On identifying risk-adjusted efficiency gains or losses of prospective systemic banks' M&A under heterogeneous production technologies: Policy implications in the era of the financial crisis*

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Abstract

This paper proposes a new approach to evaluate and compare the risk-adjusted efficiency gains or losses of potential mergers and acquisitions (M&A) within a latent class context. We test our methodology in the banking sector by examining numerous potential M&A scenarios and we investigate whether there is a transition of the new financial institution to a more efficient technological class resulting from post-M&A activity. We estimate the unobserved heterogeneity in banking technologies using a latent class stochastic frontier model and present applications of the model using data from separate banking sectors from 1987–2011. To increase the precision of our inferences, we adopt two distinct empirical methodologies: a panel data method and a pooled cross-section modelling strategy. We present strong empirical evidence that post prospective M&A financial institutions can be better equipped to withstand potential adverse economic conditions. This casts doubt on the ability of banks' recent M&A to generate and pass on merger-specific synergies to the economy. Further, our results reveal that bank heterogeneity in the banking sectors under investigation can be captured by two technological regimes. Our findings suggest a trade-off between the level of sophistication within a financial system and its level of aggregate efficiency. Finally, consistency of the results is established under both methodologies.

JEL classification: C81, D24, G21

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1 Introduction

The aftermath of the latest financial crisis has triggered a tremendous change in the financial services sector, causing a sizable build-upon a government debt in many industrialised countries. The recession leads to restructurings, a push toward lean management and a wave of M&A activities across a wide segment of industries. It created an even further urge to focus on core activities and capitalise from a differentiating position. Today's cash-laden balance sheets and limited alternative for generating returns in other asset classes sparked even further the appetite for growth through M&A.

The industry with one of the highest ratio of consolidation activity as a result of the recent financial turmoil, is the banking industry. The number of banks has declined considerably over the last years mainly due to failures during periods of crisis. In general banks merge for a number of business-related reasons. Mergers allow banks to achieve economies of scale, enhance revenues and cut costs through operational efficiencies, and diversify by expanding business lines or geographic reach. Bank mergers can result in more efficient banks and a sounder banking system, which should lead to greater access to credit at lower cost and thus be beneficial for local communities. However, the benefits of mergers and acquisitions can be offset if M&As make local banking markets less competitive and reduce the communities' access to banking services and credit. Although banking regulatory agencies monitor M&As and do not approve those that are expected to result in uncompetitive banking markets, more research is needed to determine the net effect of bank mergers on both consumer welfare and soundness of the banking system.

This study presents a novel econometric method to evaluate and compare the risk adjusted efficiency gains or losses of a potential M&A activity that can be applied in any micro-study. In this way, we shed light on the trade-off between managerial motives and social economic surplus that triggers M&A activity.[1] This is of extreme importance for policymakers and practitioners for two reasons: first, due to the numerous cases of bank M&A that we witnessed worldwide after the onset of the global financial turmoil and second, because the efficiency of the banking system is one of the major issues preoccupying the financial establishment as it is at the heart of a country's financial system. It is generally accepted that efficient bank operations, which are linked to financial stability, allow entrepreneurs and households to enjoy higher-quality services at lower costs (European Commission 2014). Thus, measuring the efficiency of a banking system and analyzing the factors that explain it is very important for supervisory authorities in order to design the regulatory framework and for bank management to draw up their business plans. It is indeed necessary to identify the nature of inefficiencies. These can occur due to infor-

[1] A crucial criterion for judging potential mergers as acceptable is their ability to pass on merger-specific efficiency gains to customers. This efficiency pass-through criterion is explicitly stated in the US and EU merger guidelines (Neven 2006; Hausman and Sidak 2007; Werden 2002) and is employed in Australia in an informal manner.

mation on the most effective processes not being easily accessible, free, or accurate. This has a direct impact on the time needed for each credit institution to respond to changes in environmental or market conditions. Therefore, the effect that inefficiencies have on organizational learning is significant and constitutes an important source of differences among financial institutions as they can create a competitive advantage in the long run.

Surveys on bank efficiency implicitly draw conclusions based on the assumption that all banks in a sample use the same production technology. Neglecting the existence of unobserved differences in technological regimes can have distorting effects on efficiency estimates by incorrectly assigning these deviations to inefficiency (Koetter, Poghosyan 2009). In this study, we approach this consideration by estimating the unobserved heterogeneity in banking technologies using a Latent Class Stochastic Frontier Model (LCSFM). In this way, we manage to identify different technological regimes within a country's banking system, and more importantly, we reveal the classification of each financial institution into these regimes. This triggers the aim of our paper, which is to measure efficiency gains or losses in real money terms of a prospective bank consolidation activity that consists of financial institutions belonging to either different or the same technological regime. In order to amplify the validity of our inferences, we examine two very different banking systems in terms of their level of sophistication.

First, we focus our attention on the UK banking system, which is very complex with an advanced capital market. Its financial institutions have expanded their roles beyond their traditional payment services, intermediation between savers and borrowers, and insurance against risk function by adopting a more universal type of banking. The members of the UK banking system are of major importance to public authorities, as they were among the first credit institutions to suffer the impact of the recent global financial meltdown. The consequences of the crisis were severe not only for the UK's public finances and capital market but also for the financial segments and public sectors of places that UK financial institutions are interconnected with. This becomes clear if one looks at the £550 billion UK government intervention following two bank rescue packages in 2008 and 2009 via the Special Liquidity Scheme and the Bank Recapitalisation Fund. Additionally, monetary authorities unavoidably had to take action and intervened by lowering interest rates to 0.5%, a figure which at the time of writing remains unchanged. The Monetary Policy Committee (MPC) recognizes that the bank rate cannot be reduced any further, and in order to give a further monetary stimulus to the economy, it has undertaken unconventional monetary action. Specifically, the Bank of England (BoE) has committed £375 billion to its asset purchasing program (quantitative easing) to date.

The second country of interest is Greece, where the stability of its simpler banking sector and its role as a financial intermediary has been distorted by the financial turmoil. Before the onset of the crisis, Greek banks were unequivocally seen as well managed and prudent, which can be justified by the fact they did not experience severe consequences after the first wave of the financial crisis that was escalated by the collapse of Lehman Brothers in September 2008. Nevertheless, the picture changed when the second wave of the global economic crisis, the Sovereign Debt Crisis, hit. As in the case of the UK, fiscal authorities intervened and tried to recapitalize Greek banks.[2] However, that was not enough for the Greek banks to withstand the augmented and more frequent cracks from the debt crisis , as they were the main holders of the so called "toxic" government bonds whose value decreases every day. In turn, the more the increase in the country's public debt, the more fragile the nation's banks become.[3]

The fundamental differences in the structure and the impact that the global financial turmoil had on the two disparate banking systems triggered our motivation to conduct an empirical analysis of any unobserved classification of both countries' financial intermediaries into distinct technological regimes and to identify their main characteristics. We are able to deduce some common policy implications for both the UK and Greece in line with recent debates regarding the creation of a unique European banking regulatory framework, the so-called CRD IV[4] package of the European Banking Authority (EBA).

Another contribution of this study is that it is the first empirical application that examines the strand of technological heterogeneity in two completely different banking systems in terms of sophistication, market characteristics, and volume of transactions—those of the UK and Greece. We separately estimate for each country a stochastic production frontier using a latent class modelling approach. To the best of our knowledge, this is the first study of both banking systems to apply a LCSFM. This is of major importance, and in what follows we explain the motivation behind it. The main reason prompting our approach is the fact that omitting the tremendous differences in regulation, supervision, size, and general market conditions and including both countries in the same sample, assuming that they are homogeneous, would create a large-scale bias in our estimates and consequently no robust inferences could be extracted. What further differentiates our study from the literature on the latent class stochastic frontier is that we adopt both a panel data methodology (Orea and Kumbhakar, 2004) that allows the efficiency term to vary every year and a pooled cross-section methodology (Bos et al. 2010) that permits each financial institution to switch between technology regimes over time in order to significantly enhance the robustness of our empirical evidence. Both strategies are compared

[2] In October 2008, the Greek government announced a €28 billion support package for Greek banks consisting of €5 billion worth of capital injections as far as a recapitalization scheme was concerned, €15 billion in state loan guarantees to credit institutions with varying maturity from three months up to three years in order for the banking system to meet its liquidity needs, and €8 billion worth of liquidity in the form of special bonds with maturity up to three years to be used as collateral to the Eurosystem and/or the interbank market for any credit provided by them.

[3] That led to the two bailout deals in May 2010 (€110 billion) and in February 2012 (€130 billion) that were agreed between Greece and both the Eurozone countries and the International Monetary Fund (IMF).

[4] CRD IV is an EU legislative package covering prudential rules for banks, building societies, and investment firms.

with a model that assumes that technology is the same for all banks we use as our baseline specification. Moreover, we account for all credit institutions of both banking systems, enabling us to extract accurate inferences with crucial policy implications for the entire banking system rather than providing an ad hoc generalization of the results.

Our empirical findings show that bank heterogeneity in both banking markets can be captured when a model with two classes is estimated. We find that in both countries, the financial institutions that belong to the first technological regime, which are well capitalized, possess superior management of both credit and liquidity risk and seem to be the most efficient. We find that a less sophisticated banking system allows Greek banks to attain higher efficiency levels compared to the UK, indicating a trade-off between the complexity of services and products and aggregate efficiency. As far as the aspect of recent and prospective M&A in the Greek and UK banking sectors is concerned, we present empirical evidence of enhanced efficiency and cost reductions in real money terms that could lead to tax benefits as a result of potential consolidation activities. Furthermore, regarding the banking institutions that belong to the second class of both countries, we argue that potentially higher efficiency levels could be achieved as a result of future M&A activity among them. Finally, regarding the Greek banking sector specifically, we present evidence of decreased efficiency in two of the four new "cornerstones" of the Greek economy, to which the country's economic recovery has been attributed, due to their particular consolidation decisions.

The rest of the paper is organized as follows. Section 2 presents the background of the stochastic frontier analysis. Section 3 provides an overview of the theoretical framework and presents the empirical model. Section 4 describes the data and specifies the model. Section 5 presents and discusses the empirical evidence of applying the models to the UK and Greek banking sectors and includes the findings regarding the proposed methodology of recent and potential M&A activity in both banking systems. Conclusions and insights for future research are presented in the final section.

2 Stochastic Frontier Analysis

Investigating the efficiency measurement literature, it is evident that stochastic production (or economic) frontier functions have been increasingly used to measure the efficiency of individual producers. Notably, they seem to dominate parametric approaches (Kumbhakar and Lovell 2000). In particular, the Stochastic Frontier Approach (SFA) separates inefficiencies from random noise; however, it needs an a priori assumption on the error term as a prerequisite. The alternative parametric techniques, such as the Distribution Free Approach (DFA) (Berger 1993) and the Thick Frontier Approach (TFA) (Berger and Humphrey 1991), may require less structure on the error term, but they impose an assumption of constant core inefficiency or do not present bank-specific point estimates. On the contrary, non-parametric techniques, while they do not impose any assumption on the error term, do not take into consideration the random noise and have an extreme sensitivity to outliers. In the present study, we follow several earlier and recent empirical works and use SFA to estimate the efficiency of banks (Kumbhakar 1990 & 1997; Resti 1997; Fiordelisi, Ibanez, and Molyneux 2011).

The stochastic frontier production function was independently proposed by Aigner, Lovell, and Schmidt (1977), Battese and Corra (1977), and Meeusen and van den Broeck (1977) and was applied to banking by Ferrier and Lovell (1990). It takes the following general form:

$$y = \beta^{'} x + v - u \tag{1}$$

where y is the observed outcome (goal attainment), $\beta^{'} x + v$ is the optimal stochastic frontier goal followed by the individual, $\beta^{'} x$ is the deterministic part of the frontier, and $v \sim N[0, \sigma_v^2]$ is the stochastic part. A stochastic frontier is created if we combine these two parts. The aggregate amount of deviation from the optimum that lies on the frontier is what constitutes u.

Economic representations of production technology include cost, revenue, and profit frontiers. These economic frontiers are then used as standards against which to measure cost, revenue, and profit efficiency. As described by Kumbhakar and Lovell (2000), a cost stochastic frontier takes the form:

$$c\left(y_i, w_i; \beta\right) \tag{2}$$

and can be written as

$$C_i \geq c\left(y_i, w_i; \beta\right) \cdot \exp\left\{v_i\right\}, \tag{3}$$

where $c\left(y_i, w_i; \beta\right) \cdot \exp\left\{v_i\right\}$ is the stochastic frontier and C_i is the observed cost. The stochastic cost frontier consists of two parts: the $c\left(y_i, w_i; \beta\right)$ part, which is the deterministic kernel and is the same for all producers, and the $\exp\left\{v_i\right\}$ part, which is unique to each producer and captures the effects of random shocks on each producer. To be more specific, β is a vector of technology parameters to be estimated, y_i and w_i indicate vectors of output and input prices, respectively, and v_i is a producer-specific random disturbance. The measure of cost efficiency is then

$$CE_i = \frac{c\left(y_i, w_i; \beta\right) \cdot \exp\left\{v_i\right\}}{C_i}. \tag{4}$$

This is the ratio of the minimum possible cost, given v_i, to actual total cost. If $C_i = c\left(y_i, w_i; \beta\right) \cdot \exp\left\{v_i\right\}$, then the firm i is fully efficient and $CE_i = 1$. Otherwise actual cost exceeds the minimum so $0 \leq CE_i \leq 1$.

Assuming that the stochastic cost frontier follows a *Cobb-Douglas* function its log form representation can be written as

$$\begin{aligned} \ln \mathrm{Ci} &\geq \ln c\left(y, w_i\right) + v_i \\ &= \ln c\left(y, w_i\right) + u_i + v_i \end{aligned} \tag{5}$$

where (u_i) is a nonnegative inefficiency component. Cost efficiency is then $CE_i = \exp\{-u_i\}$. Following Aigner, Lovell, and Schmidt (1977) we assume $v_i \sim N\left[0, \sigma_\nu^2\right]$ and $u_i \sim N\left[0^+, \sigma_u^2\right]$.

3 Theoretical Framework - Latent Class Stochastic Frontier Model

The estimation of a stochastic frontier cost function imposes a strong assumption that the underlying production technology is common to all producers. Neglecting the existence of different technologies in banking can contaminate efficiency, market power, and other performance measures. An important drawback of the homogeneous technological regime assumption is that it imposes restrictions on certain important characteristics of banking technology, such as technical progress and scale economies. That is, the estimate of the underlying technology may be biased. Thus, unobserved technological differences are not taken into account during the estimation procedure, and consequently, the effects of these omitted unobserved technological differences might be inappropriately labelled as inefficiency.

Despite the on-going harmonization of regulation, very different banks continue to exist side by side. In the literature on bank efficiency, we can identify two types of systematic differences across and within national banking markets. The first type of heterogeneity refers to the environment in which banks operate, which is exogenous to managers. Conditional on environmental differences, banks may employ different business models (retail versus wholesales) that require different intermediation technologies. The second type of systematic differences refers to managerial choices, especially those related to risk management, which affect the banking firm's efficiency (Kauko 2009). This second type of heterogeneity is identified as endogenous to managers and influences the ability to attain the optimum benchmark rather than the shape of the efficient frontier.

In this study, we account for differences in technological regimes using a LCSFM where the impact of the environmental factors is not only reflected in the magnitude of the intercepts but also affects the slope coefficients. Thus, we can have two different impacts on the stochastic frontier. First, we may have parallel shifts of the frontier and second, we may have systematically different deviations from the frontier. Specifically, the environmental variables enter as latent class determinants rather than as a part of the frontier and thus influence both estimates of the technological regime of banks and their cost efficiency simultaneously. Additionally, the latent class method does not require a priori grouping of banks. Instead, it utilizes all information available in the sample and identifies separate technological regimes based on the maximum likelihood principle. As we use panel data LCSFM for the estimation of our latent class efficiency determinants, we allow for the efficiency term to vary every year. This is an approach employed in banking studies by Orea and Kumbhakar (2004), Koetter and Poghosyan (2009), and Poghosyan and Kumbhakar (2010). However, these three studies assume that every bank in the sample remains in the same technological regime for all the years it operates (Bos et al. 2010). The novelty of our study is that it uses two methodologies proposed in the literature. First, we apply the one used by Orea and Kumbhakar (2004) that allows for a time-varying efficiency term. Second, as a robustness check of our estimates, we apply the methodology followed by Bos et al. (2010), which permits the financial institution to be in one regime in a specific year and in another regime the year after. Thus, the first methodology adopts a panel-based approach, whereas the second one treats the data set as a pooled cross-section. To the best of our knowledge, this is the first time in the latent class stochastic frontier literature that both models would be applied to answer the same research question. Thus, we manage to surmount several modelling limitations and are able to produce the most accurate comparisons and inferences.

In determining efficiency, the technology of banks belonging to each class must be modelled. Following Orea and Kumbhakar (2004), we assume that the technology is represented by a cost function. This may be written for class k as

$$\ln C_{it} = \ln C(y_{it}, w_{it}, t \; ; \beta_k) + u_{it|k} + v_{it|k}, \tag{6}$$

where subscripts $i = 1, ...N$, $t = 1, ..., T_i$ and $k = 1, ..., K$, stand for bank, time and class respectively. C_{it} is individual bank total cost; y_{it} and w_{it} indicate vectors of output and input prices; and β_k is a class-specific vector of parameters to be estimated. The two-sided random error term $v_{it|k}$ is assumed to be independent of the non-negative cost efficiency variable $u_{it|k}$ for each class. Here the technology is represented by a dual cost function.

To estimate the model using maximum likelihood we assume that the random error term for class k, $v_{it|k}$, follows a normal distribution with zero mean and constant variance, $\sigma^2_{vk.}$ and the non-negative inefficient component follows a normal-half normal distribution.

The likelihood function (LF) for firm i, at time t belonging to class k (see Battese and Coeli 1992 and Greene 2005) is:

$$LF_{ikt} f\left(C_{it} \mid x_{it}, \beta_k, \sigma_k, \lambda_k\right) = \frac{\phi\left(\lambda_k \cdot \varepsilon_{it|k}/\sigma_j\right)}{\phi\left(0\right)} \cdot \frac{1}{\sigma_k} \cdot \phi\left(\frac{\varepsilon_{it|k}}{\sigma_k}\right) \tag{7}$$

where, $\varepsilon_{it|k} = \ln C_{it|k} - \beta_j' x_{it}$; $\sigma_k = [\sigma^2_{vk} + \sigma^2_{uk}]^{\frac{1}{2}}$; $\lambda_k = \sigma_{u|k}/\sigma_{\nu|k}$; and the λ_k parameter is the ratio of the standard deviation of the one-sided inefficient component to the standard deviation of the two sided random error, and ϕ and $\phi\left(0\right)$ denote the standard normal density and cumulative distribution function respectively.

The unconditional likelihood of bank i, where $\theta_k = (\beta_k, \sigma_k^2, \lambda_k,)$ are the parameters associated with the technology of class k, is obtained as a weighted sum of the k-class likelihood functions, where the weights are the class membership probabilities reflecting the uncertainty regarding the true membership in the sample:[5]

$$LF_i(\theta, \delta) = \sum_{k=1}^{K} LF_{ik}(\theta_k) \cdot P_{ik}(\delta_k) \tag{8}$$

where $0 \leq P_{ik} \leq 1$ and $\sum_{k=1}^{K} P_{ik} = 1$

We can parameterize the class probabilities by employing the multinomial logit model:

$$P_{ik}(\delta_k) = \frac{e^{\left(\delta'_k q_i\right)}}{\sum_{k=1}^{K} e^{\left(\delta'_k q_i\right)}} \tag{9}$$

where $k = 1, ..., K$, denotes classes; $\delta_1 = 0$ is a parameter normalization for the reference class and q_i is a vector of bank-specific and time-invariant class determinants.

Combining equations (7) and (9), the overall likelihood function is a continuous function of the vectors of parameters θ and δ and is indicated as:

$$\ln LF(\theta, \delta) = \sum_{i=1}^{N} \ln LF_i(\theta, \delta) = \sum_{i=1}^{N} \ln \left\{ \sum_{k=1}^{K} LF_{ik}(\theta_k) \cdot P_{ik}(\delta_k) \right\} \tag{10}$$

The estimated parameters can then be used to compute the conditional posterior class probabilities. Greene (2002) showed that the posterior probability of class-k membership for bank i can be computed as:

$$P(k \mid i) = \frac{LF_{ik}(\theta_k) \cdot P_{ik}(\delta_k)}{\sum_{k=1}^{K} LF_{ik}(\theta_k) \cdot P_{ik}(\delta_k)} \tag{11}$$

Unlike the standard SFA, where the cost frontier is the same for each bank, in the LCSFM, we estimate several frontiers (equal to the number of classes).

What remains to be estimated is the cost inefficiency term in the case when we have several benchmarks. According to Greene (2002), we can achieve that by getting the weighted average of the cost inefficiency terms:

$$\ln EF_i = \sum_{k=1}^{K} P(k \mid i) \cdot \ln EF_i(k), \tag{12}$$

[5] For the sake of brevity, we note that in the robustness section when we use the methodology of Bos et al. (2010), our notation in the following equations changes slightly, and when we write 'i|k', which indicates the financial institution conditional on being in class k, we mean instead 'it|k', indicating that the financial institution at specific time t is conditional to class k because we treat each specific observation as independent throughout the years for each credit institution.

where $EF_i(k)$ is the bank's cost efficiency using class-k technology as a reference. In this case technologies from every class are taken into account when estimating the cost efficiency.

4 Data

4.1 UK & Greek banking market

We now turn to our data characteristics. For the estimation of the model, we use data that consist of an unbalanced panel of all the financial institutions that provided credit during the years 1988–2011 in the UK and 1993–2011 in Greece.[6][7] Overall, both our samples account for a significant market share in terms of assets, loans, and deposits, occasionally even more than 90% in each respective category in both countries. More precisely, the UK sample comprises 2,324 observations for 162 financial institutions, whereas the Greek sample consists of 30 financial institutions with a total of 356 observations. The main difference between the two banking sectors is that commercial banks incorporated in Greece are the dominant group in the banking system. The dominance of commercial banking can also be confirmed by the number of branches and employees. According to the Hellenic Banking Association (2011), Greek commercial banks have 3,302 branches in operation (out of 3,575 for all credit institutions, which is equivalent to 92.36%), while the number of their employees stands at 51,012 (out of 56,611 employed in all credit institutions, which is equivalent to 90.11%).

A novel feature of our study is the period that is covered, which is the largest of all surveys that have been elaborated in both financial systems. The number of banks we examine in our study changes during the sample period in both countries. This occurs specifically in Greece due to the many M&A that took place at the end of the 1990s. The observed wave of M&A events was triggered primarily by the willingness of the small banks to obtain a higher market share and secondarily by the privatization process initiated by the government, in line with the second Banking Directive. At the end of 2011, the Greek banking system was dominated by six leading large banks in terms of assets, deposits, and loans (Ethniki Bank, also known as the National Bank of Greece, Alpha Bank, Eurobank, Piraeus Bank, and Emporiki Bank, also known as Commercial Bank, and Agricultural Bank), which altogether held 74.6% of the market share, a figure higher than the average European[8] concentration ratio calculated by the market share of the five largest banks

[6] Our sample consists of commercial banks, real estate and mortgage banks, bank holding companies, cooperative banks, and savings banks.

[7] The reasoning behind selecting 1993 as the starting year for the sample regarding the Greek banking sector is because in that year, the Greek banking system was fully liberalized. This followed the provision of the Second Banking Directive regarding establishment, supervision, and operation in 1992 by the Basic Banking Law Banking Directive

[8] In the Greek banking sector, a bank is classified as large if it holds total assets above €20 billion in 2011.

in each country (CR5). This stands at 59.6% for the 27 member countries of the EU (Greece has 72.0%) and 58.1% for the 17 member countries of the European Monetary Union (EMU) (European Central Bank, 2011). On the contrary, in the UK, despite the fact that the market is dominated, as in the case of Greece, by six dominant financial institutions (Barclays, HSBC, RBS, Lloyds, Santander, and Nationwide Building Society), the banking sector is less concentrated.

In tables 1.a–1.b and 2.a–2.b, we report representative figures of the UK and Greek financial institutions used in both our samples. More specifically, tables 1a and 1b provide an overview of some important banking indicators of the UK and Greek banking sectors for the whole period of our study, whereas tables 2a and 2b provide insight on the UK and Greek financial intermediaries for each year of our sample.

4.2 Model Specification

The LCSFM (Orea and Kumbhakar, 2004) presented in the previous section requires the following three sets of variables to be determined:

- Main variables: (C, y, w, eq, t)
- Inefficiency determinants: z
- Class membership determinants: k

4.2.1 Main Variables

A critical discussion of the two most widespread approaches for measuring and defining inputs and outputs is that by Berger and Humphrey (1997). They conclude that despite the fact that none of the approaches is ideal, the production approach is preferable when we want to evaluate the efficiency of financial institutions' branches, whereas the intermediation approach is preferable when we want to analyze the efficiency of the whole financial institution. Therefore, in line with the vast and established literature regarding the determinants of cost efficiency in banking (Berger 2007), we specify the cost kernel components that represent the intermediation approach of banks used by Sealey and Lindley (1977) to define inputs and outputs.[9]

In the present study, we specify the two mainstream types of outputs as total loans (y_1) and total earning assets (y_2). However, as Stiroh (2004) emphasizes, fee income is increasingly becoming a substitute for the revenues that can be earned on narrowing interest margins in the classical intermediation business. To take into consideration this development, we also account for total off-balance sheet activities (OBS), credit commitments and derivatives, as an additional output(y_3).[10] Additionally, we specify as our

[9] The key difference between the two approaches is that the production approach treats deposits as outputs, whereas the intermediation approach treats them as inputs.

[10] Numerous banks around the world have broadened their portfolio to offer non-traditional services. Additionally, OBS activities such as securitization, loan origination, derivative securities, and standby letters of credit among others have been expanding at a rapid pace. As a result, the share of fee-based

three types of inputs: (1) the total intermediated funds (F), which consists of savings accounts, current accounts, time deposits, repurchase agreements and alternative funding sources; (2) labor (L), which refers to the manpower involved in the operations of all the credit institutions in the sample and (3) physical capital depreciation and amortization (K), which consists of fixed assets, including tangible fixed assets (land, buildings, office equipment, etc., less depreciation) and intangible assets (software, underwriting expenses, research expenses, etc.). Furthermore, following Berger and Mester (1997), we specify equity as a quasi-fixed input to control for differences in risk preferences, which may arise due to regulation, financial distress, or informational asymmetries.[11] Raising equity is associated with higher costs than is raising deposits and the mix of these liabilities can have a direct impact on cost (Berger and Mester, 1997). As the dependent variable we use total cost (TC) which is defined as the sum of personnel and administrative expenses, interest fee and commission expenses. Finally, we include a time trend (T) to capture the potential technical change that occurred during the examination period for each financial institution. Note that inputs and outputs increased by a considerable amount during the years of our samples, due to the growing size of both domestic and foreign credit institutions and to the increasing number of M&As. We measure the price of input (w_1) using the ratio of interest expenses to total deposits and short term funding. We also measure the price of input (w_2) using the ratio of staff expenses to total assets.[12] Last, we measure the price of input (w_3) using the ratio of fee and commission expenses added to administration expenses to fixed assets. As for the measurement of the quasi-fixed input variable, we measure (eq) using the amount of equity capital.

Following the majority of empirical studies in banking, we obtain the largest part of our bank-level data from the Bankscope database of the Bureau Van Dijk company. Any missing information is obtained from the official websites of UK and Greek financial institutions, the British Bankers and Building Societies Association, the Hellenic Bank Association, and the annual reports of the Governors of the Bank of England and of the Bank of Greece. We obtain detailed information on M&A from the Zephyr database of the Bureau Van Dijk company.[13] All data are deflated using each country's GDP deflator

and other non-interest income to total income has increased dramatically.

[11] Berger and Mester (1997) argue that not accounting for equity can result in a scale bias, while the efficiency of banks could be miscalculated even if they behave optimally given their risk preferences.

[12] In calculating ($w2$), we use total assets rather than the number of employees due to data unavailability. Our approach is consistent with several other studies (e.g. Altunbas et al., 2000)

[13] We highlight crucial points of our data selection strategy that have been omitted by the bulk of empirical studies that have used Bankscope database (Claessens and van Horen 2012; Clerides et al 2013). This strategy is essential to ensuring the accuracy of results and inferences. First, both samples are checked for double-counted observations. Bankscope provides company account statements for banks and financial institutions worldwide, by collecting financial statements with both consolidated and unconsolidated statuses. Only the unconsolidated data are selected avoid double counting the same financial institution (in cases where unconsolidated data are not available, consolidated data were used).

Additionally, M&As were taken into consideration, by thoroughly checking all M&A activities that (using 2005 as the base year) obtained from the World Bank database and converted to US dollars. In addition to the two considerations in our data filtering process, we exclude observations of missing, negative, or zero values for inputs/outputs and control variables (Lozano-Vivas and Pasiouras, 2010). Our final samples account for 124 financial institutions and 1,856 observations for the UK banking sector and for 30 financial institutions and 356 observations for the Greek banking sector.

4.2.2 Inefficiency determinants

Turning our attention to the parametric part of the inefficiency component, we consider three (z_{it}) variables, for each banking sector.

Time The first variable is time, indicating spillover effects from recent developments, such as deregulation processes and the transfer of know-how. The parametric component becomes a function of time with only one parameter. In turn, efficiency either increases, decreases, or remains constant. We use the time trend to measure time.

Size The second variable is *size*, reflecting recent debates concerning the optimum size a financial institution should be. In general, this variable is supposed to have a positive effect on efficiency as it increases to a certain level. Nevertheless, the impact of an extremely large size can be proved to be counterproductive for the credit institution's efficient operation. According to empirical findings, the relationship between efficiency and size is not linear. We use each bank's real assets to measure this determinant.

Type and Ownership The third variable is different for each country. In the UK, we recognize that two different types of financial institutions dominate the provision of credit: banks and building societies. Therefore, we create a dummy variable, *bs*, which takes the value of 1 if the financial institution is a building society and 0 otherwise. Regarding the Greek banking sector, a key development we take into account is the increase in the number of privately owned institutions. We check the impact of privately and publicly owned or government-owned banks on bank efficiency. The efficiency of the banking industry can benefit from the fact that privately owned banks perform more efficiently compared to their rivals, who often operate on different business plans due to the meddling of politicians in the banks' affairs (see La Porta et al. 2002). There is empirical evidence supporting this hypothesis, particularly for the period in which the share of the publicly owned banks is very high and their performance is critical for the Greek financial system (Delis and Papanikolaou 2009). We control for the effects using a dummy variable *owner*

took place within both banking sectors to ensure only the merged entity or the acquiring bank remained in the sample after take-over. For example, assuming that bank A and bank B merged in 2003 to create a new entity, bank C, then the two individual banks A and B are each included in the dataset until 2003. From 2003 onwards, these two banks' operations are considered to be terminated and the new bank (bank C) is included in the database. In the same spirit, assume that bank A was acquired by bank B in 2003; both banks are included in the database until 2003, with bank A then becoming inactive after 2003 and bank B remaining active after 2003.

that takes the value of 1 if the depository institution is privately owned and 0 otherwise.

4.2.3 Class membership determinants

We consider the firm-average value of five variables, apart from an intercept, as determinants of the latent class probabilities.

Capital adequacy Examining the annual reports of the governors of both countries' central banks, we notice that the financial institutions are quite heterogeneous in terms of capital requirements. According to the literature, credit institutions that have a significant amount of capital are considered more stable, can implement high-cost plans to ameliorate their economies of scope, and are able to achieve this in a safer way by reducing the potential risks. Furthermore, they can adjust better to unexpected developments. In addition, shareholders of banks that are well capitalized can reduce moral hazard by controlling the bank's management more closely. We expect the most efficient banks to have higher levels of capital. In order to measure the capital adequacy, we use the equity to assets ratio.

Liquidity risk The recent financial turmoil demonstrates the severe impact that this risk can have on the financial system. Clearly, credit institutions with high liquidity are able to expand and/or face potential adverse conditions in the economic environment better than those that need to resort to stock markets to raise funds, especially at times of worsening conditions in money markets like the one we experienced in the recent financial turmoil. Although liquidity risk can be measured in different ways, we follow the approach by Altunbas et al. (2000) and measure it using the loans to assets ratio. The higher this ratio, the greater the need of the financial institutions to raise finance.

Credit risk This specific determinant reflects a very important risk that depository institutions confront. An indication of the quality of the credit risk management of an institution stems from the level of this risk, given that high values are associated with less efficient lending procedures (Berger and De Young 1997). That said, credit institutions seeking higher rents undertake risky projects in the expectation of higher yields. It can also be that borrowers face difficulties meeting their obligations due to unexpected adverse economic developments. Thus, high-value credit risk may not be attributable to poor management. Additionally, a financial institution may choose a strategy that reflects reduced efforts in granting and monitoring loans that may appear to be cost-efficient but that have an increased credit risk. We measure this specific category of risk by each bank's provisions to total assets ratio.

Service Concentration We stress the different strategies that credit institutions follow to create their products. We carefully examine the income statements and identify substantial differences in the level of loans, securities, investment assets, and OBS activities. For this purpose, we measure each financial institution's degree of specialization.

We argue that there exists a trade-off between the variety of products and services that a bank offers and its efficiency level as in this case it requires a more specialized management. We measure it as the sum of the squared ratios of the value of each output to the total value of outputs of each financial institution.

Profitability All depository institutions' annual income statements show tremendous differences regarding their profitability. This determinant can have opposite effects depending on which economic efficiency is the subject of interest. High profitability allows banks to invest in improved technology and in skilled personnel with higher wages as they expect this to result in much higher output gains and thus higher profit efficiency. However, higher wages and investments in advanced technology would mark an increase in costs, resulting in a decline in cost efficiency. We proxy the specific variable with the ratio of pre-tax profits to assets (ROA).

Tables 3.a and 3.b present descriptive statistics of the variables we use in the estimation of the cost frontier kernel, the inefficient component, and the regime class membership for the UK and Greek banking sectors.[14] Even though we use natural logarithms of variables in the cost kernel components (these represent the intermediation technology) to compute the efficiency scores, we show the mean and standard deviations in levels to allow meaningful comparisons.

The final specification of our latent class cost stochastic frontier model takes the following translog production function:[15]

$$\begin{aligned}
\ln TC_{it} = {} & \beta_0 + \sum_{l=1}^{3} \beta_{yl} \ln y_{it,l} + \sum_{s=1}^{2} \beta_{ws} \ln w_{it,s} + \frac{1}{2} \sum_{l=1}^{3} \sum_{s=1}^{2} \beta_{ylys} \ln y_{it,l} \ln y_{it,s} \\
& + \frac{1}{2} \sum_{l=1}^{2} \sum_{s=1}^{2} \beta_{wlws} \ln w_{it,l} \ln w_{it,s} + \sum_{l=1}^{3} \sum_{s=1}^{3} \beta_{ylws} \ln y_{it,l} \ln w_{it,s} \\
& + (\sum_{s=1}^{2} \beta_{ws} \ln w_{it,s}) * T + (\sum_{l=1}^{3} \beta_{ws} \ln y_{it,l}) * T + \beta_E \ln E_{it} \\
& + \beta_t T + \frac{1}{2} \beta_{tt} T^2 + u_{it} + v_{it}
\end{aligned} \tag{13}$$

where $k = 1, ..., K$, expresses class membership.

Inefficiency is modelled as a function of its determinants:[16]

[14] We do not include the two dummy variables that we use to account for type (bs) and ownership ($owner$).

[15] The translog function has been widely applied in the literature due to its flexibility. Berger and Mester (1997) found that both the translog and the Fourier-flexible form specifications yielded essentially the same average level and dispersion of measured efficiency, and both ranked the individual banks in almost the same order.

[16] We note here that in the second methodology (Bos et al. 2010) we employ as a robustness check, inefficiency is not modelled as a function of its determinants. The class membership probability is.

$$u_{it|k} = \exp^{[\eta_{1|K} TIME + \eta_{2i|k} SIZE + \eta_{3i|k} BS} \quad (14)$$

and

$$u_{it|k} = \exp^{[\eta_{1|K} TIME + \eta_{2i|k} SIZE + \eta_{3i|k} OWNER} \quad (15)$$

for the UK and Greek banking sectors, respectively.

$TIME, SIZE, BS$, and $OWNER$ refer to a *time-trend* variable, the *size* (in terms of assets) of each financial institution, a dummy variable reflecting the *type* of each UK financial institutions and the *ownership* of the Greek banks respectively.

The latent class probabilities are specified as:

$$P_{ik}(\delta_k) = \frac{e^{\left(\delta_{ok} + \delta_{1i|k} CAP\_ADEQ + \delta_{2i|k} LIQ\_RISK + \delta_{3i|k} CRED\_RISK + \delta_{4i|k} SERV\_CON + \delta_{5i|k} PROF\right)}}{\sum_{k=1}^{K} e^{\left(\delta_{ok} + \delta_{1i|k} CAP\_ADEQ + \delta_{2i|k} LIQ\_RISK + \delta_{3i|k} CRED\_RISK + \delta_{4i|k} SERV\_CON + \delta_{5i|k} PROF\right)}} \quad (16)$$

where $CAP\_ADEQ, LIQ\_RISK, CRED\_RISK, SERV\_CON, and\ PROF$ refers to the *capital adequacy, liquidity risk, credit risk, service concentration* and *profitability* of each financial institution in both samples.

The estimated cost frontier must satisfy the following regularity conditions in order to ensure that is well behaved. There should be monotonicity and concavity in input prices. These two characteristics can only be checked after the estimation procedure of the model, whereas an additional one, linear homogeneity in input prices, has to be imposed a priori. The latter property requires:

$$\sum_{s=1}^{3} \beta_{wsk} = 1 \quad (17)$$

Because the cost function is homogeneous of degree 1 in input prices, linear homogeneity restrictions are imposed on all price and cost variables with respect to one of the input prices. Here, we use the price of the physical capital depreciation and amortization (w_3) as a numeraire.

5 Empirical results

5.1 Determination of the number of classes

One of the most important points in the estimation of the latent class models is the determination of the number of classes. A key method in the literature of the standard latent class models for identifying the number of regimes is the computation of an information criterion. The two most widely used statistics are the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) or Schwarz criterion. The preferred model is the one with the lowest statistic.

The two statistics are computed as:

$$AIC\left(K\right)=-LN\left(\sum_{i=1}^{N}\sum_{t=1}^{T_i}\left(\sum_{k=1}^{K}p\left(k\mid i\right)\cdot\varepsilon_{it}^{2}\left(k\right)\right)\right)+\ln\left(\sum_{i=1}^{N}T_i\right)+\frac{2\pi\left(K\right)}{\sum_{i=1}^{N}T_i} \quad (18)$$

$$BIC\left(K\right)=-2\cdot\ln LF\left(K\right)+\pi\left(K\right)\cdot\ln\left(\sum_{i=1}^{N}T_i\right) \quad (19)$$

where K, is the number of classes, $\pi\left(K\right)$ is the number of parameters to estimate for specification with K latent classes and T_i is the number of observations for bank i.

Tables 4.a and 4.b report the AIC and BIC values for the UK and Greek banking sectors respectively. Comparing a pooled model, that is, the baseline model as it was described in section 3, which assumes homogenous production technology for all the financial institutions in the sample, that is, $k = 1$, and a model with two different technological regimes, that is, $k = 2$, the values of both criteria indicate that the preferred model in both countries is the one with two classes.[17] To illustrate this result, in Figures 1.a and 1.b we plot the kernel density estimates of the variance of the residuals of inefficiency for both models for the UK and Greece, respectively. A leftward movement of the kernel in the second model with two technological regimes can easily be seen, implying that the inefficiency is removed when taking into account bank heterogeneity. Specifically, the sample is split by setting 17 and 73 banks in the first technological regime and 13 and 51 in the second one for Greece and the UK, respectively.

In order to check the sensitivity of the class size selection to inefficiency, we compute the average efficiency scores for each year, which are obtained by estimating models with one and two technological classes. These are reported in Table 5.a for the UK and in Table 5.b for Greece. One can see that the average efficiency monotonically increases with the number of classes. In turn, this suggests that if bank heterogeneity is not taken into account, this omission can lead to downward-biased efficiency score estimates.

5.2 Which technological regime is the most efficient?

Tables 6.a and 6.b report average cost efficiency estimates using the highest probability cost frontier as a reference technology with respect to the UK and Greece. It is revealed that for both countries the first technological regime consists of banks that exhibit higher

[17] We tried to estimate a model with more than two classes as well. In the case of the Greek banking sector, it failed to achieve convergence, indicating the model is over-specified. However, for the UK banking sector, neither multicollinearity nor over-specification prohibits convergence of the maximum likelihood estimator. That said, none of the parameters differ significantly from zero, and the number of observations in the additional regime is very small.

cost efficiency levels compared to the second one. A graphical illustration of the kernel density estimates of the variance of the inefficiency residuals of both a pooled model and of a two latent classes model for both countries is provided in Figures 1.a and 1.b. A leftward movement of the kernel in the model that assumes two latent classes is apparent, implying that the inefficiency has been removed by taking into account bank heterogeneity.

It is noteworthy to highlight that in 2007 for the UK and in 2008 for Greece, efficiency levels started to decline at the highest rate during both of the sample periods. This coincides with the dawn of the global financial crisis in August 2007 and the turmoil of the global money markets that followed and reached the point of eruption with the collapse of Lehman Brothers in September 2008. An overall comparison of all the banks in both banking systems for the entire common sample period (1993–2011) emphasizes the fact that Greek banks operate under higher efficiency levels than their European counterparties, albeit their systems are more sophisticated , a result that is in line with Casu and Girardone (2006). The answer to this conundrum could lie in the simplicity of activities and in the smaller size of the Greek banking sector. This is a point that has triggered various recent debates related to the diversity of banking activities and the complexity of financial systems (Arcand, Berkes, and Panizza 2012; Cecchetti and Kharroubi 2012).

Additionally, in tables 6.a and 6.b, we can see essential differences for each year in the efficiency estimates within the two classes in both the UK and the Greek banking sectors. More precisely, the average level of efficiency in the first technological class for Greece is close to 82%, whereas in the second technological class it is close to 66%. The gap between the two regimes is even larger in the UK. Specifically, the overall efficiency of class one and class two is approximately 70% and 41%, respectively. Therefore, we highlight that the first technological regime in both banking systems consists of financial intermediaries that exhibit, on aggregate, higher cost efficiency levels compared to those that belong to the second latent class.

5.3 Interpretation of heterogeneous technologies using the determinants

The parameter estimates of our LCSFM are presented in tables 7.a and 7.b b for the UK and Greece, respectively, and are estimated by maximum likelihood estimation using NLogit 5 (Greene 2009). All the variables are normalized by their respective geometric mean. Thus, the translog form represents a second-order Taylor approximation around the geometric mean to any generic cost frontier. In both countries, the estimated cost frontier elasticities are found to be positive; in turn, the estimated cost frontiers are increasing in input prices and outputs. The signs of the parameter estimates of the variables included in the functional form suggest that the monotonicity and concavity properties are satisfied. In most cases, the estimated parameters of the efficiency frontiers are significant at the conventional confidence levels. From these two tables we note that in both technological regimes of the two different banking systems, the estimated *Lambda* (λ_k) parameter is statistically insignificant in contrast to a model that assumes homogeneous production technology. This suggests that bank heterogeneity is fully captured when a model with two classes is estimated.[18]

Next, we examine the results that emanate from determinants that affect the inefficiency component. As far as the UK banks are concerned, we notice that in the first technological regime efficiency increases over time, whereas there is an erosion of efficiency throughout the years in the second one. This can be seen from the positive sign of the statistically significant determinant (i.e. *TIME*) in class two; inefficiency increases during the years of the sample. The significant and negative effect that *size* has on efficiency prevails in both classes, but there is a mixed effect of the nature of a financial institution in the two regimes. More precisely, the dummy variable *BS* does not have any significant effect in the second class; nonetheless, it has a detrimental effect on efficiency if the financial institution is a bank and not a building society.[19]

As far as the Greek banks are concerned, we notice similarities among the two different regimes in terms of the sign and the significance of the effect that *size* has on efficiency. Although we report similar results with respect to the banks that belong to the first technological regime in both countries' banking sectors, the *time* determinant has exactly the opposite effect on efficiency in the Greek banking system (compared to the UK) regarding the banks that belong to the second technological regime. Last, we highlight that ownership has no important effect on the efficiency of banks, regardless of their classification among the two regimes.

Subsequently, we shed light on the differences of technology regimes based on the posterior production variable distributions. For both countries, the majority of determinants are statistically significant, indicating that they are critical for the classification of banks among the two regimes. Analysis of the class determinants in terms of their sign and their statistical significance suggests that in the UK banking sector the first technological regime is very likely to consist of banks with a strong capital base, with high-quality credit and liquidity risk management, and a broader scope in product provision. This outcome is in line with the main principles of the Basel II accord regarding the adequate level of capital that each bank must hold on their balance sheets in order to become more efficient. On the contrary, banks not adequately capitalized, that undertake risky projects, and with parsimonious liquidity but increased service specialization are likely to be found in the second latent class. The effect of profitability is subdued.

[18] When the same production technology is assumed for all the banks in the sample the estimated λ parameter is 3.513 with a t-value of 2.765 for the UK and 3.981 with a t-value of 3.593 for Greece.

[19] '*BS*' is a dummy variable that takes the value 0 if the financial institution is a bank and the value 1 if it is a building society. In turn, the higher the value of a *BS*, the lower (greater) the level of inefficiency (efficiency).

Turning to the Greek banking sector, we notice that the banks that belong to those two different latent classes exhibit similar characteristics in terms of capital and the level of both credit and liquidity risk they undertake as the UK banks in the same regimes. The primary difference between the two classes and in essence between the two countries is that not only profitability but service concentration as well has a statistically insignificant effect on the classification process of the Greek banks (see table 7.*b*).

5.4 Classification of financial institutions

The empirical evidence suggests that for both countries, each regime consists of institutions of similar characteristics, despite their differences in terms of the number of banks. This finding strengthens the motivation and scope of this paper, as it casts doubt on an a priori sample separation depending uniquely on banking segments. A thorough look into the two classes permits us to extract interesting inferences regarding the nature of the financial institutions that belong to each regime.

Regarding the UK banking sector, the vast majority of the building societies appears to be in the first regime. Savings banks appear almost universally in the first regime as well. This implies that both building societies and savings banks exhibit rather high efficiency levels compared to commercial banks. One might conjecture that the miscellaneous activities of commercial banks may be the primary cause of financial turmoil like that we experienced starting in August 2007 and that inevitably had calamitous consequences for the economic growth of both developed and emerging markets. If this assumption holds, we potentially provide preliminary evidence in favor of one of the most crucial points in recent debates regarding the separation between the investment and commercial arms of banks.[20] To this end, some action has already taken place in the UK. Specifically, the Independent Commission on Banking (ICB) has proposed "ring fencing" retail and small business commercial banking from investment banking in the UK.[21]

Turning to the Greek banking sector, we find similar evidence to that described for the UK. Savings banks and one cooperative type of bank (Pancretan Cooperative) appear in the first technological regime; however, both regimes are actually dominated by commercial banks, as is the Greek banking sector in general. Nevertheless, the rest of the cooperative banks (such as Panellinia Bank) appear in the less efficient regime.[22] As far as *ownership* is concerned, we highlight that it has rather a subdued effect, as there is an equal distribution of state-owned and privately owned banks between the two regimes. Note that most of the banks from the whole sample whose operations have been ter-

[20] It should be noted that in the UK major job losses have been recorded in investment banking and other financial institutions trading short-term financial instruments against long-term securities and loans.

[21] However, the ring-fencing idea has not yet been put into action as there are opposing ideas from other European Commission member countries, such as Germany and France.

[22] Panellinia Bank was established in April 2001 by the Cooperative Banks and Credit Union in Greece in an effort to achieve economies of scale and due to commercial competition.

minated either because they were acquired or because they were involved in a merging activity belong to the first technological group as well.

A common point to both countries is that the four largest banks (in terms of assets, deposits, and loans) are classified as being in the first regime.[23] These are HSBC, RBS, Lloyds, and Barclays in the UK and Ethniki, Eurobank, Alpha, and Pireaus in Greece. This finding is of extreme importance for Greece, as the four aforementioned banks compose the four cornerstones of the recovery of the Greek economy.[24] Consequently, the classification of all four systemic banks into the most efficient technological regime has major policy implications regarding the success and the scope of the recent wave of banks' M&A activity and in general for the country's detachment from the recession after many consecutive years. In the appendix, we quote the alternative empirical strategy (Bos et al. 2010) that we adopt to estimate the latent class stochastic frontier framework in order to test the accuracy of our findings. We also describe a series of robustness checks for the UK and Greek banking systems in tables 10a, 10b, 11a, 11b and figure 2.

5.5 Recent & Prospective Mergers and Acquisitions

As a next step, we shed light on the various aspects of recent and potential M&A of UK and Greek banks. We endeavor to examine from an efficiency point of view whether the creation of the new bank will potentially move it to the most efficient technological regime between the two existing ones, or even to a new and higher in terms of efficiency technological class that is created after the consolidation activity. In turn, we investigate, whether a prospective M&A can increase the total factor productivity scores of the industry, resulting in larger efficiency synergies. At this point, we highlight our twofold contribution. First, we provide a novel econometric method to evaluate and compare the efficiency gains or losses of a potential M&A activity that can be applied to any micro-study. This is of extreme importance for policymakers and practitioners, as after the onset of the global financial turmoil we witnessed many banks' M&A, regardless of whether they were commercial, savings, co-operative, or real estate and mortgage banks. Second, we are able to extract inferences with major policy implications regarding the true origins of an M&A activity in terms of promoting economic prosperity or managerial purposes. To achieve the last two contribution points, we investigate all the possible M&A

[23]For the sake of brevity, detailed classification of all the banks into the two technological regimes for both banking sectors is available upon request.

[24]The Bank of Greece, in close cooperation with the Troika (i.e. the tripartite committee led by the European Commission (Eurogroup) with the European Central Bank and the International Monetary Fund) set out to create a viable and well-capitalized banking sector, recognizing that it would play a fundamental role in steering the economy. Their strategy aimed at creating well-capitalized banks, new confidence for depositors, and renewed access to capital markets so that Greek banks could return to their basic role of financing the Greek economy. This resulted in a series of M&As until the end of 2013. Finally, four systemic banks, Alpha Bank, Eurobank, Ethniki Bank, and Piraues Bank, were created. These banks were assigned the role of sustaining and promoting the Greek economy and their recapitalization process through the European Financial Stability Fund (EFSF) and the Hellenic Financial Stability Fund (HFSF).

combinations that could occur in the two banking sectors and that are motivated by the significant changes that have been taking place since the summer of 2012 in the Greek banking sector. In what follows, we present a brief summary of our motivation.

Prior to the crisis, the Greek banking sector was highly competitive by international standards, with a sound fundamental base. However, the sovereign crisis put the sector under stress as banks experienced substantial deposit outflows, became cut off from capital markets, and took sharp losses on Greek sovereign bonds. The banks responded by deleveraging, a process that itself contributed to economic contraction and created negative feedback loops between the financial and real sectors. Under these circumstances, the stability of the Greek banking system was at risk, with possible implications beyond Greece. Unequivocally, a leaner, restructured Greek banking sector was needed. In this environment, the Bank of Greece, in close cooperation with the Troika, i.e. the tripartite committee led by the European Commission (Eurogroup) with the European Central Bank and the International Monetary Fund, set out to create a viable and well-capitalized banking sector, recognizing that it would play a fundamental role in steering the future course of the economy. Their strategy aimed at strengthening viable institutions and winding down nonviable institutions while safeguarding financial stability. It basically included two fundamental points: i) a major consolidation of the banking sector and ii) a restructuring and recapitalization of the new Greek banking sector. Regarding the first point, the idea was that the expected market shares of the remaining banks will ensure a competitive environment while allowing banks to benefit from economies of scale. The intention of the second point was to create stronger, well-capitalized banks, new confidence for depositors, and renewed access to capital markets so that finally Greek banks can return to their basic role of financing the Greek economy. This resulted in a series of M&A until the end of 2013 and finally the creation of four systemic banks, i.e. Alpha Bank, Eurobank, Ethniki Bank and Piraues Bank, that were assigned the important role of sustaining and promoting the Greek economy and their recapitalization process through the EFSF and the HFSF. In Table 12 we provide detailed information regarding the formation of each one of the four systemic banks via the recent M&A activity and their capital enhancement from the HFSF. We also report on the remaining banks in the Greek banking sector.

5.5.1 Modelling Strategy

Our study contributes to the literature by testing for the first time two hypotheses related to M&A activity and different technological regimes. First, we investigate whether the recent wave of M&A that the Greek banking sector experienced allocates the "new" bank to either a higher or lower technological regime in terms of efficiency. Second, we examine whether potential M&A in both the Greek and UK banking systems will be beneficial for the newly created bank in terms of efficiency.[25]

Before we continue with the analysis of the results, we highlight a discrepancy within the examination strategy of potential M&A of the two systems. For the UK banking sector, we select the nine most important banks in terms of assets, deposits, and loans that belong to the most efficient technological regime (i.e. the first one) and the 11 most important from the second technological and less efficient group after we ensure that each of these 20 banks is not a subsidiary of the remaining 19. Table 13 includes information on all the UK banks and their classification that we use in this analysis as well as on the amount of capital injection that Lloyds and RBS received from the UK government. The methodology is as follows. We create every potential combination of M&A among the nine and 11 respective banks in each regime. In this way, we are able to test whether the new bank would benefit from the M&A activity through a transition from a lesser to a more efficient class or would lose its efficiency level through the opposite move. Turning our attention to the Greek banking sector, we differentiate our empirical strategy due to the M&A that recently took place. Specifically, we select all the remaining banks that have not been involved in the recent wave of consolidation of the four systemic banks, and we create all potential combinations of M&A either among themselves or with one of the four cornerstones of the Greek economy. Additionally, we control for both single and multiple M&A by one banking institution. Last, regarding the four systemic banks, we examine both their recent and potential M&A in every possible combination (i.e. either one-by-one, two-by-two, etc. or by all the acquired banks together) to test what the bank's regime/classification would be if it had not been involved in the recent consolidation process. We focus only on the potential M&A. In tables 14.a and 14.b we present all the cases of potential and recent/potential M&A activity for the UK and Greece, respectively, and their classification in the two different technological regimes.[26] Moreover, both tables report information with respect to prospective gains or losses in real money values (£/€) resulting from each hypothetical M&A that is quoted for both the pre-crisis period and the post-crisis period.[27]

[25] To create the prospective M&A in both baking sectors, the following econometric steps will be used: specifically, the weighted sum for the three main variables (C, y, and eq) will be computed for the banks involved in each potential M&A that we examine. With respect to the input prices (w), we compute the weighted average of the banks constituting each prospective M&A, while we treat the time trend (T) variable as before (i.e. $T = .year1, year2..., final\text{-}year$). We then re-estimate the model as expressed by equation 2. We select the first operating year in the sample that is common to all involved institutions as the starting year of each hypothetical consolidation scenario. For example, if bank A and B's observations are between 1995 and 2011 and 2001 and 2011, respectively, then the hypothetical bank AB will be operating between 2001 and 2011. Consequently, the observations for both banks can be deleted within the overlapping period (i.e., 2001 to 2011). In the end, we re-estimate the cost efficiency of the new financial institution as it was explicitly described in section 3 and specified by equation 6.

[26] The empirical evidence in both banking sectors reveals that the 'new' financial institutions that are created after all prospective consolidation activity are classified in the two existing technological regimes, without creating a new technological class.

[27] Regarding the recent M&A cases that the Greek banking sector experienced, we approach each one

5.5.2 UK - Prospective M&As

Here, we focus our analysis on the UK banking sector and its potential consolidation wave. Table 14.a shows a summary of the results[28] for all potential M&A activity regarding the 20 (nine in the first technological regime and 11 in the second) most important players in terms of assets, loans, and deposits at the end of our sample period. Specifically, we account for every potential combination of M&A among those financial institutions that belong to different classes and among those that are all found ex-ante in the second regime to examine whether a specific consolidation activity can result in the transition of the new bank in the higher technological regime (i.e. the first one) in terms of efficiency.[29]

As far as the category of potential M&A among the banks that belong in the two different regimes is concerned, in approximately 40% of the cases the new financial institution will be classed in the first and most efficient technological regime. It is noteworthy that 20% of these potential M&A cases involve a building society, namely Nationwide, and not a bank. Additionally, our results indicate that two of the big four of the UK banking sector, namely Barclays and HSBC, account for a bit less than a quarter of the potential M&A cases that result in enhanced efficiency, whereas the remaining two large UK banks (RBS and Lloyds) account for just 12% and 8%, respectively, of those potential M&A that create a financial institution with a higher efficiency level than before. This might reflect the calamitous impact of the financial crisis on the latter pair of banks, which resulted in significant financial assistance by the UK government with the aim of avoiding the collapse of both banks.[30] Regarding the banks that belonged to the second group before they were involved in M&A activity, we notice that in 75% of the cases, three banks and one building society are found to create a financial institution that belongs to the most efficient class following their consolidation with their peers from the first technological regimes.

We now examine the potential combinations of consolidation among the financial institutions that belong in the second technological regime. Contrary to the previous picture, we infer that approximately in only 25% of the overall cases we find the new bank to be classified in the first regime. What is interesting is that the aforementioned three banks and the one building society account once again for two-thirds of the overall cases where

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as a potential scenario in the economy, as our sample is dated up to 2011 and the recent consolidation wave took place in 2012 and 2013.

Additionally, to construct the potential M&A combinations we exclude the banks whose operations were terminated in the last year of our sample (i.e. 2011) and those who terminated their operations after 2011 and up until the present in order for the results to be of relative policy importance.

[28] Due to space constraints, a detailed illustration of all potential consolidation activity considered is available upon request.

[29] We have also considered each potential M&A case among the 9 financial institutions that belong ex-ante to the first class and we find the new bank to be classified in the same technological regime. The results are available upon request.

[30] In 2008 and 2009, the UK government bailed out RBS and Lloyds. As a result, both were partially nationalized.

we experience a transition towards a more efficient technological regime. Last, our results show that the largest financial institution among those that belong to the second regime, would experience a transition to the first and more efficient technological class if it merged with one of either the big four of the UK banking system or with Santander, or Standard Chartered.

It is noteworthy that in the vast majority of cases, if the new financial institution is classified in the first and more efficient regime, regardless of whether the emerged bank consisted of institutions that were allocated either to different technological classes or to the same one, there will be a cost reduction, that is, an economic gain in real money terms in both periods around the crisis. This is of extreme importance, especially for RBS and Lloyds, as a prospective consolidation activity of each one of those two banks with some specific financial institutions could lead to cost benefits and thus to the alleviation of the taxpayers' burden, given that the UK government partially nationalized both of them as part of their bailout program. On the contrary, when the consolidated institution is allocated to the second technological regime, the results are mixed with respect to the pre-crisis period. Whereas in most of the cases regarding the aftermath of the crisis, it is evident that there is a deterioration with respect to the cost, highlighting the detrimental negative impact of the recent financial turmoil on the cost efficiency of those institutions.

5.5.3 Greece - Recent M&As

One of the most substantial finding as far as the Greek banking sector is concerned is that two out of the four newly designed engines to promote the Greek economic recovery, namely Eurobank and Piraeus, are found after their series of acquisitions to be in the less efficient technological class as opposed to the other two, Alpha Bank and Ethniki Bank, which despite their recent acquisitions still belong to the first technological regime. On the one hand, it seems that if Eurobank had absorbed only TT-Hellenic Postbank, the new bank would have placed in the first and higher efficiency regime, whereas the acquisition of only Proton Bank (without TT-Hellenic Postbank) would have deteriorated Eurobank's position before any M&A activity had occurred. On the other hand, it may be easier to comprehend the case of Piraeus Bank, as it is involved in the largest consolidation activity that may affect its efficiency levels. In order to provide a more thorough explanation, we look at each one of Piraeus Bank's acquisitions separately and gradually add to them another financial institution from the list of banks that were absorbed in the end. Table 14.*b* demonstrates a summary of the results. [31]It is noteworthy that only two banks, namely Marfin Egnatia Bank and Millenium Bank, after being acquired by Piraeus Bank either individually or simultaneously, would have led to a newly created bank that would have been allocated to the most efficient technological class. On the contrary we find

[31]As in the case of the UK banking sector, due to space constraints, a detailed illustration of all potential consolidation activity considered is available upon request.

evidence that every combination of banking institutions regarding the potential M&A of Pireaus bank with ATE Bank and/or Geniki Bank with or without the presence of Marfin Egnatia Bank and Millenium Bank places the new bank in the second and less efficient regime.[32] The last points cast major doubt on the ability of specific banks' M&A in the recent wave of consolidation in Greece to generate and pass on merger-specific synergies to the economy. Consequently, concerns are raised about the decisions of the policymakers and about involving banks in the selection process about which financial institution will be the acquirer and which one will be the target in terms of the resulting economic benefit of the consolidation process. However, we confirm the concerns of the officials regarding the cancelled attempt at consolidation of two of the four big banks, namely Ethiki and Eurobank, as we find a potential M&A entity among them in the less efficient technological regime.

5.5.4 Greece - Prospective M&As

Turning our attention now to potential M&A between the four major banks of the new era of the Greek economy and the four remaining banking institutions, namely Attica Bank, Aegean Bank, Panellinia Bank, and Pancretan Co-operative Bank,[33] we acquire some insightful outcomes. We examine all potential combinations of consolidation between the last four banking institutions, which are equally split among the two technological regimes, with or without the four systemic banks and before and after their recent acquiring activity. It is noteworthy to see that all potential M&A of each of the four remaining banks with each of the systemic banks before they got involved in the recent consolidation would have resulted in the new bank being classed into the first technological regime. This would be even more important for Attica Bank and Panellinia Bank as it would upgrade their efficiency levels because they both belong to the second class.

Shedding light on all future possible combinations of M&A between the remaining four banks and the four systemic banks reveals that the two co-operative banks (Pancretan and Panellinia) and Aegean Bank create combinations of M&As where most of the time the new bank is found to be classified in the first technological regime. The first systemic bank, Alpha Bank, in the aftermath of Emporiki's acquisition, seems to create four out of 15 of its overall potential combinations of M&A that are found to exhibit high efficiency levels, that is, that belong in the first technological class. These four prospective scenarios are constituted of the two co-operative banks and in two cases of the Aegean bank as well. We find similar results regarding Ethniki Bank (and FFB Bank and Probank as well) and its potential combinations of consolidation with non-systemic banks. The estimation results show that in 30% of the overall cases, the new bank will be allocated in the first and

[32] We study every combination of potential M&A activity of Pireaus bank, which can consist of two to five banking institutions.

[33] Attica bank and Aegean Bank are commercial banking institutions, whereas Panellinia Bank and Pancretan Co-operative Bank deal with co-operative banking activities.

most efficient technological class and thus enhance its level of cost efficiency due to the prospective consolidation activity. All the cases include Pancreatan Bank. Nevertheless, there is a high frequency of the appearance of both Attica Bank and Panellinia Bank. This is of extreme importance, as those two financial institutions are initially found in the lower technologically efficient class, and it seems that their efficiency levels would have been enhanced after the specific prospective M&A. On the contrary, only approximately 7% of the potential combinations of the current structure of Eurobank (that is, it has already absorbed both the New Proton Bank and the New TT-Hellenic Postbank) with the four non-systemic banks creates a new bank that will have higher levels of efficiency. This will consist of a potential M&A between the new systemic Eurobank and Pancretan Bank. The remaining systemic bank, Pireaus Bank (with ATE Bank, Geniki Bank, Marfin Egnatia Bank and Millenium Bank), creates twice as many M&A cases than Eurobank that are in the first technological regime (i.e. which have enhanced efficiency levels). This consists of potential combinations of M&As among the new systemic Piraeus Bank either with Attica Bank or with Attica Bank and one of Aegean Bank or Pancretan-Cooperative Bank. All these results strengthen our initial and main finding that two out of the four systemic banks classified in the highest technological class in terms of efficiency are the ones that create potential combinations of consolidation whose efficiency is enhanced after the potential M&A activity.

As a last exercise, we examine the non-systemic banks and their potential interactions. We can infer that 30% of the overall potential combinations of those four banking institutions is classified in the first technological regime. All the successful (i.e. enhanced efficiency after the consolidation process) combinations consist of either Aegean Bank or Pancretan Bank with either Attica Bank or with the combination of both Attica Bank and Panellinia Bank together. This outcome is of great interest as both Attica Bank and Panellinia Bank belong to the second technological regime. Thus, based on the empirical evidence, it seems that both can achieve higher efficiency levels after a potential consolidation with either Aegean Bank or Pancretan Bank. In turn, our results indicate that there are still considerable economies of scale for the smaller financial institutions in Greece that need to be exploited, and there are additional efficiency gains and benefits of synergies that could be derived from the correct consolidation actions, which will enable economic prosperity and growth.

Additionally, as in the case of the UK banking sector, on all the occasions where the consolidated financial entity is classified in the higher technological regime in terms of efficiency, it would lead to significant cost reductions in real money terms in both the pre-crisis period and in the post-crisis period. On the contrary, regarding those new financial institutions allocated to the second technological regime, in most cases and for both distinct economic periods they do not create any beneficial cost efficiency synergies. Notable exceptions from the previous category (i.e. the new bank belongs to the second regime but the consolidation process leads to a cost reduction) are a few potential M&A cases created by Alpha Bank and Ethniki bank in either their pre- or post-systemic formation. This is in line with our concerns about whether two of the four cornerstones of the restructured Greek banking sector (i.e. Eurobank and Piraeus bank) following the recent wave of M&A could benefit the economy. Last, in order to be more precise on the extracted inferences regarding the last empirical evidence, we report in table 14.b (see column $HFSF$) a summary of the additional (i.e. taxpayers' losses) or the lower (i.e. taxpayers' gains) level of capital that the HFSF would need to inject into the country's banking system compared to the level of capital that was actually raised in order to support the current formation of the four systemic banks and the current formation of the sector in improving its soundness in the aftermath of the financial turmoil.[34] The results suggest the recent specific M&A wave of both Alpha Bank and Ethniki Bank consists of the optimum selection of financial institutions that leads to the highest economic gains (see the negative HFSF values). On the contrary, Eurobank and Piraeus Bank could have been involved in a consolidation activity with alternative financial institutions (other than those they actually got involved with during the recent M&A wave), which could have resulted in effective alleviation of the tax burden.

5.5.5 The UK and Greece

Table 15 illustrates the average gains or losses that stem from all the prospective consolidation activity of the largest banks in each banking sector in both the pre- and post-crisis periods. As far as the UK banking sector is concerned, the results suggest that pre-crisis, all large banks' potential combinations of M&A would generate gains for the UK economy, whereas in the aftermath of the crisis, this could only occur for the M&A cases of Barclays and HSBC. Regarding the Greek banking sector, the empirical evidence highlights a similar picture before and after the crisis. Specifically, in both eras around the crisis only two financial institutions of the so-called big four of the sector, namely Alpha Bank and Ethniki Bank, seem to create synergies that can result in cost reduction. This is quite a surprising finding, especially for the post-crisis period given the new systemic formation (as a result of the recent post-crisis consolidation wave) of those four banks and their emerging importance as the new cornerstones of the Greek economy.

6 Concluding remarks

In this paper, we propose an econometric method to evaluate and compare the risk-adjusted efficiency gains or losses of a potential consolidation activity under different technological regimes. The performance of our approach is tested in the banking sector as it is the dominant sector of a country's financial system. In this spirit, evidence is provided on the existence of heterogeneous technological classes in two different banking systems

[34] Detailed information for each prospective M&A case is available upon request.

in terms of sophistication, market characteristics, and volume of transactions, those of the UK and Greece. Contrary to previous cross-country studies in the framework of an LCSFM model that derive their country-specific inferences by assuming a common sample for all different countries and thus neglecting substantial differences that exist among them, we attempt to compare the countries of interest by examining them separately. Furthermore, we employ two different modelling strategies to test the sensitivity and the robustness of our results. To the best of our knowledge from all previous efficiency-related banking studies, not only is the period we investigate the most extended, but we allow for different financial institutions in terms of their activities. The former allows us to account for all the important developments of both banking sectors, while the latter enables us to thoroughly examine the entire banking system of each country.

The results suggest that bank heterogeneity in both countries is fully captured by two different technological classes. More precisely, the first regime in each banking system consists of the most efficient credit institutions. We find strong empirical evidence of a trade-off with regard to efficiency and the level of sophistication of a banking system. The findings hold across both different modelling strategies that we follow and after various robustness tests that we perform. Furthermore, we provide detailed empirical evidence of an enhanced efficiency in both countries as well as important cost reductions as a result of prospective M&A that can be proved to be a significant factor in the alleviation of taxpayers' burden. Finally, in a circumspect manner, we cast doubt on the decisions of the policymakers with regard to the selection of specific acquirers and targets during the recent wave of consolidation that took place in the Greek banking sector and on its ability to generate the most optimum synergies from an economic benefit point of view.

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Appendix

Robustness checks

In order to examine the robustness of our findings, we perform a series of robustness tests. First, as noted in section 3, we conduct exactly the same analysis, but instead of following Orea and Kumbhakar's (2004) panel data methodology, we follow Bos et al.'s (2010) pooled cross-section strategy that allows the financial institution to be in one regime in a specific year and in another regime the year after. Unequivocally, for both countries the results do not reveal any significant differences regarding the number of different technological regimes (i.e. two classes) and the classification of banks among these two regimes. Specifically, more than 80% of the yearly observations of each credit institution in both banking sectors are in the same class as they are when we use Orea and Kumbhakar's (2004) modelling strategy. With respect to the remaining 20%, where for some year observations the credit institution seems to change class, we highlight that this transition occurs in no more than two consecutive years and in the first year observations for all the credit institutions that belong to this 20% in both countries. The only rudimentary difference apparent in the results in both countries is that all the class membership determinants are statistically significant and larger than in the previous panel datasets. Consequently, we add to our previous findings that for both countries the credit institutions that belong to the first technological regime are more profitable compared with their peers in the second regime. Specifically, in terms of the Greek banking sector, it seems that the broader the variety of products the banks provide, the higher the probability for them to be classified in the first technological regime.[35] This larger statistical significance is apparent in the case of the kernel determinants as well. It must be noted that no change in terms of signs is found. In turn, we argue that the influence of all determinants is in the same direction as before. Tables 10.a and 10.b show all the aforementioned findings for the UK and Greek banking sectors. Thus, we are confident regarding the correct number of identified distinct technological regimes, the appropriateness of our determinants to classify the credit institutions into the two regimes, and most importantly, the exact classification of each credit institution into one of the two technological groups.

Next, we notice that the level of loan to loss provisions increases considerably after 2007 and 2008 for the UK and Greece, respectively. Some concerns arise regarding the scenario that our results-in terms of efficiency and allocation of banks to the two technological regimes-may be biased as they may be driven by the global financial crisis. In order to exclude any element of the crisis and examine the heterogeneity of the two banking sectors in a tranquil period, we truncate our sample and re-estimate our model without including

[35] Nonetheless, it must be noted that despite the broader variety of products and services Greek banks provide compared to the last decade, it is still small in size and sophistication compared to the services being provided by the universal type of banks, such as the large UK financial institutions.

the period 2007–2011 for both countries. As far as the Greek banks are concerned, we notice that in table 11.b the classification remains almost unchanged.[36] Thus, we have strong evidence that our inferences regarding the Greek banking sector are extracted with precision. As far as the UK banks are concerned, we note in table 11.a that 20% of the banks (10 banks) that belonged to the second (and less efficient) regime move to the first class, whereas less than 5% of banks (three banks) move from the first to the second class.[37] Similar to the initial results (i.e. where we follow the panel-data estimation strategy; see section 3), we can conclude again that the financial crisis had a greater impact on the UK banking sector than in the Greek banking sector. Specifically, it had a severe impact on the technology of the UK financial institutions, which made them quite cost inefficient. Consequently, their initial position deteriorated and they have moved further away from the efficient frontier.[38]

In order to be even more persistent in testing our implications regarding both the efficiency and the heterogeneity of the UK and Greek banks, we account for macroeconomic, financial, country-specific and bank-specific conditions, as previous studies have noted (Pasiouras 2008). Therefore, we account for additional factors that we use both as inefficiency and class membership determinants. Regarding macroeconomic conditions, we take into consideration the level of real GDP growth. As far as financial traits are concerned, we account for the three-month treasury bill rate. Additionally, we account for a bank-specific financial factor, such as the stock return both in time t and $t-1$.[39] We next consider specific dynamics regarding the nature of each banking sector. For this, we add to our analysis the Herfindahl Hirschman Index (HHI) to capture the concentration of each banking system and to examine whether it has any impact on the efficiency and consequently on technological heterogeneity among the banks. We calculate the HHI not only in terms of assets but in terms of loans and deposits as well so as to be as robust as possible. Furthermore, as in the case of the financial factors, we examine the bank-specific traits relating to the HHI. We account for the market power of each bank in the sample. Last, we consider the number of acquisitions the bank has made throughout the sample period, following a previous study that highlights the importance of this inclusion (Orea

[36] Only one bank, Millenium Bank, moves towards the most efficient class and another, Panellinia Bank, exits our sample because after the year filtering, it was left with only one year observation.

[37] As in the case of Greece, seven banks do not appear in the classification up to 2006 in Table 11.a for the same reason.

[38] The case of HBOS constitutes an example of a bank that moved to the less efficient regime during the years of the financial crisis.

HBOS was formed by the 2001 merger of Halifax plc. and the Bank of Scotland. The formation of HBOS was heralded as creating a fifth force in British banking and the UK's largest mortgage lender. HBOS was acquired by Lloyds TSB in January 2009. In February 2009, Lloyds Banking Group revealed losses of £10 billion at HBOS, £1.6 billion higher than Lloyds had anticipated in November because of the deterioration in the housing market and weakening company profits.

[39] We note here that not all the banks in the sample are quoted. There is missing data, especially in the UK sample.

and Kumbhakar, 2004).[40] Unequivocally, for each country none of these determinants are found to be statistically significant, which could support their inclusion. This finding confirms our selection of determinants regarding their suitability in capturing and revealing all the differences in terms of efficiency and technological heterogeneity of the UK and Greek banking sectors.

Concentrating on the Greek banking sector, we check the performance of the banks' stock returns during the years in our sample (displayed in figure 2).[41] The results are in line with our previous findings regarding the systemic banks and their classification in the most efficient regime and are consistent with previous empirical studies (Pasiouras et. al 2008). The stock returns of the four cornerstones in the new era of the Greek banking system outperformed the remaining four banks, which all belong to the second technological class.

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[40] In order to take into consideration each bank's acquisitions, we construct a dummy variable that takes a value of zero if the bank does not acquire any financial institution, and its value is increased by one every time the bank acquires another bank.

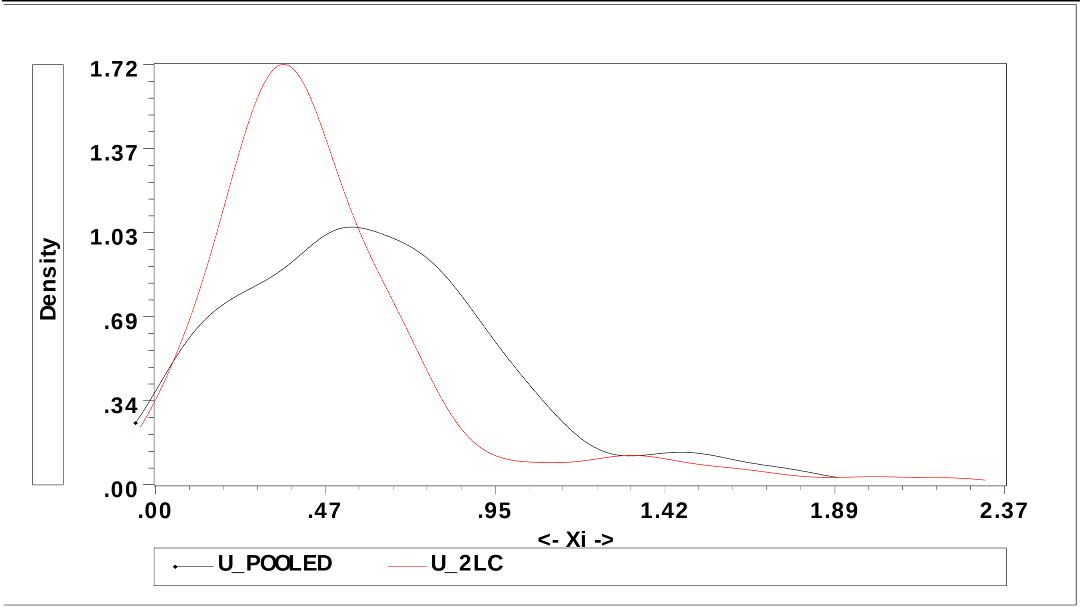
[41] Stock return movement for listed Greek banks on the Athens Stock Exchange (ASE) were obtained from Datastream.

Some banks are not listed on the stock market; nonetheless, their total market share is less than 3% of the total assets of the Greek banking sector.

The absence of many large banks (in terms of assets) from the UK stock exchange prevents us from conducting the same analysis for the UK.

Figures

Figure 1.a: UK - Kernel density of the estimated variance of the inefficient component

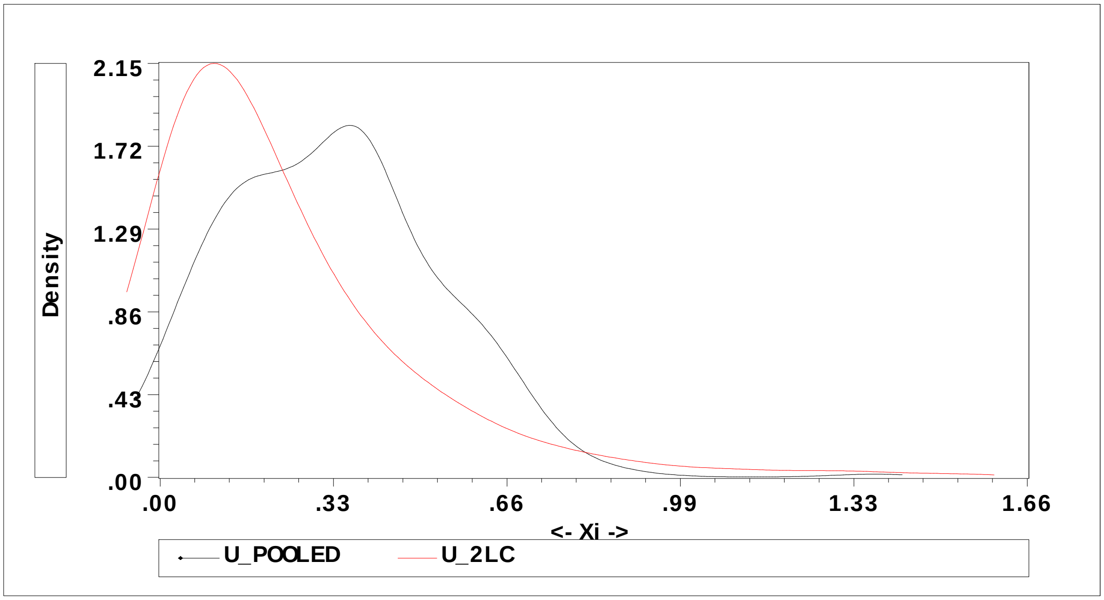


Notes: This figure displays the kernel density estimators for the two sets of the variance of inefficiencies {σ²u|k} as far as the UK banking sector is concerned. The model is

$$lnC(it)=lnC(y[it],w[it],t\ ;\beta[k])+u[it|k]+v[it|k]$$

where subscripts i=1,....N, t=1,....,T_{i} and k=1,...,K, stand for bank, time and class respectively. C{it} is individual bank total cost; y{it} and w{it} indicate vectors of output and input prices; β{k} is a class-specific vector of parameters to be estimated.The two-sided random error term v[it|k] is assumed to be independent of the non-negative cost efficiency variable u[it|k] for each class. Here the technology is represented by a dual cost function. U_POOLED' and 'U_2LC' refer to a model that assumes the same (k=1) production technology for all the banks in the sample and to a model with two (k=2) latent classes respectively.

Figure 1.b: Greece - Kernel density of the estimated variance of the inefficient component

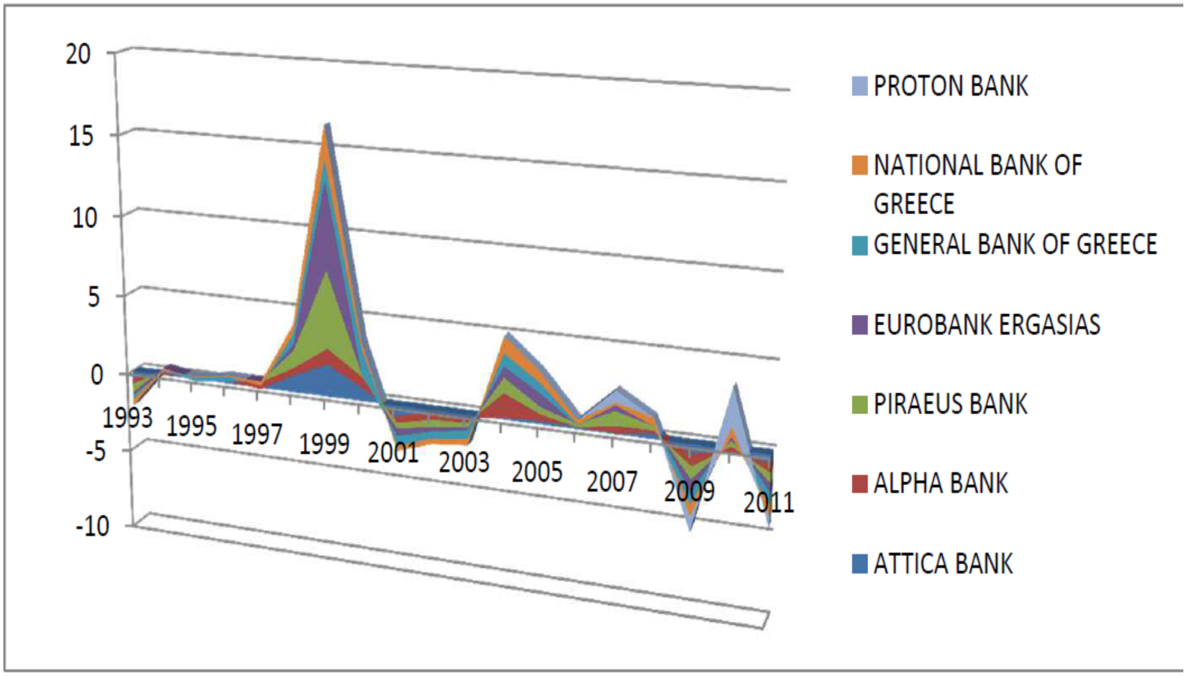


Notes: This figure displays the kernel density estimators for the two sets of the variance of inefficiencies {σ²u|k} as far as the Greek banking sector is concerned . The model is

$$lnC(it)=lnC(y[it],w[it],t\ ;\beta[k])+u[it|k]+v[it|k]$$

where subscripts i=1,....N, t=1,....,T_{i} and k=1,...,K, stand for bank, time and class respectively. C{it} is individual bank total cost; y{it} and w{it} indicate vectors of output and input prices; β{k} is a class-specific vector of parameters to be estimated.The two-sided random error term v[it|k] is assumed to be independent of the non-negative cost efficiency variable u[it|k] for each class. Here the technology is represented by a dual cost function. U_POOLED' and 'U_2LC' refer to a model that assumes the same (k=1) production technology for all the banks in the sample and to a model with two (k=2) latent classes respectively.

Figure 2: Greece - Stock returns of the 'quoted' Financial Intermediaries



Notes: This figure illustrates the movement of the Greek banks' stock returns that are listed in the Athens Stock Market for the period 1993 - 2011.

Tables

Table 1.a: UK - Time Series Analysis of characteristic banking indicators

year	Num OBS	T.A (B)	Gr. Ls (B)	Dep. (B)	Eqt. (B)	L.L.P (M)	HHI
1988	13	10.73	18.09	9.58	0.55	25.77	0.19
1989	40	16.6	26.98	14.33	0.86	338.95	0.12
1990	49	19.4	36.34	16.76	0.96	205.41	0.08
1991	53	21.63	37.9	18.64	1.11	287.72	0.08
1992	66	17.16	25.94	14.39	0.87	227.15	0.08
1993	69	15.95	23.62	13.04	0.81	147.54	0.07
1994	70	19.92	31.13	15.9	1.01	76.32	0.08
1995	80	14.56	22.57	11.56	0.89	45.88	0.06
1996	110	14.76	25.06	11.75	0.92	30.11	0.05
1997	114	18.04	29.84	14.22	0.99	38.9	0.08
1998	115	20.52	34.13	16.16	1.16	100.34	0.06
1999	116	18.3	29.59	14.47	1.2	73.44	0.05
2000	117	24.06	35.9	18.94	1.7	67.05	0.07
2001	120	23.65	34.3	18.73	1.77	95.16	0.06
2002	125	33.11	53.37	26.58	2.05	127.42	0.07
2003	127	35.3	63.01	27.02	2.76	137.02	0.06
2004	127	73.56	142.07	59.93	5.16	351.77	0.15
2005	126	87.6	150.83	62.92	4.42	223.69	0.12
2006	121	104.11	204.36	68.12	6.32	541.66	0.14
2007	120	132.24	264.95	98.8	8.22	579.07	0.23
2008	116	107.92	157.32	53.52	4.1	783.78	0.09
2009	116	87.82	142.22	53.25	7.16	971.87	0.08
2010	113	86.56	135.5	51.52	7.32	675.16	0.07
2011	101	138.39	213.96	80.69	10.43	863.94	0.08
Total	2324	1141.89	1938.98	790.82	72.74	7015.12	0.09

Notes: This table presents an overview of the UK banking system throughout our sample period. T.A, Gr. Ls, Dep., Eqt, L.L.P, HHI represent average values of Total Assets, Gross loans, Deposits, Equity, Loans and loss Provisions and Market Concentration (expressed by the Herfindahl-Hirschman (HHI) Index and it is defined as the sum of the squares of the market shares of all banks in the sample for each year: a HHI index below 0.01 indicates a highly competitive index, a HHI index below 0.15 indicates an unconcentrated index, a HHI index between 0.15 to 0.25 indicates moderate concentration, while a HHI index above 0.25 indicates high concentration.) respectively. 'B' stands for billions while 'M' for millions.

Table 1.b: Greece - Time Series Analysis of characteristic banking indicators

year	Num OBS	T.A (B)	Gr. Ls (B)	Dep. (B)	Eqt. (B)	L.L.P (M)	HHI
1993	19	3.84	5.24	3.28	0.17	12.91	0.21
1994	19	4.85	6.89	4.18	0.22	18.54	0.23
1995	19	6.05	8.7	5.25	0.26	13.78	0.21
1996	21	5.04	6.95	4.49	0.24	24.62	0.16
1997	21	5.74	6.92	5.07	0.27	32.97	0.2
1998	20	6.79	8.19	6.06	0.42	41.5	0.16
1999	16	8.77	9.1	7.47	0.9	45.36	0.16
2000	15	9.31	8.77	8.04	0.83	38.31	0.16
2001	15	9.94	8.76	8.77	0.76	44.99	0.17
2002	18	9.85	10.33	8.76	0.6	47.85	0.18
2003	20	11.84	14.96	10.17	0.81	75.79	0.16
2004	21	13.33	18.15	10.83	0.79	89.34	0.15
2005	21	13.44	15.86	10.93	0.93	75.35	0.14
2006	19	19.2	25.29	15.08	1.39	125.15	0.14
2007	19	26.95	39.68	19.55	2.27	120.8	0.13
2008	19	31.71	44.12	25.05	2.13	260.27	0.14
2009	19	34.67	49.95	28.1	2.85	424.91	0.14
2010	20	30.36	40.57	24.77	2.74	562.62	0.13
2011	15	30.54	39.51	26.21	1.1	1779.96	0.19
Total	356	282.22	367.94	232.06	19.68	3835.02	0.17

Notes: This table presents an overview of the Greek banking system throughout our sample period. T.A, Gr. Ls, Dep., Eqt, L.L.P, HHI represent average values of Total Assets, Gross loans, Deposits, Equity, Loans and loss Provisions and Market Concentration (expressed by the Herfindahl-Hirschman (HHI) Index and it is defined as the sum of the squares of the market shares of all banks in the sample for each year: a HHI index below 0.01 indicates a highly competitive index, a HHI index below 0.15 indicates an unconcentrated index, a HHI index between 0.15 to 0.25 indicates moderate concentration, while a HHI index above 0.25 indicates high concentration.) respectively. 'B' stands for billions while 'M' for millions.

Table 2.a: UK - Financial Intermediaries Analysis of characteristic banking indicators

name	Years	Num OBS	T.A (B)	Gr. Ls (B)	Dep. (B)	Eqt. (B)	L.L.P (M)	Mar. Pr (%)
ABC Int.	1996-2011	16	3.19	1.38	2.33	0.41	5.72	0.35
AIB Bank	1992-2008	17	2.23	0.14	2.05	0.14	0	0.25
AIB Group	1995-2011	17	25.81	16.41	22.26	1.36	219.22	2.86
Abbey Nat.	1990-2011	22	190.34	27.9	126.34	3.65	45.36	21.09
Adam & Company	1989-2011	23	1.63	0.59	1.52	0.08	1.47	0.18
Ahli United	1989-2011	23	2.78	1.29	2.32	0.21	10.63	0.31
Alliance & Leic. BS	1988-1996	9	29.95	23.6	26.42	1.49	106.78	3.32
Alliance & Leic. Bank	1995-2006	12	5.44	1.65	4.32	0.45	6.17	0.6
Alliance & Leic. Plc	1996-2011	16	80.46	57.6	59.22	2.64	182.14	8.92
Alpha Bank	1989-2011	23	0.59	0.29	0.5	0.08	1.49	0.07
Anglo-Romanian	1989-2010	22	0.25	0.11	0.17	0.06	2.26	0.03
Arbuthnot	1991-2011	21	0.27	0.14	0.21	0.04	1.55	0.03
BMCE Int.	2006-2011	6	0.36	0.17	0.28	0.06	0.55	0.04
Bank Leumi	1996-2011	16	1.72	1.17	1.5	0.15	7.13	0.19
Bank Mandiri	1999-2011	13	0.17	0.08	0.11	0.05	3.42	0.02
Bank Saderat	1996-2011	16	0.82	0.18	0.55	0.19	0.61	0.09
Bank of Beirut	2002-2011	10	0.35	0.14	0.27	0.06	0.08	0.04
Bank of China	2007-2011	5	1.18	0.6	1.01	0.24	7.36	0.13
Bank of Cyprus	1997-2003	7	0.85	0.55	0.75	0.07	0.43	0.09
Bank of N.Y. Mellon	1997-2011	15	5.11	0.22	4.47	0.33	0	0.57
Bank of Scotland	1990-2011	22	368.13	256.88	260.55	12.28	3821.53	40.79
Bank of Tokyo	1988-1996	9	0.68	0.28	0.59	0.06	5.91	0.08
Bank of Philip. Isl.	2009-2011	3	35.73	0.49	3.45	32.01	18	3.96
Barclays Bank	1992-2011	20	1262.61	431.68	647.54	42.14	3266.07	139.91
Barclays Priv. & Tr.	2002-2005	4	2.07	0.18	1.79	0.24	0.47	0.23
Barclays Priv. Clien.	2002-2008	7	27.88	4.01	26.22	1.06	10.92	3.09
Barnsley BS	1992-2007	16	0.45	0.34	0.41	0.03	0.27	0.05
Bath BS Sav. & Inv.	1995-2010	16	0.26	0.19	0.24	0.02	0.09	0.03
Beneficial Bank	1988-1998	11	2.2	1.95	1.31	0.23	98.35	0.24
Beverley BS	1996-2011	16	0.17	0.13	0.16	0.01	0.18	0.02
Birmingham Mid. BS	1988-1998	11	8.43	6.96	7.63	0.4	16.74	0.93
Bradford & Bingley BS	1988-1999	12	23.59	18.76	21.38	1.26	24.3	2.61
Bradford & Bingley Int.	2007-2010	4	3.91	3.74	3.53	0.37	0	0.43
Bradford & Bingley Bank	1999-2011	13	68.99	54.42	35.75	2.18	181.36	7.65
Bristol & West BS	1988-1996	9	10.93	8.83	9.81	0.54	39.43	1.21
Britannia BS	1989-2009	21	35.06	22.06	27.75	1.64	19.22	3.89
British Arab	1989-2011	23	2.68	0.62	2.3	0.21	5.32	0.3
Buckinghamshire BS	2003-2011	9	0.25	0.18	0.23	0.02	0.02	0.03
Butterfield Guernsey	1996-2011	16	1.12	0.22	1.02	0.07	0.62	0.12
Butterfield Holdings	1992-2010	19	0.5	0.11	0.44	0.05	-0.01	0.06
Cambridge BS	1996-2011	16	1.24	0.91	1.15	0.08	0.49	0.14
Capital One	2002-2011	10	6.96	6.07	2.64	0.65	382.69	0.77
Catholic BS	1997-2007	11	0.06	0.04	0.06	0	0	0.01
Chelsea BS	1990-2009	20	12.72	9.61	11.08	0.55	12.7	1.41
Cheltenham & Gloucester BS	1988-1995	8	22.82	19.26	20.98	1.08	79.71	2.53
Cheltenham & Gloucester Bank	1996-2011	16	66.45	94.73	88.26	2.41	-6.19	7.36
Cheshire BS	1990-2007	18	5.2	4.02	4.07	0.25	4.04	0.58
Citibank	1989-2011	23	31.44	9.95	24.01	2.69	234.57	3.48
City of Derry BS	1998-2010	13	0.04	0.03	0.04	0	0.16	0
Co-operative	1990-2011	22	17.88	11.85	15.27	0.93	112.16	1.98
Consolidated Credits	2002-2011	10	0.15	0	0.12	0.03	0	0.02
Coventry BS	1989-2011	23	18.11	12.92	15.16	0.71	8.33	2.01
Credit Agricole	2000-2004	5	2.6	0.47	1.45	0.07	0	0.29
Credit Suisse	1997-2011	15	1.75	0.44	1.59	0.09	0	0.19
Cuscatlan Bank and Trust	2002-2006	5	0.33	0.19	0.28	0.04	0.38	0.04

(Continued)

Table 2.a: UK - Financial Intermediaries Analysis of characteristic banking indicators (Continued)

name	Years	Num OBS	T.A (B)	Gr. Ls (B)	Dep. (B)	Eqt. (B)	L.L.P (M)	Mar. Pr (%)
DB UK	1996-2011	16	14.44	3	7.57	1.31	1.39	1.6
Darlington BS	1996-2011	16	0.87	0.67	0.8	0.06	0.52	0.1
Derbyshire BS	1992-2007	16	6.4	5.02	5.85	0.34	0.92	0.71
Dexia Municipal	1992-1999	8	0.61	0.52	0.53	0.05	0.28	0.07
Dunbar	1995-2010	16	1.12	0.99	0.85	0.21	70.78	0.12
Duncan Lawrie	2008-2010	3	0.24	0.06	0.2	0.04	0	0.03
Dunfermline BS	1992-2007	16	3.26	2.52	2.99	0.17	0.84	0.36
Ecology BS	1997-2011	15	0.1	0.07	0.09	0.01	0.09	0.01
Egg	1996-2011	16	11.89	7.14	9.81	0.58	258.35	1.32
Europe Arab	2005-2011	7	5.61	2.51	5.38	0.42	47.33	0.62
FBN	2003-2011	9	1.49	0.34	1.25	0.11	-1.35	0.17
FIBI	1996-2011	16	0.35	0.25	0.27	0.07	0.63	0.04
Fairbairn	1998-2011	14	1.01	0.26	0.94	0.06	0.3	0.11
Finsbury Pavement	1991-2006	16	0.8	0.16	0.58	0.17	0.17	0.09
Furness BS	1996-2011	16	1.2	0.93	1.1	0.07	0.36	0.13
Gainsborough BS	1992-2000	9	0.05	0.03	0.04	0	0	0.01
Ghana	1998-2011	14	0.51	0.05	0.43	0.07	0.16	0.06
Gresham Trust	1993-2000	8	0.15	0	0.02	0.13	0	0.02
HBOS	2000-2011	12	494.11	387.03	383.7	26.91	7010.74	54.75
HFC	1989-2011	23	4.29	3.25	2.35	0.46	230.8	0.48
HSBC Middle East	1989-2011	23	12.93	7.17	10.38	1.04	144.53	1.43
HSBC	1989-2011	23	488.09	200.1	279.61	22.28	1175.48	54.09
Habib Allied	2001-2011	11	122.81	40.29	103.93	11.85	246.18	13.61
Habibsons	1996-2011	16	0.32	0.08	0.29	0.02	0.41	0.04
Halifax	1996-2006	11	301.63	220.16	264.75	10.49	526.95	33.43
Harpenden BS	1996-2011	16	0.21	0.16	0.19	0.01	0.09	0.02
Heritable	1989-2007	19	0.46	0.41	0.38	0.05	1.3	0.05
ICBC	2003-2011	9	0.91	0.35	0.72	0.16	-0.16	0.1
Ilkeston Permanent BS	1997-2000	4	0.03	0.02	0.02	0	0	0
Isle of Man Bank Limited	1995-2011	17	5.09	1.11	4.64	0.36	0.27	0.56
Italian Int.	1988-1997	10	2.37	0.35	2.14	0.12	1.16	0.26
JP Morgan	1996-2011	16	1.95	1.5	0.14	0.98	0	0.22
Jordan Int.	1996-2011	16	0.33	0.07	0.28	0.04	6.69	0.04
KDB Bank	1992-1998	7	0.38	0.08	0.31	0.05	5	0.04
Kaupthing Singer & Friedlander	1989-2007	19	1968.65	1233.45	1638.98	144.34	7931.22	218.15
Kingdom	2009-2011	3	0.08	0.05	0.07	0.01	0.4	0.01
Kookmin	1995-2010	16	0.26	0.03	0.21	0.04	1.46	0.03
Lazard & Co Holdings	1999-2011	13	1.1	0.31	0.81	0.21	0	0.12
Leeds BS	1989-2011	23	9.75	7.63	8.28	0.53	23.14	1.08
Leek United BS	1996-2011	16	1.1	0.86	1.01	0.07	0.15	0.12
Lloyds (BLSA)	1992-2001	10	1.96	0.72	1.7	0.12	13.81	0.22
Lloyds	1988-1998	11	132.06	78.23	109.79	5.85	999.95	14.63
Lloyds TSB	1998-2011	14	539.94	309.35	373.09	25.28	3962.68	59.83
Lloyds TSB Scotland	1989-2010	22	11.54	8.41	10.4	0.73	43.28	1.28
London Int.	2001-2006	6	0.01	0	0	0.01	0	0
London Trust	1991-1998	8	0.06	0.03	0.04	0.01	0.7	0.01
MBNA Europe Bank	1995-2010	16	11.94	9.83	6.49	1.82	607.25	1.32
Manchester BS	1990-2011	22	0.83	0.64	0.75	0.05	0.99	0.09
Mansfield Building Society	1995-2011	16	0.32	0.25	0.29	0.03	0.05	0.04
Market Harborough BS	1998-2011	14	0.64	0.5	0.59	0.04	0.03	0.07
Marsden BS	1996-2011	16	0.53	0.38	0.48	0.04	0.59	0.06
Melli	2001-2011	11	1.54	0.19	1.14	0.27	4.49	0.17
Melton Mowbray BS	1996-2011	16	0.6	0.43	0.54	0.05	0.2	0.07
Mercantile BS	1992-2005	14	0.29	0.22	0.26	0.02	0.04	0.03
Merrill Lynch	1990-2005	16	11.59	5.81	8.24	0.8	3.28	1.28

(Continued)

Table 2.a: UK - Financial Intermediaries Analysis of characteristic banking indicators (Continued)

name	Years	Num OBS	T.A (B)	Gr. Ls (B)	Dep. (B)	Eqt. (B)	L.L.P (M)	Mar. Pr (%)
Morgan Stanley	2001-2011	11	7.61	2.14	4.1	1.02	17.26	0.84
National Bank of Kuwait	1996-2011	16	1.88	0.65	1.55	0.28	0.66	0.21
National Counties BS	1996-2011	16	1.57	1.15	1.11	0.44	1.28	0.17
National Westminster	1989-2011	23	294.59	167.49	240.32	14.12	2146.48	32.65
Nationwide BS	1990-2011	22	175.11	135.5	145.05	6.57	241.61	19.41
Newcastle BS	1989-2011	23	5.16	4.02	4.48	0.27	3.85	0.57
Northern	1995-2010	16	7.54	5.71	6.24	0.48	42.29	0.84
Northern Rock	1996-2011	16	89.7	72.91	51.35	2.29	370.68	9.94
Northern Rock BS	1987-1996	10	10.41	8.61	9.56	0.48	14.03	1.15
Norwich & Peterborough BS	1995-2010	16	5.52	4.17	5.07	0.27	4.93	0.61
Nottingham BS	1992-2011	20	3.07	2.48	2.82	0.18	0.92	0.34
PNB	1997-2011	15	0.03	0	0.02	0.01	0.11	0
Penrith BuS	2008-2011	4	0.14	0.09	0.12	0.02	0	0.02
Portman BS	1989-2006	18	15.72	11.46	13.84	0.77	7.4	1.74
Principality BS	1989-2011	23	6.22	4.72	5.48	0.34	9.59	0.69
Progressive BS	1996-2011	16	1.84	1.46	1.71	0.09	1.46	0.2
Prudential-Bache	1996-2001	6	0.58	0.21	0.48	0.08	0	0.06
Riggs	1989-2004	16	0.41	0.24	0.34	0.05	4.45	0.05
Riyad	1993-1997	5	0.16	0.02	0.12	0.05	0.1	0.02
Royal Bank of Scotland Int.	1996-2008	13	29.11	5.41	26.63	2.08	35.04	3.23
Royal Bank of Scotland	1995-2011	17	930.46	401.98	482.44	42.5	4124.73	103.11
Saffron BS	1996-2011	16	1.09	0.77	1.01	0.06	0.36	0.12
Sainsbury's	2002-2011	10	6.86	3.65	6.2	0.31	104.87	0.76
Santander	1989-2011	23	243.49	150.01	177.69	8.59	461.62	26.98
Schroders	1989-2011	23	8.2	1.03	3.9	1.6	5.18	0.91
Secure Trust	1999-2011	13	0.13	0.08	0.11	0.01	1.11	0.01
Shepshed BS	1997-2011	15	0.12	0.08	0.11	0.01	0.08	0.01
Skipton BS	1989-2011	23	13.26	9.2	11.44	0.71	16.35	1.47
Staffordshire BS	1989-2002	14	1.82	1.5	1.64	0.13	1.7	0.2
Standard	2000-2011	12	21.72	5.95	12.61	1.01	31.88	2.41
Standard Chartered	1998-2011	14	240.37	102.85	145.94	16.09	677.87	26.64
Standard Chartered Plc	1990-2011	22	122.96	72.43	124.62	11.31	601.8	13.63
Stroud & Swindon BS	1994-2009	16	3.64	2.61	3.38	0.14	0.45	0.4
Swansea BS	1996-2011	16	0.16	0.11	0.14	0.01	0.07	0.02
TSB	1988-1997	10	41.56	27.36	35.78	2.69	276.84	4.61
Teachers' BS	1996-2011	16	0.36	0.28	0.25	0.11	-0.01	0.04
The Access	2008-2011	4	0.3	0.03	0.26	0.04	0	0.03
Tipton & Coseley BS	2001-2011	11	0.5	0.39	0.46	0.03	0.41	0.06
Turkish	1996-2011	16	0.18	0.06	0.16	0.03	0.04	0.02
Ulster	1989-2011	23	29.02	21.05	21.82	2.3	812.56	3.22
Union	2005-2011	7	0.94	0.04	0.87	0.05	-0.08	0.1
United National	2001-2011	11	0.23	0.09	0.16	0.06	0.15	0.03
United Trust	1999-2011	13	0.13	0.09	0.1	0.02	1.44	0.01
Unity Trust	1991-2011	21	0.54	0.12	0.49	0.04	1.08	0.06
Universal BS	1992-2005	14	0.6	0.48	0.54	0.03	0.31	0.07
VTB Capital	2004-2011	8	4.91	1.53	1.67	0.65	15.32	0.54
Vernon BS	1993-2011	13	51.9	39.3	48.13	3.51	9.98	5.75
Weatherbys	1997-2011	15	0.23	0.07	0.2	0.02	0.83	0.03
Wesleyan	2001-2011	11	0.16	0.05	0.15	0.02	0.98	0.02
West Merchant	1988-1997	10	4.39	0.78	3.79	0.13	7.81	0.49
Woolwich BS	1988-1996	9	34.41	28.12	31.44	1.81	83.53	3.81
Yorkshire BS	1989-2011	23	25.51	16.76	21.5	1.17	12.8	2.83
Total		2327	9024.17	4977.99	6409.96	500.22	42418.32	100

Notes: This table presents an overview of all the UK financial intermediaries throughout our sample period. T.A, Gr. Ls, Dep., Eqt, L.L.P, Mar. Pr represent average values of Total Assets, Gross loans, Deposits, Equity, Loans and loss Provisions and Market Power (measured as each bank's share of the indrustry's total assets) respectively. 'B' stands for billions while 'M' for millions.

Table 2.b: Greece- Financial Intermediaries Analysis of characteristic banking indicators

name	Years	Num OBS	T.A (B)	Gr. Ls (B)	Dep. (B)	Eqt. (B)	L.L.P (M)	Mar. Pr (%)
Aegean Baltic	2003-2011	9	0.3	0.17	0.23	0.07	1.59	0.1
Agricultural (ATE)	1993-2011	19	22.86	16.02	20.41	1.16	154.05	7.8
Alpha	1993-2011	19	37.62	24.22	28.64	2.42	422.81	12.9
Attica	1993-2011	19	2.9	2.16	2.54	0.25	33.54	1
Bank of Athens	1993-1997	5	0.36	0.18	0.32	0.03	2.15	0.1
Bank of Central Greece	1993-1998	6	0.51	0.24	0.44	0.05	2.84	0.2
Bank of Crete (Cretabank)	1993-1998	6	1.24	0.62	1.13	0.07	6.38	0.4
Emporiki (Commercial)	1993-2011	19	21.58	14.61	17.91	1.19	313.21	7.4
Ergobank	1993-1999	7	4.21	1.6	3.53	0.34	18.21	1.4
Eurobank Ergasias	1993-2011	19	42.12	26.19	33.16	2.66	753.08	14.4
FBB First Business	2002-2011	10	1.76	1.39	1.59	0.15	27.33	0.6
General	1993-2011	19	3.5	2.71	3.13	0.19	103.4	1.2
Ionian and Popular	1993-1998	6	5.53	1.75	4.79	0.26	39.29	1.9
Laiki	1993-2005	13	1.62	1.04	1.47	0.12	16.96	0.6
Macedonia Thrace	1993-1999	7	1.53	0.62	1.32	0.14	12.58	0.5
Marfin	1993-2005	13	0.48	0.2	0.43	0.04	4.28	0.2
Marfin Egnatia	1993-2010	18	8.58	5.59	7.34	0.5	70.25	2.9
Millennium	2000-2011	12	5.7	4.24	4.7	0.33	31.51	1.9
National Bank of Greece (Ethiki)	1993-2011	19	68.15	35.19	58.65	4.02	465.16	23.3
National Mortgage Bank	1993-1997	5	7.09	3.53	5.63	0.22	8.3	2.4
Omega	2001-2004	4	0.76	0.45	0.67	0.08	2.7	0.3
PRObank	2001-2011	11	3.42	2.42	3.03	0.3	35.49	1.2
Pancretan Cooperative	2002-2011	10	1.74	1.42	1.49	0.19	0	0.6
Panellinia	2005-2011	7	1.04	0.78	0.91	0.11	12.34	0.4
Piraeus	1993-2011	19	25.57	17.15	20.84	1.42	332.39	8.8
Proton	2002-2010	9	1.92	0.98	1.59	0.28	19.76	0.7
T Bank	1993-2010	18	2.26	1.58	1.89	0.14	11.55	0.8
TELESIS Investment	1993-2000	8	0.35	0.14	0.25	0.08	1.53	0.1
TT Hellenic Postbank	1998-2011	14	16.51	5.78	14.72	1.32	37.74	5.7
Xiosbank	1993-1998	6	0.93	0.35	0.84	0.05	3.18	0.3
Total		356	292.12	173.29	243.58	18.16	2943.63	100

Notes: This table presents an overview of all the Greek financial intermediaries throughout our sample period. T.A, Gr. Ls, Dep., Eqt, L.L.P, Mar. Pr represent average values of Total Assets, Gross loans, Deposits, Equity, Loans and loss Provisions and Market Power (measured as each bank's share of the indrustry's total assets) respectively. 'B' stands for billions while 'M' for millions.

Table 3.a: UK - Descriptive Statistics of the variables of interest.

Variable		Mean	St. Dev	Percentiles	
				5th	95th
Kernel determinants					
Total Cost	tc	1147.161	174.709	804.612	1489.709
Price of borrowed funds	w1	0.126	0.019	0.089	0.163
Price of labor	w2	0.023	0.001	0.021	0.025
Price of physical capital	w3	6.36	0.744	4.901	7.82
Total loans	y1	26154.18	2781.631	20700.58	31607.78
Total earning assets	y2	21727.69	2127.914	17555.82	25899.56
Off-balance sheet items	y3	14404.49	1150.945	12147.57	16661.41
Equity	eq	2925.062	327.158	2283.656	3566.467
Inefficiency determinants					
Time	z1	14.375	0.092	14.194	14.556
Size	z2	48946.8	4949.264	39243.56	58650.03
Class determinants					
Capital adeqaucy	q1	0.157	0.003	0.15	0.163
Liquidity risk	q2	0.511	0.005	0.502	0.521
Credit risk	q3	0.946	0.264	0.427	1.464
Service concentration	q4	0.566	0.004	0.559	0.573
Profitability	q5	0.024	0.013	0.021	0.089

Notes: This table refers to 1,856 observations and 124 UK financial institutions between 1988-2011. The table reports descriptive statistics of the kernel, inefficiency and the class membership variables we use in the estimation of the latent class stochastic cost frontier model (apart from the dummy variable that represents the type of the financial institution, i.e. 'BS') as described in Figure 1.a. All monetary variables are deflated using 2005 as a base year. Kernel determinants consist of the dependent variable, i.e. total cost (tc), inputs prices (w), output quantities (q) and equity (eq) as a quasi-fixed input variable. Inefficiency determinants (z) consist of 'Time'= time-trend and 'Size' = bank's real assets. Finally the class ratio, determinants (q) consist of 'Capital adequacy' = equity to assets ratio, 'Liquidity risk' = loans to assets 'Credit risk'= loans loss provisions to total assets ratio and 'Service Concentration' = the sum of the squared ratios of the value of each output to the total value of outputs of each financial institution.

Table 3.b: Greece - Descriptive Statistics of the variables of interest.

Variable		Mean	St. Dev	Percentiles	
				5th	95th
Kernel determinants					
Total Cost	tc	392.932	38.422	317.365	468.499
Price of borrowed funds	w1	0.058	0.002	0.054	0.062
Price of labor	w2	0.017	0.0005	0.016	0.018
Price of physical capital	w3	1.549	0.303	0.952	2.146
Total loans	y1	6913.851	625.514	5683.612	8144.091
Total earning assets	y2	4248.469	369.007	3522.74	4974.198
Off-balance sheet items	y3	2899.264	384.447	2142.604	3655.925
Equity	eq	812.078	73.574	667.383	956.773
Inefficiency determinants					
Time	z1	9.938	0.291	9.366	10.51
Size	z2	14750.98	1378.103	12040.71	17461.25
Class determinants					
Capital adeqaucy	q1	0.1	0.005	0.09	0.11
Liquidity risk	q2	0.556	0.01	0.535	0.576
Credit risk	q3	0.127	0.036	0.056	0.197
Service concentration	q4	0.464	0.006	0.453	0.475
Profitability	q5	0.0016	0.0019	0.0022	0.0033

Notes: This table refers to 356 observations and 30 Greek financial institutions between 1993-2011. The table reports descriptive statistics of the kernel, inefficiency and the class membership variables we use in the estimation of the latent class stochastic cost frontier model (apart from the dummy variable that represents the onwership of the financial institution, i.e. 'OWNER') as described in Figure 1.b. All monetary variables are deflated using 2005 as a base year. Kernel determinants consist of the dependent variable, i.e. total cost (tc), inputs prices (w), output quantities (q) and equity (eq) as a quasi-fixed input variable. Inefficiency determinants (z) consist of 'Time'= time-trend and 'Size' = bank's real assets. Finally the class determinants (q) consist of 'Capital adequacy' = equity to assets ratio, 'Liquidity risk' = loans to assets ratio, 'Credit risk'= loans loss provisions to total assets ratio and 'Service Concentration' = the sum of the squared ratios of the value of each output to the total value of outputs of each financial institution.

Table 4.a: UK - Selection of the number of latent classes

	No. of classes	No. of banks	No. of Param.	Log-Likelihood	AIC	BIC
Pooled Model	1	124	12	-456.9226	0.50998	0.54598
Latent Class	2	73(1) 51(2)	28	-251.6265	0.30411	0.38811

Notes: This table features stochastic frontier model estimations for 1 and 2 latent classes using 1,856 observations and 124 UK financial institutions between 1988-2011. The preferred model is the one with the lowest AIC and BIC statistic.

Table 4.b: Greece - Selection of the number of latent classes

	No. of classes	No. of banks	No. of Param.	Log-Likelihood	AIC	BIC
Pooled Model	1	30	12	-4.211612	0.1247	0.28904
Latent Class	2	17(1) 13(2)	28	90.97407	-0.48442	-0.10096

Notes: This table features stochastic frontier model estimations for 1 and 2 latent classes using 356 observations and 30 Greek financial institutions between 1993-2011. The preferred model is the one with the lowest AIC and BIC statistic.

Table 5.a: UK - Average cost efficiency indexes with different number of classes

Year	SFM with one Latent class	SFM with two Latent classes
1988	0.48	0.68
1989	0.57	0.69
1990	0.49	0.68
1991	0.49	0.68
1992	0.58	0.67
1993	0.56	0.66
1994	0.58	0.65
1995	0.59	0.65
1996	0.61	0.66
1997	0.58	0.68
1998	0.61	0.7
1999	0.61	0.69
2000	0.58	0.66
2001	0.57	0.65
2002	0.57	0.64
2003	0.58	0.64
2004	0.61	0.65
2005	0.61	0.64
2006	0.61	0.64
2007	0.6	0.62
2008	0.6	0.62
2009	0.58	0.61
2010	0.56	0.59
2011	0.53	0.56
Total	0.57	0.65

Notes: This table reports the average cost efficiency scores for each year of the UK banking industry, which are obtained by estimating stochastic frontier models with one and two

Table 5.b: Greece - Average cost efficiency indexes with different number of classes

Year	SFM with one Latent class	SFM with two Latent classes
1993	0.63	0.69
1994	0.64	0.68
1995	0.66	0.69
1996	0.71	0.72
1997	0.68	0.76
1998	0.69	0.76
1999	0.67	0.73
2000	0.7	0.72
2001	0.71	0.73
2002	0.7	0.72
2003	0.7	0.71
2004	0.76	0.79
2005	0.73	0.82
2006	0.7	0.83
2007	0.72	0.86
2008	0.7	0.85
2009	0.69	0.84
2010	0.67	0.82
2011	0.64	0.79
Total	0.69	0.76

Notes: This table reports the average cost efficiency scores for each year of the Greek banking industry, which are obtained by estimating stochastic frontier models with one and two technological classes.

Table 6.a: UK - Average cost efficiency estimates

	Overall Sample		LCM			
			Class1		Class2	
Year	Mean	Obs.	Mean	Obs.	Mean	Obs.
1988	0.68	6	0.68	6	-	-
1989	0.69	29	0.73	22	0.48	7
1990	0.68	38	0.71	28	0.46	10
1991	0.68	42	0.7	31	0.49	11
1992	0.67	50	0.71	37	0.47	13
1993	0.66	52	0.69	38	0.48	14
1994	0.65	53	0.7	39	0.47	14
1995	0.65	62	0.69	42	0.5	20
1996	0.66	85	0.71	56	0.41	29
1997	0.68	89	0.67	58	0.43	31
1998	0.7	89	0.73	57	0.42	32
1999	0.69	90	0.72	55	0.42	35
2000	0.66	92	0.71	56	0.41	36
2001	0.65	96	0.73	59	0.34	37
2002	0.64	100	0.71	58	0.35	42
2003	0.64	103	0.71	59	0.39	44
2004	0.65	103	0.72	58	0.41	45
2005	0.64	104	0.71	58	0.4	46
2006	0.64	103	0.71	56	0.4	47
2007	0.62	99	0.7	57	0.37	42
2008	0.62	98	0.69	56	0.36	42
2009	0.61	97	0.68	55	0.34	42
2010	0.59	94	0.66	53	0.32	41
2011	0.56	82	0.63	50	0.3	32
Total	0.65	1856	0.7	1144	0.41	712

Notes: This table reports the average cost efficiency estimates for each year of the UK banking industry with respect to the number of financial institutions that belong to the first and to the second technological class.

Table 6.b: Greece - Average cost efficiency estimates

	Overall Sample		LCM			
			Class1		Class2	
Year	Mean	Obs.	Mean	Obs.	Mean	Obs.
1993	0.69	21	0.77	13	0.44	8
1994	0.68	21	0.76	13	0.46	8
1995	0.69	21	0.77	13	0.49	8
1996	0.72	21	0.78	13	0.56	8
1997	0.76	21	0.8	13	0.52	8
1998	0.76	20	0.78	12	0.59	8
1999	0.73	16	0.76	8	0.57	8
2000	0.72	15	0.78	7	0.63	8
2001	0.73	16	0.78	7	0.65	9
2002	0.72	19	0.8	8	0.63	11
2003	0.71	20	0.8	9	0.64	11
2004	0.79	20	0.85	9	0.75	11
2005	0.82	20	0.88	9	0.76	11
2006	0.83	18	0.9	9	0.79	9
2007	0.86	18	0.91	9	0.82	9
2008	0.85	18	0.89	9	0.81	9
2009	0.84	18	0.89	9	0.81	9
2010	0.82	18	0.86	9	0.79	9
2011	0.79	15	0.83	8	0.77	7
Total	0.76	356	0.82	187	0.66	169

Notes: This table reports the average cost efficiency estimates for each year of the Greek banking industry with respect to the number of financial institutions that belong to the first and to the second technological class.

Table 7.a: UK - Latent cost frontier, inefficiency, and class determinants estimates

Technology Class	1		2	
	Coefficient	b/St.Er.	Coefficient	b/St.Er.
Kernel determinants				
Constant	1.585	22.288	0.447	4.311
LNP1	0.059	7.732	0.07	2.495
LNP2	0.872	83.717	0.662	33.423
LNY1	0.482	33.109	0.292	8.623
LNY2	0.303	23.577	0.251	10.341
LNY3	-0.031	-4.045	-0.039	-2.141
LNEQ	0.183	9.549	0.32	4.681
Trend	-0.001	-0.647	0.013	2.036
Ineffficient determinants				
TIME	-0.056	-5.589	0.047	3.153
SIZE	0.225	8.473	0.165	3.056
BS	-0.884	-2.207	0.007	0.005
Class determinants				
CONSTANT	0.78	5.944	Control Group	
CAPITAL ADEQUACY	0.568	6.056	Control Group	
LIQUIDITY RISK	-0.736	4.694	Control Group	
CREDIT RISK	-0.263	-4.513	Control Group	
SERV_CON	-0.628	-3.637	Control Group	
PROFITABILTY	1.472	0.864	Control Group	
Sigma	0.181	4.837	0.388	5.876
Lambda	0.358	0.608	0.307	1.044
Number of observations	1144		712	
Prior class probabilities at data means	0.573		0.427	

Notes: The table feautures latent cost frontier, inefficiency, and class determinants estimates of 1856 observations for 124 UK financial institutions in the period 1988-2011. The estimation is conducted under a panel data nature methodology (Orea and Kumbhakar 2004) which allows the efficiency term to vary every year. Dependent variable is lnTC/lnW3. Log likelihood is -456.9226. Lamda (λ) and Sigma (σ) are efficient parameters, where λ (= σu/σv), the ratio of the standard deviation of efficiency over the standard deviation of the noise term, and σ (= σu+σv), the composite standard deviation. The variables are as described in Table 3.a.

Table 7.b: Greece - Latent cost frontier, inefficiency, and class determinants estimates

Technology Class	1		2	
	Coefficient	b/St.Er.	Coefficient	b/St.Er.
Kernel determinants				
Constant	0.933	5.502	0.346	10.479
LNP1	0.042	6.286	0.713	12.876
LNP2	0.852	18.514	1.026	10.808
LNY1	0.529	10.5	0.626	8.171
LNY2	0.352	7.214	0.292	2.597
LNY3	-0.017	-4.862	0.087	5.383
LNEQ	0.133	3.034	0.023	4.156
Trend	0.177	1.851	0.104	2.722
Ineffficient determinants				
TIME	-0.075	-3.244	-0.143	-3.969
SIZE	0.694	6.298	0.297	2.879
Owner	0.267	0.435	0.703	0.33
Class determinants				
CONSTANT	1.276	2.609	Control Group	
CAPITAL ADEQUACY	0.547	4.831	Control Group	
LIQUIDITY RISK	-0.947	-5.874	Control Group	
CREDIT RISK	-0.686	-3.039	Control Group	
SERV_CON	-0.097	-0.982	Control Group	
PROFITABILTY	0.001	0.222	Control Group	
Sigma	0.948	11.63	0.974	26.655
Lambda	0.118	0.422	0.24	0.402
Number of observations	187		169	
Prior class probabilities at data means	0.625		0.375	

Notes: The table feautures latent cost frontier, inefficiency, and class determinants estimates of 356 observations for 30 Greek financial institutions in the period 1993-2011. The estimation is conducted under a panel data nature methodology (Orea and Kumbhakar 2004) which allows the efficiency term to vary every year. Dependent variable is lnTC/lnW3. Log likelihood is 90.97407. Lamda (λ) and Sigma (σ) are efficient parameters, where λ (= σu/σv), the ratio of the standard deviation of efficiency over the standard deviation of the noise term, and σ (= σu+σv), the composite standard deviation. The variables are as described in Table 3.b.

Table 10.a: UK - "Pooled-Cross Section Data", Latent cost frontier and class determinants estimates

Technology Class	1		2	
	Coefficient	b/St.Er.	Coefficient	b/St.Er.
Kernel determinants				
Constant	1.782	24.642	0.732	5.249
LNP1	0.081	8.019	0.076	2.893
LNP2	0.928	92.761	0.676	23.884
LNY1	0.491	36.534	0.292	8.623
LNY2	0.303	23.577	0.428	15.093
LNY3	-0.035	-4.824	-0.063	-3.691
LNEQ	0.183	9.549	0.32	4.682
Trend	0.009	4.37	0.054	2.847
Class determinants				
CONSTANT	1.025	7.864	Control Group	
CAPITAL ADEQUACY	0.894	8.186	Control Group	
LIQUIDITY RISK	-0.942	5.138	Control Group	
CREDIT RISK	-0.648	-4.975	Control Group	
SERV_CON	-0.849	-4.013	Control Group	
PROFITABILTY	1.188	3.046	Control Group	
Sigma	0.236	7.317	0.658	11.914
Lambda	0.748	0.964	0.483	1.204
Number of observations	1144		712	
Prior class probabilities at data means	0.573		0.427	

Notes: The tablepresents latent cost frontier, inefficiency, and class determinants estimates of 1856 observations for 124 UK financial institutions in the period 1988-2011. The estimation is conducted under a pooled cross-section methodology (Bos et al. 2010) which permits each financial institution to switch between technology regimes over time. Dependent variable is lnTC/lnW3. Log likelihood is -431.6557. Lamda (λ) and Sigma (σ) are efficient parameters, where λ (= σu/σv), the ratio of the standard deviation of efficiency over the standard deviation of the noise term, and σ (= σu+σv), the composite standard deviation. The variables are as described in Table 3.a.

Table 10.b: Greece - "Pooled-Cross Section Data", Latent cost frontier and class determinants estimates

Technology Class	1		2	
	Coefficient	b/St.Er.	Coefficient	b/St.Er.
Kernel determinants				
Constant	1.024	5.749	0.412	11.723
LNP1	0.051	6.476	0.787	13.244
LNP2	0.938	19.247	1.122	11.625
LNY1	0.604	11.264	0.714	8.668
LNY2	0.378	7.461	0.313	2.934
LNY3	-0.019	-4.903	0.091	5.427
LNEQ	0.144	3.854	0.051	4.764
Trend	0.204	2.314	0.187	2.876
Class determinants				
CONSTANT	1.258	2.897	Control Group	
CAPITAL ADEQUACY	0.639	4.924	Control Group	
LIQUIDITY RISK	-1.014	-6.013	Control Group	
CREDIT RISK	-0.816	-3.944	Control Group	
SERV_CON	-0.849	-2.975	Control Group	
PROFITABILTY	0.758	2.496	Control Group	
Sigma	0.988	13.47	1.013	27.486
Lambda	0.247	0.549	0.285	0.501
Number of observations	187		169	
Prior class probabilities at data means	0.642		0.358	

Notes: The tablepresents latent cost frontier, inefficiency, and class determinants estimates of 356 observations for 30 Greek financial institutions in the period 1993-2011. The estimation is conducted under a pooled cross-section methodology (Bos et al. 2010) which permits each financial institution to switch between technology regimes over time. Dependent variable is lnTC/lnW3. Log likelihood is 98.4726. Lamda (λ) and Sigma (σ) are efficient parameters, where λ (= σu/σv), the ratio of the standard deviation of efficiency over the standard deviation of the noise term, and σ (= σu+σv), the composite standard deviation. The variables are as described in Table 3.b.

Table 11.a: UK - Classification of banks before the financial crisis

	Latent Class 1				Latent Class 2		
	name	Years	Num OBS		name	Years	Num OBS
_1	ABC Int.	1996-2006	11	_1	AIB Group	1995-2006	12
_2	AIB Bank	1992-2006	15	_2	Abbey Nat.	1990-2006	17
_3	Adam & Company	1989-2006	18	_3	Alliance & Leic. Bank	1995-2006	12
_4	Ahli United	1989-2006	18	_4	Alpha Bank	1989-2006	18
_5	Alliance & Leic. Plc	1996-2006	11	_5	Anglo-Romanian	1989-2006	18
_6	Arbuthnot	1991-2006	16	_6	Bank Leumi	1996-2006	11
_7	Bank of Cyprus	1997-2003	7	_7	Bank Mandiri	1999-2006	8
_8	Bank of Tokyo	1988-1996	9	_8	Bank Saderat	1996-2006	11
_9	Barclays Bank	1992-2006	15	_9	Bank of Beirut	2002-2006	5
_10	Barclays Priv. & Tr.	2002-2005	4	_10	Bank of N.Y. Mellon	1997-2006	10
_11	Bath BS Sav. & Inv.	1995-2006	12	_11	Barclays Priv. Clien.	2002-2006	5
_12	Beneficial Bank	1988-1998	11	_12	British Arab	1989-2006	18
_13	Britannia BS	1989-2006	18	_13	Butterfield Holdings	1992-2006	15
_14	Buckinghamshire BS	2003-2006	4	_14	Cuscatlan Bank and Trust	2002-2006	5
_15	Butterfield Guernsey	1996-2006	11	_15	DB UK	1996-2006	11
_16	Cambridge BS	1996-2006	11	_16	Dunbar	1995-2006	12
_17	Cheshire BS	1990-2006	17	_17	Egg	1996-2006	11
_18	Co-operative	1990-2006	17	_18	FBN	2003-2006	4
_19	Coventry BS	1989-2006	18	_19	Fairbairn	1998-2006	9
_20	Credit Suisse	1997-2006	10	_20	Finsbury Pavement	1991-2006	16
_21	Darlington BS	1996-2006	11	_21	Gresham Trust	1993-2000	8
_22	Dexia Municipal	1992-1999	8	_22	Halifax	1996-2006	11
_23	Dunfermline BS	1992-2006	15	_23	Heritable	1989-2006	18
_24	FIBI	1996-2006	11	_24	ICBC	2003-2006	4
_25	HSBC Middle East	1989-2006	18	_25	JP Morgan	1996-2006	11
_26	HSBC	1989-2006	18	_26	Jordan Int.	1996-2006	11
_27	Habib Allied	2001-2006	6	_27	KDB Bank	1992-1998	7
_28	Habibsons	1996-2006	11	_28	Kookmin	1995-2006	12
_29	Isle of Man Bank Limited	1995-2006	12	_29	Lazard & Co Holdings	1999-2006	8
_30	Italian Int.	1988-1997	10	_30	London Int.	2001-2006	6
_31	Kaupthing Singer & Friedlander	1989-2006	18	_31	Morgan Stanley	2001-2006	6
_32	Leeds BS	1989-2006	18	_32	PNB	1997-2006	10
_33	Lloyds (BLSA)	1992-2001	10	_33	Progressive BS	1996-2006	11
_34	Lloyds	1988-1998	11	_34	Riggs	1989-2004	16
_35	Lloyds TSB	1998-2006	9	_35	Sainsbury's	2002-2006	5
_36	Lloyds TSB Scotland	1989-2006	17	_37	United Trust	1999-2006	8
_37	London Trust	1991-1998	8	_38	VTB Capital	2004-2006	3
_38	Manchester BS	1990-2006	17	_39	**Ghana**	1998-2006	9
_39	Marsden BS	1996-2006	11	_40	**Riyad**	1993-1997	5
_40	Melli	2001-2006	6	_41	**United National**	2001-2006	6
_41	Melton Mowbray BS	1996-2006	11				
_42	Merrill Lynch	1990-2005	16				
_43	National Bank of Kuwait	1996-2006	11				
_44	National Counties BS	1996-2006	11				
_45	National Westminster	1989-2006	17				
_46	Nationwide BS	1990-2006	17				
_47	Newcastle BS	1989-2006	18				
_48	Nottingham BS	1992-2006	15				
_49	Principality BS	1989-2006	18				
_50	Prudential-Bache	1996-2001	6				

(Continued)

Table 11.a: UK - Classification of banks before the financial crisis (Continued)

	Latent Class 1			Latent Class 2		
	name	Years	Num OBS	name	Years	Num OBS
_51	Royal Bank of Scotland Int.	1996-2006	11			
_52	Royal Bank of Scotland	1995-2006	12			
_53	Santander	1989-2006	18			
_54	Schroders	1989-2006	18			
_55	Secure Trust	1999-2006	8			
_56	Skipton BS	1989-2006	18			
_57	Standard	2000-2006	7			
_58	Standard Chartered	1998-2006	9			
_59	Standard Chartered Plc	1990-2006	17			
_60	Stroud & Swindon BS	1994-2006	13			
_61	Swansea BS	1996-2006	11			
_62	TSB	1988-1997	10			
_63	Turkish	1996-2006	11			
_64	Unity Trust	1991-2006	16			
_65	Weatherbys	1997-2006	10			
_66	West Merchant	1988-1997	10			
_67	Yorkshire BS	1989-2006	18			
_68	**Bank of Scotland**	1990-2006	17			
_69	**Bradford & Bingley Bank**	1999-2006	8			
_70	**Capital One**	2002-2006	5			
_71	**Chelsea BS**	1990-2006	17			
_72	**Citibank**	1989-2006	18			
_73	**HBOS**	2000-2006	7			
_74	**MBNA Europe Bank**	1995-2006	12			
_75	**Northern**	1995-2006	12			
_76	**Northern Rock**	1996-2006	11			
_77	**Ulster**	1989-2006	18			
	Total		980			403

Notes: This table reports the classification of 118 UK financial institutions for the period 1988-2006 (i.e. before the financial crisis) into the two latent technological classes according to the regime membership determinants desribed in Table 3.a. Those financial insitutions that change class (compared with their previous classification where the sample was up to 2011 as diplayed in table 9.a) are labeled with a bold font.

Table 11.b: Greece - Classification of banks before the financial crisis

	Latent Class 1				Latent Class 2		
	name	Years	Num OBS		name	Years	Num OBS
_1	Aegean Baltic	2003-2006	4	_1	Agricultural (ATE)	1993-2006	14
_2	Alpha	1993-2006	14	_2	Attica	1993-2006	14
_3	Bank of Athens	1993-1997	5	_3	Emporiki (Commercial)	1993-2006	14
_4	Bank of Central Greece	1993-1998	6	_4	FBB First Business	2002-2006	5
_5	Bank of Crete (Cretabank)	1993-1998	6	_5	General	1993-2006	14
_6	Ergobank	1993-1999	7	_6	Laiki	1993-2005	13
_7	Eurobank Ergasias	1993-2006	14	_7	Macedonia Thrace	1993-1999	7
_8	Ionian and Popular	1993-1998	6	_8	Marfin	1993-2005	13
_9	National Bank of Greece (Ethiki)	1993-2006	14	_9	Marfin Egnatia	1993-2006	14
_10	National Mortgage Bank	1993-1997	5	_10	Omega	2001-2004	4
_11	PRObank	2001-2006	6	_11	Proton	2002-2006	5
_12	Pancretan Cooperative	2002-2006	5				
_13	Piraeus	1993-2006	14				
_14	T Bank	1993-2006	14				
_15	TELESIS Investment	1993-2000	8				
_16	TT Hellenic Postbank	1998-2006	9				
_17	Xiosbank	1993-1998	6				
_18	**Millennium**	2000-2006	7				
	Total		150				117

Notes: This table reports the classification of 29 Greek financial institutions for the period 1993-2006 (i.e. before the financial crisis) into the two latent technological classes according to the regime membership determinants desribed in Table 3.b. Those financial insitutions that change class (compared with their previous classification where the sample was up to 2011 as diplayed in table 9.b) are labeled with a bold font.

Table 12: GREECE - M&As, Recapitalisation & Structure of the banking sector

Systemic Banks	*HFSF CAPITAL ENHANCEMENT* (in millios of Euro in the end of 2013)	*M&As*	*Year of the M&A activity*
ALPHA BANK	4571	EMPORIKI	2012
EUROBANK	5839	NEW PROTON BANK, NEW TT-HELLENIC POSTBANK	2013 (Both financial institutions)
ETHNIKI BANK	8400	FBB, PROBANK	2013 (Both financial institutions)
PIRAEUS BANK	9756	ATE BANK, GENIKI BANK, MARFIN_EGNATIA, MILLENIUM	a. 2012 : ATE BANK and GENIKI Bank
			b. 2013: MARFIN- EGNATIA and MILLENIUM
Remaining Banks		*Type*	
ATTICA		Commercial	
AEGEAN		Commercial	
PANELLINIA		Commercial created by Co-operatives banks	
PANCRETAN		Co-operative	

Notes: This table reports detailed information about the recent wave of M&As where the 'big-four' of the Greek banking sector, i.e. ALPHA BANK, EUROBANK, ETHNIKI BANK and PIRAEUS BANK, were involved and resulted to the creation of the four 'systemic' banks. The table cites as well the total level of capital that the Hellenic Financial Stability Fund (HFSF) has injected in the four aforementioned systemic banks till the end of 2013, in order to facilitate both their soundness and 'the procedure of the consolidation activity that they were involved. Additionally, the table ' presents the financial intermediaries 'and their business model that constitute the current structure of the Greek banking sector. As far as "ATE BANK, 'NEW PROTON BANK, NEW TT-HELLENIC POSTBANK, FBB and PROBANK" are concerned, only the 'healthy' part of assets and liabilities of those financial institutions was acquired. It should be noted that PIRAEUS BANK acquired in 2013 'CYPRUS BANK' and 'HELLENIC BANK' as well, 'however due to unavailability of data we do not include these two cases. 'ETHNIKI' stands for the 'NATIONAL BANK OF GREECE' while 'MARFIN_EGNATIA' stands for 'CYPRUS POPULAR BANK '(LAIKI BANK)'. 'Finally, there are a few more 'Co-operative' type banks which we do not quote them as their aggregate market share is less than 2% in assets, deposits and loans of the whole banking sector.

Table 13: UK - 20 Largest banks in both regimes in the end of 2011

	Class 1		Class 2
_1	Barclays Bank	_1	Alpha Bank
_2	Co-operative	_2	The Access
_3	HSBC	_3	Bank of Beirut
_4	Habib Allied	_4	Citibank
_5	Lloyds TSB (*)	_5	DB UK
_6	Nationwide BS	_6	Europe Arab
_7	Royal Bank of Scotland (*)	_7	Bank Leumi
_8	Santander	_8	Bank of N.Y. Mellon
_9	Standard Chartered	_9	Progressive BS
		_10	Sainsbury's
		_11	Union

Notes: This table presents the classification among the two different techonlogical latent classes of the 20 largest UK financial institutions that were used in the analysis of the prospective M&As scenarios. Specifically, all potential consolidation activities consist of combinations of financial intermediaries that belong either in different technological regimes, or in the second (i.e. less efficient) latent class.

(*) The UK government during the financial crisis in 2007-2009 injected 20 and 45 Billion pounds (GB) in capital to Lloyds TSB and Royal Bank of Scotland respectively to support their soudness.

Table 14.a: UK - Hypothetical M&As Scenarios

	Panel A: Potential M&As among banks in the ***2nd class***	Class	dif[TC*CostInef] - **Pre Crisis** (M)	dif[TC*CostInef] - **Post Crisis** (M)
_1	ALPHA-ACCESS	2	-296.24	-314.48
_2	ALPHA-BEIRUT	1	195.52	228.1
_3	ALPHA-CITIBANK	1	340.15	394.27
_4	ALPHA-DBUKBANK	2	163.36	-217.85
_5	ALPHA-EUROPEARAB	2	242.72	-335.62
_6	ALPHA-LEUMI	1	181.22	137.5
_7	ALPHA-BAN OF NEW YORK	2	108.24	-134.19
_8	ALPHA-PROGRESSIVE	1	157.51	-119.19
_9	ALPHA-SAINSBURY'S	2	-114.49	-151.79
_10	ALPHA-UNION	2	-184.32	-207.91
_11	LEUMI-ACCESS	2	-124.99	-177.48
_12	LEUMI-BEIRUT	1	164.23	117.17
_13	LEUMI-CITIBANK	1	296.45	354.16
_14	LEUMI-DBUKBANK	2	-157.68	-185.95
_15	LEUMI-EUROPE	2	191.07	-343.14
_16	LEUMI-NEW_YORK	2	165.19	-243.06
_17	LEUMI-PROGRESSIVE	1	124.95	218.51
_18	LEUMI-SAINSBURY'S	2	-137.2	-361.59
_19	LEUMI-UNION	2	-119.85	-177.56
_20	BEIRUT-ACCESS	1	-269.2	267.11
_21	BEIRUT-CITIBANKJ	1	349.91	404.02
_22	BEIRUT-DBUKBANK	2	162.04	-222.65
_23	BEIRUT-EUROPEARAB	2	224.32	-231.3
_24	BEIRUT-NEWYORK	2	185.9	-231.19
_25	BEIRUT-PROGRESSIVE	1	205.25	197.26
_26	BEIRUT-SAINSBURY'S	2	-117.64	-242.94
_27	BEIRUT-UNION	2	-347.62	-245.93
_28	NEW_YORK-ACCESS	2	-293.16	-434.73
_29	NEW_YORK-CITIBANK	2	394.62	-505.53
_30	NEW_YORK-DBUKBANK	2	185.71	-454.96
_31	NEW_YORK-EUROPE	2	188.97	-456.52
_32	NEW_YORK-PROGRESSIVE	2	172.17	-438.88
_33	NEW_YORK-SAIBURY'S	2	-219.46	-476.58
_34	NEW_YORK-UNION	2	-138.41	-436.95
_35	CITIBANK-ACCESS	2	-348.75	-409.38
_36	CITIBANK-DBUKBANK	2	295.78	-353.56
_37	CITIBANK-EUROPEARAB	2	371.53	-430.37
_38	CITIBANK-PROGRESSIVE	1	210.5	262.47
_39	CITIBANK-SAINBURY'S	1	462.35	554.62
_40	CITIBANK-UNION	2	-353.45	-412.97
_41	DBUKBANK-EUROPEARAB	2	138.76	-253.74
_42	DBUKBANK-PROGRESSIVE	1	120.19	231.6
_43	DBUKBANK-SAINSBURY'S	2	-139.3	-174.14
_44	DBUKBANK-ACCESS	2	-109.46	-208.51
_45	DBUKBANK-UNION	2	-120.95	-247.25
_46	EUROPE-PROGRESSIVE	1	126.38	139.84
_47	EUROPE-SAINSBURY'S	2	-148.65	-177.22
_48	EUROPE-ACCESS	2	-123.48	-136.01
_49	EUROPE-UNION	2	-129.46	-137.03
_50	PROGRESSIVE-ACCESS	2	-88.65	-114.89

(continued)

Table 14.a: UK - Hypothetical M&As Scenarios (Continued)

	Panel A: Potential M&As among banks in the ***2nd class***	Class	dif[TC*CostInef] - **Pre Crisis** (M)	dif[TC*CostInef] - **Post Crisis** (M)
_51	PROGRESSIVE-SAINSBURY'S	2	-115.67	-157.14
_52	PROGRESSIVE-UNION	1	-92.06	-115
_53	SAINSBURY'S -ACCESS	2	-127.62	-154.11
_54	SAINSBURY'S -UNION	2	-139.65	-154.59
_55	ACCESS-UNION	2	-74.66	-111.71

	Panel B: Potential M&As among banks in ***both classes***	Class	dif[TC*CostInef] - **Pre Crisis** (M)	dif[TC*CostInef] - **Post Crisis** (M)
_1	BARCLAYS-ACCESS	2	-1426.5	-2278.41
_2	BARCLAYS-ALPHA	1	4654.62	9339.09
_3	BARCLAYS-LEUMI	1	4410.91	9968.47
_4	BARCLAYS-BEIRUT	1	4588.26	9241.86
_5	BARCLAYS-CITIBANK	2	-1604.96	-2765.78
_6	BARCLAYS-DBUKBANK	2	4846.46	-9695.83
_7	BARCLAYS-EUROEPARAB	1	4521	8931.76
_8	BARCLAYS-NEWYORK	2	4622.29	-9177.2
_9	BARCLAYS-PROGRESSIVE	1	4355.07	8835.41
_10	BARCLAYS-SAINSBURY'S	1	4297.16	9390.19
_11	BARCLAYS-UNION	2	-4387.14	-17697.3
_12	CO-OPERATIVE-ACCESS	2	-210.49	-456.09
_13	CO-OPERATIVE-ALPHA	1	309.18	451.7
_14	CO-OPRATIVE-BEIRUT	1	318.17	447.87
_15	CO-OPERATIVE-CITIBANK	2	-589.16	-850.71
_16	CO-OPERATIVE-DBUKBANK	2	-241.26	-476.8
_17	CO-OPERATIVE-EUROPEARAB	2	-229.15	-472.81
_18	CO-OPERATIVE-LEUMI	1	337.06	461.73
_19	CO-OPERATIVE-NEW_YORK	2	-406.26	-575.04
_20	CO-OPERATIVE-PROGRESSIVE	2	-223.72	-455.81
_21	CO-OPERATIVE-SAINBURY'S	2	-349.06	-599.33
_22	CO-OPERATIVE-UNION	2	-281.05	-452.99
_23	HABIB-ALPHA	1	36.66	54
_24	HABIB-BEIRUT	1	21.69	34.78
_25	HABIB-LEUMI	1	84.1	15.02
_26	HABIB-ACCESS	2	-61.95	-90.79
_27	HABIB-CITIBANK	2	-170.61	-139.46
_28	HABIB-DBUKBANK	2	17.83	-25.2
_29	HABIB-EUROPE	2	24.78	-34.64
_30	HABIB-NEW_YORK	2	71.09	-134.82
_31	HABIB-PROGRESSIVE	1	59.19	12.01
_32	HABIB-SAINSBURY'S	2	-89.27	-149.8
_33	HABIB-UNION	2	-61.56	-90.98
_34	HSBC-ACCESS	2	-2754.56	-4166.57
_35	HSBC-ALPHA	1	3903.56	7287.22
_36	HSBC-BEIRUT	1	3852.11	7223.32
_37	HSBC-CITIBANK	1	3925.25	7221.89
_38	HSBC-DBUKBANK	2	4057.69	-4516.08
_39	HSBC-EUROPE	2	3820.38	-4104.65
_40	HSBC-LEUMI	1	3907.91	7305.28
_41	HSBC-NEW_YORK	2	3975.68	-5382.91
_42	HSBC-PROGRESSIVE	1	873.71	7284.19
_43	HSBC-SAINSBURY'S	1	3904.56	7358.25
_44	HSBC-UNION	2	-3894.17	-4189.95

Table 14.a: UK - Hypothetical M&As Scenarios (Continued)

	*Panel B: Potential M&As among banks in **both classes***	Class	dif[TC*CostInef] - **Pre Crisis** (M)	dif[TC*CostInef] - **Post Crisis** (M)
_44	HSBC-UNION	2	-3894.17	-4189.95
_45	LlOYDS-ACCESS	2	-4802.56	-6296.5
_46	LlOYDS-ALPHA	1	5024.22	1834.3
_47	LlOYDS-BEIRUT	1	4995.63	1736.95
_48	LlOYDS-CITIBANK	2	4959.47	-6827.55
_49	LlOYDS-DBUKBANK	2	5092.21	-6907.95
_50	LlOYDS-EUROPE	2	4870.25	-6944.92
_51	LlOYDS-LEUMI	2	4929.48	-6408.41
_52	LlOYDS-NEW_YORK	2	4949.44	-6392.38
_53	LlOYDS-PROGRESSIVE	2	4855.67	-6128.18
_54	LlOYDS-SAINSBURY'S	2	-2825.17	-6517.86
_55	LlOYDS-UNION	2	-1719.06	-6582.57
_56	NATIONWIDE-ACCESS	2	-420.9	-872.27
_57	NATIONWIDE-ALPHA	1	555.71	947.9
_58	NATIONWIDE-BEIRUT	1	503.36	868.58
_59	NATIONWIDE-CITIBANK	1	816.06	1257.86
_60	NATIONWIDE-DBUKBANK	2	628.03	-1056.14
_61	NATIONWIDE-EUROPE	1	770.5	1268.99
_62	NATIONWIDE-LEUMI	1	625.32	1055.29
_63	NATIONWIDE-NEW YORK	1	815.28	1368.67
_64	NATIONWIDE-PROGRESSIVE	1	621.33	1050.01
_65	NATIONWIDE-SAINSBURY'S	1	702.59	1256.84
_66	NATIONWIDE-UNION	1	527.65	1092.6
_67	RBS-ACCESS	2	-8432.48	-7921.57
_68	RBS-ALPHA	2	2878.1	-7388.76
_69	RBS-BEIRUT	1	2847.86	1765.73
_70	RBS-CITIBANK	2	514.63	-6476.14
_71	RBS-DBUKBANK	2	-2168.71	-7389.31
_72	RBS-EUROPE	2	-2379.19	-6816.68
_73	RBS-LEUMI	1	2879.84	1421.2
_74	RBS-NEW_YORK	2	2745.87	-6976.79
_75	RBS-PROGRESSIVE	1	2672.64	1967.75
_76	RBS-SAINSBURY'S	2	-1716.27	-7151.32
_77	RBS-UNION	2	-1268.37	-7314.78
_78	SANTANDER-ACCESS	2	-618.56	-2001.99
_79	SANTANDER-ALPHA	1	533.48	601.75
_80	SANTANDER-BEIRUT	1	1313.38	1999.53
_81	SANTANDER-CITIBANK	2	-733.9	-782.01
_82	SANTANDER-DBUKBANK	2	1285.36	-1973.6
_83	SANTANDER-EUROPE	2	1339.35	-2014.58
_84	SANTANDER-LEUMI	1	1161.8	1794.1
_85	SANTANDER-NEW_YORK	2	1262.84	-1959.15
_86	SANTANDER-PROGRESSIVE	2	1155.13	-1784.74
_87	SANTANDER-SAINSBURY'S	2	-1272.17	-2159.51
_88	SANTANDER-UNION	2	-859.35	-2010.11
_89	STANDARD-ACCESS	2	-1269.3	-6497.3
_90	STANDARD-ALPHA	1	1406.69	1594.5
_91	STANDARD-BEIRUT	1	1396.94	1579.45
_92	STANDARD-CITIBANK	2	1325.61	-2988.39
_93	STANDARD-DBUKBANK	2	1452.9	-2708.24
_94	STANDARD-EUROPE	2	1385.06	-2441.2
_95	STANDARD-LEUMI	2	1281.66	-2304.23

(continued)

Table 14.a: UK - Hypothetical M&As Scenarios (Continued)

	*Panel B: Potential M&As among banks in **both classes***	Class	dif[TC*CostInef] - **Pre Crisis** (M)	dif[TC*CostInef] - **Post Crisis** (M)
_96	STANDARD-NEW_YORK	2	1459.35	-2651.65
_97	STANDARD-PROGRESSIVE	1	1270.46	1263.78
_98	STANDARD-SAINSBURY'S	1	1462.72	1693.62
_99	STANDARD-UNION	2	-1346.16	-2583.71

*Notes: This table reports all the prospective scenarios of M&As among 20 UK financial institutions and the classification of the 'new' financial entity into the two latent technological classes according to the regime membership determinants described in Table 3.a. Specifically, we select the nine most important financial intermediaries in terms of assets, deposits and loans that belong to the most efficient technological regime (i.e. the first one) and the eleven most important from the second technologically and less efficient class after we ensure that each of these latter twenty banks is not a subsidiary of the remaining nineteen. The first column presents all possible combinations of consolidation between those financial institutions that belong to different technological class, while the second column reposts all possible combinations of consolidation between those financial institutions that belong to the second and less efficient technological regime. 'difTotal Cost * Cost Ineff' measures the difference of the total cost associated with the level of cost inefficiency between the individuals ones (A+B) and the prospective financial institution (AB) and indicates prospective gains (positive sign) or losses (negative sign) in real money values (£) resulting from each hypothetical M&A that is quoted for both the 'pre' crisis and the 'post' crisis period. 'M' stands for million.*

Table 14.b: Greece - Hypothetical M&As Scenarios

	RECENT - M&As	CLASS	dif[TC*CostInef] - **Pre Crisis** (M)	dif[TC*CostInef] - **Post Crisis** (M)	*HFSF*
_1	ALPHA-EMPORIKI	1	108.43	211.79	-
_2	EUROBANK-PROTON-TT_HELLENIC	2	-107.54	-144.85	-
_3	ETHNIKI-FFB-PROBANK	1	108.49	242.38	-
_4	PIRAEUS-ATE-GENIKI-MARFIN_EGNATIA-MILLENIUM	2	-161.53	-204.04	-
			0	0	
			0	0	
	RECENT (POTENTIAL) - M&As		0	0	
_1	EUROBANK-PROTON	2	-58.54	-94.01	50.84
_2	EUROBANK-TT_HELLENIC	1	71.72	105.3	250.15
_3	ETHNIKI-FBB	1	74.06	132.82	-109.56
_4	ETHNIKI-PROBANK	1	59.6	104.74	-137.64
_5	PIRAEUS-ATE	2	-82.44	-129.36	74.68
_6	PIRAEUS-MARFIN_EGNATIA	1	41.96	82.21	286.25
_7	PIRAEUS-MILLENIUM	1	20.45	47.82	251.86
_8	PIRAEUS-GENIKI	2	-41.17	-77.58	126.46
_9	PIRAEUS-ATE-GENIKI	2	-92.45	-119.37	84.67
_10	PIRAEUS-MILLENIUM-GENIKI	2	-23.44	-74.58	129.46
_11	PIRAEUS-MARFIN_EGNATIA-GENIKI	2	-61.21	-82.35	121.69
_12	PIRAEUS-MILLENIUM-MARFIN_EGANTIA	1	70.69	5.04	209.08
_13	PIRAEUS-MILLENIUM-ATE	2	-82.85	-113.03	91.01
_14	PIRAEUS-MARFIN_EGANTIA-ATE	2	-50.98	-118.49	85.55
_15	PIRAEUS-ATE-GENIKI-MARFIN_EGANTIA	2	-71.74	-121.39	82.65
_16	PIRAEUS-ATE-GENIKI-MILLENIUM	2	-86.61	-97.49	106.55
_17	PIRAEUS-GENIKI-MILLENIUM-MARFIN_EGNATIA	2	-71.09	-104.13	99.91

	POTENTIAL - M&As	CLASS	dif[TC*CostInef] - **Pre Crisis** (M)	dif[TC*CostInef] - **Post Crisis** (M)	*HFSF*
_1	ALPHA-ATTICA	1	35.55	72.58	-139.21
_2	ALPHA-AEGEAN	1	37.37	81.96	-129.83
_3	ALPHA-PANELLINIA	1	23.29	46.87	-164.92
_4	ALPHA-PANCRETAN	1	27.71	41.83	-169.96
_5	ALPHA-EMPORIKI-ATTICA	2	-54.89	-111.34	-323.13
_6	ALPHA-EMPORIKI-AEGEAN	2	104.42	-85.84	-297.63
_7	ALPHA-EMPORIKI-PANELLINIA	1	118.27	178.9	-32.89
_8	ALPHA-EMPORIKI-PANCRETAN	1	112.89	232.5	20.71
_9	ALPHA-EMPORIKI-ATTICA-AEGEAN	2	111.74	-84.66	-296.45
_10	ALPHA-EMPORIKI-ATTICA-PANELLINIA	2	150.34	-131.11	-342.9
_11	ALPHA-EMPORIKI-ATTICA-PANCRETAN	2	185.59	-142.24	-354.03
_12	ALPHA-EMPORIKI-AEGEAN-PANNELINIA	1	194.83	287.79	76
_13	ALPHA-EMPORIKI-AEGEAN-PANCRETAN	1	174.53	292.63	80.84
_14	ALPHA-EMPORIKI-PANELLINIA-PANCRETAN	2	121.23	-160.09	-371.88
_15	ALPHA-EMPORIKI-ATTICA-AEGEAN-PANELLINIA	2	200.15	-185.73	-397.52
_16	ALPHA-EMPORIKI-ATTICA-AEGEAN-PANCRETAN	2	240.67	-205.74	-417.53
_17	ALPHA-EMPORIKI-ATTICA-PANELLINIA-PANCRETAN	2	236.75	-144.27	-356.06
_18	ALPHA-EMPORIKI-AEGEAN-PANELLINIA-PANCRETAN	2	-143.72	-219.55	-431.34
_19	ALPHA-EMPORIKI-ATTICA-AEGEAN-PANELLINIA-PANCRETAN	2	-162.92	-254.55	-466.34
_20	EUROBANK-ATTICA	1	63.94	110.72	255.57
_21	EUROBANK-AEGEAN	1	26.82	106.04	250.89
_22	EUROBANK-PANELLINIA	1	35.97	94.15	239
_23	EUROBANK-PANCRETAN	1	34.84	85.35	230.2

(continued)

Table 14.b: Greece - Hypothetical M&As Scenarios (Continued)

	POTENTIAL - M&As	CLASS	dif[TC*CostInef] - **Pre Crisis** (M)	dif[TC*CostInef] - **Post Crisis** (M)	*HFSF*
_24	EUROBANK-PROTON-TT_HELLENIC-ATTICA	2	-108.44	-184.7	-39.85
_25	EUROBANK-PROTON-TT_HELLENIC-AEGEAN	2	-84.63	-133.83	11.02
_26	EUROBANK-PROTON-TT_HELLENIC-PANELLINIA	2	-88.26	-149.05	-4.2
_27	EUROBANK-PROTON-TT_HELLENIC-PANCRETAN	1	69.06	112.87	257.72
_28	EUROBANK-PROTON-TT_HELLENIC-ATTICA-AEGEAN	2	-56.42	-234.85	-90
_29	EUROBANK-PROTON_TT-HELLENIC-ATTICA-PANELLINIA	2	-79.48	-263.97	-119.12
_30	EUROBANK-PROTON-TT_HELLENIC-ATTICA-PANCRETAN	2	-62.81	-216.79	-71.94
_31	EUROBANK-PROTON-TT_HELLENIC-AEGEAN-PANELLINIA	2	-97.94	-253.69	-108.84
_32	EUROBANK-PROTON-TT_HELLENIC-AEGEAN-PANCRETAN	2	-79.51	-246.95	-102.1
_33	EUROBANK-PROTON_TT-HELLENIC-PANELLINIA-PANCRETAN	2	-87.02	-278.79	-133.94
_34	EUROBANK-PROTON-TT_HELLENIC-ATTICA-AEGEAN-PANELLINIA	2	-40.17	-152.68	-7.83
_35	EUROBANK-PROTON-TT_HELLENIC-ATTICA-AEGEAN-PANCRETAN	2	-35.52	-123.59	21.26
_36	EUROBANK-PROTON-TT_HELLENIC-ATTICA-PANELLINIA-PANCRETAN	2	-52.37	-160.04	-15.19
_37	EUROBANK-PROTON-TT_HELLENIC-AEGEAN-PANELLINIA-PANCRETAN	2	-49.19	-187.46	-42.61
_38	EUROBANK-PROTON-TT_HELLENIC-ATTICA-AEGEAN-PANELLINIA-PANCRETAN	*2*	-88.82	-219.8	-74.95
_39	ETHNIKI-ATTICA	1	64.22	187.96	-54.42
_40	ETHNIKI-AEGEAN	1	52.65	163.18	-79.2
_41	ETHNIKI-PANELLINIA	1	37.71	132.2	-110.18
_42	ETHNIKI-PANCREATAN	1	29.99	102.7	-139.68
_43	ETHNIKI-FFB-PROBANK-ATTICA	1	157.17	303.19	60.81
_44	ETHNIKI-FFB-PROBANK-AEGEAN	2	142.7	-154.85	-397.23
_45	ETHNIKI-FFB-PROBANK-PANELLINIA	2	117.65	-143.09	-385.47
_46	ETHNIKI-FFB-PROBANK-PANCRETAN	1	106.86	180.92	-61.46
_47	ETHNIKI-FFB-PROBANK-ATTICA-AEGEAN	2	113.17	-252.48	-494.86
_48	ETHNIKI-FFB-PROBANK-ATTICA-PANELLINIA	1	109.41	101.17	-141.21
_49	ETHNIKI-FFB-PROBANK-ATTICA-PANCRETAN	1	124.26	118.17	-124.21
_50	ETHNIKI-FFB-PROBANK-AEGEAN-PANELLINIA	2	150.14	-230.51	-472.89
_51	ETHNIKI-FFB-PROBANK-AEGEAN-PANCRETAN	2	117.03	-172.52	-414.9
_52	ETHNIKI-FFB-PROBANK-PANELLINIA-PANCRETAN	1	93.4	42.83	-199.55
_53	ETHNIKI-FFB-PROBANK-ATTICA-AEGEAN-PANELLINIA	2	121.51	-258.59	-500.97
_54	ETHNIKI-FFB-PROBANK-ATTICA-AEGEAN-PANCRETAN	2	141.94	-269.22	-511.6
_55	ETHNIKI-FFB-PROBANK-ATTICA-PANELLINIA-PANCRETAN	1	130.64	204.69	-37.69
_56	ETHNIKI-FFB-PROBANK-AEGEAN-PANELLINIA-PANCRETAN	2	104.85	-219.91	-462.29
_57	ETHNIKI-FFB-PROBANK-ATTICA-AEGEAN-PANELLINIA-PANCRETAN	2	136.64	-267.61	-509.99
_58	PIRAEUS-ATTICA	1	53.7	141.42	345.46
_59	PIRAEUS-AEGEAN	1	42.32	113.64	317.68
_60	PIRAEUS-PANELLINIA	1	30.2	87.84	291.88
_61	PIREAUS-PANCRETAN	1	26.73	92.43	296.47
_62	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-ATTICA	2	-183.96	-276.91	-72.87
_63	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-AEGEAN	2	-156.96	-234.37	-30.33
_64	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-PANELLINIA	2	-164.97	-206.35	-2.31
_65	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-PANCRETAN	2	-159.43	-192.34	11.7
_66	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-ATTICA-AEGEAN	1	83.91	146.45	350.49
_67	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-ATTICA-PANELLINIA	2	-189.03	-290.94	-86.9
_68	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-ATTICA-PANCRETAN	1	75.9	123.38	327.42
_69	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-AEGEAN-PANELLINIA	2	-178.56	-253.8	-49.76
_70	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-AEGEAN-PANCRETAN	2	48.83	-73.29	130.75
_71	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-PANELLINIA-PANCRETAN	2	-194.27	-281.19	-77.15
_72	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-ATTICA-AEGEAN-PANELLINIA	2	-211.45	-296.69	-92.65
_73	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-ATTICA-AEGEAN-PANCRETAN	2	-197.95	-273.29	-69.25

(continued)

Table 14.b: Greece - Hypothetical M&As Scenarios (Continued)

	POTENTIAL - M&As	CLASS	dif[TC*CostInef] - **Pre Crisis** (M)	dif[TC*CostInef] - **Post Crisis** (M)	*HFSF*
_74	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-ATTICA-PANELLINIA-PANCRETAN	2	-229.68	-336.24	-132.2
_75	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-AEGEAN-PANELLINIA-PANCRETAN	2	-209.8	-307.03	-102.99
_76	PIRAEUS-ATE-MARFIN_EGNATIA-MILLENIUM-GENIKI-ATTICA-AEGEAN-PANELLINIA-PANCRETAN	2	-257.86	-358.94	-154.9
_77	ATTIKA-AEGEAN	2	-3.45	-28.84	-
_78	ATTICA-PANELLINIA	2	7.16	-1.93	-
_79	ATTICA-PANCRETAN	2	-2.4	-19.64	-
_80	AEGEAN-PANELLINIA	2	4.7	-4.92	-
_81	AEGEAN-PANCRETAN	1	4.58	8.64	-
_82	PANELLINIA-PANCRETAN	2	2.53	-1.23	-
_83	ATTICA-AEGEAN-PANELLINIA	2	-13.61	-62.75	-
_84	ATTICA-AEGEAN-PANCRETAN	1	1.13	19.62	-
_85	ATTICA-PANELLINIA-PANCRETAN	2	-7.17	-32.08	-
_86	AEGEAN-PANELLINIA-PANCRETAN	2	2.69	-1.38	-
_87	ATTICA-AEGEAN-PANELLINIA-PANCRETAN	1	86.45	157.39	-

*Notes: This table reports all the prospective scenarios of M&As among all the Greek financial institutions and the classification of the 'new' financial entity into the two latent technological classes according to the regime membership determinants described in Table 3.b.The first column presents two categories entitled 'Recent' and 'Recent (Potential)'. The former consists of all consolidation activities that took place recently and created the four so- called 'Systemic' banks (ALPHA, ETHNIKI, EUROBANK, PIRAEUS). As far as the latter is concerned it consists of all possible combinations of consolidation between the 'big four' of the Greek banking sector and the institutions that they finally were absorbed by them and altogether formed their systemic nature. We approach each one of these cases in both categories as a prospective M&A scenario in the economy, since our sample is dated up to 2011 and the recent consolidation wave took place in 2012 and 2013. The second column reports all possible combinations of consolidation between the four major banks of the Greek economy, before and after they got involved into the recent wave of M&As, and the four remaining banking institutions namely, Attica bank, Aegean bank, Panellinia bank and Pancretan. The table presents all possible combinations of consolidation among those four remaining banks (i.e. only non-systemic banks) and the classification of the new financial entity as well. 'dif[TC*CostInef]' measures the difference of the total cost associated with the level of cost inefficiency between the individuals ones (A+B) and the prospective financial institution (AB) and indicates prospective gains (positive sign) or losses (negative sign) in real money values (€) resulting from each hypothetical M&A that is quoted for both the 'pre' crisis and the 'post' crisis period. 'HFSF' indicates prospective gains (positive sign) or losses (negative sign) in real money values (€) for the Hellenic Financial Stability Fund (HFSF) and consequently for the Greek Economy and its tax payers in general, that result from each hypothetical M&A activity where each one of the four 'Systemic' banks could have been involved into, instead of the 'Recent' wave of M&As that was actually realised. All gains and losses with respect to 'HFSF' refer to the 'post' crisis period since the HFSF did not exist in the 'pre' crisis era. 'M' stands for million.*

Table 15: UK & Greece - Largest Banks' M&As Scenarios Gain/Losses

Panel A: UK	Pre Crisis (M)			Post Crisis (M)		
	Min	Max	Median	Min	Max	Median
BARCLAYS	-4387.14	4846.46	4410.91	-17697.3	9968.47	8835.41
HSBC	-3894.17	4057.69	3903.56	-5382.91	7358.25	7221.89
LlOYDS	-4802.56	5092.21	4929.48	-6944.92	1834.3	-6408.41
RBS	-8432.48	2879.84	514.63	-7921.57	1967.75	-6976.79
SANTANDER	-1272.17	1339.35	1155.13	-2159.51	1999.53	-1959.15
STANDARD	-1346.16	1462.72	1385.06	-6497.3	1693.62	-2441.2
Panel B: Greece						
ALPHA	-162.92	240.67	112.315	-254.55	292.63	85.25
EUROBANK	-108.44	71.72	-60.675	-278.79	110.72	-150.865
ETHNIKI	29.99	157.17	111.29	-269.22	303.19	101.935
PIRAEUS	-257.86	83.91	-82.44	-358.94	146.45	-118.49

Notes: This table presents both the range and the average of gains (positive sign) or of losses (negative sign) in real money values(for UK in £ and for Greece in €), resulting from each hypothetical M&A of the largest banks (in terms of assets, deposits and loans) in each banking system that is quoted for both the 'pre' crisis and the 'post' crisis period.

M' stands for million.