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Dynamics of Bank Efficiency in the EU and Southern Mediterranean: Is there a convergence?

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Abstract

Against a background of decades of regulatory reforms aimed at fostering integration, promoting competition, efficiency and productivity growth in the financial industry, both in developed and developing countries, the authors seek to assess the outcomes of these reform processes on the dynamics of bank efficiency – via the estimation of stochastic meta-frontiers – and convergence for a large sample of countries over the period 1997-2010. For the purpose of this analysis, they divide the sample into four 'regions': i) northern Europe; ii) eastern Europe; iii) Mediterranean Europe and iv) MENA. In addition, the authors group the countries in two 'macro areas': northern and eastern Europe and Mediterranean Europe and MENA.

The results seem to indicate efficiency improvements and convergence in the northern and eastern European region, but not in the Mediterranean Europe and MENA region. More specifically, the northern and eastern parts of the EU are much more homogenous in the progressive movement towards a common technology, although significant differences among groups of countries remain. Taken together, the research results suggest that the reform experience of the MENA countries has been less successful than in other developing and transition countries, particularly in eastern Europe.

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Dynamics of Bank Efficiency in the EU and Southern Mediterranean: Is there a convergence?

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1. Introduction

It is a long held belief among economists and policy-makers that financial development can help foster economic development (Pagano, 1993; Levine, 2001; 2004; Demirgüç-Kunt and Levine, 2008). The mechanisms by which financial development affects real growth, however, often differ among theories. These include: i) an improved allocation of savings and investment opportunities; ii) the entry of foreign banks, which in turn fosters iii) an influx of new capital; iv) product and process innovation; v) increased competition and vi) an increased efficiency of the domestic banking system. Indeed, banks' ability to intermediate funds in a cost efficient manner is of fundamental importance to financial development. The emerging consensus in the literature, however, is that, for financial development to be beneficial, certain conditions need to be met, including an adequate and operational regulatory structure, a well-defined supervisory authority, legal systems that reinforce property and creditor rights, restrained control of government over the financial system and macroeconomic stability (Ayadi et al., 2011). To achieve these objectives, governments of developed and developing countries alike have recently undertaken a comprehensive set of financial reforms, aimed at strengthening the resilience of the financial sector and promoting a better allocation of resources within the economy. This often involves fostering integration by removing entry barriers and promoting competition, efficiency and productivity growth in the financial industry. Financial integration is thought to bring a number of benefits, which should lead ultimately to enhanced economic growth.

A key example of the aforementioned process is the deregulation experience of the European Union member states. Since the passing of the First Banking Co-ordination Directive in 1977, EU legislation has been directed towards creating an integrated and competitive European banking system.[1] The monetary union, with the introduction of the euro, contributed to fostering increased integration.[2] Evidence suggests that there has indeed been increased entry of foreign banks; cross-border mergers and acquisitions; enhanced competition and price convergence in many market segments. As a result

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[1] Early EU regulatory developments that have influenced the competitive environment under which EU banks operate include the 1985 White Paper on the Completion of the Internal Market and the 1986 Single European Act. The 1989 Second Banking Coordination Directive sought to enhance competition by establishing EU-wide recognition of single banking licences. Further regulatory initiatives include the Financial Services Action Plan (FSAP) in 1999, which introduced a range of regulatory actions designed to harmonise the EU financial services. In 2005, the EU White Paper on Financial Services Policy (2005-2010) re-emphasised the aim to achieve a fully integrated Single Market in financial services.

[2] The 1992 Maastricht Treaty created the European Union and led to the establishment of the euro currency and the European Central Bank in 1999. Exchange rates between the national currencies were fixed in 1999, and were replaced by the euro by July 2002. The 11 eurozone countries originally participating in the Economic and Monetary Union (EMU) are the following: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Spain, and Portugal. On July 2000 the conversion rates between the euro and the Greek drachma were set as Greece fulfilled the conditions for joining the EMU. Since then, five more countries have adopted the euro: Slovenia on 1 January 2007, Cyprus and Malta on 1 January 2008, Slovakia on 1 January 2009 and Estonia on 1 January 2011.

of these changes, there has also been an increased emphasis on the importance of improved efficiency in the banking sector. Regulatory reforms led the way to the EU enlargement of 2004 and 2007, fostering a process of economic convergence, the harmonisation of regulations and the consolidation and integration of the banking systems of the new EU member states, bringing EU membership from the original six founding nations to a union of 27 member states.[3] During the 1990s and early 2000s, transition economies of Central and Eastern Europe (CEE) underwent remarkable changes due to financial liberalisation programmes and large-scale privatisations of the banking sector, which led to consolidation and entry of foreign banks.

In a similar vein, in recent years, developing countries, mostly following International Monetary Fund (IMF) and/or World Bank inspired programmes, have sought to improve the performance and efficiency of their financial sectors to enhance their overall economic performance. More specifically, the authorities of several countries in the southern Mediterranean regions of the Middle East and North Africa (SEMCs) have engaged in a variety of reforms to modernise their financial sectors. These include restructuring and privatisation of public banks, implementation of prudential regulation and risk management frameworks and enhancing supervisory responsibilities (Ayadi et al., 2011). In addition, governments of some countries have instituted reforms to establish a market-based financial sector, reduce state ownership and allow greater foreign participation (Ben Naceur et al., 2011). Although there is some evidence that these reforms have led to a growth of credit to the private sector, there is also evidence of persistent financial under-development in some countries. Despite the reforms, the financial sector in these countries remains dominated by banks and government ownership is still prevalent. Key problems in the southern Mediterranean countries include poor credit screening and lending practices leading to a high volume of non-performing loans and (in some countries) reduced foreign penetration.

The reform experience of the MENA countries has been less comprehensive and far reaching compared to other developing and transition countries, particularly in Eastern Europe and South Asia, and the economic development of the region is lagging behind. Further privatisation of banks, increased modernisation of the legal and regulatory environment and fuller integration into the global financial sector are seen as long-term solutions to foster growth in the region (Ben Naceur et al., 2011).

It is against this background that we seek to assess the dynamics of bank efficiency for a large sample of countries located in the European Union and in the MENA region over the period 1997 - 2010. For the purpose of this analysis, we divide the sample according to the geographical location of the country in four 'regions': i) northern Europe (which includes: Austria; Belgium; Denmark; Germany; Finland; the United Kingdom; Ireland; the Netherlands and Sweden); ii) Eastern Europe (which includes: Bulgaria; the Czech Republic; Estonia; Hungary; Latvia; Lithuania; Poland; Slovenia and Slovakia); iii) Mediterranean Europe (which includes: Cyprus; Spain; France; Greece; Italy; Malta and Portugal) and finally iv) MENA (which includes: Algeria; Egypt; Israel; Jordan; Lebanon, Libya; Morocco; Syria and Tunisia). Finally we group the countries in two 'macro areas' (Northern & Eastern Europe and Mediterranean Europe & MENA).

The first part of the study examines the dynamics of efficiency for the banking industries of the sample countries. We do so via the estimation of stochastic frontiers. In addition, we recognise the heterogeneous nature of banks technology across countries, and consequently conduct the comparative empirical analysis in the context of a meta-frontier framework (Battese et al., 2004; O'Donnell et al., 2008). In the second part of the analysis, we assess whether the banking systems in our sample countries are converging toward the same efficiency and technology by testing for the existence of β and σ convergence.

[3] In May 2004, eight countries of central and eastern Europe – the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia and Slovakia – join the EU. Cyprus and Malta also become members. Two more countries from eastern Europe, Bulgaria and Romania, join the EU in January 2007.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature. Section 3 explains the models used in the empirical analysis. Section 4 presents the dataset and variables. The results of the empirical investigation are discussed in Section 5, while Section 6 summarises and concludes.

2. Literature review

The key issues addressed in this study are the impact of financial reforms on bank efficiency and convergence. Both concepts are well investigated in the literature. However, only a handful of studies directly address the issue of the relationship between efficiency and convergence.

A. Bank efficiency

There is a vast literature on the evaluation of bank performance and on the measurement of cost structure and efficiency in banking. A review of the early literature is provided by Berger and Humphrey (1997) while more recent literature is reviewed by Berger (2007); and Hughes and Mester (2010). Efficiency is commonly estimated by employing parametric methods (such as Stochastic Frontier Analysis, SFA) or non-parametric methods, the most popular of which is Data Envelopment Analysis (DEA). The bulk of the early studies focus mostly on the US and European banking sectors, whereas more recent literature offers many cross-country studies as well as an increased focus on developing countries. The dramatic restructuring process undertaken by transition countries of CEE also received considerable interest (Grigorian and Manole, 2002; Weill, 2003; Bonin et al., 2005 (a,b); Fries and Taci, 2005; Kasman and Yildirim, 2006; Yildirm and Philippatos, 2007; Brissimis et al., 2008; Fang et al., 2011).

Despite a comprehensive reform programme, the MENA region has received comparatively less attention in the academic literature, although existing studies seem to indicate that banks in the region are still significantly cost inefficient (Ben Naceur et al., 2011; Olson and Zoubi, 2011).

The early bank efficiency literature presenting cross-country studies of bank efficiency levels often assumes that banks in different countries use the same banking production technology and thereby assumes a common production frontier to estimate and compare efficiency across borders. This assumption of technological homogeneity is clearly very strong, and if incorrect, will cause a bias in the estimations. More recent studies have attempted to overcome this problem by integrating country-specific environmental variables into the efficiency estimation (Bikker, 2004; Bos and Kool, 2006). In addition, a handful of recent studies highlights the importance of accounting for cross-country heterogeneity (Bos and Schmiedel, 2007; Kontolaimou and Tsekouras, 2010, Casu et al., 2013).

Our study contributes to the recent literature by carrying out a comprehensive cross-country study, including developed and developing economies (EU, CEE and MENA). We test for and reject the existence of technological homogeneity across countries, so we evaluate efficiency via the estimation of country-specific stochastic frontiers and then apply the meta-frontier approach (Battese et al., 2004; O'Donnell et al., 2008) to compare the technological development of commercial banks in different states and to analyse the existence of technology-spillovers.

B. Convergence

Several studies investigate the existence and implications of financial convergence, especially in relation to the deregulation process, the creation of the single market for financial services and the introduction of the euro. Recent empirical evidence suggests that the sustained legislative changes at the EU level, as well as other major developments such as the introduction of the euro in 1999, have contributed towards the integration of European banking and financial markets (Goddard et al., 2007).

The degree of convergence towards best practice technologies by banks in different countries over time is to some extent driven by the level to which barriers to such convergence exist. Evidence suggests that despite legislative changes and a variety of policy measures to promote integration in European banking, by the end of the 2000s there were still barriers to the creation of a fully integrated

European Single Market in banking and financial services (Gropp and Kashyap, 2009; Casu and Girardone, 2010). Barriers to integration include a lack of consumer trust and confidence; local banks' access to private information about borrowers' creditworthiness; and the bundling of financial services. While there is a general view that competition in EU banking has increased over the last decade or so, it is questionable whether this is reflected in any trend towards the convergence of bank efficiency and productivity across EU countries. Variations in efficiency levels may still exist due to differences in the intensity of competition in specific banking industries; differences between countries in the nature of the business cycle; and in managerial practices. Gropp and Kashyap (2009) propose a new test of integration based on convergence in banks' profitability (return on assets or ROA), based on the assumption that in equilibrium (with well-functioning markets) the expected returns of comparable assets in an economy should be similar. Overall, they conclude, banking markets in Europe appear far from being integrated. A robust alternative to using banks' profitability is to check for convergence in banks' profit or cost efficiency. In this context, Casu and Girardone (2010) utilise dynamic panel methods to explore the extent to which EU bank efficiency is moving toward a common best practice. The results suggest that while there is some evidence of convergence of efficiency levels towards an EU average, there is no evidence of an overall improvement of efficiency levels towards best practice. While only a handful of studies directly address the issue of the relationship between the integration and efficiency (Tortosa-Ausina, 2002; Murinde et al., 2004; Weill, 2009; Mamatzakis et al., 2008.), with the exception of Mamatzakis et al. (2008) previous studies focus on the European Union.

This study contributes to the existing literature by extending the analysis of financial sector integration to all the 27 EU countries as well as countries from the MENA region. The aim is to evaluate the recent dynamics of bank cost efficiency and their convergence both towards best practice and towards 'regional frontiers'. Specifically, we look at convergence patterns in four 'regions': i) northern Europe; ii) eastern Europe; iii) Mediterranean Europe and finally iv) MENA and two 'macro areas' (Northern & Eastern Europe and Mediterranean Europe & MENA).

3. Empirical methodology

3.1 Stochastic Frontier Analysis

From an input minimisation perspective, an efficiency frontier is defined as the minimum level of input(s) for a given level of output(s). The efficiency of a firm is measured as a radial distance D from the frontier such that D = 1 when the firm is fully efficient, and D>1 otherwise.

Since the data for our empirical analysis could not be pooled across different countries, we have estimated stochastic cost frontiers at the country level, followed by supra-national meta-frontiers estimated using the deterministic technique of linear programming.

The stochastic translog cost frontier with two inputs and two outputs was defined as follows:

$$\begin{aligned}\ln C_{it} &= \alpha_0 + \sum_{m=1}^{2}\alpha_m \ln y_{mit} + \sum_{j=1}^{2}\beta_j \ln w_{jit} + \sum_{m=1}^{2}\sum_{q=1}^{2}\alpha_{mj} \ln y_{mit} \ln y_{qit} + \\ &+ \sum_{n=1}^{3}\sum_{j=1}^{3}\beta_{nk} \ln w_{nit} \ln w_{jit} + \sum_{j=1}^{3}\sum_{m=1}^{2}\gamma_{jm} \ln w_{jit} \ln y_{mit} + \\ &+ \lambda_1 T + \lambda_2 T^2 + \sum_{m=1}^{2}\theta_m T \ln y_{mit} + \sum_{j=1}^{3}\zeta_j T \ln w_{jit} + \sum_{p}^{P}\eta_p E_{it} + v_{it} + u_{it}\end{aligned} \quad (1)$$

In Equation (1) C_{it} is the observed total cost of bank *i* at time *t*; it is expressed as a function of two outputs *y* (total loans and other earning assets), the prices of two inputs *w* (the cost of funding; the cost of labour, capital and other administrative costs), time *T* which enters the equation quadratically and is also interacted with the outputs and input prices variables; and finally a vector *E* of control variables

such as: GDP per capita, GDP growth, banking concentration (the share of three largest banks of the assets of all commercial banks), the ratio of deposit money bank assets to GDP, the equity to assets ratio, deposits to loans ratio, liquidity ratio, the level of fixed assets and finally dummy variables to identify public and foreign banks when possible. Linear homogeneity in inputs prices as required by microeconomic theory is imposed prior to estimation. Equation (1) has a composite error term given by the sum of noise v_{it} ~N(0, σ^2) and inefficiency u_{it} (Aigner et al., 1977; Meeusen and Van den Broek, 1977). The distributional assumptions for u_{it} and its modelling as having a variable mean or variance have been based on LR tests if the hypothesis were nested, and on the Akaike criterion otherwise.

The estimation of national frontiers leads to the calculation of cost efficiency values for each bank in each country in each year (EFF_{it}). Since these values come from separate national frontiers they cannot be compared between countries. In order to make some meaningful cross-country comparisons we have then estimated meta-frontiers at the supra-national level. The idea behind a meta-frontier is that an ideal 'best' meta-technology does exist that is available to all the groups in the sample (in our case to the various countries), even if they are not all using it. In other words it allows for the theoretical possibility of technological spillovers. Its estimation, and in particular the calculation of Technical Gap Ratios (TGR), allows one to measure how far each country is from this best meta-technology.

The meta-frontier is derived as the envelope of the single-country frontiers by linear programming. Define:

$$C_{it}^{k} = \exp(X_{it}\beta^{k})\exp(v_{it}^{k} + u_{it}^{k}) \tag{2}$$

as the *k*-th country cost frontier, that depends on a matrix of independent variables *X* and a vector of country-specific parameters β^k. The meta-frontier is defined as the envelope of the *k* estimations of Equation (2):

$$C_{it}^{*} = f(X_{it}\beta^{*}) = \exp(X_{it}\beta^{*}) \tag{3}$$

Equation (3) has the same functional form of Equation (2) and a vector of parameters β^* satisfying:

$$X_{it}\beta^{*} \leq X_{it}\beta^{k} \tag{4}$$

This means that by construction the meta-technology will always give the minimum possible cost among all the groups. As we said (3) and (4) are estimated by the deterministic technique of linear programming.

The distance of each bank from the meta-frontier is called meta-efficiency (EFF_{it}^*) and it is defined as the product of its national cost efficiency (EFF_{it}) and the Technical Gap Ratio (TGR), that is

$$EFF_{it}^{*} = TGR \times EFF_{it} \tag{5}$$

The TGR is a measure of the distance between the country frontier and the metafrontier and it is ≤ 1 with higher values indicating closer proximity to the best available technology and vice versa.

3.2 Convergence analysis

We assess whether the banking systems in our samples are converging toward the same efficiency and TGR levels by testing for the existence of β and σ convergence in the short run (i.e. year by year). Testing for β convergence means testing for the speed in the growth of a certain variable, in this case a measure of performance; in other words β convergence means that countries with initially lower performance levels grow faster than countries with higher performance levels thus catching up (i.e. converging) with the latter. If the steady state performance levels towards which the countries are moving are the same we talk of absolute convergence; if they differ we talk of conditional convergence. σ convergence instead consists of a reduction in the dispersion in the levels of

performance among countries over time. Both β and σ convergence should be found to be able to conclude that convergence exists.

To test for β convergence we estimate the following equation:

$$\ln Z_{i,t} - \ln Z_{i,t-1} = \gamma_0 + \lambda \ \ln Z_{i,t-1} + \gamma_i D_i + \varepsilon_{i,t} \tag{6}$$

where $Z_{i,t}$ is the performance measure under scrutiny: the average efficiency, or meta-efficiency or TGR level of country i at time t. The Ds are country dummies which we introduce to allow for country-conditional convergence. Absolute β-convergence is found if $\lambda < 0$ and $\gamma_i = 0$, and conditional β convergence is found if $\lambda < 0$ and γ_i is $\neq 0$. To confirm the existence of a process of convergence as opposed to one of mean-reversion, σ-convergence must also be present. To test for σ-convergence we follow Lichtenberg (1994) and calculate

$$c = \frac{R^2}{(1+\lambda)^2} \sim F^{NT-k}_{NT-k} \tag{7}$$

based on the results of (6), under the null hypothesis of σ-convergence.

Equation (6) is estimated with respect to cost efficiency (the average distance of banks from their own country frontier), TGR (the average distance between national frontiers and the meta-frontier) and meta-efficiency (the distance of a bank from the meta-frontier). As we do with the meta-frontiers, we look at the four blocks separately first (northern Europe, eastern Europe, Mediterranean Europe and MENA countries respectively) and then at two larger groupings (northern & eastern Europe and Mediterranean Europe & MENA).

4. Data

Our dataset encompasses a period during which many structural and regulatory changes were carried out both within the EU and in the MENA region. Data were collected from banks' annual balance sheets and income statements made available via the Bankscope database over the period 1997 to 2010. This dataset presents a number of challenges, particularly in terms of creating consistent time series, as the definition of some of the variables of interest changed with the adoption of International Financial Reporting Standards (IFRS).[4] In an effort to ensure consistency, our sample considers only commercial banks. Data were revised for reporting errors, inconsistencies and missing values. In addition, we apply a number of filters: i) we exclude banks with missing data on relevant accounting variables, including assets, loans, other earning assets, deposits, equity, interest income and non-interest income; ii) to ensure that the results are not driven by outliers, we restrict our analysis to commercial banks with a loan to assets ratio greater than 10%; iii) we eliminate those banks that operate mainly as credit specialists, or which provide asset management and private banking services as their main activity; iv) we eliminate foreign branches if the bank does not have retail operations in a specific country; v) if banks underwent M&A during the sample period they were treated as separate units until the M&A.

The final sample covers 39407 bank year observations for commercial banks operating in the 33 sample countries for the period 1997 to 2010, thus providing a maximum of 14 time-series observations on each bank.[5] All data are in euro and deflated using the domestic GDP deflator with 2005 as a base year.

[4] Most banks in the sample stopped reporting their accounts using Generally Accepted Accounting Principles (GAAP) over the sample period. From January 1st, 2005, all EU-listed banks were required to implement IFRS and most large unlisted banks also switched to IFRS.

[5] Having applied the above filters and for other data reasons we could not include Luxemburg, Romania,

Table 1. Descriptive statistics of main variables

	TC	Loans	OEA	Int. cost	Non int. cost	Eq/ asst	Loans/ Dept	Liq. ratio	Total Assets
AT	14.75	188.33	113.65	0.03	0.02	0.07	0.69	1.22	327.61
BE	66.00	662.77	688.02	1.66	0.01	0.06	0.55	0.45	1572.32
BG	17.18	111.51	89.41	0.03	0.04	0.13	0.66	9.80	252.64
CY	57.79	484.52	268.89	0.05	0.03	0.06	0.62	5.78	740.64
CZ	80.40	723.86	638.41	0.03	0.02	0.07	0.77	2.14	1618.93
DE	23.15	261.50	150.65	0.03	0.02	0.05	0.69	2.44	446.10
DK	15.68	171.51	76.45	0.03	0.04	0.13	0.79	1.69	271.11
DZ	88.32	623.76	383.39	0.01	0.02	0.09	0.62	20.59	1987.88
EE	25.29	136.04	112.91	0.03	0.04	0.10	0.83	10.99	265.07
EG	82.69	473.56	488.23	0.06	0.02	0.09	0.57	2.97	1290.30
ES	204.50	3284.83	1192.53	0.03	0.02	0.07	0.85	2.45	4933.42
FIN	886.28	11172.17	6288.13	0.03	0.02	0.06	0.92	2.20	23173.70
FR	189.58	1964.38	770.94	0.03	0.02	0.07	0.80	1.17	3451.83
GB	362.75	2918.48	1822.72	0.04	0.02	0.07	0.68	1.10	6787.39
GR	191.87	1811.23	673.04	0.03	0.02	0.08	0.93	3.87	2816.25
HU	82.60	459.54	322.12	0.06	0.04	0.09	0.75	4.62	771.63
IE	613.70	7959.72	7787.00	0.03	0.01	0.05	0.80	1.66	19227.00
IL	234.96	2929.15	823.51	0.04	0.02	0.06	0.84	8.02	4053.77
IT	94.18	1234.73	467.51	0.03	0.03	0.08	1.02	1.15	1888.00
JO	62.66	527.54	466.62	0.04	0.02	0.12	0.64	10.52	1256.54
LB	31.22	127.13	210.63	0.06	0.02	0.08	0.34	16.42	476.67
LV	15.91	111.22	113.30	0.02	0.03	0.09	0.55	7.08	277.31
LY	35.11	593.87	846.04	0.01	0.01	0.05	0.37	5.70	2795.50
MA	174.97	2277.61	878.54	0.02	0.02	0.09	0.79	7.90	3915.22
MT	20.60	291.88	251.55	0.03	0.02	0.08	0.63	5.01	591.13
NL	187.05	1855.93	1387.74	0.05	0.01	0.07	0.71	1.75	3672.45
PL	92.51	620.75	404.25	0.05	0.04	0.10	0.65	4.58	1282.26
PT	169.17	1382.27	875.28	0.04	0.02	0.07	0.78	1.93	3140.10
SE	5.59	107.69	28.18	0.02	0.02	0.13	0.93	0.85	144.36
SI	49.21	537.36	287.31	0.04	0.03	0.09	0.75	3.48	921.11
SK	86.57	721.00	484.89	0.04	0.03	0.08	0.56	2.61	1282.15
SY	19.62	199.49	224.22	0.02	0.01	0.08	0.53	24.23	615.78
TN	58.62	848.85	189.84	0.04	0.02	0.10	0.92	2.99	1199.16

All variables are in million euro and are deflated using 2005 as base year. TC = Total Costs; Loans = Total Loans; OEA = Other Earning Assets; Int. cost = Total interest costs; Non int. cost = Total non-interest costs;Eq/asst = ratio of Equity to Total Assets; Loans/Dept = Loans to Deposit ratio; Liq. ratio = Liquidity ratio; Total Assets.

AT = Austria; BE = Belgium; BG = Bulgaria; CY = Cyprus; CZ = Czech Republic; DE = Germany; DK = Denmark; DZ = Algeria; EE = Estonia; EG= Egypt; ES = Spain; FIN = Finland; FR = France; GB = Great Britain; GR = Greece; HU = Hungary; IE = Ireland; IL = Israel; IT = Italy; JO= Jordan; LB = Lebanon; LV = Latvia; LY = Libya; MA = Morocco; MT = Malta; NL = the Netherlands; PL = Poland; PT = Portugal; RO = Romania; SE = Sweden; SI = Slovenia; SK = Slovakia; SY = Syria; TN = Tunisia.

Source: Data from Bankscope; authors' estimations.

5. Empirical results

This section presents the results of our empirical analysis of bank efficiency and convergence in the European Union and MENA countries. The first part of the efficiency analysis consists of estimating

Lithuania and Turkey in the final data set.

Equations (1) and (2) at the country level,[6] so the efficiency scores reflect the distance from different (national) benchmarks. Equation (1) is estimated by Maximum Likelihood (ML), with linear homogeneity in input prices and Young's symmetry imposed prior to estimation. The results show that the cost function is always consistent with its theoretical properties, inputs and outputs point elasticities have the expected sign and inefficiency is always significant. The second part of the efficiency analysis relates to the findings derived from the estimation of a meta-frontier. As discussed in Section 3.1, the meta-frontiers are derived by estimating Equation (3) subject to Equation (4) by linear programming; the meta-efficiency score of a bank is its distance from the meta-frontier and it is defined in equation (5) as the product of its country-specific efficiency score and the TGR. We first estimate four meta-frontiers, one for each of the four blocks of the analysis (northern Europe, eastern Europe, Mediterranean Europe and MENA countries). We then group them into two larger sets (northern Europe & eastern Europe and Mediterranean Europe & MENA countries). We cannot estimate a global meta-frontier using all the countries in the sample as the results do not comply with economic theory.

5.1 Efficiency, meta-efficiency and TGRs: Mediterranean Europe & MENA countries

In this section we present the analysis of single-country efficiency, meta-efficiency and technology gap ratios for the Mediterranean Europe and MENA countries. Table 2 presents the efficiency scores (Column 1) the TGRs (Column 2) and the meta efficiency scores (Column 3) for the banking industries of countries located in Mediterranean Europe (Panel A: Mediterranean Europe) and in the MENA region (Panel B: MENA). Recall that "Efficiency" relates to the distance from the single-country frontier; "Meta-efficiency" relates to the distance to the meta-frontier; and Technology Gap ratios (TGRs) measure the distance between the country and meta-frontier.

Table 2. Efficiency, meta-efficiency and TGRs

	Efficiency			**TGR**			**Meta-Efficiency**			**No of obs**
	Min	*Mean*	*Max*	*Min*	*Mean*	*Max*	*Min*	*Mean*	*Max*	*Total*
Panel A: Average efficiency, TGR and Meta-efficiency scores for Mediterranean Europe banking industries										
CY	0.955	0.973	0.985	0.783	0.845	0.877	0.767	0.822	0.856	138
ES	0.963	0.971	0.976	0.908	0.926	0.938	0.883	0.899	0.917	1215
FR	0.93	0.941	0.952	0.82	0.892	0.926	0.764	0.841	0.877	2791
GR	0.965	0.977	0.985	0.633	0.737	0.799	0.618	0.72	0.784	194
IT	0.939	0.961	0.97	0.845	0.872	0.889	0.815	0.838	0.854	1821
MT	0.899	0.959	0.994	0.792	0.829	0.864	0.712	0.795	0.851	44
PT	0.973	0.982	0.989	0.789	0.818	0.841	0.774	0.804	0.831	249
Panel B: Average efficiency, TGR and Meta-efficiency scores for MENA banking industries										
DZ	0.861	0.919	0.986	0.745	0.843	0.952	0.654	0.774	0.873	93
EG	0.989	0.991	0.992	0.653	0.836	0.924	0.647	0.829	0.917	334
IL	0.95	0.973	0.992	0.299	0.378	0.496	0.291	0.368	0.475	138
JO	0.987	0.989	0.991	0.712	0.79	0.834	0.706	0.782	0.827	133
LB	0.966	0.979	0.987	0.73	0.888	0.953	0.706	0.871	0.934	496
LY	0.188	0.64	0.993	0.364	0.615	0.999	0.14	0.366	0.883	16
MA	0.93	0.972	0.989	0.67	0.824	0.929	0.643	0.802	0.911	110
SY	0.878	0.956	0.984	0.638	0.758	0.999	0.581	0.726	0.975	38
TN	0.966	0.982	0.992	0.836	0.856	0.867	0.817	0.841	0.856	149

[6] The small sample size in some cases made it necessary to group some countries together. This was done for Cyprus and Malta; Algeria and Libya; Syria and Jordan; Latvia and Estonia.

Mediterranean Europe includes: CY = Cyprus; ES = Spain; FR = France; GR = Greece; IT = Italy; MT = Malta; PT = Portugal. MENA includes: DZ = Algeria; EG = Egypt; IL = Israel; JO= Jordan; LB = Lebanon; LY = Libya; MA= Morocco; SY = Syria; TN = Tunisia.

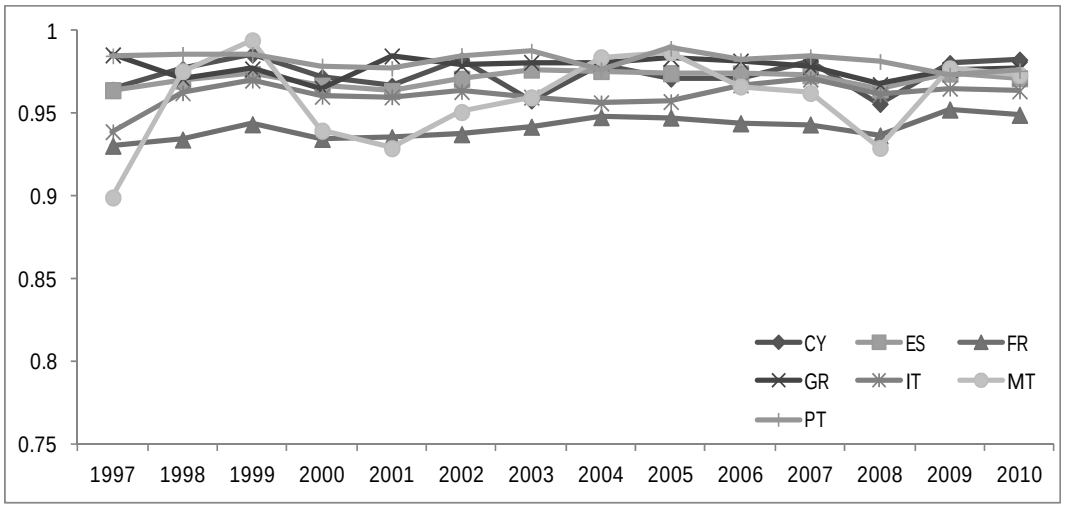
Efficiency is the distance from the country frontier. Meta-efficiency is the distance from the meta-frontier. Technology Gap Ratios (TGRs) measure the distance between the country and meta-frontier. Meta-efficiency is the product of Efficiency and TGR.

Source: Data from Bankscope; authors' estimations.

For the results presented in Panel A (Mediterranean Europe) the meta-frontier relates to the envelope of the single-country frontiers for: Cyprus; Spain; France; Greece; Italy; Malta and Portugal. For the results presented in Panel B (MENA) the meta-frontier relates to the envelope of the single-country frontiers for: Algeria; Egypt; Israel; Jordan; Lebanon; Libya; Morocco; Syria and Tunisia.

Looking at single-country efficiency scores for the Mediterranean Europe countries, with the exception of Malta, the results do not show relevant changes during the sample period (see Figure 1). Average levels are relatively high and tend to remain stable over time.

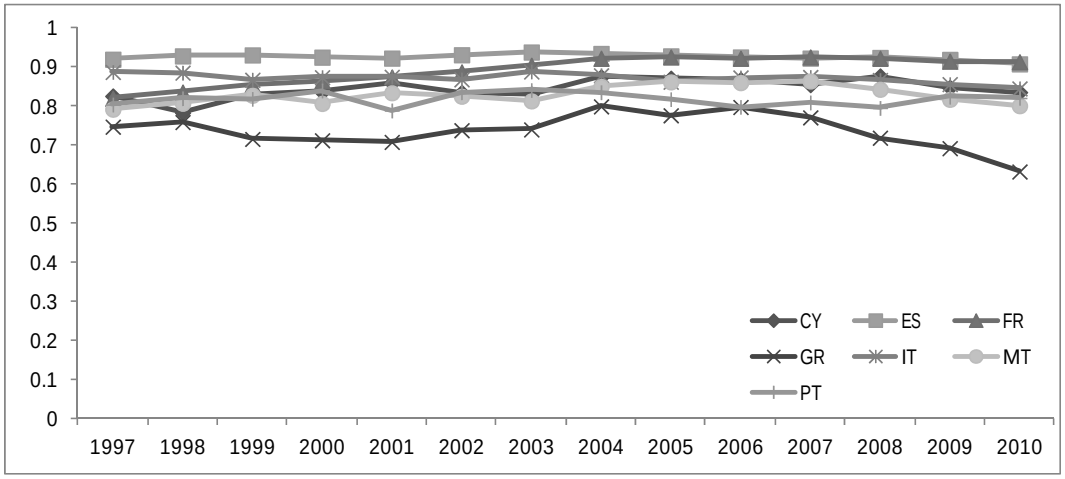
Figure 1. Single-country efficiency scores: Mediterranean Europe



Source: Data from Bankscope; authors' estimations.

More interesting in our context is the analysis of TGR values across countries and time, as they indicate differences in technological levels. Figure 2 illustrates the trend of TGRs over the sample period. In the Mediterranean Europe area, the meta-technology is dominated by Spanish banks which, on average, are consistently displaying TGRs higher than 0.9. French banks are closing the gap towards the end of the sample period, as they display increasing TGRs. Interestingly, the results identify that Greek banks have consistently lower TGRs compared to other banking industries, and the gap increases from 2006 onwards. These results could be driven by the fact that the Greek banking sector is relatively small and highly concentrated, but could also reflect the fact that Greek banks were encountering a period of turmoil prior to the current sovereign crisis faced by the Greek economy. Figure 2 therefore suggests the existence of moderate, but possibly persistent, differences in TGR levels at least between groups of countries.

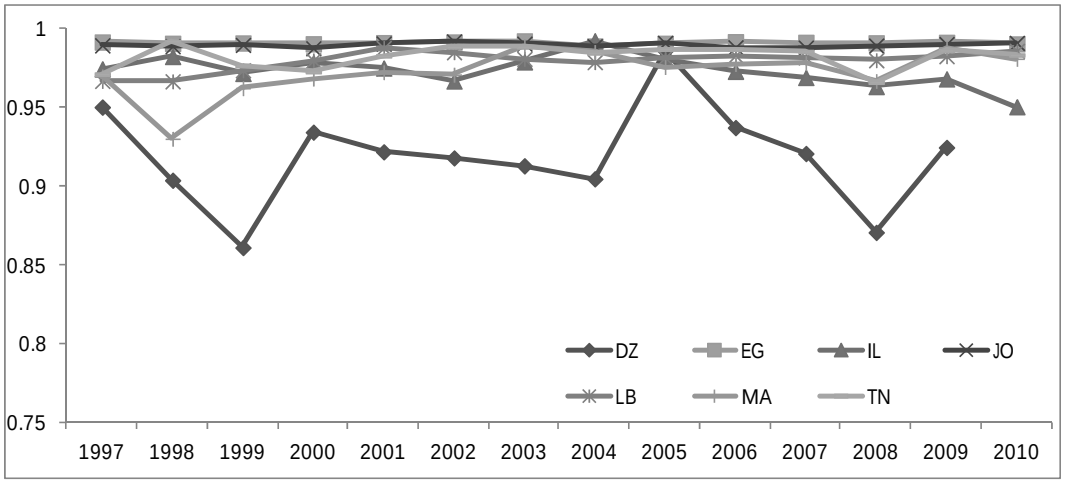
Figure 2. TGRs Mediterranean Europe



Source: Data from Bankscope; authors' estimations.

Figures 3 illustrates the trends for the single-country efficiency scores for the MENA region. For the purpose of presenting the results in a time-series graph, we removed Libya and Syria from the sample as their data series were incomplete, with missing values over a number of years. With the exception of Algeria, the results do not show relevant changes during the sample period. Most countries' efficiency scores are consistently close to unity, indicating efficiency relative to their own national technology. However, these results need to be treated with caution as in some countries the number of banks is remarkably small.

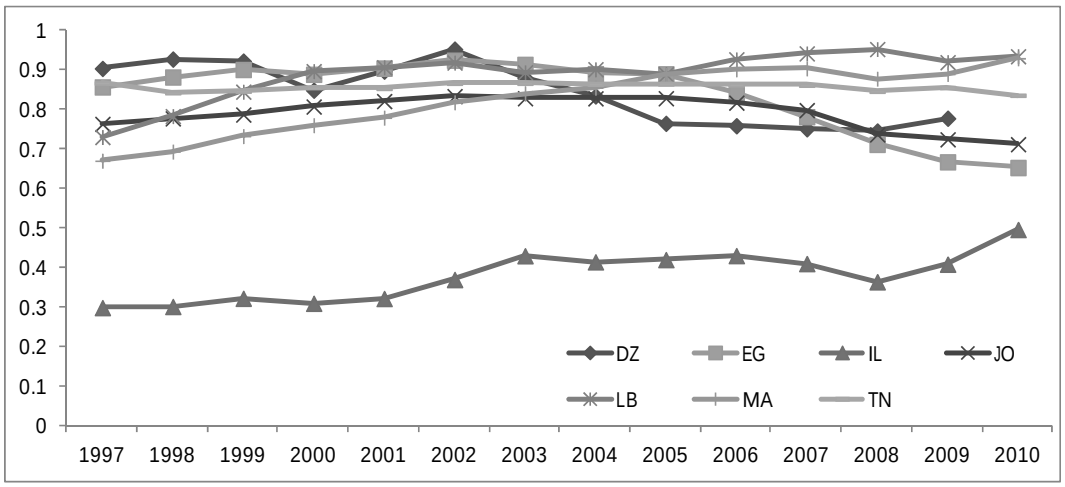
Figure 3. Single-country efficiency scores: MENA countries



Source: Data from Bankscope; authors' estimations.

Figure 4 illustrates the trend of TGRs for MENA countries over the sample period, again without Libya and Syria. At the beginning of the sample period Egyptian banks score much better than other countries, with TGRs above 0.85. This trend reverses in the early 2000s when Egyptian banks TGRs deteriorate, indicating that the gap between the meta-frontier and the national one widens progressively. On the other hand, banks in Lebanon and Morocco display a better performance as their respective TGRs increase over time. The worst performer in the sample is Israel, with the lowest TGR values all along, although a positive improvement can be seen towards the end of the time series. Such extreme results for Israel are quite unexpected and could indicate that Israeli banks are using a completely different technology from the rest of the MENA countries. As we said above, a word of caution is due here since the data series for the MENA countries are rather volatile leading at times to question their reliability.

Figure 4. TGR: MENA



Source: Data from Bankscope; authors' estimations.

The next step of the analysis is to investigate how the banks in the different Mediterranean Europe and MENA countries would fare if the reference technology was the over-arching frontier encompassing all the countries in the SMCs region (i.e. the meta-frontier envelopes the single-country frontiers for: Cyprus; Spain; France; Greece; Italy; Malta and Portugal; Algeria; Egypt; Israel; Jordan; Lebanon; Libya; Morocco; Syria and Tunisia). The results of this part of the analysis are reported in Table 3.

Table 3. Efficiency, meta-efficiency and TGRs (Mediterranean Europe and Mena)

	Efficiency			**TGR**			**Meta Efficiency**			**No of obs**
	Min	*Mean*	*Max*	*Min*	*Mean*	*Max*	*Min*	*Mean*	*Max*	*Total*
CY	0.955	0.973	0.985	0.597	0.708	0.756	0.586	0.689	0.730	138
ES	0.963	0.971	0.976	0.533	0.755	0.858	0.516	0.736	0.830	1215
FR	0.934	0.945	0.985	0.68	0.735	0.775	0.639	0.699	0.736	2791
GR	0.965	0.977	0.985	0.606	0.695	0.773	0.594	0.680	0.750	194
IT	0.939	0.961	0.97	0.677	0.747	0.827	0.652	0.721	0.779	1821
MT	0.899	0.959	0.994	0.628	0.763	0.889	0.607	0.732	0.856	44
PT	0.973	0.982	0.989	0.511	0.667	0.766	0.507	0.658	0.754	249
DZ	0.861	0.919	0.986	0.318	0.478	0.671	0.293	0.432	0.614	93
EG	0.989	0.991	0.992	0.432	0.651	0.749	0.428	0.645	0.743	334
IL	0.95	0.973	0.992	0.48	0.682	0.838	0.468	0.665	0.808	138
JO	0.987	0.989	0.991	0.475	0.65	0.767	0.470	0.643	0.758	133
LB	0.966	0.979	0.987	0.583	0.696	0.791	0.576	0.683	0.775	496
LY	0.188	0.640	0.993		0.195	0.999		0.122	0.883	16
MA	0.930	0.972	0.989	0.583	0.670	0.772	0.568	0.652	0.757	110
SY	0.878	0.956	0.984	0.118	0.401	0.581	0.116	0.381	0.566	38
TN	0.966	0.982	0.992	0.534	0.710	0.791	0.519	0.697	0.781	149

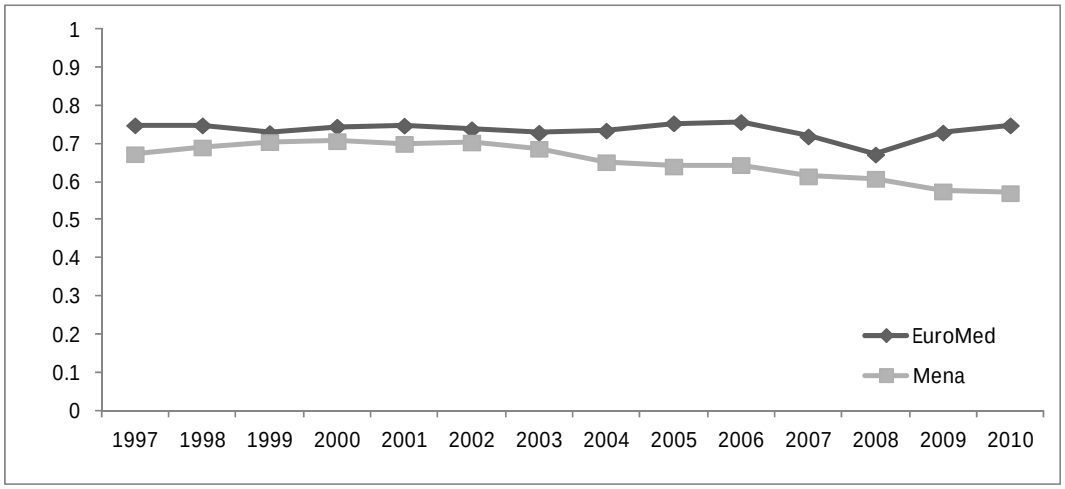
Mediterranean Europe + MENA includes: CY = Cyprus; ES = Spain; FR = France; GR = Greece; IT = Italy; MT = Malta; PT = Portugal; DZ = Algeria; EG = Egypt; IL = Israel; JO= Jordan; LB = Lebanon; LY = Libya; MA= Morocco; SY = Syria; TN = Tunisia.

Efficiency is the distance from the country frontier. Meta-efficiency is the distance from the meta-frontier. Technology Gap Ratios (TGRs) measure the distance between the country and meta-frontier. Meta-efficiency is the product of Efficiency and TGR.

Source: Data from Bankscope; authors' estimations.

Figure 5 illustrates the trend of TGRs over the sample period relative to the overall Mediterranean Europe & MENA meta-frontier. Mediterranean Europe banking industries have consistently higher TGRs compared to the countries in the MENA region. Interestingly, the gap seems to become bigger from 2003 onwards. Mediterranean Europe TGRs show a decline in the period running up to the global financial crisis (with a dip in 2008) increasing again afterwards. MENA countries show a reduction in TGRs over the latter part of the sample period. Since these averages are across all the banks in each country, this may indicate that technical improvements are shifting the meta-frontier upwards, therefore making it more difficult for some banks and/or banking sectors to catch up. In addition, the technological gap between Mediterranean Europe countries and MENA country seem to increase post-crisis (from 2008 onwards). The results for Israel are now a lot better, suggesting that the possible reason for the poor performance of Israeli banks in terms of TGRs previously discussed was indeed a significant difference in technology between Israel and the other countries in the MENA region.

Figure 5. TGRs: Mediterranean Europe and Mena



Source: Data from Bankscope; authors' estimations.

5.2 Efficiency, meta-efficiency and TGR: Northern and Eastern Europe

In this section we present the analysis of single-country efficiency, meta-efficiency and technology gap ratios for the northern and eastern European countries, first separately and then looking at the region as a whole.

Table 4 presents the efficiency scores (column 1) the TGRs (column 2) and the meta efficiency scores (column 3) for the banking industries of countries located in northern Europe (Panel A: northern Europe) and in eastern Europe (Panel B: eastern Europe). For the results presented in Panel A (northern Europe) the meta-frontier relates to the envelope of the single-country frontiers for: Austria, Belgium, Germany, Denmark, Finland, Great Britain, Ireland, the Netherland and Sweden. For the results presented in Panel B (eastern Europe) the meta-frontier relates to the envelope of the single-country frontiers for: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Poland, Slovenia and Slovakia).

Table 4. Efficiency, meta-efficiency and TGR: Northern and Eastern European banking industries

	Efficiency			**TGR**			**Meta Efficiency**			**No of obs**
	Min	*Mean*	*Max*	*Min*	*Mean*	*Max*	*Min*	*Mean*	*Max*	*Total*
Panel A: Average efficiency, TGR and Meta-efficiency scores for northern European banking industries										
AT	0.962	0.975	0.982	0.725	0.861	0.936	0.709	0.840	0.920	2413
BE	0.99	0.993	0.994	0.604	0.681	0.749	0.601	0.676	0.745	207
DE	0.997	0.997	0.997	0.334	0.582	0.775	0.333	0.58	0.772	21756
DK	0.928	0.946	0.965	0.694	0.802	0.881	0.646	0.757	0.843	1239
FI	0.932	0.958	0.987	0.621	0.744	0.916	0.596	0.713	0.879	87
GB	0.954	0.973	0.978	0.559	0.687	0.904	0.542	0.669	0.884	540
IE	0.904	0.966	0.984	0.553	0.731	0.829	0.495	0.708	0.808	104
NL	0.962	0.975	0.982	0.725	0.861	0.936	0.709	0.84	0.920	261
SE	0.990	0.993	0.994	0.604	0.681	0.749	0.601	0.676	0.745	868
Panel B: Average efficiency, TGR and Meta-efficiency scores for eastern European banking industries										
BG	0.871	0.941	0.976	0.826	0.872	0.945	0.721	0.821	0.875	231
CZ	0.89	0.933	0.962	0.494	0.715	0.869	0.46	0.672	0.832	58
EE	0.967	0.978	0.984	0.66	0.799	0.937	0.649	0.781	0.915	280
HU	0.956	0.961	0.965	0.843	0.884	0.937	0.811	0.851	0.904	190
LV	0.958	0.978	0.988	0.732	0.839	0.948	0.715	0.821	0.931	430
PL	0.967	0.975	0.982	0.767	0.83	0.884	0.747	0.810	0.855	207
SI	0.968	0.979	0.989	0.817	0.873	0.917	0.791	0.855	0.903	164
SK	0.976	0.981	0.986	0.766	0.860	0.906	0.75	0.844	0.890	2413

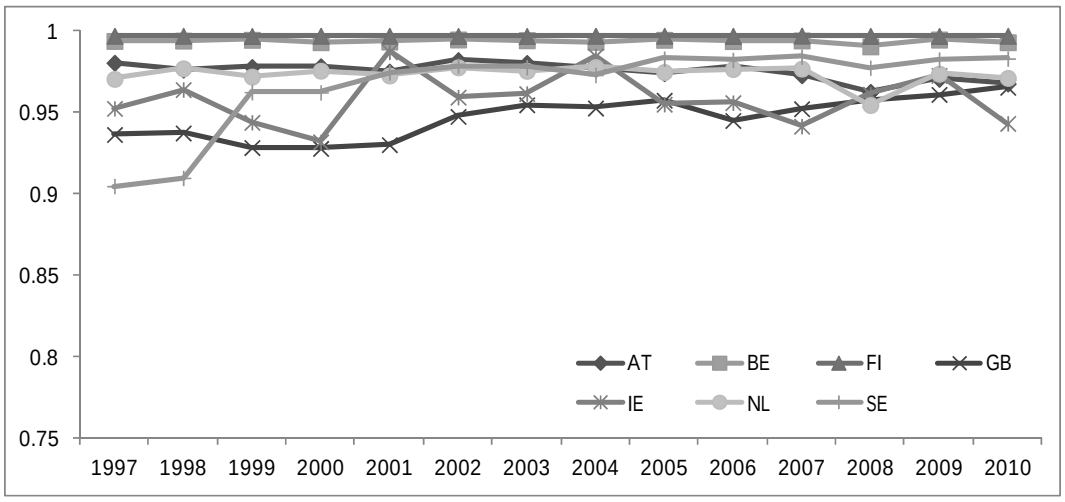
Northern Europe includes: AT = Austria; BE = Belgium; DE = Germany; DK = Denmark; FIN = Finland; GB = Great Britain; IE = Ireland; IL = Israel; NL = the Netherlands; SE = Sweden. Eastern Europe includes: BG = Bulgaria; CZ = Czech Republic; EE = Estonia; HU = Hungary; LV = Latvia; PL = Poland; SI = Slovenia; SK = Slovakia.

Efficiency is the distance from the country frontier. Meta-efficiency is the distance from the meta-frontier. Technology Gap Ratios (TGRs) measure the distance between the country and meta-frontier. Meta-efficiency is the product of Efficiency and TGR.

Source: Data from Bankscope; authors' estimations.

Figures 6 illustrates the trends for the single-country efficiency scores for the Northern European region. Single-country efficiency scores for the northern countries also show little change over the sample period. The banking industries of Belgium and Finland display efficiency scores consistently close to unity (which can be driven by the fact that both countries have a highly concentrated banking sector with few very large banks). The banking industry in Sweden displays the greater improvement in efficiency scores, possibly as a consequence of the recovery of the sector from the crisis it underwent in the early 1990s.

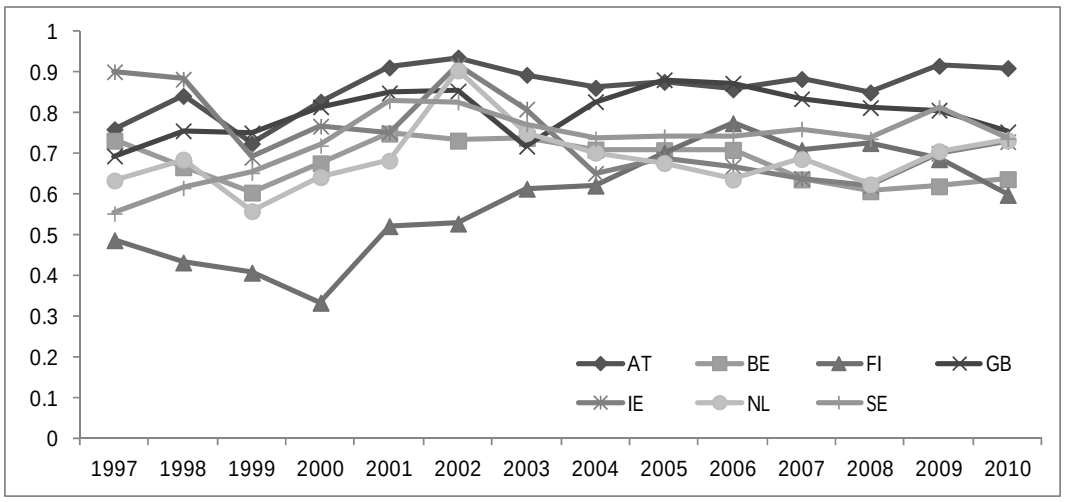
Figure 6. Single-country efficiency scores: Northern Europe



Source: Data from Bankscope; authors' estimations.

Figure 7 illustrates the trend of TGRs for Northern European countries over the sample period. Looking at banking sectors with the higher TGRs at the beginning of the sample period, the results indicate that Irish and Austrian banks score much better than other countries (with TGRs at around 0.8). The performance of Austrian banks remains consistently good over the sample period and in 2010 the average TGRs for Austrian banks is at around 0.9. On average, the lowest TGR is found in Finland: again this could be because its banking system is relatively small and highly concentrated. Finnish banks however seem to catch up and by the mid-2000s their TGRs are similar to those of Belgian and Dutch banks (although the trend reverses again towards the end of the sample period).

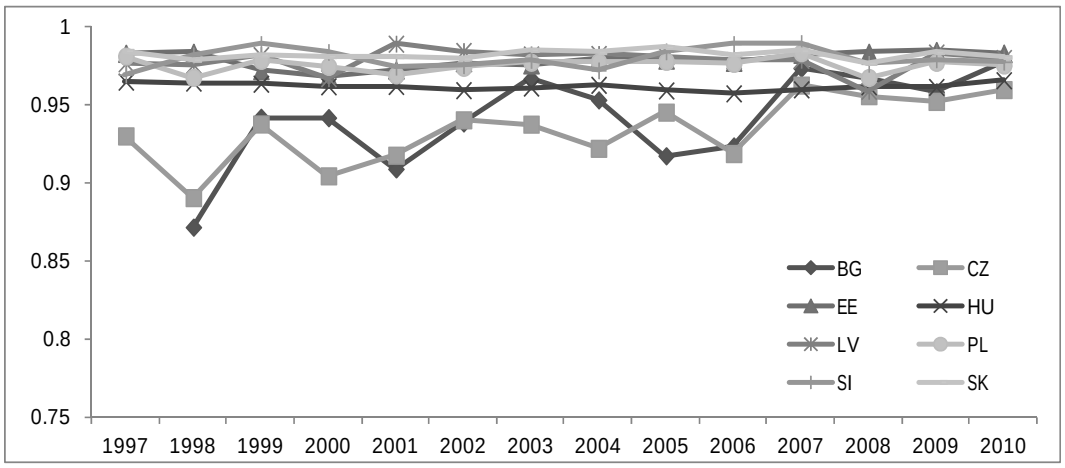
Figure 7. TGRs: Northern Europe



Source: Data from Bankscope; authors' estimations.

Looking now at the efficiency scores of Eastern European banks, we find that banks located in Bulgaria and the Czech Republic significantly underperformed their regional peers in the late 1990s. There is evidence of improved cost efficiency for banks in these countries and by 2010 efficiency levels seem to have converged to the average of the region, at around 0.97.

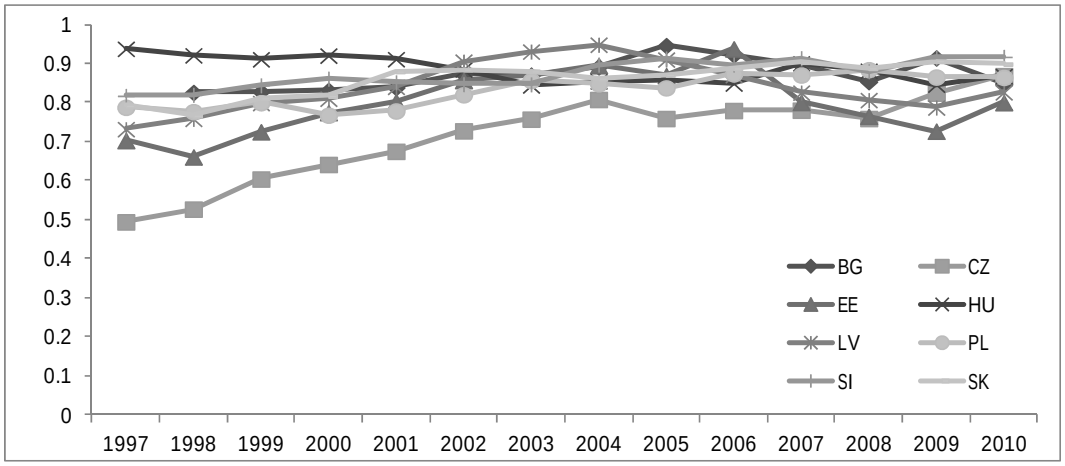
Figure 8. Single-country efficiency scores: Eastern Europe



Source: Data from Bankscope; authors' estimations.

More interesting in this context is the analysis of TGRs, illustrated in Figure 9. At the beginning of the sample period, banks in the Czech Republic have the lower average TGRs at 0.5, indicating that the gap between the national frontier and the meta-frontier is wide. Czech banks, however, steadily reduce the gap and by 2007 their average TGR is in line with the regional average. Looking at Figure 9, TGR figures indicate a convergence towards best practice in the region. This concept will be investigated further in Section 5.3 when we will discuss the result of the convergence analysis.

Figure 9. TGRs: Eastern Europe



Source: Data from Bankscope; authors' estimations.

The final step of the efficiency analysis is to investigate how the banks located in the different Northern and Eastern European countries would fare if the reference technology was the over-arching frontier encompassing all the countries region (i.e. the meta-frontier envelopes the single-country frontiers for: Austria, Belgium, Germany, Denmark, Finland, Great Britain, Ireland, the Netherlands, Sweden, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Poland, Slovenia and Slovakia). The results of this part of the analysis are reported in Table 5.

Table 5. Efficiency, meta-efficiency and TGRs (Northern and Eastern Europe)

	Efficiency			**TGR**			**Meta Efficiency**			**No of obs**
	Min	*Mean*	*Max*	*Min*	*Mean*	*Max*	*Min*	*Mean*	*Max*	*Total*
AT	0.962	0.975	0.982	0.624	0.824	0.907	0.612	0.804	0.883	2413
BE	0.99	0.993	0.994	0.595	0.708	0.789	0.592	0.704	0.784	207

DE	0.982	0.989	0.993	0.705	0.868	0.934	0.7	0.859	0.924	21756
DK	0.984	0.987	0.989	0.534	0.768	0.865	0.528	0.758	0.856	1239
FI	0.997	0.997	0.997	0.387	0.619	0.8	0.386	0.618	0.797	87
GB	0.928	0.946	0.965	0.578	0.725	0.779	0.537	0.684	0.743	540
IE	0.932	0.958	0.987	0.675	0.735	0.78	0.636	0.704	0.748	104
NL	0.954	0.973	0.978	0.596	0.689	0.74	0.577	0.671	0.724	261
SE	0.904	0.966	0.984	0.567	0.703	0.795	0.51	0.68	0.782	868
BG	0.871	0.936	0.976	0.555	0.711	0.846	0.52	0.667	0.789	301
CZ	0.89	0.933	0.962	0.453	0.64	0.764	0.415	0.602	0.71	231
EE	0.967	0.978	0.984	0.475	0.627	0.743	0.468	0.614	0.727	58
HU	0.956	0.961	0.965	0.587	0.776	0.91	0.566	0.746	0.878	280
LV	0.958	0.978	0.988	0.591	0.719	0.858	0.576	0.703	0.843	190
PL	0.967	0.975	0.982	0.646	0.744	0.801	0.63	0.725	0.783	430
SI	0.968	0.979	0.989	0.723	0.813	0.882	0.706	0.797	0.868	207
SK	0.976	0.981	0.986	0.695	0.769	0.818	0.681	0.755	0.801	164

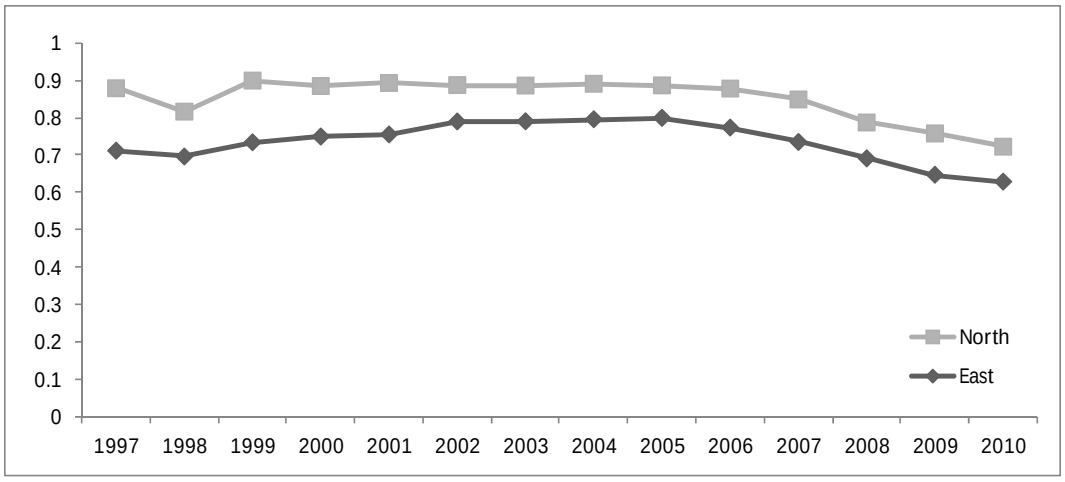
Northern Europe includes: AT = Austria; BE = Belgium; DE = Germany; DK = Denmark; FIN = Finland; GB = Great Britain; IE = Ireland; IL = Israel; NL = the Netherlands; SE = Sweden. Eastern Europe includes: BG = Bulgaria; CZ = Czech Republic; EE = Estonia; HU = Hungary; LV = Latvia; PL = Poland; SI = Slovenia; SK = Slovakia.

Efficiency is the distance from the country frontier. Meta-efficiency is the distance from the meta-frontier. Technology Gap Ratios (TGRs) measure the distance between the country and meta-frontier. Meta-efficiency is the product of Efficiency and TGR.

Source: Data from Bankscope; authors' estimations.

Figure 10 illustrates the trend of TGRs over the sample period relative to the overall northern & eastern meta-frontier. Although the average TGRs for banks located in Northern European countries are consistently higher, the gap seems to be reducing during the early 2000s. Interestingly, the two areas seem to follow a similar trend, with the gap between the meta-frontier and individual countries frontier widening from 2006 onwards, at the onset of the global financial crisis, as indicated by the decline in TGRs.

Figure 10. TGRs: Northern and Eastern Europe



Source: Data from Bankscope; authors' estimations.

Overall, the results of the efficiency analysis so far imply that the technological gap among northern and eastern Europe has narrowed significantly over time, whereas the gap between the Mediterranean Europe countries and the MENA region, after a positive period has widened again in recent years (despite some Mediterranean Europe countries falling behind). In the following section we investigate

further into this issue by testing for the existence of convergence in efficiency, meta-efficiency and technological gap ratios.

5.3 Convergence analysis

We assess whether the banking systems in our sample countries are converging toward the same average efficiency and TGR levels by testing for the existence of β and σ convergence in the short run (i.e. year by year). As explained in Section 3.2, β convergence is tested for by estimating equation (6) with respect to each country's average annual cost efficiency, TGR and meta-efficiency. Conditional convergence is modelled by introducing country-specific dummies, allowing for the possibility of different national steady state levels of performance. The existence of β convergence means that λ in (5) is negative and significant. This convergence is absolute if the countries dummies are not significant, whereas the existence of a different intercept per country (or per sub-group of countries) indicates conditional convergence. Consistently with the meta-frontier analysis, we look first at the four blocks separately (northern Europe, eastern Europe, Mediterranean Europe and MENA countries) and then at two larger groupings (northern & eastern Europe and Mediterranean Europe & MENA). The main results are summarised in Table 6 and can be explained as follows.

Table 6. Convergence analysis

	λ (β convergence)	γ_i (conditional or absolute convergence)	c (σ convergence)
EU North			
Efficiency	-0.550 (0.00)	conditional, in blocks	1.893 (0.00)
TGR	-0.408 (0.00)	conditional, in blocks	0.711 (0.96)
EU East			
Efficiency	-0.760 (0.00)	conditional, in blocks	14.210 (0.00)
TGR	-0.270 (0.00)	absolute	0.630 (0.999)
EU North & East			
Meta Efficiency	-0.373 (0.00)	conditional, in blocks	0.633 (0.999)
TGR	-0.314 (0.00)	almost absolute	0.413 (0.999)
Mediterranean Europe			
Efficiency	-0.99 (0.00)	conditional	0.380 (0.999)
TGR	-0.293 (0.00)	conditional, in blocks	0.500 (0.999)
Mena			
Efficiency	-0.450 (0.00)	almost absolute	1.070 (0.37)
TGR	0.010 (0.112)	none	n.a.
Mediterranean Europe & Mena			
Meta Efficiency	-0.220 (0.00)	almost absolute	0.194 (0.999)
TGR	-0.0760 (0.045)	v. slow almost absolute	0.190 (0.999)

The coefficients are derived from the estimation of equations (5) and (6). P-values in brackets.

Source: Data from Bankscope; authors' estimations.

5.3.1 Mediterranean Europe

For the countries of the Mediterranean European region, we find very fast convergence in efficiency (λ = -0.99) but conditional on the single country especially for the largest economies of the region (France, Italy, Spain). More homogeneity is found in the convergence in TGR levels, where rather than being totally separate from one another the results indicate groupings among the countries, with France, Spain and to a lesser extent Italy on the one hand, and the other countries (in particular Greece), on the other. In other words, as was suggested by Figure 2, convergence in TGR is divided in two blocks, with the largest banking industries converging towards a different steady state level of technical performance.

5.3.2 MENA countries

The sample of the MENA countries is the most fragile of the whole exercise, with a very small number of observations and a great deal of missing values. Here we find full (i.e. absolute) convergence in efficiency but not in TGR values, unless we remove Libya and Syria from the sample as both countries have very incomplete data series. This means that the progress towards a common best technology for the MENA countries is at best very slow, if at all significant, whereas all show similar patterns of efficiency when it comes to their own country frontiers, as we saw in Figure 3.

5.3.3 Mediterranean Europe and MENA countries

When we put all these countries together to form a global meta-frontier,[7] we find an almost non-existent convergence in TGR, i.e. an extremely slow process, which only marginally improves if again we remove Syria and Libya from the sample. This reflects the pattern observed in Figure 5 which showed an increasing gap in TGRs after 2003. Similar results hold true for the overall meta-efficiency scores, with all countries moving in the same direction at a relatively slow pace, except Algeria and to a lesser extent Egypt.

5.3.4 Northern Europe

We do not find significant convergence in efficiency among Northern European countries, in the sense that we find β convergence conditional upon groups of countries, but this is not confirmed by the σ convergence test to be able to make a firm conclusion. One possible explanation is that the average levels of efficiency in the Northern European countries are among the highest in the whole sample, therefore leaving a smaller scope for further significant improvements. On the other hand, this also indicates that whatever improvements are made over time, any existing differences among countries are not getting any smaller. We do find convergence in TGR instead, and this appears to be conditional upon groups of countries. Namely, Germany, Austria, Sweden and the UK, which are the top four countries in terms of TGR levels in Northern Europe, appear to be in a group of their own in terms of TGR levels, whereas Finland, Denmark, Belgium and partially Ireland, which are at the bottom of the ranks in terms of TGR levels, are grouped separately.

5.3.5 Eastern Europe

As for the case of Northern Europe we do not find convergence in efficiency among Eastern European countries because the β convergence process is not confirmed by the σ convergence test. Interestingly though, we do find full convergence in TGR (that is β confirmed by σ, and no difference between countries). This is a very interesting result which means that these countries are all moving towards the same frontier, i.e. the use of the same technology, even if they might be doing so at different levels of efficiency.

[7] This is possibly the less meaningful of the comparisons, given the fragility of the MENA sample, the difference in sample sizes between the two groups and the possibly very different banking systems.

5.3.6 Northern and Eastern Europe

When we analyse together these two groups of countries to form a general, global meta-frontier we do find almost absolute convergence in TGR with the only exception of Bulgaria and Estonia. So when put all together, these countries show a greater deal of homogeneity than they did when analysed separately. They do however remain remarkably different in their efficiency levels, and as a consequence when we look at the two measures together as meta-efficiency we find two blocks of convergence: Germany, Belgium, Austria, Czech Republic, Denmark, Latvia, Poland, Slovakia, Slovenia, Sweden and the UK on the one hand, and Estonia, Finland, Ireland, Hungary and Bulgaria on the other. In other words, while they appear to be moving towards the adoption of the same technology the efficiency with which they do this is not the same.

This result is consistent with the fact that the estimation of a global meta-frontier was rejected by the data, as we mentioned earlier.

To summarise, it appears to be the case that banking industries in the two macro areas under analysis do not share a common meta-technology, and therefore within the two macro area differences still remain. The northern and eastern parts of the EU are much more homogenous in the progressive movement towards a common technology but maintain significant differences between groups of countries in the efficiency with which they perform their operations. The same cannot be said of the southern part of the sample, where convergence in technology is barely existent, making the higher homogeneity in efficiency levels less meaningful, since they are defined with respect to very different technologies. Recent theoretical and empirical evidence has emphasised that countries (industries) chose the best technology available to them, given their input mix (Bos et al., 2010). As a consequence, industries become members of a 'technology club' if their marginal input productivity (that is, the technology parameters that characterise the efficient production frontier) are the same for a given level of inputs (Jones, 2005, Bos et al., 2010). Our results seem to indicate that the differences among banking industries, even among countries within the same macro area, are still very relevant. Domestic and international barriers are often cited as the key determinants in the timing and pace of technological catch-up. These issues might help explain our results of convergence in blocks, although this would necessitate further analysis.

6. Conclusions

This study investigates bank efficiency and convergence for a large cross-country sample of European Union member states and countries in the Middle East and North Africa region. The sample period covers 14 years (1997-2010), during which all countries under investigation underwent a series of regulatory reforms aimed at fostering integration. The reform agenda was firmly based on the assumption that regulators believe that a well integrated financial system is necessary to increase economic efficiency, by reducing the cost of capital and improving the allocation of financial resources. It was also expected that deregulation-induced competition would foster efficiency by providing incentives to managers to cut costs in order to remain profitable. In reality, the extent to which empirical evidence supports these theoretical predictions is rather mixed and seems to be dependent on a number of factors that are country specific, such as the regulatory framework.

This study makes three main contributions. First we analyse empirically the dynamics of bank cost efficiency, to identify whether the regulatory reforms fostered an improvement in banks' operating performance. We do so via the estimation of country-specific stochastic cost frontiers, since the existence of heterogeneity prevents us from estimating a common frontier. We then proceed to estimate meta-frontiers to measure the difference in technology across countries and assess its dynamics. Finally, we assess whether the banking systems in our sample countries are converging toward the same efficiency and technology by testing for the existence of β and σ convergence. For the purpose of the analysis, we divide the sample according to the geographical location of the country in four 'regions': i) Northern Europe; ii) Eastern Europe; iii) Mediterranean Europe and finally iv) MENA. Finally we group the countries in two 'macro areas': Northern & Eastern Europe and Mediterranean Europe & MENA (north and east and south and MENA).

The average annual efficiency bank scores of each country relative to each country's own frontier reveal stability or a slight general improvement over the sample period for most countries in the sample. However, since these values come from separate frontiers they cannot be compared between countries. We therefore estimate four meta-frontiers at the supra-national level and calculate the relative Technical Gap Ratios (TGRs) to measure how far each country is from the best available meta-technology in the reference region.

Comparing TGR ratios for Mediterranean Europe and MENA countries we find that banking industries in Mediterranean Europe have consistently higher TGRs compared to the countries in the MENA region, and the gap is widening from the mid-2000s and increasing further post-crisis (from 2008 onwards). These results suggest that the MENA region is still lagging behind in terms of the ability of its banks to appropriate the best technology available.

Looking at Northern & Eastern Europe, we find a different picture. Although the average TGRs for banks located in Northern European countries are consistently higher than those of banks located in Eastern Europe, the gap seemed to be reducing during the early 2000s. Moreover, the two areas seem to follow a similar trend, with the gap between the meta-frontier and individual countries frontier widening from 2006 onwards, at the onset of the global financial crisis.

These results seem to indicate convergence in the Northern & Eastern European region, unlike those from the Mediterranean Europe and MENA region. To investigate this further, we carry out a series of tests for the existence of β and σ convergence. The results confirm that the northern and eastern parts of the EU are much more homogenous in the progressive movement towards a common technology, although significant differences between groups of countries remain.

Taken together, our results suggest that the reform experience of the MENA countries has been less successful compared to other developing and transition countries, particularly in Eastern Europe. The policy agenda should therefore focus on the type of regulatory and supervisory reforms that promote bank efficiency and financial sector stability simultaneously.

References

Aigner, D., C.A.K. Lovell and P. Schmidt (1977), "Formulation and estimation of stochastic frontier production models", *Journal of Econometrics*, Vol. 6, No. 1, pp. 21–37.

Ayadi, R., E. Arbak, S. Ben Naceur and B. Casu (2011), *Convergence of Bank Regulations on International Norms in the Southern Mediterranean: Impact on Bank Performance and Growth*, CEPS Paperback, Centre for European Policy Studies, Brussels.

Battese, G.E., D.S.P. Rao and C.J. O'Donnell (2004), "A meta-frontier production functions for estimation of technical efficiencies and technology gaps for firms operating under different technologies", *Journal of Productivity Analysis*, Vol. 21, pp. 91–103.

Ben Naceur, S., H. Ben-Khedhiri and B. Casu (2011), "What Drives the Performance of Selected MENA Banks? A Meta-Frontier Analysis", IMF Working Paper WP/11/34, International Monetary Fund, Washington, D.C.

Berger, A.N. (2007), "International comparisons of banking efficiency", *Financial Markets, Institutions and Instruments*, Vol. 16, No. 3, pp. 119–144.

Berger, A.N. and D.D. Humphrey (1997), "Efficiency of Financial Institutions: International Survey and Directions for Future Research", *European Journal of Operational Research*, Vol. 98, pp. 175–212.

Bikker, J.A. (2004), *Competition and efficiency in a unified European banking market*, Cheltenham, UK: Edward Elgar.

Bonin, J., I. Hasan and P. Wachtel (2005a), "Bank Performance, Efficiency and Ownership in Transition Countries", *Journal of Banking and Finance*, Vol. 29, No. 1, pp. 31–53.

Bonin, J., I. Hasan and P Wachtel (2005b), "Privatization matters: Bank efficiency in transition countries", *Journal of Banking and Finance*, Vol. 29, pp. 2155–2178.

Bos, J.W.B., C. Economidou and M. Koetter (2010), "Technology Clubs, R&D and Growth Patterns: Evidence from EU Manufacturing", *European Economic Review,* Vol. 51, No. 1, pp. 60-79.

Bos, J.W.B. and C.J.M. Kool (2006), "Bank Efficiency: The Role of Bank Strategy and Local Market Conditions", *Journal of Banking and Finance*, Vol. 30, No. 7, pp. 1953–1974.

Bos, J.W.B. and H. Schmiedel (2007), "Is there a single frontier in a single European banking market?", *Journal of Banking and Finance*, Vol. 31, No. 7, pp. 2081–2102.

Brissimis, S.N., M.D. Delis and N.I. Papanikolaou (2008), "Exploring the nexus between banking sector reform and performance: Evidence from newly acceded EU countries", *Journal of Banking and Finance*, Vol. 32, No. 12, pp. 2674–2683.

Casu, B., A. Ferrari and T. Zhao (2013), "Regulatory Reform and Productivity Change in Indian Banking", *Review of Economics and Statistics*, (forthcoming).

Casu, B. and C. Girardone (2010), "Integration and Efficiency Convergence in EU Banking Markets. Omega", *The International Journal of Management Science*, Vol. 38, No. 5, pp. 260–267.

Demirgüç-Kunt, A., L. Laeven and R. Levine (2004), "Regulations, Market Structure, Institutions, and the Cost of Financial Intermediation", *Journal of Money, Credit, and Banking*, Vol. 36, No. 3, pp. 623–626.

Fang, Y., I. Hasan and K. Marton (2011), "Bank efficiency in transition economies: recent evidence from South-Eastern Europe", Discussion Paper No. 5, Bank of Finland Research, Helsinki.

Fries, S. and A Taci. (2005), "Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries", *Journal of Banking and Finance*, Vol. 29, No. 1, pp. 55−81.

Goddard, J.A., P. Molyneux, J.O.S. Wilson and M. Tavakoli (2007), "European banking: an overview", *Journal of Banking and Finance*, Vol. 31, No. 7, pp. 1911–1935.

Grigorian, D.A. and V. Manole (2006), "Determinants of commercial bank performance in transition: an application of data envelopment analysis", *Comparative Economic Studies*, Vol. 48, No. 3, pp. 497–522.

Gropp, R. and A. Kashyap (2009), "A New Metric for Banking Integration in Europe", NBER Working Paper No. 14735, National Bureau of Economic Research, Cambridge, MA.

Hughes, J. and L. Mester (2010), "Efficiency in Banking: Theory, Practice, and Evidence", in A.N. Berger, P. Molyneux and J.O.S. Wilson (eds), *The Oxford Handbook of Banking*, Oxford: Oxford University Press, pp. 463–485.

Jones, C.I. (2005) "The Shape of Production Functions and the Direction of Technical Change," Quarterly Journal of Economics, 120(2), 517–549.

Kasman, A. and H.S. Yildirim (2006), "Cost and profit efficiencies in transition banking: the case of new EU members", *Applied Economics*, Vol. 38, No. 9, pp. 1079–1090.

Kontolaimou, A. and K. Tsekouras (2010), "Are cooperatives the weakest link in European banking? A non-parametric metafrontier approach", *Journal of Banking & Finance*, Vol. 34, No. 8, pp. 1946–1957.

Levine, R. (2004), "Finance and Growth: Theory and Evidence", NBER Working Paper No. 10766, National Bureau of Economic Research, Cambridge, MA.

Levine, R. (2001), "International financial liberalization and economic growth", *Review of International Economics*, Vol. 9, No. 4, pp. 688–702.

Lichtenberg, F.R. (1994), "Testing the convergence hypothesis", *Review of Economics and Statistics*, Vol. 76, No. 3, pp. 576–579.

Mamatzakis, E., C. Staikouras and A. Koutsomanoli-Filippaki (2008), "Bank efficiency in the new European Union member states: Is there convergence?", *International Review of Financial Analysis*, Vol. 17, No. 5, pp. 1156–1172.

Meeusen, W. and J. Van den Broek (1977), "Efficiency estimations from Cobb-Douglas production functions with composed error", *International Economic Review*, Vol. 18, No. 2, pp. 435–444.

Murinde, V., J. Agung and A.W. Mullineux (2004), "Patterns of corporate financing and financial system convergence in Europe", *Review of International Economics*, Vol. 12, No. 4, pp. 693–705.

O'Donnell, C.J., D.S.P. Rao and G.E. Battese (2008), "Meta-frontier frameworks for the study of firm-level efficiencies and technology ratios", *Empirical Economics*, Vol. 34, No. 2, pp. 231–255.

Olson, D. and T.A. Zoubi (2011), "Efficiency and Bank Profitability in MENA countries", *Emerging Markets Review*, Vol. 12, No. 2, pp. 94–110.

Pagano, M. (1993), "Financial Markets and Growth: an Overview", *European Economic Review*, Vol. 37, Nos 2-3, pp. 613–622.

Tortosa-Ausina, E. (2002), "Exploring efficiency differences over time in the Spanish banking industry", *European Journal of Operational Research*, Vol. 139, No. 3, pp. 643–664.

Weill, L. (2003), "Banking efficiency in transition economies: The role of foreign ownership", *The Economics of Transition*, Vol. 11, No. 3, pp. 569−592.

Weill, L. (2009), "Convergence in banking efficiency across European countries", *Journal of International Financial Markets, Institutions & Money*, Vol. 19, No. 5, pp. 818–833.

Yildirim, H.S. and G. Philippatos (2007), "Efficiency of banks: Recent evidence from the transition economies of Europe, 1993–2000", *The European Journal of Finance*, Vol. 13, No. 2, pp. 123−143.

About MEDPRO

MEDPRO – Mediterranean Prospects – is a consortium of 17 highly reputed institutions from throughout the Mediterranean funded under the EU's 7th Framework Programme and coordinated by the Centre for European Policy Studies based in Brussels. At its core, MEDPRO explores the key challenges facing the countries in the Southern Mediterranean region in the coming decades. Towards this end, MEDPRO will undertake a prospective analysis, building on scenarios for regional integration and cooperation with the EU up to 2030 and on various impact assessments. A multi-disciplinary approach is taken to the research, which is organised into seven fields of study: geopolitics and governance; demography, health and ageing; management of environment and natural resources; energy and climate change mitigation; economic integration, trade, investment and sectoral analyses; financial services and capital markets; human capital, social protection, inequality and migration. By carrying out this work, MEDPRO aims to deliver a sound scientific underpinning for future policy decisions at both domestic and EU levels.

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