fixed capital formation	0.7499	0.6755	1.000							
Exports	0.5782	0.4658	0.4050	1.000						
Imports	0.6228	0.5533	0.6058	0.9023	1.000					
DEA	0.1548	0.1500	0.2145	0.0143	0.0547	1.000				
C3	0.0665	0.0933	-0.0096	-0.0211	-0.0530	0.0494	1.000			
HHI	0.0702	0.0946	-0.0167	-0.0164	-0.0530	0.0336	0.9818	1.000		
ROA	0.3276	0.2898	0.1314	0.2303	0.2338	-0.0443	0.0933	0.1175	1.000	
ROE	0.2075	0.1449	0.0459	0.1419	0.1324	-0.0028	0.0023	0.0348	0.8064	1.000

(*) More precisely, the variables used are:

GDP = First difference of the natural logarithm of the Gross Domestic Product

Final consumption = First difference of the natural logarithm of the final consumption

Gross fixed capital formation = First difference of the natural logarithm of the gross fixed capital formation

Exports = First difference of the natural logarithm of the exports

Imports = First difference of the natural logarithm of the imports

DEA bank cost efficiency = Natural logarithm of the DEA (Data Envelopment Analysis) bank cost efficiency

C3 concentration measure = Natural logarithm of the bank market concentration (C3) measure

HHI concentration measure = Natural logarithm of the bank market concentration (Herfindahl-Hirschman Index) measure

ROA = Return on assets ratio

ROE = Return on equity ratio

Appendix H – Estimation results of the model represented by the equation 1^(*) for GDP and its components ^()**

Table H1 – GDP

	Estim. Coefficient	Standard Error	t-statistic	P-value
Model 1				
Lag1 GDP	-.0071848	.003807	-1.89	0.060
DEA bank cost efficiency	.0300956	.0148715	2.02	0.044
Bank market concentration (HHI) measure	-.0143891	.0113649	-1.27	0.207
Return on assets (ROA) ratio	.5765727	.2993796	1.93	0.055
Constant	.136441	.0771146	1.77	0.078
F(41, 281) = 13.53 Prob > F = 0.0000				
R-squared = 0.51				
Number of obs = 323				
Model 2				
Lag1 GDP	-.0072858	.0038125	-1.91	0.057
DEA bank cost efficiency	.030228	.0152627	1.98	0.049
Bank market concentration (C3) measure	-.0186492	.0173772	-1.07	0.284
Return on assets (ROA) ratio	.5573989	.3028159	1.84	0.067
Constant	.1066834	.0638236	1.67	0.096
F(41, 281) = 13.19 Prob > F = 0.0000				
R-squared = 0.51				
Number of obs = 323				
Model 3				
Lag1 GDP	-.0073208	.003697	-1.98	0.049
DEA bank cost efficiency	.0249126	.0149545	1.67	0.097
Bank market concentration (HHI) measure	-.0143963	.0112594	-1.28	0.202
Return on equity (ROE) ratio	.0571032	.0216469	2.64	0.009
Constant	.1335425		1.75	0.082
F(41, 281) = 13.37 Prob > F = 0.0000				
R-squared = 0.51				
Number of obs = 323				
Model 4				
Lag1 GDP	-.0073991	.0036963	-2.00	0.046
DEA bank cost efficiency	.0252481	.0151935	1.66	0.098
Bank market concentration (C3) measure	-.018443	.0170693	-1.08	0.281
Return on equity (ROE) ratio	.0558858	.021638	2.58	0.010
Constant	.1030202	.0629114	1.64	0.103
F(41, 281) = 13.05 Prob > F = 0.0000				
R-squared = 0.51				
Number of obs = 323				

Table H2 – Final consumption

	Estim. Coefficient	Standard Error	t-statistic	P-value
Model 1				
Lag1 Final consumption	-.0061036	.0039308	-1.55	0.122
DEA bank cost efficiency	.0204266	.0147358	1.39	0.167
Bank market concentration (HHI) measure	-.0087379	.0109251	-0.80	0.425
Return on assets (ROA) ratio	.2645169	.310571	0.85	0.395
Constant	.1056773	.0736742	1.43	0.153
F(41, 281) = 11.91 Prob > F = 0.0000				
R-squared = 0.48				
Number of obs = 323				
Model 2				
Lag1 Final consumption	-.0062289	.0039245	-1.59	0.114
DEA bank cost efficiency	.0191408	.015116	1.27	0.206
Bank market concentration (C3) measure	-.0156481	.0165433	-0.95	0.345
Return on assets (ROA) ratio	.2463248	.3118491	0.79	0.430
Constant	.1040328	.0598293	1.74	0.083
F(41, 281) = 11.77 Prob > F = 0.0000				
R-squared = 0.48				
Number of obs = 323				
Model 3				
Lag1 Final consumption	-.0059839	.0038121	-1.57	0.118
DEA bank cost efficiency	.0176473	.0147898	1.19	0.234
Bank market concentration (HHI) measure	-.0086698	.0108329	-0.80	0.424
Return on equity (ROE) ratio	.0346203	.0211535	1.64	0.103
Constant	.103507	.0731082	1.42	0.158
F(41, 281) = 11.94 Prob > F = 0.0000				
R-squared = 0.48				
Number of obs = 323				
Model 4				
Lag1 Final consumption	-.0060845	.0038017	-1.60	0.111
DEA bank cost efficiency	.0166097	.0150126	1.11	0.270
Bank market concentration (C3) measure	-.0151678	.0162347	-0.93	0.351
Return on equity (ROE) ratio	.0335062	.0209705	1.60	0.111
Constant	.1005776	.0588447	1.71	0.089
F(41, 281) = 11.80 Prob > F = 0.0000				
R-squared = 0.48				
Number of obs = 323				

Table H3 – Gross fixed capital formation

	Estim. Coefficient	Standard Error	t-statistic	P-value
Model 1				
Lag1 Gross fixed capital formation	-.0086819	.0062959	-1.38	0.169
DEA bank cost efficiency	.0805218	.0300559	2.68	0.008
Bank market concentration (HHI) measure	-.0465085	.0233284	-1.99	0.047
Return on assets (ROA) ratio	-1.398121	.9409315	-1.49	0.138
Constant	.3462776	.1644267	2.11	0.036
F(41, 281) = 5.95 Prob > F = 0.0000				
R-squared = 0.42				
Number of obs = 323				
Model 2				
Lag1 Gross fixed capital formation	-.008731	.0063164	-1.38	0.168
DEA bank cost efficiency	.0850035	.0304422	2.79	0.006
Bank market concentration (C3) measure	-.0472685	.0330015	-1.43	0.153
Return on assets (ROA) ratio	-1.438665	.9446563	-1.52	0.129
Constant	.3462776	.1644267	2.11	0.036
F(41, 281) = 5.72 Prob > F = 0.0000				
R-squared = 0.42				
Number of obs = 323				
Model 3				
Lag1 Gross fixed capital formation	-.0071703	.0062881	-1.14	0.255
DEA bank cost efficiency	.0907374	.0334168	2.72	0.007
Bank market concentration (HHI) measure	-.0460204	.0235382	-1.96	0.052
Return on equity (ROE) ratio	-.0933274	.0705539	-1.32	0.187
Constant	.3480401	.1657073	2.10	0.037
F(41, 281) = 5.96 Prob > F = 0.0000				
R-squared = 0.42				
Number of obs = 323				
Model 4				
Lag1 Gross fixed capital formation	-.0071577	.0063471	-1.13	0.260
DEA bank cost efficiency	.0958274	.0341574	2.81	0.005
Bank market concentration (C3) measure	-.0455535	.0334307	-1.36	0.174
Return on equity (ROE) ratio	-.0958592	.0704921	-1.36	0.175
Constant	.1994248	.129321	1.54	0.124
F(41, 281) = 5.72 Prob > F = 0.0000				
R-squared = 0.41				
Number of obs = 323				

Table H4 – Exports of goods and services

	Estim. Coefficient	Standard Error	t-statistic	P-value
Model 1				
Lag1 Exports of goods and services	-.0081474	.0048716	-1.67	0.096
DEA bank cost efficiency	-.0006868	.0179542	-0.04	0.970
Bank market concentration (HHI) measure	-.039573	.0224389	-1.76	0.079
Return on assets (ROA) ratio	.1772964	.3978669	0.45	0.656
Constant	.333854	.1589434	2.10	0.037
F(41, 281) = 14.17 Prob > F = 0.0000				
R-squared = 0.55				
Number of obs = 323				
Model 2				
Lag1 Exports of goods and services	-.0085633	.0050788	-1.69	0.093
DEA bank cost efficiency	-.0014427	.0184145	-0.08	0.938
Bank market concentration (C3) measure	-.0550607	.0338401	-1.63	0.105
Return on assets (ROA) ratio	.1168983	.4198096	0.28	0.781
Constant	.2662168	.1310428	2.03	0.043
F(41, 281) = 13.92 Prob > F = 0.0000				
R-squared = 0.55				
Number of obs = 323				
Model 3				
Lag1 Exports of goods and services	.0085008	.0047255	-1.80	0.073
DEA bank cost efficiency	-.0016974	.0185071	-0.09	0.927
Bank market concentration (HHI) measure	-.0396696	.0223542	-1.77	0.077
Return on equity (ROE) ratio	.0069824	.0242296	0.29	0.773
Constant	.3343515	.1581902	2.11	0.035
F(41, 281) = 14.06 Prob > F = 0.0000				
R-squared = 0.55				
Number of obs = 323				
Model 4				
Lag1 Exports of goods and services	-.0088462	.0048804	-1.81	0.071
DEA bank cost efficiency	-.0020997	.0185456	-0.11	0.910
Bank market concentration (C3) measure	-.0554089	.0332982	-1.66	0.097
Return on equity (ROE) ratio	.0030896	.025184	0.12	0.902
Constant	.2676152		2.08	0.039
F(41, 281) = 13.81 Prob > F = 0.0000				
R-squared = 0.55				
Number of obs = 323				

Table H5 – Imports of goods and services

	Estim. Coefficient	Standard Error	t-statistic	P-value
Model 1				
Lag1 Imports of goods and services	-.0098502	.0053353	-1.85	0.066
DEA bank cost efficiency	.0087401	.0201282	0.43	0.664
Bank market concentration (HHI) measure	-.0408689	.0203694	-2.01	0.046
Return on assets (ROA) ratio	-.0047979	.4599935	-0.01	0.992
Constant	.3265767	.1441066	2.27	0.024
F(41, 281) = 15.26 Prob > F = 0.0000				
R-squared = 0.58				
Number of obs = 323				
Model 2				
Lag1 Imports of goods and services	-.0102397	.0055195	-1.86	0.065
DEA bank cost efficiency	.0084843	.0206161	0.41	0.681
Bank market concentration (C3) measure	-.0551813	.0298578	-1.85	0.066
Return on assets (ROA) ratio	-.0640436	.4722492	-0.14	0.892
Constant	.2502594	.1155164	2.17	0.031
F(41, 281) = 15.13 Prob > F = 0.0000				
R-squared = 0.58				
Number of obs = 323				
Model 3				
Lag1 Imports of goods and services	-.01032	.005179	-1.99	0.047
DEA bank cost efficiency	.0096191	.020782	0.46	0.644
Bank market concentration (HHI) measure	-.0410148	.0203074	-2.02	0.044
Return on equity (ROE) ratio	-.0152038	.0315356	-0.48	0.630
Constant	.3294463	.1434333	2.30	0.022
F(41, 281) = 15.29 Prob > F = 0.0000				
R-squared = 0.58				
Number of obs = 323				
Model 4				
Lag1 Imports of goods and services	-.0106366	.0053054	-2.00	0.046
DEA bank cost efficiency	.0096433	.0209428	0.46	0.646
Bank market concentration (C3) measure	-.0557925	.0294442	-1.89	0.059
Return on equity (ROE) ratio	-.0190431	.0321867	-0.59	0.555
Constant	.2546847	.1137431	2.24	0.026
F(41, 281) = 15.15 Prob > F = 0.0000				
R-squared = 0.58				
Number of obs = 323				

(*) $\text{Growth}_{i,t} = \alpha_0 + \alpha_1 \text{year dummies}_i + \alpha_2 \text{country dummies}_i + \alpha_3 \text{lag1 growth}_{i,t-1} + \alpha_4 \text{bank efficiency}_{i,t} + \alpha_5 \text{bank market concentration}_{i,t} + \alpha_6 \text{control variables}_{i,t}$ (1)

Where:

Growth = natural logarithm of the GDP (at market prices), or of one of its main components: final consumption, gross fixed capital formation, exports or imports

i = EU country (i = 1, ... 27)

t = year (t = 1996, ..., 2008)

Lag1 growth = first lag (t-1) of the growth endogenous variable

Bank efficiency = natural logarithm of the Data Envelopment Analysis (DEA) bank cost efficiency
Bank market concentration = natural logarithm of the percentage share of the total assets held by the three
largest banking institutions (C3) or natural logarithm of the Helfindahl-Hirschman Index (HHI)
Control variables = return on assets (ROA) or return on equity (ROE)

(**) In all equations, year and the country dummies are included and their specific results are available on request.