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Liquidity Creation Through Efficient M&As: A Viable Solution for Vulnerable Banking Systems? Evidence From a Stress Test Under a Panel VAR methodology.*

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Abstract

According to the "cost efficiency - liquidity creation" hypothesis (CELCH), introduced in this paper, a rise in a bank's cost efficiency level increases its liquidity creation. By employing a novel stress test scenario under a panel VAR methodology, the CELCH and the direction of causality between liquidity creation and cost efficiency are tested. Moreover, using new measures of liquidity creation (Berger and Bouwman 2009), the question of whether potential bank mergers and acquisitions (M&As) can enhance liquidity creation and generate additional credit channels in the economy is addressed. The robustness of potential consolidation scenarios are evaluated and compared through the use of new "half-life" measures (Chortareas and Kapetanios 2013). In line with CELCH, the positive impact of cost efficiency on liquidity creation is shown. The empirical evidence further suggests that potential consolidation activity can enhance the flow of credit in the economy. Bank shocks seem to have the most persistent effect on both liquidity creation and cost efficiency. Finally, doubts are cast on the strategies followed by policy authorities regarding the recent wave of M&As in the banking sector.

Keywords: bank distress; liquidity risk; efficiency; capital structure; regulation; M&As; PVAR

JEL classification: G21, G28, G32, G34

1 Introduction

The challenge of safeguarding financial stability has become even more vital in light of the rapidly evolving global financial environment, which is characterized by enhanced financial liberalization and integration, rapid development of new financial products and technologies, consolidation in the banking industry, and increasing competition. Throughout the global financial crisis, many banks struggled to maintain adequate liquidity. Consequently, creating substantial liquidity buffers across the board is the explicit aim of a number of regulatory responses to the crisis, such as the Committee of European Banking Supervisors' (CEBS) guidelines on liquidity buffers (CEBS 2009b) and the forthcoming Basel III liquidity standards, the liquidity coverage ratio (LCR), and the net stable funding ratio (NSFR). These all exert additional pressure on banks to effectively manage their liquidity, while ensuring a high level of efficiency.

The recent financial crisis underscored the importance of having a better understanding of the ways that liquidity conditions influence credit extension to domestic and foreign customers. Before the financial turmoil occurred, bank liquidity came quite often from abroad (i.e. capital and money markets) due to the incapability of domestic deposits to support the large expansion in credit growth. Currently, it is difficult for new liquidity to come from abroad, especially in countries where the recession is still accelerating and the value of collateralized assets is decreasing . Consequently, in periods of contracting economies when investment opportunities are limited because funding sources are scarce, any funding possibility (i.e. loan expansion) must be created within the country itself. This requires certain domestic policy actions to be taken, such as reducing reserve requirements, increasing capital in state-owned banks, increasing the minimum insurance on bank deposits, or coming to terms with the mechanisms of the International Monetary Fund (IMF). Thus, investigation of different possibilities to increase the credit channels in the economy is of primary concern for governments and policy authorities, especially in countries with a high level of sovereign debt and default risk.

With this in mind, we contribute to the literature by conducting, to the best of our knowledge, the first combined theoretical and empirical study that links efficiency to liquidity. We investigate the concept of potential consolidation activity among banks and address whether it can lead to an increase of liquidity in the banking sector and consequently increase the credit channels in the economy, especially in countries with a high level of sovereign debt and severe country default risk. This leads us to the following two prerequisites: the first raises concerns that a potential consolidation activity in the banking sector increases concentration in the system and may cause anticompetitive effects with a negative impact on social well-being. The second addresses the issue of how we will measure liquidity with respect to potential bank M&As in the future. For this purpose, the "cost efficiency - liquidity creation" hypothesis (CELCH) is proposed to measure the liquidity creation of a potential bank consolidation activity through its level of efficiency. The CELCH argues that after a consolidation activity, if the new financial institution generates cost efficiency gains, these can be reflected in both liquidity creation enhancement and a sounder banking system. Both the US and EU merger guidelines explicitly note that the criterion for judging potential mergers acceptable is their ability to create merger-specific efficiency gains and pass them on to customers. Thus, the CELCH has both theoretical and empirical foundations.

Nevertheless, the result of an increase in both liquidity creation and stability of the banking sector via potential cost-efficient bank M&As can lose its significance if these positive outcomes vanish when adverse economic conditions occur in the future. From this perspective, this is the first study to address the impact of potential adverse economic conditions on liquidity creation and cost efficiency in an economy. To this end, a stress test under a panel vector autoregressive (PVAR) methodology is created, where two completely different, in terms of sophistication, market characteristics and volume of transactions, banking systems are examined by imposing macroeconomic, financial, and bank-specific shocks.[1] This is of extreme importance, considering the anticompetitive consequences that could result from a potential consolidation activity. We are able to provide

[1] We apply the stress test under the PVAR methodology in two polar cases (i.e. two completely different banking systems) in order to test and amplify the validity of our inferences.

inferences on the contribution of each specific prospective M&A to the robustness of each country's banking sector with respect to both liquidity creation and cost efficiency, and consequently, on whether each consolidation should be realized from both an economic and a social perspective in the aftermath of the recent financial crisis. This leads to the third novelty of our study; via the PVAR framework, we investigate the impact of efficiency on liquidity creation and the direction of causality among these two economic variables. Moreover, we are able to empirically examine the CELCH. The final contribution of the present study is the proposition of an innovative methodology to evaluate and compare the robustness of each potential bank M&A scenario through recent half-life measures (Chortareas and Kapetanios 2013). It is worth noting that this methodology can be used to evaluate and compare the performance of firms and individuals in any industry (e.g., energy, labor, food) and enable regulatory authorities to extract important policy implications, particularly in an era of on-going economic and financial turbulence in the aftermath of the global financial crisis.

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. It is noteworthy that two of the four big-banks of the UK banking sector, specifically Lloyds and RBS faced severe liquidity problems. Thus, the first main reason that we investigate the UK banking sector is due to the fact that 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 countries with which UK financial institutions are interconnected. 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 Recapitalization Fund. Additionally, monetary authorities intervened by lowering interest rates to 0.5%, a figure which at the time of writing remains unchanged. Nevertheless, the UK economy itself confronted tremendous problems of liquidity as a consequence of the recent financial turmoil. The Monetary Policy Committee (MPC) recognizes that the bank rate cannot be reduced any further, and to provide additional 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. With this in mind, via the suggested in the paper CELCH we propose an alternative way in boosting both the banking's sector and in extend the overall economy's level of liquidity creation. This could be proven vital in reducing the scale of unconventional monetary activities.

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 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 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. With this in mind, the reason that we examine Greece is due to the recent wave of M&As that took place in the country's banking sector and lead to the creation of the four so called "Systemic" banks. These four 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).Thus, in this study we are interested in investigating whether these four "Systemic" banks did indeed create cost efficiency synergies and liquidity creation enhancement that could lead to economic growth.

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 comparative and forecasting pre-crisis and post-crisis analyses. The CELCH is suggested as an alternative solution in situations where liquidity problems are quite alarming. During these periods we observe waves of consolidation activity in the banking sector as the

[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 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 two bailout deals, one in May 2010 (€110 billion) and one in February 2012 (€130 billion), that were agreed upon between Greece and both the Eurozone countries and the International Monetary Fund (IMF).

management's solution to reduce the costs. On one hand, we exploit whether prospective M&As in the UK and Greek banking systems can enhance households and firms with the creation of additional credit channels[4] in the context of a severe contraction of the country's economic activity; on the other hand, we shed light on the trade-off between managerial motives and social economic surplus that triggers M&A activity. In this way, 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[5] package of the European Banking Authority (EBA).

The empirical evidence presented from the stress test scenario confirms the proposed CELCH in two ways: first, by the estimated positive impact of cost efficiency on liquidity creation, and second, by the fact that bank shocks, specifically the level of non-performing loans in the sector, have the more persistent effect and account for most of the deviations of the forecasted values of both the cost efficiency and liquidity creation variables from their true levels. The causality between these two variables of interest runs stronger from liquidity creation toward cost efficiency than vice versa . Overall, the UK banking sector seeks to be more robust than the Greek banking sector when adverse conditions occur in the economy. Through the proposed CELCH, we provide evidence in both countries of increased liquidity that is created after potential M&A activity between either two or three banking institutions in both the pre-crisis and post-crisis eras, with considerably stronger evidence for the former period. In addition, in both periods and in both banking systems, the highest liquidity derived from potential consolidation activity is due to large financial institutions. Finally, we note that the impact of adverse macroeconomic and bank-specific conditions on the Greek banking sector's liquidity creation is greater in its current systemic formation than it was prior to the recent wave of M&As. This finding casts doubt on the decisions of both the foregoing policy makers and the boards of those banks that participated in the recent wave of bank consolidations, which resulted in the creation of the so-called four *cornerstones* of the Greek economy, with respect to the actual economic benefits that derive from these recent M&As.

The rest of the paper is organized as follows. Section 2 provides an overview of the theoretical framework and presents recent liquidity creation measures. Section 3 discusses the empirical methodology. Section 4 describes the data. Section 5 presents the empirical evidence. Conclusions and insights for future research are offered in the final section.

[4]Figures 1.*a* and 1.*b* show the annual growth rate of the volume of credit facility (i.e., loans) provided in both the public and private sectors by the financial intermediaries operating respectively in the UK and Greece.

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

2 Theoretical Framework

2.1 Liquidity Creation

According to the theory of financial intermediation, banks provide liquidity, and specifically, better liquidity insurance than financial markets. On one hand, banks can create liquidity through their on-balance sheet activities by funding long term illiquid assets (e.g., business loans) with short term liquid liabilities (e.g., transactions deposits) (Bryant 1980; Diamond and Dybvig 1983). In other words, banks can be liquidity providers, as they hold illiquid assets and provide cash and demand deposits to the rest of the economy. On the other hand, banks can enhance their liquidity provision via off-balance sheet activities through loan commitments and claims to liquid funds because, from the customer's perspective, the features of loan commitments are very similar to demand deposits (Holmstrom and Tirole 1998; Kashyap et al. 2002). However, liquidity can be destroyed when banks use illiquid liabilities or equity to finance liquid assets (e.g., treasury securities). Consequently, they expose themselves to the risk of facing a sudden increase in deposit withdrawals, and thus to the risk of a bank run.

In periods of crisis, Diamond and Dybvig (1983) and Allen and Santomero (1998) argue that liquidity creation increases the probability of higher losses when illiquid assets are sold to meet a sudden increase in customers' liquidity demands. Nevertheless, Carletti et al. (2007) argue that this risk is partially mitigated through a bank merger. The authors note that the behavior of banks after a merger is changed by the creation of an internal money market, a venue through which reserves can be exchanged internally. Through this internal market, the merged bank increases the weight of its relatively illiquid assets, which is the group of assets from which the bank can generate higher rates of return. Thus, if a sudden increase on the liability side occurs, the bank will not have to be involved in so-called "asset fire sales". The reason that after a consolidation activity the bank's ability to increase the weight of illiquid assets is ameliorated is that M&A activity reduces information asymmetries and enables them to screen borrowers more efficiently (Panetta et al. 2009). This view is supported by Berger and Bouwman (2009), who demonstrate that recently completed bank mergers and acquisitions (M&As) account for the overall liquidity of the industry and generate the greatest growth in liquidity creation over time. Additionally, a recent study by Pana et al. (2010) presents empirical evidence that banks with higher levels of deposit insurance create higher levels of liquidity around mergers.

2.2 Measurement of Liquidity Creation

Liquidity creation by banks has historically been measured by the loans to asset ratio, as shown in Hughes et al. (1996), or the ratio of cash and related liquid items to total assets, as proxies of bank liquidity (Molyneux and Thornton 1992; Demirguc-Kunt and Huizinga

1999). However, such liquidity indicators have been criticized as they do not consider the comprehensive aspects of bank liquidity provision and the development of market conditions connected with financial markets (Shleifer and Vishny 2010). The existing literature indicates that there have only been two papers that attempt to measure bank liquidity creation. The first is one by Deep and Schaefer (2004), where a measure of liquidity transformation is constructed and applied to data gathered from 200 of the largest US banks over the period 1997-2001. The liquidity transformation gap, or "LT gap", is defined as liquid liabilities minus liquid assets divided by total assets. The authors consider all loans with a maturity of one year or less to be liquid in this model; loan commitments and other off-balance sheet activities are explicitly excluded due to their contingent nature. Nonetheless, to precisely measure a bank's aggregate liquidity supply, all aspects of the balance sheet should be considered. To be more precise, the liquidity that a bank provides is attributed to the structure of both the asset and liability sides, but on the other hand, is also attributed to off-balance sheet activities. This leads us to the second methodological attempt in the literature to gauge liquidity, proposed by Berger and Bouwman (2009). The authors claim that the "LT gap" is a step forward but argue that it is not sufficiently comprehensive by highlighting a few differences between their approach and the "LT gap" developed by Deep and Schaefer (2004). The Berger and Bouwman (2009) model also classifies loans by category rather than solely by maturity and employs measures that include off-balance sheet activities, consistent with the arguments of Kashyap et al. (2002) and Repullo (2004).

Berger and Bouwman (2009) construct their liquidity creation measure using a three-step approach. In the first step, they classify all bank balance sheet and off-balance sheet activities as liquid, semi-liquid, or illiquid based on the ease, cost, and time for banks to dispose of their obligations to obtain liquid funds to meet customers' demands. Within each category, shorter maturity items are defined as more liquid than longer maturity items because they self-liquidate without as much effort. Loans are classified by category ("cat") or entirely by maturity ("mat"). In the second step, the authors assign weights to the activities classified in the first step. The weights are based on the liquidity creation theory, according to which banks create the most liquidity when they transform illiquid assets into liquid liabilities, whereas maximum liquidity is destroyed when liquid assets are transformed into illiquid liabilities. Therefore, positive weights are applied to both illiquid assets and liquid liabilities and negative weights to liquid assets and illiquid liabilities. They argue that the magnitudes of the weights are based on simple dollar-for-dollar adding up constraints, so that \$1 of liquidity is created (destroyed) when banks transform \$1 of illiquid (liquid) assets into \$1 of liquid (illiquid) liabilities. In the last step, they combine the activities as classified in the first step, and weighted according to the second step, in order to construct four liquidity measures. These measures classify loans by category or maturity ("cat" vs "mat") and differentiate on whether banks include off-balance sheet activities ("fat") or exclude them ("nonfat"). Thus, four liquidity creation measures are constructed based on the four combinations: "*catfat*", "*catnonfat*", "*matfat*", "*matnonfat*". A detailed description of the three-step procedure is provided in table 1.

Berger and Bouwman (2009) suggest that "*catfat*" is the preferred liquidity creation measure, as in this specific category, business loans can be treated as illiquid regardless of their maturity because banks generally cannot easily dispose of them to meet liquidity needs; residential mortgages and consumer loans can be treated as semiliquid because these loans can often be securitized and sold to meet demand for liquid funds. In addition, this measure includes off-balance sheet activities, consistent with the arguments in Holmston and Tirole (1998) and Kashyap et al. (2002), who suggest that banks also create liquidity off-balance sheet through loan commitments and similar claims to liquid funds. [6]

3 Empirical Methodology

3.1 Recent & Potential M&As - "Cost Efficiency-Liquidity Creation" Hypothesis (CELCH)

The first step of our empirical strategy is to examine whether prospective banks' M&As[7] could lead to an increase of liquidity in the banking sector and in turn, to an increase of the credit channels (i.e. loans) in the economy, especially in the spectrum of a severe country default risk. To conduct our analysis, we create potential M&As between the most important financial institutions in terms of assets, loans and deposits in the UK and Greek banking sector respectively and we compare their potential liquidity creation, computed by Berger and Bouwman's (2009) preferred measure of liquidity creation, (i.e. catfat), against the sum of each individual bank's liquidity creation.

Nevertheless, this leads to the following challenge; 'How to measure *potential* liquidity creation?'. In this paper liquidity creation is measured by the recently proposed in the literature liquidity measures of Berger and Bouwman (2009). However, the problem with

[6] It is noteworthy that either CATFAT or the CELCH is not related to CATFIN proposed by Allen et al. (2012). The authors investigate whether aggregate systemic risk predicts real economic activity. They construct monthly aggregate systemic risk from historical stock returns on U.S. financial firms. In particular, they exploit the cross-sectional variation in individual firms' realised stock returns within a given month to proxy financial sector tail risk. They find that the constructed measure (termed catastrophic risk in the financial sector, CATFIN hereafter) predicts various real economic activity indicators several months into the future. However, as the constructed tail risk measure relies on realised stock returns, this measure is best regarded as a measure of realised financial sector tail risk. This may be significantly different from the market's forward-looking expectation of future tail risk which should be more informative for future economic activity.

[7] In the case of an acquisition one financial institution takes over another one and establishes itself as the new owner. Consequently, from a legal point of view, the target financial institution ceases to exist.

these measures is that they are constructed by an accounting rather than an estimation procedure and consequently, we cannot calculate the liquidity creation of *potential* M&As. To be more explicit, let's assume bankA and bankB where we have data for both of them in time t and we calculate each bank's liquidity creation (i.e. 'catfat'). Let's assume now that we create a potential consolidation activity among these two banks (bankAB) in time t. Attempting to calculate the liquidity creation difference between the 'new' bank (i.e. the merged bank) and the two 'old' ones (i.e. the 'proforma' bank[8]), the result will be:

$$difcatfat = catfat_{AB,t} - (catfat_{A,t} + catfat_{B,t}) = 0 \quad (1)$$

The reason that the above equation leads to a sum of zero lies on the definition of the AB financial institution; since '$catfat_{AB,t/t+1}$' does not represent the liquidity creation of a hypothetical *merged* bank, as it was explained above, but of a hypothetical *proforma* bank since the consolidation process has not occurred historically and thus we cannot observe its effect on the level of liquidity creation. For this reason, we introduce the "*cost efficiency - liquidity creation" hypothesis* (CELCH) which states that after a consolidation activity if the new financial institution generates cost efficiency gains these can be reflected in liquidity creation enhancement. Thus, we propose to measure the liquidity creation of a potential M&A through its potential level of efficiency. It is noteworthy that banks' efficiency enhancement is an explicit policy objective in the Single Market Directive of the European Commission, highlighting is importance.

At this point, it is important to provide a theoretical justification for our proposed methodology. We need to explain both our theoretical motivation and testable propositions that constitute the methodological steps, which combine concepts of efficiency, M&As, liquidity creation, and social benefit. Therefore, the following will discuss the CELCH that states that a prospective bank consolidation activity can possibly have a twofold contribution: the creation of a sounder banking system via the enhanced level of efficiency and the amelioration of the social welfare via higher levels of liquidity creation which can lead to reduced rates on bank loans for the borrowers. These methodological steps are as follows:

- Step 1 - "*For a bank-consolidation to be acceptable is to create synergies and pass on these benefits to customers.*"

During the last decade, antitrust and competition law assessment of M&As has been altered to accommodate the growing skepticism regarding the use of concentration and market share measures (Hausman and Sidak 2007; Werden 2002). Subsequently, a criterion for judging potential mergers as acceptable is their ability to pass on merger-specific

[8]Proforma bank consists of the acquirer and the target one year before the M&A occurs.

efficiency gains to customers. This efficiency pass-through criterion is explicitly stated in the US and EU merger guidelines (Neven 2006) and is employed informally in Australia.

- Step 2 - "*Bank M&As can lead to an increase in efficiency.*"

Economic theory suggests that mergers can restructure an industry, and the subsequent efficiency gains from mergers can be larger than customer losses resulting from increased market concentration. Theoretical studies have investigated the relationship between merger-specific efficiency and price changes. Williamson (1968) claimed that merger-specific cost efficiency gains outweighed possible anticompetitive effects. Within this general framework, increased cost efficiency from mergers can be larger than the deadweight loss of reduced production, which stems from the increase in market power. A trade-off between efficiency gains and anticompetitive effects of M&As may be experienced, as efficiency enhancement could result in a limited price increase.

- Step 3 - "*Efficiency enhancing bank M&As could lead to consumer benefits.*"

Farrell and Shapiro (1990) demonstrate that prices will rise if a merger generates no synergies (efficiencies) and does not lower marginal costs. Thus, they argue that M&As can only contribute to social well-being when efficiency has increased substantially and when these gains are passed on to consumers. Additionally, Focarelli and Panetta (2003) highlight that, although in the short run consolidation generates adverse price changes, these are only temporary. Efficiency gains dominate the market power effect of mergers, leading to prices that are more favorable for consumers.

- Step 4 - "*M&As of large banks ameliorate the terms of the issuing loans from the borrower's point of view.*"

Nonetheless, the positive effect of a consolidation process is influenced by the size of the financial institutions involved. M&As of small banks increase the market share of larger, more efficient banks, increasing the market's total surplus. M&As of large banks shift market share to smaller, less efficient banks, which need additional efficiency gains to increase total surplus. In a recent study, Park and Pennacchi (2009) examine the differences in pricing effects of large and small banks. Their results indicate that, as large merging banks borrow more funds from money markets than from retail deposits, large bank mergers will result in reduced rates for depositors and improved rates for borrowers.

- Step 5 - "*Potential bank M&A activities in banking sectors in the UK and in Greece can be proclaimed as acceptable by the Single Market Directive of the European Commission.*"

Though DeYoung et al. (2009) show that US bank M&As have a negative impact on efficiency, the empirical evidence these authors present reveals that European bank M&As have a positive impact on efficiency. Moreover, Haynes and Thompson (1999) note that UK bank mergers have been associated with positive performance effects. Ashton and Pham (2007) infer that UK (and German) bank mergers have led to enhanced cost efficiency for the merging banks. Consequently, examining potential consolidation activities of M&As between Greek and UK banks in terms of whether they lead to increased liquidity creation is in line with the established criteria of EU M&As guidelines. Thus, prospective bank M&A activities in banking sectors in Greece and the UK can be proclaimed as acceptable by the Single Market Directive of the European Commission.

- Step 6 - "*A consolidation activity can lead to an increase in liquidity creation.*"

Berger and Bouwman (2009) indicate that recently completed M&As between banks account for the industry's overall liquidity. Additionally, in a more recent study conducted by Pana et al. (2010), it is it is found that banks with higher levels of deposit insurance create higher levels of liquidity around mergers. The findings from these two studies is justified theoretically by the fact that M&A activity reduces information asymmetries, enables the new financial entity to screen borrowers more efficiently and, in turn, increases the weight of illiquid assets, all of which lead to the enhancement of liquidity creation (Panetta et al. 2009).

- Step 7 - "*Cost efficiency gains can lead to increased liquidity creation*"

According to the theory of economic efficiency, a financial institution can enhance its cost efficiency if it achieves the minimum level of input costs to produce a certain level of outputs. This is done by establishing a new business plan enabling the bank to exploit economies of scale or economies of scope. Additionally, it can acquire or invent more sophisticated technology to reduce its input unit cost. Alternatively, cost efficiency is achieved by minimizing information asymmetries, which will result in the minimization of costs. According to banking efficiency theory, loans are one of the main outputs banks produce. The primary problem that banks face with loans is the level of those that are non-performing.[9] Nevertheless, if the bank is able to reduce its information asymmetries then it ameliorates its ability to screen borrowers and thus reducing the level of non-performing loans. Consequently, it can reallocate its resources and increase the weight of loans; i.e., illiquid assets, which results in an increase in liquidity creation. Thus, considering that consolidation activity reduces information asymmetries and results in

[9] A Non-performing loan (NPL) is a loan that is in default or close to being in default. Many loans become non-performing after being in default for 90 days, but this can depend on the contract terms.

increased liquidity (Panetta et al. 2009), we infer that the same mechanisms that lead to cost efficiency gains lead as well to increased liquidity creation and to an increased flow of credit to the economy.

The next challenge is to demonstrate a mathematical proof of the theory that underlines our proposed CELCH. To provide this proof, the hypothetical scenario of bankA, bankB, and the potential bankAB in time t will be used once again.

To estimate the level of economic efficiency and the level cost efficiency,[10] we opt for the stochastic frontier approach (SFA)[11] under the intermediation approach by Sealey and Lindley (1977).[12] In particular, we follow the specification:

$$\ln TC_{it} = \ln C(y_{it}, w_{it}, T, E_{it}\ ; \beta) + u_{it} + v_{it}, \tag{2}$$

where subscripts $i = 1, ...N$ stand for each financial institution (i.e. each M&A activity), $T = .year1, year2..., final\text{-}year$, indicates a time trend and is included in each specification to allow for technological change, using both linear and quadratic (i.e. T and T^2) respectively. TC_{it} is individual bank total cost which is defined as the sum of personnel and administrative expenses, interest fee and commission expenses; y_{it} and w_{it} indicate vectors of output and input prices. Specifically, 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).[13][14] Additionally, we specify as our 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

[10]Due to unavailability of data on output prices, we do not estimate profit efficiency.

[11]Kubhakar and Lovell (2000) provide an excellent guide on stochastic frontier analysis and its parametric framework on the estimation of efficiency

[12]Several approaches have been suggested in the literature to define bank inputs and outputs (for a review, see Berger and Humphrey, 1992). In our study, we are interested in the estimation of overall the efficiency and economic viability of M&As between banks and the relationship with liquidity creation. Thus, the intermediation approach seems to fit the purposes of our analysis (Berger and Mester 1997).

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

[14]By the inclusion of OBS activities as an additional output, we completely capture the bank output mixes and thus avoid any spurious correlation between the cost efficiency (CE) and the liquidity creation (LC) variable. Nevertheless, we do perform a test on its presence, and indeed, we found no evidence of spurious correlation between the CE and the LC variable.

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.). We measure the price of input (w_1) using the ratio of interest expenses to total deposits and short term funding and the price of input (w_2) using the ratio of staff expenses to total assets.[15] Last, we measure the price of input (w_3) using the ratio of fee and commission expenses added to administration expenses to fixed assets. 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.[16] 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). We measure (E) using the amount of equity capital; β is a vector of parameters to be estimated. The two-sided random error term v_{it} is assumed to follow a normal distribution around the frontier and u_{it} accounts for the firm's inefficiency and is assumed to follow a half-normal distribution (i.e. non-negative). v_{it} and u_{it} are independent and independent of the regressors. To empirically implement the cost frontier, we opt for[17]:

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

Standard linear homogeneity and symmetry restrictions in all quadratic terms are imposed in accordance with economic theory. Efficiency values range between 0 (the least efficient financial institution in the sample) and 1 (the most efficient financial institution in the sample).

Attempting to calculate the difference between the level of the estimated economic (cost) efficiency of the 'new' bank and of the two 'old' ones at the same point in time (i.e.

[15]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)

[16]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.

[17]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.

in time t) the result will be:

$$difeff = eff_{AB,t} - \frac{(eff_{A,t} + eff_{B,t})}{2} \neq 0^{18}, \tag{4}$$

because efficiency is a result of an empirical estimation procedure. Berger and Bouwman's (2009) liquidity measures, on the other hand, are a result of an accounting procedure, where

$$catfat_{AB,t} = (catfat_{A,t} + catfat_{B,t}) \tag{5}$$

Thus, from equations 4 and 5 we construct the mathematical representation of our "*cost efficiency - liquidity creation" hypothesis* expressed by the following equations:

If

$$eff_{AB,t} > \frac{(eff_{A,t} + eff_{B,t})}{2}, \tag{6}$$

then

$$\mid catfat_{AB,t} \mid * eff_{AB,t} > \frac{(eff_{A,t} + eff_{B,t})}{2} * \mid (catfat_{A,t} + catfat_{B,t}) \mid \tag{7}$$

which results in

$$dif(eff_{AB,t} - \frac{(eff_{A,t} + eff_{B,t})}{2}) * \mid catfat_{AB,t} \mid > 0, \tag{8}$$

in which both sides of the inequality 7 are calculated at the same point in time when the hypothetical M&A takes place (i.e. t). Note that liquidity creation can be negative (for example, the bank destroys liquidity), which the CELCH takes into account. In other words, the theoretical intuition of CELCH is not affected, even if a consolidated institution AB destroys liquidity (i.e. the sum of liquidity of institutions A & B is negative) because, according to the CELCH, this could be mitigated if the consolidation process leads to cost efficiency gains. We include the absolute value of $catfat$ in inequalities 7 and 8 so that the latter is always above zero, representing the liquidity creation enhancement that can occur via cost efficiency enhancement resulting from synergies of prospective M&As between banks. Hence, we are able to evaluate and compare the liquidity efficiency gains or losses of potential M&A activity.[19]

[18]Because efficiency is computed via the parametric SFA and is expressed as a ratio of the actual observed level of efficiency to the optimum level of efficiency of the best-practice bank in the sample, its value ranges from 0 to 1. Consequently, we cannot use the sum (as we did with respect to the measurement of liquidity of two banks in section 3.1). Instead, we take the weighted average level of efficiency (as weight we use the size of the bank measured by its total assets) of the involving financial institutions.

[19]To create the prospective M&A in both baking sectors, the following econometric steps will be used: specifically, the weighted sum for the four main variables ($Catfat$, 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

Furthermore, we conduct a comparative analysis pre-crisis and post-crisis. With respect to the examination of the former period, we use data of the financial institutions up to 2006. For the investigation of the latter period, we use data subsequent to the 2007 to 2009 financial crisis up to 2011. In this way, we test whether the level of liquidity associated with efficiency that had been created by the same potential M&As has changed due to the crisis.

Moreover, we select all the banks that have not been involved in the recent wave of consolidations among the four systemic banks and create all potential M&As either among themselves or with one of the four cornerstones of the Greek economy. Additionally, we control for both single and multiple M&As by one banking institution. Finally, regarding the four systemic banks, we examine their recent and potential M&As in every possible combination (i.e. either one-by-one, two-by-two, and so on, or by all the acquired banks together).[20] The purpose of examining these combinations is to test the bank's liquidity creation associated with its economic efficiency if it had not been involved in the recent consolidation process and to focus only on the potential cases of M&As.[21]

3.2 Stress test scenario

In the second step of our empirical methodology, we examine whether potential bank consolidation activity will create the essential dynamics that enhance the liquidity-stability of the sector in the face of future adverse economic conditions. Our intuition derives from

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 2.

[20]Regarding recent M&As in the Greek banking sector, we approach each one of these cases as a potential scenario in the economy, since 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 with operations that were terminated in the last year of our sample (2011) and those who have terminated their operations anytime from 2011 to present to ensure that the results are of relative policy importance.

[21]We thoroughly acknowledge that each of the following financial institutions for each banking sector is not a subsidiary of the rest.

From the UK banking sector, we select AIB PLC, Barclays Bank PLC, Royal Bank of Scotland PLC, HSBC Bank PLC, Lloyds TSB Bank PLC, Standard Chartered Bank PLC, Santander UK PLC, Co-operative Bank PLC, Sainsbury's Bank PLC, and UBS PLC. From the Greek banking sector, we choose National Bank of Greece (or Ethinki Bank), EFG Eurobank, Alpha Bank, Piraeus Bank, Attica Bank, Panellinia Bank, Pancretan Co-operative Bank, Aegean Bank, Commercial Bank (or Emporiki Bank), Agricultural Bank (or ATE Bank), Marfin-Egnatia Bank, TT-Hellenic, Genini Bank, Millennium Bank, Proton Bank, Probank, and FBB Bank. The last nine banks have been already acquired by the four new systemic' banks: National Bank of Greece or Ethinki Bank (acquired Probank, FBB Bank) , EFG Eurobank (acquired TT-Hellenic, Proton Bank), Alpha bank (acquired Emporiki Bank), Piraeus Bank (acquired ATE Bank, Marfin-Egnatia Bank, Genini Bank, and Millenium Bank).

the tremendous impact the recent financial meltdown has had on the stability of financial intermediaries. To investigate the robustness of liquidity creation in banking sectors we develop a stress environment that will consist of the potential liquidity shortage faced by the banks due to adverse macroeconomic, financial, and bank-specific conditions. In other words, we stress each country's banking system in three different ways: using a macroeconomic shock, a financial shock, and a bank shock. The real growth rate of gross domestic product (GDP) is used for each country to account for macroeconomic conditions, in line with Rossi and Sekhposyan (2015) who characterise GDP as the most important macroeconomic factor. The policy interest rates described by the three-month treasury bill rate and the real effective exchange rate are used to account for financial distress, and the total problem loans in each banking sector is used to capture the banks' liquidity risk. These specific variables directly affect the liquidity of banks (Freixas and Rochet 2008). The efficiency of the banking system has been one of the major issues in the new monetary and financial environment as it is the dominant segment of a country's financial system. In addition, it is generally accepted that efficient bank operation, which is linked to financial stability, allows enterprisers and households to enjoy higher-quality services at lower costs. With this in mind and given that banking theory considers a high level of efficiency as the preponderant precondition against a bank's default,[22] we account for an additional bank-specific shock: the cost efficiency score of each potential M&A and of each financial institution in each country that we used in the previous subsection. This additional bank-specific shock will allow us to examine how its deviation affects liquidity creation. The choice of variables is in line to Rauch et al. (2010) where they document the determinants of bank liquidity creation. To the best of our knowledge, this is the first study in the literature that addresses the impact of efficiency on liquidity creation and the direction of causality among those two variables.

To examine the resilience of banking to a variety of different shocks, we follow an econometric procedure that is based upon a vector autoregressive (VAR) model and enables us to implement a stress test in banking. The choice of VAR as stress test in the banking sector is not the first time used in the literature. It has been employed by Hoggarth et al. (2005), to impose a stress test in the UK banking sector, by Dovern et al. (2008) in the German banking sector, by Koutsomanoli-Filippaki and Mamatzakis (2009) to the European banking sector among others. A vast body of literature (Hoggarth, Sorensen, and Zicchino, 2005; Marcucci and Quagliariello, 2005; Filosa, 2007) indicates that changes in the macroeconomic conditions of any economy impacts bank performance, simultaneously or with a lag. Feedback effects of bank instability on economic activity could amplify the fluctuations, especially during recessions. The VAR model allows us to fully capture and

[22] Low levels of efficiency could lead banks to try to boost their performance via laxer credit standards and/or less intensive monitoring of credit that may weaken their stability (Fiordelisi et al. 2011).

treat the interaction among macroeconomic and financial variables as endogenous. It also captures the entailed feedback effect. We use a panel-data vector autoregression (PVAR) methodology (Holtz - Eakin et al. 1988). This technique combines the traditional VAR approach, which treats all the variables in the system as endogenous, with the panel-data approach, which allows for unobserved individual heterogeneity (Love and Zicchino, 2006).

$$Z_{it+p} = \Gamma_i + \sum_{j=1}^{q} \Phi_j Z_{it+p-j} + \varepsilon_{it+p} \tag{9}$$

where, $i = 1, 2, 3..I$ represents each panel (i.e. each different bank), Γ_i is a constant vector, Φ_j are matrices, ε_{it+p} is a vector of residuals/shocks, and p denotes the forecasting time horizon. Z_{it+p-j} is a vector of residuals/shocks, and p denotes the forecasting time horizon. Z_{it+p-j} is the vector of endogenous variables, including the real growth rate of GDP, the policy interest rates, the real effective exchange rate, the three-month treasury bill rate, the level of bad loans, the cost efficiency estimates, and the level of liquidity creation calculated by the preferred measure "$catfat$". We are mainly interested in examining the behavior of the liquidity creation and of the cost efficiency variable. The equation in the model for the preferred measure of liquidity creation and, thus, the equation defining the shock to the preferred measure of liquidity is of the following form:

$$lc_{it+p} = \gamma_{lc,i} + \phi_{lc} Z_{it+p-1} + \varepsilon_{lc,it+p} \tag{10}$$

where lc_{it+p} represents the liquidity creation measure("$catfat$"), $\varepsilon_{lc,it+p}$ is a white noise shock, $\gamma_{lc,i}$ is a constant, ϕ_{lc} is a row vector of parameters corresponding to the row of coefficients in Φ_p in the equation for liquidity creation. Z_{it+p-1} is the vector of the variables in the VAR, including liquidity creation itself. The last equation describes the determinants of the bank liquidity creation, which are lagged values of the variables included in the VAR. Modelling the dynamics of macroeconomic, financial, bank-specific, and liquidity creation variables using a VAR is advantageous because impulse response analysis can be carried out, the stress test proposed in this paper. By estimating the system, it is possible to simulate various shocks to these variables and consider the feedback from these shocks to the level of liquidity created by a bank, as well as the aggregate level of a country's liquidity needs. One can also investigate whether shocks to the liquidity of the banks have an impact on future macroeconomic, financial, and bank developments.

Accordingly, the equation in the model for the economic efficiency and thus the equation defining the shock to the cost efficiency scores is of the following form:

$$ceff_{it+p} = \gamma_{ceff,i} + \phi_{lc} Z_{it+p-1} + \varepsilon_{ceff,it+p} \quad (11)$$

where the left hand-side variable; $ceff_{it+p}$, represents bank-specific cost efficiency estimates.

An appealing fact of the VAR modelling is that it does not require the imposition of strong structural relationships, although theory is involved to select the appropriate normalization and to interpret the results. Another advantage is that only a minimal set of assumptions is necessary to interpret the impact of shocks on each variable of the PVAR system. The reduced form VAR, once the unknown parameters are estimated, enables dynamic simulations to be implemented. However, this method only allows for analysis of short-run adjustment effects and not of structural long-run effects. The results come in the form of impulse response functions (IRFs) and their coefficients analysis, as well as forecast error variance decompositions (FEVDs) that let one examine the impact of innovations or shocks to any particular variable on other variables in the system. IRFs model the dynamics of the response; the coefficients represent the average effects of IRFs and permit recognition of the significance of the overall response. Variance decompositions give information about the variation in one variable due to shocks to the others. The response corresponds to a one-time shock in other variables, holding all the other shocks constant at zero. In other words, orthogonalizing the response allows us to identify the effect of one shock at a time, while holding other shocks constant.[23]

When applying the VAR procedure to panel data, it is important to ensure that the underlying structure is the same for each cross-sectional unit. Since this constraint is likely to be violated in practice, one way to overcome the restriction on parameters is

[23]Since the variance-covariance matrix of the VAR residuals/shocks is unlikely to be diagonal, the residuals need to be orthogonalised to obtain orthogonalized impulse response functions. Consequently, we decompose the residuals in a way that makes them orthogonal. Such exercises require careful application of a VAR identification procedure. The most common way to deal with this problem is to choose a causal ordering. A standard procedure in the literature is to apply a Cholesky decomposition, which is equivalent to adopting a particular ordering of the variables and allocating any correlation between the residuals of any two elements to the variable that is ordered first. These impulse response functions can be sensitive to the ordering of the variables. In turn, the variables in the model were initially ordered in ascendance according to the likely speed of reaction to any particular shock. Variables at the front end of the VAR are assumed to affect the following variables contemporaneously but are only affected by shocks to the other variables after a lag. Variables at the bottom of the VAR only affect the preceding variables after a lag but are affected themselves immediately. The financial variables (three-month treasury bill rate and the real effective exchange rate), were ordered at the bottom of the VAR, implying that they react instantaneously to shocks in the real side variables. The remaining variables (the growth rate of gross domestic product, the level of total problem loans, the estimated cost efficiency, and the level of liquidity creation), react only after a lag following shocks to the financial variables. The growth rate of GDP was ordered after the level of total problem loans and economic efficiency respectively, reflecting priors that the economic cycle affects bank losses. The liquidity creation variable was ordered last. Note that the ordering would be irrelevant if there are low estimated covariances between the errors across equations. Results show that these covariances are low.

to allow for individual heterogeneity[24] in the levels of the variables by introducing fixed effects, (Love and Zicchino, 2006). Hence, equation 9 becomes

$$Z_{it+p} = \Gamma_i + \sum_{j=1}^{q} \Phi_j Z_{it+p-j} + d_i + \varepsilon_{it+p}, \tag{12}$$

where d_i denotes the fixed effects.

Since the fixed effects are correlated with the regressors due to lags of the dependent variables, the mean-differencing procedure commonly used to eliminate fixed effects would create biased coefficients. To avoid this problem, we use forward mean differencing, also referred to as the Helmert procedure (Arellano and Bover 1995). This procedure removes only the forward mean (i.e. the mean of all the future observations available for each bank-year). This transformation preserves the orthogonality between transformed variables and lagged regressors, so we can use lagged regressors as instruments and estimate the coefficients by system GMM . Further, to analyze the impulse response functions, an estimate of their confidence intervals is needed. Since the matrix of impulse-response functions is constructed from the estimated VAR coefficients, their standard errors need to be taken into account. We calculate standard errors of the impulse response functions and generate confidence intervals with 1000 Monte Carlo simulations.[25] Finally, we present variance decompositions, which show the percentage of the variation in one variable that is explained by the shock to another variable, accumulated over time. The variance decompositions show the magnitude of the total effect. We report the total effect accumulated over 10, 20, and 30 periods ahead.

Therefore, stability is compared to the liquidity of the whole banking system for each hypothetical M&A scenario against a baseline case in which there has been no consolidation activity within the sector. Regarding the Greek banking sector, we create an additional baseline case, which incorporates all the recent consolidation activity in the country though some specific M&A formations were found to enhance cost efficiency-liquidity creation.[26] In this way, we can accurately compare the two benchmark banking statuses and extract important inferences from a policy perspective.

[24]In this study, the nature of individual heterogeneity is based on different business models (i.e. commercial banks, cooperative banks) employed by banks in both banking sectors.

[25] In practice, we randomly generate a draw of coefficients of model (1) using the estimated coefficients and their variance covariance matrix. Then, we re-calculate the impulse-responses. We repeat this procedure 1000 times (we experimented with a larger number of repetitions and obtained similar results). We generate 5th and 95th percentiles of this distribution that we use as a confidence interval for the impulse-responses.

[26]This baseline scenario will include only the final formation of the four systemic banks, after their series of consolidation activity and the potential M&A category.

3.2.1 'Half-Life' Methodology

To conduct precise evaluations and comparisons among these baseline cases and the various combinations of potential M&As, we use the concept of '*half-life*' because it represents a measure for assessing the speed of mean reversion or persistence in the variable of interest. Specifically, we employ the recently proposed '*half-life*' measures proposed by Chortareas and Kapetanios (2013),[27] and we calculate the '*half-life*' of the response of liquidity creation to each specific shock for each specific potential M&A using the following equation:

$$\int_{o}^{h^*} \mid \phi(s) \mid ds = \int_{h^*}^{\infty} \mid \phi(s) \mid ds \tag{13}$$

where we define the impulse response as a function of s, which we denote as $\phi(s)$ to provide a distinction from standard impulse responses; ds is the order of integration. Then, h^* (i.e. '*half-life*') is the point in time at which half the absolute cumulative effect of the shock has dissipated. It is noteworthy to mention that the methodology that we propose in this study (i.e. the PVAR model associated with the half-life measures) can be used to evaluate and compare the performance of firms and individuals in every industry (e.g., energy, labor, food) and extract important policy implications for regulators.

4 Data

The data consists of an unbalanced panel of all the financial institutions that provided credit[28] from 1988 to 2011 in the UK and from 1993 to 2011 in Greece.[29] Following the majority of empirical studies in banking, we obtain the largest part of our annual bank-level data from the Bankscope database. Any missing information is supplemented with information from the official websites of UK and Greek financial institutions, as well as by the British Bankers and Building Societies Association, the Hellenic Bank Association, and by the annual reports of both the governors of the Bank of England and the Bank of Greece. We obtain detailed information on M&As from the Zephyr database.[30] Overall, both our samples account for a significant market share in terms of assets, loans, and

[27] For a recent summary see also Choi, Mark, and Sul (2006).

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

[29] The year 1993 has been selected as the starting year for the sample of the Greek banking sector because full liberalization of the Greek banking system occurred in that year. This followed the provision of the Second Banking Directive outlining establishment, supervision, and operation in 1992 by the Basic Banking Law Banking Directive.

[30] 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).

deposits, which occasionally amount to more than 90% in each respective category in both countries. 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 number of branches and employees also confirms the dominance of commercial banking. 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 employees is 51,012 (out of 56,611 employed in all credit institutions, equivalent to 90.11%), according to the Hellenic Banking Association (2011).

All data are deflated using each country's GDP deflator (with 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 explained in the appendix, we exclude observations of missing, negative, or zero values for inputs/outputs and control variables. Our final samples consist of 124 financial institutions and 1834 observations for the UK banking sector, and 30 financial institutions and 356 observations for the Greek banking sector. In tables 2.a and 2.*b* , we provide an overview of characteristic banking indicators of the UK and Greek banking sector for each year of our study.

5 Empirical Results

5.1 Recent & Prospective M&As - "Cost Efficiency-Liquidity Creation Hypothesis" (CELCH)

In tables 3.*a* and 3.*b*, we present a summary of the results[31] of all potential and recent/potential M&A activity for the UK and Greece, respectively.[32] One of the most significant findings is that, in both banking sectors, the majority of potential combinations of

Additionally, M&As were taken into consideration, by thoroughly checking all M&A activities that 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.

[31]Due to space constraints, a detailed illustration of all potential and recent/potential cases of consolidation activity considered is available upon request.

[32]In the UK banking sector, all the M&As cases we demonstrate in table 3.*a* are artificially created and labelled as '*Potential*'. With respect to the Greek banking system and its consolidation activities presented in table 3.*b*, we have established three categories. Specifically, we label as '*Recent M&As*' those M&As that actually have taken place during the recent wave of consolidation. Nevertheless, as it is aforementioned, we approach each one of those as a potential M&A in the economy, since our sample is dated up to 2011, and the recent wave of consolidation took place in 2012 and 2013. . The remaining two categories of M&As in table 3.b, entitled *'Could Exist (if recent M&As were different)'* and *'Potential'*, consist of consolidation activities that are artificially created as in the case of the UK banking sector.

M&A would have contributed considerably to the enhancement of the liquidity-efficiency relationship had they occurred in the pre-crisis period. Precisely, the empirical evidence reveals that in more than 99.4% and 98.1% of the UK and Greek (pre-crisis) hypothetical M&As, cost efficiency and liquidity creation would increase, respectively. In the post-crisis period, the results highlight a crucial difference between the two countries. In the UK banking sector, we report a small decrease compared to the pre-crisis period, however, the difference is much higher in the Greek banking sector between the two periods, where only 43% of the total hypothetical post-crisis scenarios (as opposed to 87% in the UK) could have possibly created additional credit channels in the economy with enhanced cost efficiency. Nevertheless, is important to examine whether the bank size does in any way affect these results. Small and medium banks can matter for stress scenarios or systemic risk issues just as much as the big ones. This is true when we think about it from the perspective of a "too many to fail" crisis as opposed to a "too big to fail" crisis (Acharya and Yorulmazer, 2007).[33] With this in mind, we consider banks' M&As not only among large institutions, but among large and medium/small size institutions as well and among medium/small size institutions only. Overall, in both banking systems for both periods, hypothetical consolidation activity among large financial institutions creates the greatest cost efficiency benefits. This could result in increased provision of liquidity to the economy, which is in line with the findings presented on one hand by Berger and Bouwman (2009) and Pana et al. (2010), who show a positive relationship between size and liquidity creation in the US banking sector and on the other hand with Joh and Kim (2013) who demonstrate that large and well capitalised banks as well as more concentrated banking sectors seem to have the highest levels of liquidity creation. The size effect that we find could be explained by the fact that large-sized banks have the infrastructure and ability to manage their inputs, taking advantage of scale economies as well. Small banks achieve relatively good performance due to specialization and better control of their inputs as a result of size. For both the UK and the Greek banking systems in the pre-crisis period, the same hypothetical M&A combinations produce higher efficiency gains respectively compared to the years following the crisis. This illustrates the detrimental impact that

The reason we examine the category entitled '*Recent M&As*', is to test whether the selection by the authorities of those specific institutions to be involved in the recent wave of consolidation activity, could indeed create cost efficiency synergies and liquidity creation enhancement that could lead to economic growth.

Nevertheless, we also wanted to investigate every possible combination of M&A among all the banks in the Greek banking sector in the hope that some of them could be beneficial for the economic growth of the country. As a result we construct the aforementioned cases where we label them *'Could Exist (if recent M&As were different)'* and *'Potential'* combinations. Thus, in this way, we are confident that we present all the spectrum of consolidation activity, i.e., both actual and non-actual M&As that could be proven vital for the amelioration and stability of the Greek banking sector.

[33] We are grateful to an anonymous referee for suggesting this point.

the recent financial turmoil had on both banking system stability in both countries.

In the UK banking sector, for most of the cases that contribute successfully to the cost efficiency-liquidity relationship, the combinations that consist of three banking institutions produce higher positive differences compared to those consisting of two credit institutions. Precisely, it seems that the big-four of the UK banking sector (Barclays, HSBC, Lloyds, and RBS) create the most cost-efficient combinations of potential M&A activity, which could result in increased liquidity creation, with Barclays producing the highest during the pre-crisis period and Lloyds producing the highest during the post-crisis period. On the contrary, potential M&As among small banks do not improve their cost efficiency and liquidity creation. This is consistent with Hughes and Mester (2013), who provide empirical evidence of higher level of scale economies for large USA banks compared to their small counterparts. Thus, increased size and increased market share deriving from potential M&A activity is essential in the exploitation of economies of scale, which will enhance cost efficiency and produce increased liquidity creation.

Regarding the Greek banking sector, empirical evidence reveals a positive relationship between size and the CELCH for the pre-crisis period, as in the UK banking sector. The big four of the Greek banking sector (National bank of Greece, EFG Eurobank, Alpha Bank, and Piraeus Bank), produce the highest cost efficiency-liquidity creation gains, with the National Bank of Greece first in this list. This holds when we examine them in their previous individual formation and in the current systemic shape resulting from the recent consolidation process. Nonetheless, the results for the post-crisis period are mixed. To be more precise, we report strong evidence of decreased cost efficiency-liquidity creation produced by potential M&A combinations for all four new systemic cornerstones of the Greek economy. On the contrary, our empirical examination indicates that the big four in their pre-systemic shape or during their systemic formation (i.e. if they had not acquired specific financial institutions), would produce higher cost efficiency-liquidity levels. Unavoidably, these points cast doubts on the selection process followed by the Greek government and other financial institutions (such as the EFSF, the HFSF, and executive boards involved in recent consolidations in Greece) in deciding which financial institution will be the acquirer and which the target.

For both banking systems and for both periods, we observe strong empirical evidence of prospective consolidation activities among specific banking institutions that could ameliorate economic activity and growth via the efficiency and liquidity headway the new banks experience.[34]

[34]We have performed a series of robustness checks for both banking systems by using alternative liquidity indicators that have been vastly used by bank managers and practitioners in supranational institutions. The empirical evidence reveals no statistical significant difference. The results are available upon request.

5.2 Stress test scenario

In this subsection, the empirical analysis has a twofold scope: on the one hand, we investigate the contribution of the successful potential combinations of M&As of UK and Greek banks in the post-crisis period to the robustness of banking system in terms of liquidity risk using PVAR methodology. In this context, success is defined in terms of cost efficiency-liquidity creation gains. At the same time, we examine the impact of bank cost efficiency on liquidity creation and the direction of their causality. This, in essence, econometrically tests the empirical foundations of our suggested *"cost efficiency - liquidity creation" hypothesis*.

Before proceeding with the PVAR approach, an essential condition is that all variables included in the system are stationary. With respect to this, we run the model in first differences to focus on the dynamics of liquidity creation adjustments and short run effects.[35] Additionally, we test whether the main variables of interest are stationary by examining two different panel unit root tests: the augmented Dickey-Fuller test (ADF) and the Phillips-Perron (PP) type Fisher Chi-square tests of Maddala and Wu (1999).[36] All unit root tests are reported in tables 4.a and 4.b for the UK and Greece, respectively.[37] The results strongly suggest that all the variables included in the analysis do not follow a unit root process in each potential M&A scenario for both banking systems.

Another important issue before we proceed with the estimation of the PVAR is to determine the appropriate lag order, p, of the right-hand variables in the system of equations. Lütkepohl (2005) suggests that models with different lag orders should be estimated. Then, the model with the highest lag order that passes the diagnostic tests should be chosen. To do so, we utilize the Arellano-Bover GMM estimator for higher order of lags. We use the Akaike Information Criterion (AIC) to choose the optimal lag length. The AIC suggests that the optimum lag length is one; the Arellano-Bond AR tests confirm this. We included more lags to control for autocorrelation. Moreover, the Sargan tests provide evidence of lag order one, as well.

[35]Another way to proceed would be to test for stationarity variables in levels and, if they are found non-stationary, to test for cointegration between variables. The absence of a cointegration relationship would justify focusing on short-run and using variables in first differences. The presence of cointegration would call for structural VAR analysis of long-run effects. Our study does not address long-run effects and, therefore, we directly use variables in first differences.

[36]Because we have unbalanced data, we can conduct either the unit root test of Im-Pesaran-Shin (IPS) (2003) or the Fisher-type unit-root tests. Nevertheless, the IPS unit-root test requires at least 10 observations per panel, which is not the case in our study. Additionally, Maddala and Wu (1999) favor Fisher-type unit-root tests as they are more powerful in distinguishing the null and the alternative hypotheses and cross-sectional correlation among variables.

[37]We test for a unit root in each potential M&A scenario for both countries. However for brevity purposes, we report only the two common in both countries baseline cases where no bank consolidation activity has been held in the sector.

5.2.1 Impulse response functions

Figure 2 illustrates the IRFs with respect to liquidity creation deriving from the PVAR system for both the UK and Greek baseline scenario consisting of no bank consolidation activity in the sector and the additional baseline scenario including the recent wave of Greek banks' for each of our shocks. Looking at figure 2, financial and bank shocks have the most persistent effect on liquidity creation. As far as the financial shock is concerned, in all three rows a one standard deviation shock of the three month treasury bill rate on liquidity is positive and statistically significant, while the effect of the real effective exchange rate is innocuous.

Comparing the two countries' banking sectors, the effect of a change in the level of policy rates on liquidity is more persistent in the Greek banking sector, in which it takes about two years to lose significance, while it requires approximately one and a half years in the UK banking sector. Looking at the two Greek baseline scenarios,[38] is noteworthy the fact that its effect is slightly greater in the systemic formation of the banking sector. As far the bank shock is concerned, we highlight that both its sources (the cost efficiency and total problem loans variables) generate a positive and statistical significant impact on liquidity creation.[39] As far as the shock on the non-performing loans variable is concerned, it is always statistically significant and more persistent in the Greek banking sector with a statistically significant time-period difference of about half a year more than the UK. Additionally, the impact is more pronounced after the recent M&As in the Greek banking system.

That a positive one standard deviation shock of cost efficiency (i.e. bank-specific shock) on liquidity creation variable triggers a positive and statistically significant response in both countries,[40] is of major importance for two reasons: For the first time in the literature, we provide empirical insight on the impact of efficiency on liquidity creation and its sign. Second, that the response of liquidity is positive provides empirical proof of the positive impact cost efficiency has on liquidity creation, which is in line with

[38]The two baseline scenarios (or formations) in the Greek banking sector refer to the Greek banking system *before* and *after* the recent wave of consolidation activity that led to the creation of the four systemic banks (i.e. the big-four banks of the sector after a series of specific M&As that each of the four realized).

[39]The fact that the liquidity creation variable (i.e. $catfat$) has a positive response in the same direction in both sources of the bank shock variables (i.e. *cost efficiency* and *total problem loans*), confirms that there is no violation from a theoretical perspective. In other words, it is theoretically correct to construct our bank-specific shock using the average of both *cost efficiency* ($ceff$) and *total problem loans* (TPL) variables, since the IRFs in figure 2 illustrate that the response of the *liquidity creation* variable on each proceeds the same direction. In the scenario where the response of $catfat$ was not in the same direction for both bank specific variables (i.e $ceff$ and TPL), we would not be able to use the average of $ceff$ and TPL to create a common bank-specific shock. This is because the two different, in direction, responses could potentially cancel out the individual effect of each bank specific variable on liquidity creation.

[40]This positive response of liquidity creation to the cost efficiency shock becomes more apparent in the formation that includes the recent consolidation activity in the Greek banking sector.

the CELCH. Furthermore, we highlight that the cost efficiency bank-specific shock on liquidity creation takes at least six months less to be absorbed in the UK than in the Greek banking sector. An interesting finding is that this impact seems to be of minor importance in the Greek banking system without its current systemic nature. This amplifies our belief that recent M&As between Greek banks did not contribute to the amelioration of the cost efficiency of proforma banks' and to the overall sector's cost efficiency which could enhance liquidity creation.[41] Lastly, we note that in both countries and in both formations of the Greek banking system, the response of liquidity to a macroeconomic shock, exhibits a rather oscillating pattern which reflects a downwards movement during the first periods and an upward direction thereafter, though is not statistical significant.

Figure 3 displays the response of cost efficiency for all three categories of shocks. One of the most intrinsic differences is that all shocks are persistent on cost efficiency. A closer look at the bank shocks (i.e. liquidity creation, NPLs) reveals that cost efficiency is decreasing after innovations to each one of those two. From this, we extract two important inferences. First, non-performing loans decrease cost efficiency; thus, financial institutions seek to find strategies to confront this issue. According to the banking theory, a successful strategy regarding issuing loans is to reduce information asymmetries and improve the screening process of their borrowers. Thus, we provide additional empirical evidence in line with the proposed CELCH. Second, despite our previous report that an increase on liquidity creation is present after a positive shock of cost efficiency, we now highlight a decrease of cost efficiency when there is a positive bank-specific shock to liquidity. At first sight, this result might look odd; nevertheless, it is in line with recent studies highlighting that excess liquidity creation could distort the banking sector's stability by triggering bank failures (Fungacova et al. 2013). To put it differently, despite the fact that liquidity creation is desirable in the economy, because it increases the available credit channels and enhances investment and growth, beyond the 'optimum' level, it increases the likelihood of distress of a bank. Additionally, the severity of losses is exacerbated as assets are liquidated to meet liquidity demands (Allen and Gale 2004).

At this point, it would be interesting to pinpoint the direction of causality among liquidity creation and cost efficiency, which is quite challenging due to the conflicting direction of the response of each variable to a standard deviation shock of the other. An important difference between these two shocks is that the innovation of cost efficiency becomes apparent on liquidity creation after one period, whereas the shock of liquidity creation has an instantaneous negative impact on cost efficiency. Additionally, we high-

[41] As a robustness check, different ordering of the variables was considered. The impulse responses were computed using the generalized impulse function described by Pesaran and Shin (1998). This method constructs an orthogonal set of shocks that does not depend on the variable ordering. The results remained unchanged.

light that the persistence of liquidity creation's innovation on cost efficiency is twice as large as the cost efficiency's shock on liquidity. Considering the last two points, we argue that the direction of causality between these two variables of interest is stronger from liquidity creation towards cost efficiency than the reverse. [42]

5.2.2 Variance decompositions

To shed more light into our analysis, we also present variance decompositions (VDCs), which show the percentage of the variation for one variable is explained by the shock effects within another variable. In tables 5 and 6, the total effect accumulated over 10, 20 and 30 years for all the baselines liquidity creation and cost-efficiency conditions in the UK and the Greek banking sector are presented.

The empirical evidence in table 5 indicates the importance of the bank shocks and specifically the aggregate level of NPLs for explaining liquidity creation variations. To be more precise, approximately 11.6% and 13.6% of liquidity creation's forecast error variance over 30 years is explained by the level of NPLs in the UK and Greek banking sectors, without any potential bank consolidation activity. We highlight that the aforementioned 13.6% percentage increases and reaches 20% in the recent systemic formation of the Greek banking sector. In contrast, the cost-efficiency variable only explains approximately 4% of potential deviations between the forecasted and the true values of liquidity creation in the UK banking sector and 1% in the pre-systemic formation of the Greek banking sector (see table 6). The previous 1% percentage becomes even smaller after the creation of the four systemic cornerstones of the Greek economy. Macroeconomic factors play a more important role in explaining variations to forecasted liquidity creation in the UK compared to the Greek banking sectors, although they account for less than 2%. Financial indicators show a common pattern for both countries, specifically in the level of policy interest rates, which accounts for approximately 4% of the 30-year liquidity creation forecast error in the banking systems of both countries. The effect of the exchange rate is innocuous.

Table 6 presents the variance decompositions for cost efficiency, and a noteworthy difference shows that liquidity creation values accounts for a larger percentage of the deviation from cost efficiency values, than cost efficiency accounts for the deviation from liquidity creation's true values. This holds true for both countries and in all specifications. This finding is of crucial importance because it proves that the direction of causality from liquidity creation to cost efficiency is stronger than in the opposite direction. Additionally, both sources for the bank shock explain to a greater extent any deviations between the forecasted and true values for cost efficiency in the UK banking system, when com-

[42] As in the case of the response of the liquidity creation variable, the sign of the response of cost efficiency is the same in each one of the shocked bank variables; this shows that there is no violation from a theoretical perspective when we characterize the average innovation of both liquidity creation and total problem loans variables as a bank shock (on cost efficiency).

pared to the Greek system, with or without the recent wave of consolidations. Regarding macroeconomic and financial shocks, contributions to future deviations in cost efficiency scores are more significant in the Greek banking sector than in the UK banking sector, particularly in its recent systemic formation. This finding increases concerns for a more sound banking system deriving from the recent consolidation activity among the big-four Greek banks.

For this reason, the stability of the UK and Greek banking sectors towards their liquidity creation is investigated further (in the next subsection), in both their baseline scenarios, against hypothetical macroeconomic, financial and bank unexpected innovations, by exploring the behaviour of specific potential consolidation activities.

5.2.3 Recent & Prospective M&As - 'Half-life' comparisons

Tables 7*a* and 7*b* present potential combinations for M&As that create the necessary dynamics for UK and Greek banking system to exhibit more stable liquidity-creation levels when exposed to three different types of shocks (i.e. macroeconomic, financial, and bank shocks). Precisely, tables 7*a* and 7*b* present all potential M&A cases that form a banking sector with lowered half-life and total effect values (after each shock), compared to a banking sector without consolidation activity or without further consolidation activity (as is the case with the Greek banking sector). The prospective banking consolidation activity was compared against one benchmark for the UK's banking system, and against two benchmarks (i.e. *with* and *without* the recent bank M&A activity) for the Greek banking system. It is noteworthy that potential consolidation activity among the largest banks in each country constitutes the most robust banking sectors with respect to their liquidity creation. This result amplifies previous findings in this study concerning high levels of liquidity creation, enhanced cost efficiency, and the after-effect economic benefits that are produced by M&As among large banks. Thus, it appears that more frequent consolidation activity among large and cost efficient financial institutions leads to greater stability for liquidity creation. Finally, as far as the Greek banking system is concerned, the half-life and total effect results indicate that, in all three hypothetical stress tests the initial structure of the Greek banking sector (which does not incorporate the M&As of the big four institutions) is more robust. This finding amplifies concerns regarding the true economic gains stemming from the recent wave of consolidations.

6 Concluding Remarks

This study proposes a novel theoretical hypothesis, named "cost efficiency-liquidity creation" hypothesis (CELCH), which argues that a bank consolidation activity that generates cost efficiency gains, can result in both increased liquidity and economic growth surplus. An additional novelty of this study is that it presents empirical evidence regarding the direction of causality among these two variables. We approach this framework by employing recently developed measures of liquidity creation that account for both on and off balance sheet banks' activities (Berger and Bouwman 2009). Additionally, whether potential M&As in the UK and Greek banking system could enhance households and firms through the creation of additional credit channels in the economy is investigated. Comparative and forecasting analyses were conducted for the pre-crisis and post-crisis periods, which have major policy implications regarding the trade-off between shareholders' personal gains and society's economic prosperity that can trigger M&A activity.

A novel methodology to evaluate and compare the robustness of M&As is proposed, using a stress-test scenario and a panel vector autoregressive (PVAR) model, which enables inferences of major policy implications regarding the stability of vulnerable banking systems related to the recent financial crisis. Thus, the impact of adverse macroeconomic, financial, and bank-specific conditions were determined, and unbiased inferences regarding the robustness and liquidity creation of Greek and UK banking sectors were made, with crucial policy implications for economic growth. Additionally, this is the first study to address empirically the impact of efficiency on liquidity. This is an important aspect, since efficiency enhancement is an explicit policy objective in the Single Market Directive of the European Commission, while liquidity is the main driver of recently implemented regulations to banking supervision under the Basel III Accord. To make more precise evaluations and comparisons between potential M&A cases, recently proposed 'half-life' measures (Chortareas and Kapetanios, 2013) for associated impulse response functions were used to examine the robustness and determine the total effect on liquidity creation, of the UK and Greek banks' hypothetical consolidation activities, resulting from adverse macroeconomic, financial, and bank-specific developments. The aforementioned novel methodology can be used to evaluate and compare the performances of firms and individuals in every industry (e.g., energy, labour, food etc.) and allow supervisory authorities to design the most effective regulatory framework.

Empirical evidence is provided, via the proposed CELCH, for increased liquidity, generated from the potential M&A activity of two and three banking institutions during the pre-crisis and post-crisis era, though the evidence during the former period is considerably stronger. Large financial institutions produce the highest cost efficiency benefits, which can result in increased liquidity provisions in an economy. This is consistent in both banking systems and for both crisis periods. The recent wave of bank consolidations and the creation of the four cornerstones in Greek economy cast doubts on the decisions of policy makers and bank boards involved in the selection process for economic benefits. The results indicate decreased cost efficiency-liquidity creation levels and less efficient channels of credit able to boost economic activity and development.

The stress test scenario reveals the positive impact of cost efficiency on liquidity creation and sets a solid foundation for the proposed CELCH of this study. The empirical evidence shows that more robust conditions exist in the UK banking sector when compared to the Greek banking sector, with respect to liquidity creation, when hypothetical adverse, macroeconomic, financial, and bank-specific conditions occur within the economy. In both countries' banking sectors, bank shocks—specifically the level of NPLs—are more persistent and account for most deviations in forecasted values for liquidity from its trues levels. Nonetheless, all three types of shocks are found to play an important role in the banking sector of both countries and in all baseline cost-efficiency conditions. The results also highlight that the direction of causality for these two variables is stronger when moving from liquidity creation to cost efficiency. Lastly, the 'half-life' and total effect results of all three different in nature shocks are more persistent in the current systemic formation of the Greek banking sector compared to its pre-crisis formation, which raises further concerns about the social economic gains of the recent wave of bank M&As.

All in all, this study presents important policy implications for the post-crisis era. Additional credit channels in the economy can be generated through potential bank consolidation activity. According to the proposed CELCH, credit facilitation can contribute to economic growth only if enhanced cost efficiency is apparent in the new financial entity. However, the PVAR methodology for examining the robustness of a banking system during exogenous and endogenous shocks should be further applied before any police implementation takes place. Specifically, worldwide banking systems, not only in EU and in the Economic and Monetary Union (EMU) area but also in emerging economies, should be empirically investigated as well. It would be interesting to investigate the impact of profit efficiency on liquidity creation to determine both standards of economic efficiency in additional countries. In this way, a more complete view of the overall impact of economic efficiency on liquidity creation can be established.

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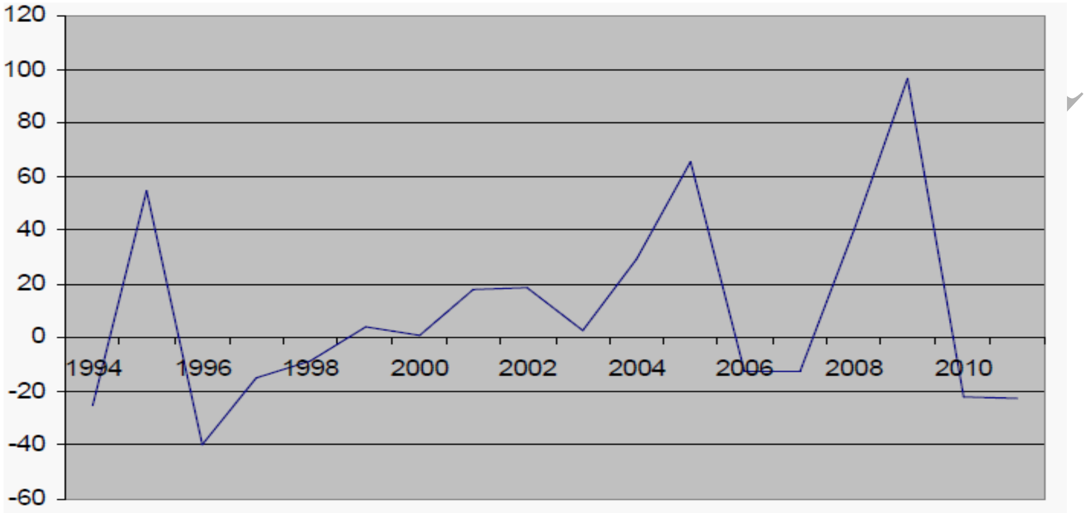
Appendix

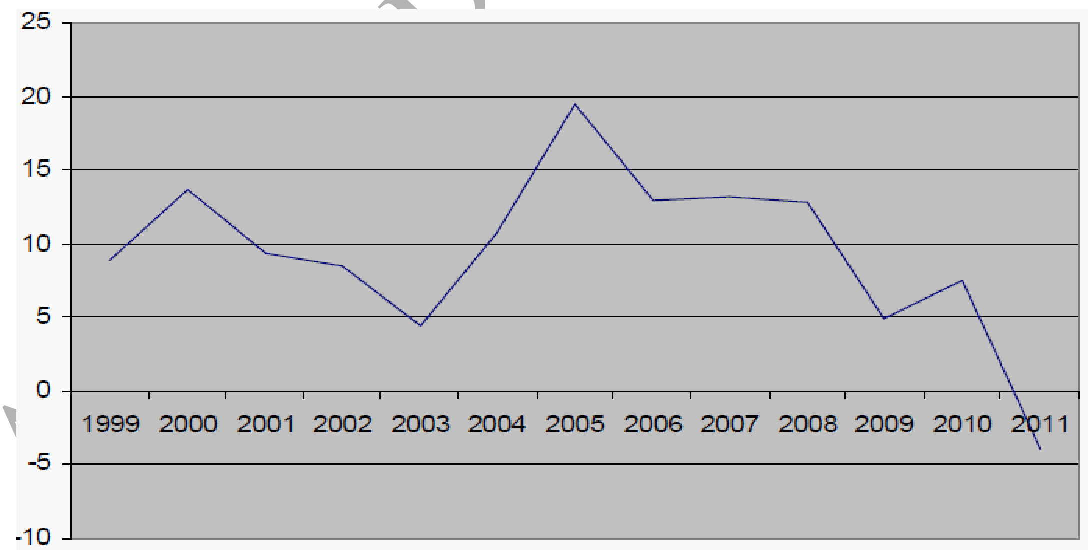
Figures

Figure 1.a: UK - Growth rate of credit to public & private sector by UK financial intermediaries



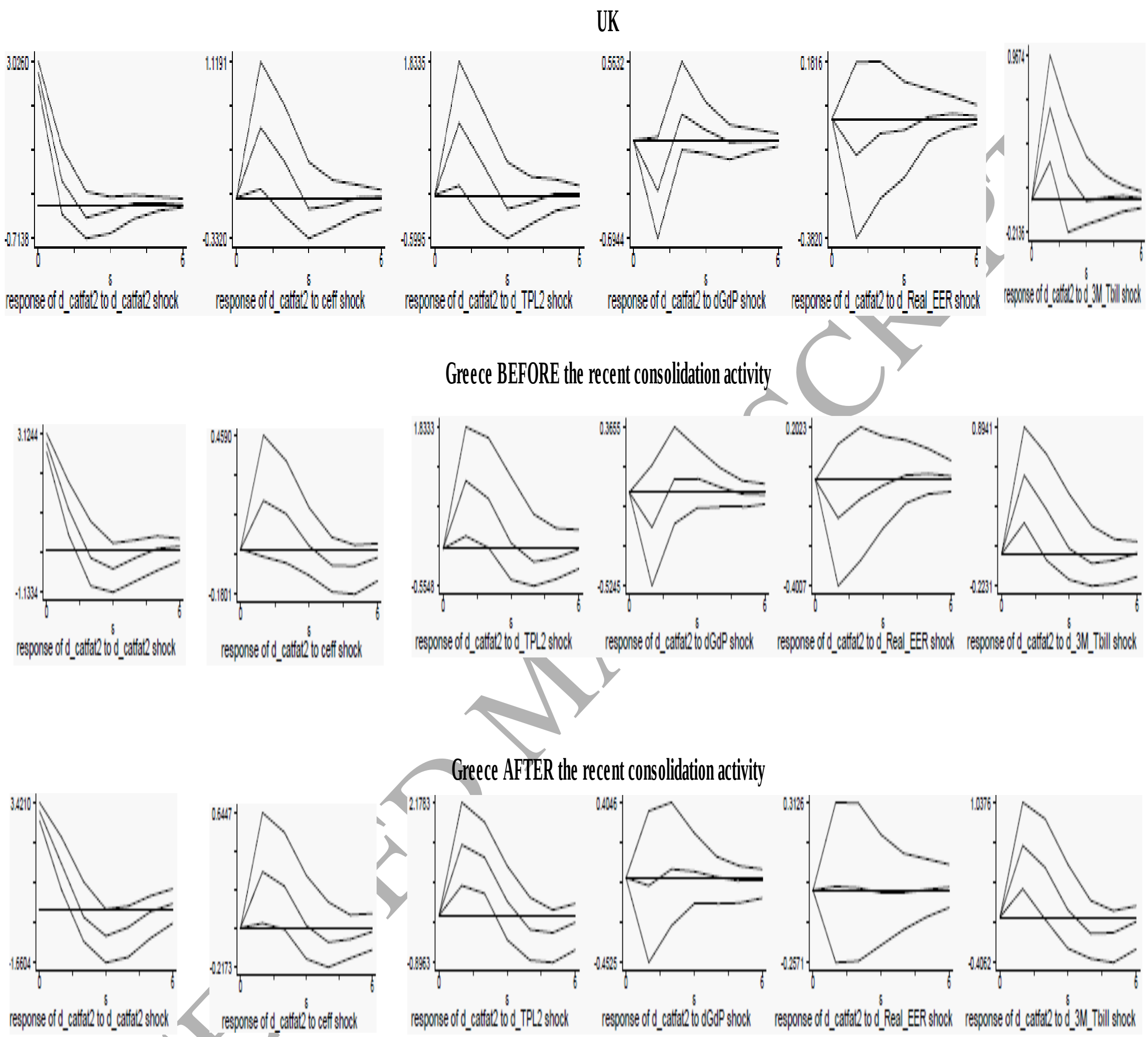
Notes: This figure displays the annual growth rate of the volume of loans and credit facility provided in both public and private sector by the financial intermediaries operating in the UK banking sector.

Figure 1.b: Greece - Growth rate of credit to public & private sector by Greek financial intermediaries



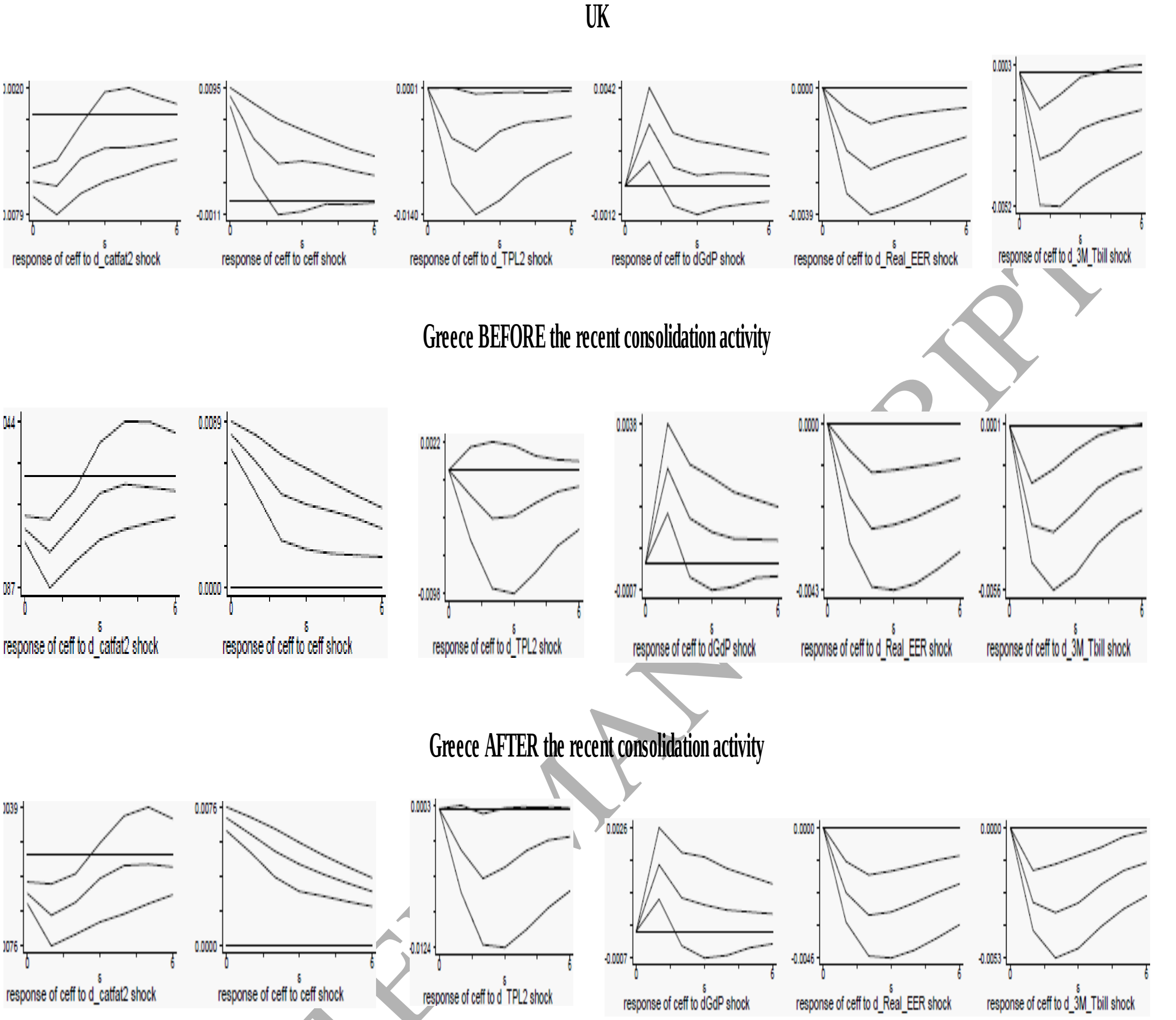
Notes: This figure displays the annual growth rate of the volume of loans and credit facility provided in both public and private sector by the financial intermediaries operating in the Greek banking sector.

Figure 2: Liquidity Creation - Impulse Response Functions



This figure illustrates the impulse response functions of Liquidity Creation with respect to a Bank, a Macroeconomic and a Financial shock, deriving from the panel vector autoregressive (PVAR) system for both the UK and Greek baseline scenario where there is no bank consolidation activity in the sector and the additional baseline scenario that indicates the current conditions of the Greek banking system after the recent wave of Greek banks' M&As. Specifically, 'd Catfat2', 'd TPL', 'd GDP', 'd Real EER' and 'd 3M Tbill' refer to the first differences of Liquidity Creation, Total Problem Loans (i.e. Bank shock), Gdp Growth Rate (i.e. Macroeconomic shock), Real Effective Exchange Rate (i.e. Financial shock) and Three month treasury bill rate (i.e. Financial shock) respectively, while 'Ceff' refers to the cost efficiency score (i.e. Bank shock).

Figure 3: Cost Efficiency - Impulse Response Functions



This figure illustrates the impulse response functions of Cost Efficiency with respect to a Bank, a Macroeconomic and a Financial shock, deriving from the panel vector autoregressive (PVAR) system for both the UK and Greek baseline scenario where there is no bank consolidation activity in the sector and the additional baseline scenario that indicates the current conditions of the Greek banking system after the recent wave of Greek banks' M&As. Specifically, 'd Catfat2', 'd TPL', 'd GDP', 'd Real EER' and 'd 3M Tbill refer to the first differences of Liquidity Creation, Total Problem Loans (i.e. Bank shock), Gdp Growth Rate (i.e. Macroeconomic shock), Real Effective Exchange Rate (i.e. Financial shock) and Three month treasury bill rate (i.e. Financial shock) respectively, while 'Ceff' refers to the cost efficiency score (i.e. Bank shock).

Tables

Table 1: Bank activities of liquidity creation measures

	Assets	
Illiquid assets (weight = 1/2) by Category	Semiliquid assets (weight = 0) by Category	Liquid assets (weight = –1/2)
Commercial real estate loans (CRE)	Residential real estate loans (RRE)	Cash and due from other institutions
Loans to finance agricultural production	Consumer loans	All securities
Other loans and leases financing	Loans to depository institutions	Trading assets
Other real estate owned (OREO)	Loans to state and local governments	Fed funds sold
Customers' liability on bankers acceptances	Loans to foreign governments	
Customers' liability on bankers acceptances		
Intangible assets		
Premises		
Other assets		
Illiquid assets (weight = 1/2) by Maturity	Semiliquid assets (weight = 0) by Maturity	
Loans and leases with a remaining maturity > 1 year	Loans and leases with a remaining maturity <= 1 year	
	Liabilities plus equity	
Liquid liabilities (weight = 1/2)	Semiliquid liabilities (weight = 0)	Illiquid liabilities plus equity (weight = –1/2)
Transactions deposits	Time deposits	Bank's liability on bankers acceptances
Savings deposits	Other borrowed money	Subordinated debt
Overnight federal funds purchased		Overnight federal funds purchased
Trading liabilities		Other liabilities
		Equity
	Off-balance sheet: Financial guarantees	
Illiquid guarantees (weight = 1/2)	Semiliquid guarantees (weight = 0)	Liquid guarantees (weight = –1/2)
Unused commitments	Net credit derivatives	Net participations acquired
Net standby letters of credit	Net securities lent	
Commercial and similar letters of credit		
All other off-balance sheet liabilities		
	Off-balance sheet: Derivatives	
		Liquid derivatives (weight=?1/2)
		Interest rate derivatives
		Foreign exchange derivatives
		Equity and commodity derivatives

Notes: This table reports definitions of both 'on' and 'off' balance sheet items in terms of their liquidity, which is the basis for calculation of the liquidity creation measures. The general functional form to calculate liquidity creation, which is the preferred measure 'catfat' of Berger and Bouwman's (2009) as well, is

Liquidity Creation (LC) = [½ × illiquid assets (cat) + 0 × semi-liquid assets (cat) – ½ × liquid assets (cat)] +
[½ × liquid liabilities + 0 × semi-liquid liabilities – ½ × illiquid liabilities – ½ × equity capital] +
[½ × illiquid guarantees + 0 × semi-liquid guarantees – ½ × liquid guarantees – ½ × liquid derivatives]

In line with Berger and Bouwman (2009) methodology:
a. Step 1: We classify all bank activities as liquid, semiliquid, or illiquid. b. Step 2: We assign weights to the activities classified in step 1.
c. Step 3: We combine bank activities as classified in step 1 and as weighted in step 2 in different ways to construct four liquidity creation measures.
d. We classify loans both by category and maturity.

Table 2.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 2.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.

Tables 3.a: UK - Prospective M&As scenarios

	Difference of Cost Efficiency/Liquidity Creation (M)			
	Up to 2006		**Up to 2011**	
Financial Institution	Min	Max	Min	Max
Co-operative Bank Plc (The)	-388.955	10755.7	-2897.36	6066.36
UBS	-388.955	4463.95	-2897.36	2298.03
Sainsbury's Bank plc	66.1156	5395.02	-2228.15	7226.36
AIB	223.02	6442.57	-1881.29	3910.95
Lloyds TSB Bank Plc	275.4	14487	-1736.16	4752.82
Royal Bank of Scotland Plc (The)	335.595	13889.6	-1697.53	2939.58
Santander UK Plc	398.14	6589.49	-1665.48	4724.22
HSBC Bank plc	415.052	14487	-1204.2	8947.36
Standard Chartered Bank	449.905	7926.39	-972.787	8947.36
Barclays Bank Plc	535.716	14487	-525.764	3897.12

This table presents for each financial institution that has been considered in the UK banking sector, the range of values that it can generate from all its prospective M&A scenario, of the difference in the estimated level of cost efficiency associated with the level of liquidity creation 'between the potentially 'consolidated' institution and of the 'proforma' institution both in 2006 (i.e. pre crisis scenario) and in 2011 (i.e. post crisis scenario). 'M' stands for millions. The level of of liquidity creation is computed by the model described in table 1, whereas the level of cost efficiency is estimated by the following model:

$$lnTC,it=lnC(y\{it\},w\{it\},T,E\{it\}\ ;\beta)+u\{it\}+v\{it\}$$

where subscripts i=1,....N stand for each financial institution (i.e. each M&A activity), T=.year1,year2...,final-year, and indicates a time trend and is included in each specification to allow for technological change, using both linear and quadratic terms (i.e. T and T²) respectively. TC_{it} is individual bank total cost; y_{it} and w_{it} indicate vectors of output and input prices; we specify equity (E) as a quasi-fixed input to control for differences in risk preferences, which may arise due to regulation, financial distress, or informational asymmetries; β is a vector of parameters to be estimated. The two-sided random error term v_{it} is assumed to be independent of the non-negative cost efficiency variable u_{it} and is assumed to follow a symmetric normal distribution around the frontier and ui, accounts for the firm's inefficiency and is assumed to follow a half-normal distribution. Detailed results of each prospective M&A scenario in the UK banking sector are available upon request.

Tables 3.b: Greece - Recent & Prospective M&As scenarios

	Difference of Cost Efficiency/Liquidity Creation (M)			
	Up to 2006	Up to 2011		
Recent M&As - Systemic formation				
ALPHA-EMPORIKI	4536.91	1395.63		
ETHNIKI-FFB-PROBANK	7648.84	4070.01		
PIRAEUS-ATE-GENIKI-MARFIN_EGNATIA-MILLENIUM	445.36	-617.14		
EUROBANK-PROTON_TT-HELLENIC	4086.79	-473.38		
	Up to 2006		Up to 2011	
Could Exist (if Recent M&As were different)	Min	Max	Min	Max
ALPHA	1525.16	3734.16	1084.44	1878.05
ETHNIKI	3950.47	7991.02	2907.92	4394.21
PIRAEUS	1636.99	3420.91	1448.64	2463.36
EUROBANK	1369.44	3215.15	1019.9	1720.31
EMPORIKI	1698.48	3602.54	1435.35	2738.82
FBB	624.24	1817.14	389.4	923.72
PROBANK	694.97	1995.33	470.61	1080.36
ATE	1597.67	3375.16	1400.86	2625.52
GENIKI	1129.94	2635.34	912.32	1838.86
MARFIN_EGNATIA	1532.12	3092.19	1334.39	2246.97
MILLENIUM	921.56	2371.75	645.2	1466.98
PROTON	777.57	2182.81	550.23	1288.17
TT-HELLENIC	1297.72	2869.94	1102.94	2153.13
PANELLINIA	1369.44	3950.47	1019.9	2950.33
AEGEAN	1528.02	4133.74	1665.81	4394.21
PANCRETAN	1904.32	4796.59	1525.53	4097.23
ATTICA	3215.15	7991.02	1448.64	2907.92
	Up to 2006		Up to 2011	
Potential	Min	Max	Min	Max
ALPHA-EMPORIKI	1310.17	1310.17	-2740.43	2706.03
ETHNIKI-FFB-PROBANK	1876.07	10080.73	-3399.33	2793.67
PIRAEUS-ATE-GENIKI-MARFIN_EGNATIA-MILLENIUM	-150.75	388.77	-7154.69	471.41
EUROBANK-PROTON_TT-HELLENIC	284.18	5828.47	-1480.27	848.77
PANELLINIA	-150.75	6079.13	-7154.69	1894.45
AEGEAN	-22.1	7776.37	-2740.43	2793.67
PANCRETAN	-22.1	8238.43	-7154.69	2706.03
ATTICA	-22.1	10080.73	-3399.33	-72.51

Notes: This tables presents for each recent and prospective M&A scenario in the Greek banking sector, the difference in the estimated level of cost efficiency 'associated with the level of 'liquidity 'creation 'between the potentially ''consolidated' institution and of the 'proforma' institution both in 2006 (i.e. pre crisis scenario) and in 2011 (i.e. post crisis scenario). We label 'as `Recent M&As - Systemic formation' those M&As that did actually take place during ' the recent wave of consolidation and resulted to the creation of the four systemic financial institutions. Nevertheless, we approach each one of those as a potential M&A scenario in the 'economy, since our sample is dated up to 2011 and the recent wave of consolidation took place in 2012 and 2013. The remaining two categories of M&As in table 3b, entitled `Could Exist (if recent M&As were different)' and `Potential' consist of consolidation activities that are artificially created. For the two aforementioned categories we present the range of values that each financial institution can 'generate from all its prospective M&A scenario. 'M' stands for millions. The level of liquidity creation is computed by the model described in table 1, whereas the level of cost efficiency is estimated by the following model:

$$lnTC,it=lnC(y\{it\},w\{it\},T,E\{it\};\beta)+u\{it\}+v\{it\}$$

where subscripts i=1,....N stand for each financial institution (i.e. each M&A activity), T=.year1,year2...,final-year, and indicates a time trend and is included in each specification to allow for technological change, using both linear and quadratic terms (i.e. T and T²) respectively. TC_{it} is individual bank total cost; y_{it} and w_{it} indicate vectors of output and input prices; we specify equity (E) as a quasi-fixed input to control for differences in risk preferences, which may arise due to regulation, financial distress, or informational asymmetries; β is a vector of parameters to be estimated. The two-sided random error term v_{it} is assumed to be independent of the non-negative cost efficiency variable u_{it} and is assumed to follow a symmetric normal distribution around the frontier and ui, accounts for the firm's inefficiency and is assumed to follow a half-normal distribution. Detailed results of each prospective M&A scenario regarding both the `Could Exist (if recent M&As were different)' and `Potential' category in the Greek

Table 4.a: Table: UK - Unit root analysis of the variables used in the stress test scenario

	Constant and Trend included in the model					
	d Catfat		Ceff		d TPL	
Method	Statistic	P-value	Statistic	P-value	Statistic	P-value
ADF - Fisher Chisquare	88.4526	0,000	41.2944	0,000	33.5951	0,000
PP - Fisher Chisquare	109.4665	0,000	49.1568	0,000	38.6641	0,000
	d GDP		d Real EER		d 3M Tbill	
Method	Statistic	P-value	Statistic	P-value	Statistic	P-value
ADF - Fisher Chisquare	162.1645	0,000	77.5161	0,000	66.2547	0,000
PP - Fisher Chisquare	241.5746	0,000	104.2543	0,000	95.2544	0,000

Notes: This table reports the empirical estimates of the unit root analysis on the variables that were considered in the panel vector autoregressive system (PVAR) as far as the UK banking sector is concerned. Specifically, 'd Catfat', 'd TPL', 'd GDP', 'd Real EER' and 'd 3M Tbill' refer to the first differences of Liquidity Creation, Total Problem Loans, Gdp Growth Rate, Real Effective Exchange Rate and Three month treasury bill rate respectively, while 'Ceff' refers to the cost efficiency score.

Table 4.b: Table: Greece - Unit root analysis of the variables used in the stress test scenario

	Constant and Trend included in the model					
	d Catfat		Ceff		d TPL	
Method	Statistic	P-value	Statistic	P-value	Statistic	P-value
ADF - Fisher Chisquare	59.2898	0,000	13.3426	0,000	9.1028	0,000
PP - Fisher Chisquare	86.4639	0,000	22.6894	0,000	14.8929	0,000
	d GDP		d Real EER		d 3M Tbill	
Method	Statistic	P-value	Statistic	P-value	Statistic	P-value
ADF - Fisher Chisquare	124.9676	0,000	36.1855	0,000	37.0507	0,000
PP - Fisher Chisquare	211.5184	0,000	61.4127	0,000	64.7155	0,000

Notes: This table reports the empirical estimates of the unit root analysis on the variables that were considered in the panel vector autoregressive system (PVAR) as far as the Greek banking sector is concerned. Specifically, 'd Catfat', 'd TPL', 'd GDP', 'd Real EER' and 'd 3M Tbill' refer to the first differences of Liquidity Creation, Total Problem Loans, Gdp Growth Rate, Real Effective Exchange Rate and Three month treasury bill rate respectively, while 'Ceff' refers to the cost efficiency score.

Table 5: Liquidity Creation - Variance Decompositions

		d_catfat2	ceff	d_TPL2	dGdP	d_Real_EER	d_3M_Tbill
UK							
d_catfat2	10	0.78493406	0.04171584	0.11601967	0.01612504	0.00167409	0.03953131
d_catfat2	20	0.78493398	0.04171584	0.11601967	0.01612504	0.00167412	0.03953135
d_catfat2	30	0.78493398	0.04171584	0.11601967	0.01612504	0.00167412	0.03953135
Greece BEFORE the recent consolidation activity							
		d_catfat2	ceff	d_TPL2	dGdP	d_Real_EER	d_3M_Tbill
d_catfat2	10	0.80889784	0.0134512	0.13678105	0.00436625	0.00224342	0.03426025
d_catfat2	20	0.80887736	0.01346604	0.13678158	0.00436657	0.00224787	0.03426058
d_catfat2	30	0.80887619	0.01346662	0.13678185	0.00436659	0.00224809	0.03426066
Greece AFTER the recent consolidation activity							
		d_catfat2	ceff	d_TPL2	dGdP	d_Real_EER	d_3M_Tbill
d_catfat2	10	0.76155485	0.00393531	0.19510167	0.00033914	0.00004538	0.03902365
d_catfat2	20	0.761545	0.00395142	0.19509328	0.00033949	0.00004988	0.03902093
d_catfat2	30	0.7615442	0.00395189	0.19509325	0.0003395	0.00005011	0.03902105

This table reports the variance decompositions of Liquidity Creation with respect to a Bank, a Macroeconomic and a Financial shock, deriving from the panel vector autoregressive (PVAR) system for both the UK and Greek baseline scenario where there is no bank consolidation activity in the sector and the additional baseline scenario that indicates the current conditions of the Greek banking system after the recent wave of Greek banks' M&As. Specifically, 'd Catfat2', 'd TPL', 'd GDP', 'd Real EER' and d 3M Tbill' refer to the first differences of Liquidity Creation, Total Problem Loans (i.e. Bank shock), Gdp Growth Rate (i.e. Macroeconomic shock), Real Effective Exchange Rate (i.e. Financial shock) and Three month treasury bill rate (i.e. Financial shock) respectively, while 'Ceff' refers to the cost efficiency score (i.e. Bank shock). The total effect accumulated is reported over 10, 20 and 30 years.

Table 6: Cost Efficiency - Variance Decompositions

		d_catfat2	ceff	d_TPL2	dGdP	d_Real_EER	d_3M_Tbill
UK							
ceff	10	0.21495877	0.31843069	0.31431747	0.01811352	0.05647597	0.07770357
ceff	20	0.21332242	0.31343812	0.31877367	0.01763171	0.05847431	0.07835977
ceff	30	0.21324806	0.31321167	0.318976	0.01760985	0.05856497	0.07838946
Greece BEFORE the recent consolidation activity							
		d_catfat2	ceff	d_TPL2	dGdP	d_Real_EER	d_3M_Tbill
ceff	10	0.13958527	0.42648238	0.24301	0.02160677	0.0769042	0.09241137
ceff	20	0.13438309	0.42511087	0.24650601	0.0213031	0.0804462	0.09225072
ceff	30	0.13412232	0.42503868	0.24668334	0.02128799	0.08062535	0.09224233
Greece AFTER the recent consolidation activity							
		d_catfat2	ceff	d_TPL2	dGdP	d_Real_EER	d_3M_Tbill
ceff	10	0.16024421	0.31277699	0.28216	0.01264193	0.11817795	0.11399892
ceff	20	0.15620581	0.31057	0.28393777	0.01248	0.12229427	0.11451215
ceff	30	0.15605264	0.31014	0.28434267	0.01247369	0.12246123	0.11452977

This table reports the variance decompositions of Cost Efficiency with respect to a Bank, a Macroeconomic and a Financial shock, deriving from the panel vector autoregressive (PVAR) system for both the UK and Greek baseline scenario where there is no bank consolidation activity in the sector and the additional baseline scenario that indicates the current conditions of the Greek banking system after the recent wave of Greek banks' M&As. Specifically, 'd Catfat2', 'd TPL', 'd GDP', 'd Real EER' and d 3M Tbill' refer to the first differences of Liquidity Creation, Total Problem Loans (i.e. Bank shock), Gdp Growth Rate (i.e. Macroeconomic shock), Real Effective Exchange Rate (i.e. Financial shock) and Three month treasury bill rate (i.e. Financial shock) respectively, while 'Ceff' refers to the cost efficiency score (i.e. Bank shock). The total effect accumulated is reported over 10, 20 and 30 years.

Table 7.a: UK: Half - Life & Total Effect after all three shocks

	Financial Institution 1	Financial Institution 2	Financial Institution 3	Macroeconomic Shock Half Life (years)	Macroeconomic Shock Total Effect (abs. values %)	Financial Shock Half Life (years)	Financial Shock Total Effect (abs. values %)	Bank Shock Half Life (years)	Bank Shock Total Effect (abs. values %)
	Banking System without any M&A			2.651	9.531	1.963	5.234	1.767	4.149
	Banking System with Potential M&A								
_1	HSBC Bank plc	Lloyds TSB Bank Plc	Royal Bank of Scotland Plc (The)	1.415	5.574	0.687	2.247	0.579	2.317
_2	Barclays Bank Plc	HSBC Bank plc	Lloyds TSB Bank Plc	1.274	4.348	0.574	2.695	0.472	1.884
_3	HSBC Bank plc	Royal Bank of Scotland Plc (The)		1.327	4.912	0.698	2.781	0.514	2.142
_4	HSBC Bank plc	Royal Bank of Scotland Plc (The)	Santander UK Plc	1.317	4.774	0.576	2.754	0.497	1.945
_5	Royal Bank of Scotland Plc (The)	Santander UK Plc	Standard Chartered Bank	1.482	7.156	0.679	3.014	0.546	2.689
_6	Barclays Bank Plc	HSBC Bank plc		1.289	4.782	0.579	2.524	0.513	2.063
_7	HSBC Bank plc	Santander UK Plc	Standard Chartered Bank	1.267	4.431	0.537	2.246	0.415	1.289
_8	Barclays Bank Plc	HSBC Bank plc	Santander UK Plc	1.243	4.317	0.528	2.197	0.423	1.374
_9	Barclays Bank Plc	Santander UK Plc	Standard Chartered Bank	1.273	4.371	0.581	2.576	0.464	1.714
_10	HSBC Bank plc	Santander UK Plc		1.297	4.782	0.591	2.768	0.472	1.63
_11	HSBC Bank plc	Standard Chartered Bank		1.301	5.379	0.608	2.943	0.487	1.671
_12	Barclays Bank Plc	HSBC Bank plc	Standard Chartered Bank	1.251	4.387	0.536	2.297	0.427	1.344
_13	Santander UK Plc	Standard Chartered Bank		1.342	5.038	0.624	3.072	0.514	1.749
_14	Barclays Bank Plc	Standard Chartered Bank		1.304	4.864	0.614	3.173	0.519	1.949
_15	Barclays Bank Plc	Santander UK Plc		1.287	4.643	0.597	3.067	0.504	1.884

This table demonstrate those UK prospective combinations of banks' M&A which form a banking sector whose half-life and total effect after all three different types of shocks (i.e Macroeconomic, Financial, Bank) with respect to its 'liquidity creation', is less than the respective ones which derive from a banking system without the presence of those specific potential banks' consolidation activities.

Table 7.b: Greece: Half - Life & Total Effect after all three shocks

		Macroeconomic Shock Half Life (years)	Macroeconomic Shock Total Effect (abs. values %)	Financial Shock Half Life (years)	Financial Shock Total Effect (abs. values %)	Bank Shock Half Life (years)	Bank Shock Total Effect (abs. values %)
	Banking system *Before* recent consolidation activity without any M&A	2.914	17.165	2.557	16.048	1.902	14.165
	Banking system *Before* recent consolidation activity with Potential M&A						
_1	ETHNIKI-AEGEAN	1.598	11.745	0.738	10.314	0.574	8.687
_2	ETHNIKI-PANCREATAN	1.645	12.186	0.791	11.183	0.607	8.988
_3	ETHNIKI-FFB-PROBANK	1.481	10.946	0.677	9.912	0.512	7.841
_4	ETHNIKI-PROBANK	1.694	12.357	0.804	11.008	0.613	9.265
_5	ETHNIKI-FFB-PROBANK-AEGEAN	1.254	9.864	0.548	9.194	0.468	8.191
_6	ETHNIKI-FBB	1.671	12.684	1.048	11.544	0.797	9.384
_7	ALPHA-EMPORIKI-AEGEAN	1.487	11.493	0.867	10.992	0.662	9.461
_8	ALPHA-EMPORIKI-PANCRETAN	1.569	11.717	0.924	11.472	0.704	9.965
_9	ETHNIKI-FFB-PROBANK-PANCRETAN	1.347	10.468	0.716	9.918	0.517	8.716
_10	ETHNIKI-FFB-PROBANK-AEGEAN-PANCRETAN	1.378	11.064	0.847	11.911	0.684	9.684
_11	ALPHA-PANCREATAN	1.617	12.397	1.041	11.986	0.791	10.411
_12	ALPHA-AEGEAN	1.571	12.078	0.976	11.502	0.804	10.485
_13	ALPHA-EMPORIKI	1.643	12.755	1.073	13.411	0.701	9.842
	Banking system *After* recent consolidation activity without any M&A	2.682	21.597	1.166	12.573	1.921	18.208
	Banking system *After* recent consolidation activity with Potential M&A						
_1	ETHNIKI-FFB-PROBANK	2.316	14.699	0.177	7.412	1.613	16.265
_2	ETHNIKI-FFB-PROBANK-AEGEAN	2.186	13.937	0.048	6.694	1.775	17.214
_3	ALPHA-EMPORIKI-AEGEAN	2.379	15.522	0.367	8.492	1.662	16.461
_4	ALPHA-EMPORIKI-PANCRETAN	2.461	16.691	0.424	8.972	1.704	16.965
_5	ETHNIKI-FFB-PROBANK-PANCRETAN	2.287	14.462	0.216	7.418	1.517	15.716
_6	ETHNIKI-FFB-PROBANK-AEGEAN-PANCRETAN	2.428	15.923	0.347	9.411	1.684	16.684
_7	ALPHA-EMPORIKI	2.583	18.461	0.573	10.911	1.701	16.842

This table demonstrate those Greek prospective combinations of banks' M&A which form a banking sector whose half-life and total effect after all three different types of shocks (i.e Macroeconomic, Financial, Bank) with respect to its 'liquidity creation', is less than the respective ones which derive from a banking system without the presence of those specific potential banks' consolidation activities. Results are reported for both states of the Greek banking sector, i.e. with and without accounting for the recent wave of M&As.