

8<sup>th</sup> International Strategic Management Conference

## Impact of European Integration on Banks' Efficiency

Alin Marius Andrieș<sup>a</sup>, Bogdan Căpraru<sup>b\*</sup>

<sup>a,b</sup>*Alexandru Ioan Cuza University of Iasi, B-dul Carol I nr.22, Iasi, 700505, Romania*

---

### Abstract

In this study we investigate the impact of European integration process on the cost efficiency of EU27 banking markets over period 2003 – 2009. The results provide evidence of both types of convergence, beta and sigma convergence, for the entire period, but ampler during crisis period (2008-2009) than pre-crisis period (2003-2007), these differences being due to a “catching up” process in pre-crises period and rather a “lagging behind” process, in the crises period. These findings confirm that the European integration had a positive impact on cost efficiency and convergence of efficiency during the pre-crises period, but in the crises period it does not seem to have an evident impact. The crises struck differently EU banking systems and there were differences in affecting cost efficiency in old member countries versus new member countries.

© 2012 Published by Elsevier Ltd. Selection and/or peer-review under responsibility of the 8th International Strategic Management Conference. Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

*Keywords:* convergence; efficiency; banks; EU27 countries

---

### 1. Introduction

The European integration is based on a single market functioning that lead to an increase in competition and harmonization of best practices. Increased integration is supposed to bring price convergence and improvements in cost efficiency via increased competition. In this context, measuring convergence of efficiency level is important in determining the impact of European integration, especially in the banking sector. More than that, the present international financial crises could relieve us evidences how European banks efficiency respond and how much integrated European banking markets are.

This study investigates the impact of integration on the efficiency of EU banking markets in the light of the convergence of cost efficiency of banks. The originality of our work consists in investigating all EU27 countries convergence of cost efficiency of banks for the period 2003 – 2009, underlining the impact of present international financial crises. Our assessing is made not only for the sample of all 27 countries as a whole, but on groups of countries: old – new member or euro and non-euro countries. In this way, we improve the investigation about convergence of cost efficiency of banks.

The rest of the study is structured as follows. Section 2 reviews the main literature on integration and convergence of efficiency in banking systems. Section 3 describes the methodology and data used to investigate the impact of

---

\* Alin Marius ANDRIEȘ. Tel.: +40-740-317-921; fax: +40-232-217-000.  
E-mail address: [alin.andries@uaic.ro](mailto:alin.andries@uaic.ro)

European integration on banks efficiency and the convergence of cost efficiency of banks in EU countries, as a whole and on groups of countries. Section 4 discusses the empirical results and Section 5 concludes.

## 2. Literature review

There is a large literature dealing the convergence of banking efficiency. A part of these studies assess the convergence of banking efficiency in single national markets, but there are also studies that analyze this phenomenon on a sample of countries.

Fung (2006) looking for convergence in productivity among bank holding companies (BHCs) in the US, using data envelopment analysis (DEA) in estimating banking efficiency. He finds strong evidence for “conditional convergence”, which means that the steady-state productivity to which a BHC is converging is conditional on the BHCs own level of X-efficiency.

In another study, Fung and Cheng (2010), assessing convergence in total factor productivity (TFP) among banks in Hong Kong from 1993 to 2002, demonstrate strong evidence for “conditional convergence”, which means that the steady-state TFP to which a bank is converging is conditional on the bank's own level of X-efficiency. Conditional convergence implies that initial differences in X-efficiency among banks can, between them, create permanent differences in TFP.

Daley and Matthews (2009) test the conditional convergence for technical efficiency among Jamaican banks between 1998 and 2007. They find that there has been a tendency towards improvement in bank efficiency levels for the largest banks and strong evidence of conditional convergence.

Among multi-countries studies evaluating convergence of banking efficiency we can mention Carbo Valverde et al. (2007), who investigate large banks across 10 countries between 1996 and 2002. They find that banks assessed are roughly equally efficient after controlling for differences in business environment, banking costs, and bank productivity. Lozano-Vivas and Pastor (2006) discover convergence over time in the evolution of banking productivity, examining the role of the banking sector in the overall economic activity and its contribution to the convergence/divergence in fifteen OECD countries over the time period of 1980–1997.

Several studies analyze the evolution and the convergence of banking efficiency in the context of European financial integration, having different results in investigating the cross-country differences. Some papers demonstrate the existence of substantial discrepancies in banking efficiency across EU countries (Altunbas and Chakravarty (1998); De Guevara and Maudos (2002); Sheldon (2001); Lozano-Vivas et al. (2001); Lozano-Vivas et al. (2002); Andrieș (2011); Murinde et al. (2004); Vander Venet (2002)) and others prove convergence on banking efficiency in the circumstances of European integration (Mamatzakis et al. (2008); Casu and Girardone (2010); Weill (2009); Evans et al. (2008)). Most of the former papers demonstrate an increase in efficiency for EU banks.

Mamatzakis et al. (2008) examine cost and profit efficiency (estimated by means of stochastic frontier approach (SFA)) in the banking systems of the ten new European Union member states over the period 1998–2003. They find a generally low level of cost and an even lower level of profit efficiency and  $\beta$ - and  $\sigma$ -convergence criteria indicate some convergence in cost efficiency across the new member states, yet no convergence appears to have been achieved in terms of profit efficiency. Casu and Girardone (2010), using data envelopment analysis (DEA) evaluate cost efficiency in EU-15 banking sector in the period 1997 – 2003. Also, they apply dynamic panel data models (GMM) to the concepts of  $\beta$ - and  $\sigma$ -convergence to assess the speed at which banking markets are integrating. They find evidence of convergence of efficiency level towards an EU average and no evidence of an overall improvement of efficiency level towards best practice.

Weill (2009) analyzing 10 EU countries between 1994 and 2005 demonstrates that financial integration has taken place on the EU banking markets in the recent years. He provides evidence of cross-country differences and of an improvement in cost efficiency and using  $\beta$ - and  $\sigma$ -convergence proves a process in convergence in cost efficiency between EU countries. He applies stochastic frontier approach (SFA) in measuring banking efficiency.

Evans et al. (2008) investigate a sample of 14 European banks over the period 1979–1997 in order to demonstrate that deregulatory process in EU was associated with increasing similarity, or convergence, of banking industries across the European Union. They find that the deregulation and the opening of banking markets to international competition led to convergence.

## 3. Methodology and data

In this section we discuss the empirical model used to investigate the impact of European integration and financial crises on banks efficiency and the convergence of cost efficiency of banks in European Union countries.

### 3.1. Efficiency measures

In the analysis of the efficiency of the banks in EU countries we will use the SFA Method (Stochastic Frontier Analysis). This approach is commonly used in works measuring banking efficiency (Hasan and Marton, 2003; Weill, 2003; Fries and Taci, 2005; Yildirim and Philippatos, 2007; and Asaftei and Kumbhakar, 2008)

This paper uses the stochastic frontier approach (SFA), as developed by Aigner et al. (1977), to estimate cost inefficiency. The main advantages of this approach are the allowance for measurement error, and the generation of firm-specific efficiency estimates, which are important for bank managers in order to improve their operational efficiency. According to the SFA, total cost takes the following specification:

$$TC_{it} = f(P_{it}, Y_{it}) + v_{it} + u_{it} \quad (1)$$

where  $TC_{it}$  denotes observed total cost for bank  $i$  at year  $t$ ,  $P$  is a vector of input prices and  $Y$  is a vector of outputs. This approach disentangles the error term in two components. The first one,  $v_{it}$ , corresponds to the random fluctuations and the second one,  $u_{it}$ , accounts for the firm's inefficiency.

For cost efficiency function, we apply a translog specification. The restrictions regarding the function of the stochastic frontier are more flexible when a functional form of the translog (TL) type production function is applied, than when a functional Cobb-Douglas-type form is applied. The translog form does not impose the hypothesis regarding the constant elasticity of the production function or of the elasticity of substitution between inputs. Another advantage of the translog form is that it allows data to indicate the real value of the curvature of the function, rather than impose prior hypotheses regarding its value.

In order to calculate de level of cost efficiency we apply following equation:

$$\ln\left(\frac{C_i}{P_{Ni}}\right) = \beta_0 + \sum_{n=1}^{N-1} \beta_n \ln\left(\frac{P_{ni}}{P_{Ni}}\right) + \sum_{m=1}^M \phi_m \ln y_{mi} + v_i + u_i \quad (2)$$

The cost efficiency level is given by the ratio between the minimum cost and the cost registered by the decisional unit and is calculated as:

$$EC = \exp(-u_i) \quad (3)$$

The SFA method assumes that the inefficiency component of the error term is positive and thus the high costs are associated with a high level of inefficiency. In the estimation of the cost efficiency level we used the model developed by Battese and Coelli (1992).

### 3.2. Modelling convergence

To analyze the convergence of bank efficiency levels across the European Union member countries over the period 2003 - 2009, we used the concepts of  $\beta$ -convergence and  $\sigma$ -convergence proposed by Barro and Sala-i-Martin (1991). The seminal papers by Barro and Sala-i-Martin (1992) and Mankiw et al. (1992) have triggered a huge amount of literature attempting to empirically detect and measure the convergence in various contexts.

While  $\beta$ -convergence focuses on detecting possible catching-up processes,  $\sigma$ -convergence simply refers to a reduction of disparities among regions in time. The two concepts are of course closely related;  $\beta$ -convergence is necessary but not sufficient for  $\sigma$ -convergence.

Recently a number of studies have emerged examining the convergence of bank performance (see Fung 2006; Fung and Leung, 2008; Mamatzakis et al., 2008; Evans et al. 2008; Weill, 2009; Casu and Girardone, 2010, and Matthews and Zhang, 2010).

In the case of European countries, studies check whether financial integration has taken place on the EU banking markets has as results an improvement in the performance of banking sectors and the convergence in banking efficiency. Weill (2009) investigates the convergence in banking efficiency, using  $\beta$ -convergence and  $\sigma$ -convergence, for 10 European countries between 1994 and 2005. Casu and Girardone (2010) assess, for the EU-15 area between 1997 and 2003, the speed at which banking markets are integrating applying a dynamic panel data models to the concepts of  $\beta$ -convergence and  $\sigma$ -convergence. Mamatzakis et al. (2008), using  $\beta$ - and  $\sigma$ -convergence, examine convergence in cost and profit efficiency across the banking systems of the ten new European Union member states over the period 1998 – 2003. Evans et al. (2008) investigate whether deregulatory process was associated with increasing similarity, or convergence, of banking industries across the European Union.

To estimate unconditional  $\beta$ -convergence, we employ the following equation:

$$\ln EFF_{i,t} - \ln EFF_{i,t-1} = \alpha + \beta \ln EFF_{i,t-1} + \gamma(\ln EFF_{i,t-1} - \ln EFF_{i,t-2}) + \varepsilon_{i,t} \tag{4}$$

where  $EFF_{i,t}$  is the mean cost efficiency of banks of country  $i$  in year  $t$ ;  $EFF_{i,t-1}$  the mean cost efficiency of banks of country  $i$  in year  $t-1$ ;  $i = 1,2,\dots,27$  and  $t = 1,2,\dots,7$ ;  $\alpha$ ,  $\beta$  and  $\gamma$  are the parameters to be estimated;  $\varepsilon_{i,t}$  the error term. There is then  $\beta$ -convergence if the coefficient  $\beta$  is negative, the higher the coefficient in relative terms the greater the tendency for convergence.

$\sigma$ -convergence is investigated through the the estimation of the following equation, following the specification for panel data used by Parikh and Shibata (2004), Fung (2006), Weill (2009) and Casu and Girardone (2010):

$$\Delta W_{it} = \alpha + \sigma W_{i,t-1} + \gamma(W_{i,t-1} - W_{i,t-2}) + \varepsilon_{i,t} \tag{5}$$

where  $\Delta W_{i,t} = W_{i,t} - W_{i,t-1}$ ;  $W_{it} = \ln(EFF_{i,t}) - \ln(\overline{EFF}_t)$ ;  $\overline{EFF}_t$  is the mean efficiency of the banking systems from CEEC at time  $t$ ;  $\alpha$ ,  $\sigma$  and  $\gamma$  are parameters to be estimated and  $\varepsilon_{i,t}$  is the error term. A negative value for  $\sigma$  parameter implies the convergence of  $EFF_{i,t}$  toward to  $\overline{EFF}_t$ .

The equations (4) and (5) are estimated by Panel Least Squares.

### 3.3. Data

The sample comprises of 923 commercial banks from 27 countries members of European Union for the 2003 – 2009 period. Only active banks with information for at least 5 years were included. All bank-level data used are obtained from the BankScope database and are reported in Euros.

In the literature in the field there is no consensus regarding the inputs and outputs that must be used in the analysis of the efficiency and productivity growth of commercial banks (Berger and Humphrey, 1997). In our paper, bank inputs and outputs are defined according to the value-added approach, originally proposed by Berger and Humphrey (1992), which suggests using deposits as outputs since they imply the creation of value added. Following Dietsch and Lozano-Vivas (2000), Maudos et al. (2002), and others, we used the following set of inputs and outputs in order to quantify the efficiency and mutations on the level of the productivity of banks: loans, other earning assets and demand deposits – outputs, personnel expenses, fixed assets and financial capital (sum of total deposits, total money market funding, total other funding and equity) – as inputs. Input prices are obtained as total personnel expenses over total assets, other operating expenses over fixed assets and interest expenses over financial capital.

## 4. Empirical results

### 4.1. Efficiency results

The mean efficiency scores for each year are presented in Table 1. The average cost efficiency score for banks from European Union banking systems over all period is 0.711. Analyzing the sample by groups of countries, we observe significant differences between banking systems, the results for non - Euro zone countries vary between 0.7158 in 2004 and 0.7067 in 2009, while the level of banking cost efficiency in Euro zone countries range from 0.7188 in 2003 and 0.7056 in 2009.

Table 1. An example of a table

Year	2003	2004	2005	2006	2007	2008	2009	Average
Euro zone countries	0.718800	0.715202	0.709922	0.708210	0.720108	0.721685	0.705245	0.713762
Non- Euro zone countries	0.715802	0.692881	0.703192	0.707231	0.711197	0.714007	0.706705	0.707144
European Union	0.717765	0.707013	0.707814	0.707907	0.717388	0.719310	0.705687	0.711660

Also, we observe an ample decrease in banking efficiency for all EU countries of our sample in 2009 and a reduction of the gap between the Euro zone countries and Non- Euro zone countries in 2009. Also, we can notice that cost efficiency scores decrease in 2009 is ampler in Euro zone countries than in Non- Euro zone countries. This finding

suggests that, even if cross-country differences in banking efficiency remain substantial in 2009, they have decreased over the period. Our results are in line with the literature on bank efficiency what support the view that European integration had a positive impact on cost efficiency of banks (Mamatzakis et al., 2008; and Weill, 2009).

#### 4.2. Evaluating convergence of efficiency

In this section we provide information relating to the convergence of efficiency scores across the 27 countries, European Union member countries over 2003 – 2009 period. In our analysis we use two major indicators of convergence, namely  $\sigma$ - and  $\beta$ -convergence.

The results provide evidence of  $\beta$ -convergence in term of cost efficiency among the EU countries, as the  $\beta$ -coefficient is negative and significant, but not of high magnitude. That meaning the most efficient banking sectors in 2003 have known a lower increase of efficiency than the least efficient banking sectors in 2003, thereby providing introductory evidence of efficiency catch-up among analyzed countries.

Similar results are obtained in the case of  $\sigma$ -convergence, meaning that the dispersion of the mean efficiency scores between European Union countries was reduced during the 2003 – 2009 period.  $\sigma$ -convergence indicates how rapidly each country's efficiency levels are converting to the sample mean.

Table 2 Beta and sigma convergence

	European Union	Pre-crisis period 2003-2007	Crisis period 2008-2009	Euro zone countries	Non-Euro zone countries	Old Members	New Members
$\beta$ -convergence							
$\alpha$	-0.421645*** (0.009844)	-0.427431*** (0.012331)	-0.687373*** (0.024243)	-0.425597*** (0.011869)	-0.410552*** (0.017824)	-0.437720*** (0.011650)	-0.349541*** (0.017025)
$\beta$	-1.181861*** (0.026952)	-1.201155*** (0.034051)	-1.926609*** (0.067297)	-1.191527*** (0.032286)	-1.153278*** (0.049482)	-1.197814*** (0.030968)	-1.072711*** (0.052248)
$\gamma$	0.140526*** (0.018098)	0.128629*** (0.021871)	0.367584*** (0.043009)	0.147633*** (0.021619)	0.119177*** (0.033509)	0.138720*** (0.020660)	0.173704*** (0.037014)
R-squared	0.561332	0.635257	0.825955	0.568161	0.542787	0.568194	0.512190
$\sigma$ -convergence							
$\alpha$	-1.302757*** (0.030247)	-1.355929*** (0.039037)	-2.054974*** (0.072216)	-1.314905*** (0.035969)	-1.264888*** (0.056834)	-1.322545*** (0.034896)	-1.205440*** (0.058556)
$\beta$	-1.216610*** (0.028170)	-1.266983*** (0.036408)	-1.918752*** (0.067355)	-1.227232*** (0.033450)	-1.182649*** (0.053095)	-1.225152*** (0.032195)	-1.158968*** (0.056441)
$\gamma$	0.175008*** (0.019827)	0.191399*** (0.025223)	0.362486*** (0.043050)	0.185040*** (0.023551)	-0.143514*** (0.037329)	0.167089*** (0.022524)	0.251880*** (0.041721)
R-squared	0.563841	0.640787	0.826267	0.571305	0.543758	0.569776	0.523896
Method	Panel Least Squares						

Note: Standard deviations are presented between brackets.

\*, \*\* and \*\*\* indicate significance levels at 10%, 5% and 1%

Another result obtained is the fact that the convergence process was ampler in banking systems from Euro-zone countries and old member countries comparing with non-euro zone countries and new member countries. Also, the evidence shows that across analyzed period the convergence process, both types beta and sigma, were ampler during crisis period than pre-crisis period. These facts could be interpreted as following: euro could be a catalyst factor for convergence and old member countries are more integrated than the new member once.

Table 3 Beta and sigma convergence in pre-crisis period

	European Union	Euro zone countries	Non-Euro zone countries	Old Members	New Members
$\beta$ -convergence					
$\alpha$	-0.427431*** (0.012331)	-0.432392*** (0.015417)	-0.413180*** (0.020546)	-0.444171*** (0.015152)	-0.359806*** (0.018083)
$\beta$	-1.201155*** (0.034051)	-1.212020*** (0.042182)	-1.166839*** (0.057787)	-1.212805*** (0.040426)	-1.119457*** (0.056359)
$\gamma$	0.128629*** (0.021871)	0.131013*** (0.027139)	0.123659*** (0.036900)	0.125558*** (0.025832)	0.166297*** (0.037718)
R-squared	0.635257	0.643499	0.607671	0.636528	0.630251
$\sigma$ -convergence					
$\alpha$	-1.355929*** (0.039037)	-1.368506*** (0.047845)	-1.315888*** (0.068542)	-1.370180*** (0.046624)	-1.295314*** (0.063289)
$\beta$	-1.266983*** (0.036408)	-1.277331*** (0.044501)	-1.232175*** (0.064283)	-1.267940*** (0.042998)	-1.250120*** (0.061303)
$\gamma$	0.191399*** (0.025223)	0.195492*** (0.030960)	0.178597*** (0.043882)	0.179702*** (0.029690)	0.281558*** (0.043577)
R-squared	0.640787	0.649311	0.612142	0.640491	0.652263
Method	Panel Least Squares				

Note: Standard deviations are presented between brackets.

\*, \*\*, \*\*\* indicates significance levels at 10%, 5% and 1%

Also, taking account the evolution of mean scores of cost efficiency between 2003-2009, we can consider that between 2003-2007 the convergence is due to a “catching up” process and, contrary, in the crises period (2008-2009), the convergence was determined by a “lagging behind” process.

Investigating convergence on groups of countries, considering two periods - pre-crisis and crises, we obtain interesting results. In pre-crisis period, the convergence of efficiency of euro countries and old member countries, measured by both indicators, was ampler than once of non-euro countries, respectively new member countries. The dispersions in case of old and new members were almost equal, meaning that cost efficiencies differences in EU were very small. These results allow us to conclude that the adoption of euro and, respectively, the moment of EU accession had a positive impact on improving cost efficiency and convergence.

Table 4 Beta and sigma convergence in crises period

	European Union	Euro zone countries	Non-Euro zone countries	Old Members	New Members
$\beta$ -convergence					
	-0.687373*** (0.024243)	-0.678344*** (0.027845)	-0.709236*** (0.049601)	-0.711780*** (0.027503)	-0.563473*** (0.054934)
$\alpha$					
	-1.926609*** (0.067297)	-1.903955*** (0.077475)	-1.980798*** (0.137021)	-1.961339*** (0.074947)	-1.697836*** (0.165258)
$\beta$					
	0.367584*** (0.043009)	0.371898*** (0.049320)	0.361062*** (0.088345)	0.378658*** (0.046955)	0.297297** (0.126743)
$\gamma$					
R-squared	0.825955	0.822222	0.835287	0.826068	0.832015
$\sigma$ -convergence					
	-2.054974*** (0.072216)	-2.027526*** (0.082969)	--2.123124*** (0.147659)	-2.104438*** (0.080916)	-1.763124*** (0.173009)
$\alpha$					
	-1.918752*** (0.067355)	-1.894129*** (0.077462)	-1.979736*** (0.137423)	-1.953722*** (0.075012)	-1.685777*** (0.165550)
$\beta$					
	0.362486*** (0.043050)	0.365325*** (0.049326)	0.360837*** (0.088572)	0.373835*** (0.046999)	0.287688*** (0.127010)
$\gamma$					
R-squared	0.826267	0.822831	0.834940	0.826324	0.832749
Method	Panel Least Squares				

Note: Standard deviations are presented between brackets.

\*, \*\*, \*\*\* indicates significance levels at 10%, 5% and 1%

In the crises period, we can observed that in the case of non-euro countries the convergence was ampler then in euro countries, not because of “catching up” of less efficient banks but because of a general decline in efficiency levels. The evidence is different in the case of old member and new member groups, the both indicators beta and sigma convergence, being less ample for the new member, the differences in intensity being much bigger than in pre-crises period. These results demonstrate that the crises had different impact on EU banking systems and there are differences in affecting cost efficiency.

## Conclusion

This study investigates the impact of integration on the efficiency of EU27 banking markets in the light of the convergence of cost efficiency of banks over 2003 – 2009 period, using  $\sigma$ - and  $\beta$ -convergence. Analyzing the sample by groups of countries, we observe significant differences in cost efficiency scores between banking systems. We observe an ample decrease in banking efficiency for all EU countries of our sample in 2009 and a reduction of the gap between the Euro zone countries and Non- Euro zone countries in 2009. This finding suggests that, even if cross-country differences in banking efficiency remain substantial in 2009, they have decreased over the period.

The evidence shows convergence for both types of beta and sigma convergence for the entire period, but ampler during crisis period (2008-2009) than pre-crisis period (2003-2007). If we consider the evolution of mean scores of cost efficiency between 2003 and 2009, we can explain these differences due to a “catching up” process in pre-crises period and a “lagging behind” process, in the crises period. These results confirm that the European integration had a positive impact on cost efficiency and convergence of efficiency during the pre-crises period, but in the crises period it does not seem to have an evident impact. The crises struck differently EU banking systems and there were differences in affecting cost efficiency in old member countries versus new member countries.

Like Casu and Girardone (2010) and Weill (2009), overall, our results show that although several steps have been made toward financial integration, and consequently toward enhancing integration in the banking systems of the EU member states, many issues still remain to be tackled. As policy recommendations, we suggest reforms to the regulatory and supervisory frameworks, promoting an intensified competition. Also, for bank management, we recommend a better concern in controlling costs, especially costs with regard to network and human resources. Banks' management has to resize their network with the present demand of products.



Also, from a policy perspective, we can conclude that there are still country-specific structural differences and the regulatory removal of cross border restrictions alone was not sufficient to equalize and improve the cost structure of EU banking systems.

## Acknowledgements

This work was supported by the project "Post-Doctoral Studies in Economics: training program for elite researchers - SPODE" co-funded from the European Social Fund through the Development of Human Resources Operational Programme 2007-2013, contract no. POSDRU/89/1.5/S/61755

## References

- Aigner D., Lovell C., & Schmidt P. (1977) Formulation and Estimation of Stochastic Frontier Production Function Models, *Journal of Econometrics*, 6: 21-37.
- Altunbas, Y., & Chakravarty S. (1998) Efficiency measures and the banking structure in Europe, *Economics Letters*, 60: 205-208.
- Andries, A.M. (2011) The determinants of bank efficiency and productivity growth in the Central and Eastern European banking systems, *Eastern European Economics*, 49(6): 39–60
- Asaftei, G., & Kumbhakar, S. (2008) Regulation and efficiency in transition: the case of Romanian banks, *Journal of Regulatory Economics*, 33(3): 253–282
- Barro, R., & Sala-i-Martin, X. (1991) Convergence across states and regions, *Brookings Papers on Economic Activity*, 1: 107–182.
- Barro, R., & Sala-i-Martin, X. (1992) Convergence, *Journal of Political Economy*, 100: 223-251.
- Battese, G., & Coelli T. (1992) Frontier Production Functions, Technical Efficiency and Panel Data: with Application to Paddy Farmers in India, *Journal of Productivity Analysis*, 3(1-2): 153-169
- Berger, A., & Humphrey, D. (1992) Measurement and efficiency issues in commercial banking, in *Output Measurement in the Service Sectors*, Zvi Griliches eds. The University of Chicago Press, 245-279.
- Casu, B., & Girardone, C., (2010) Integration and efficiency convergence in EU banking markets, *Omega* 38: 260-267
- Daley, J., & Matthews, K (2009) Efficiency and Convergence in the Jamaican banking sector 1998-2007, *Cardiff Economics Working Papers*, E2009/30
- Desli, E. (2009) Convergence and efficiency: evidence from the EU-15, *Journal of Post Keynesian Economics*, 31(3): 403-430
- Dietsch, M., & Lozano-Vivas, L. (2000) How the environment determines banking efficiency: a comparison between French and Spanish industries, *Journal of Banking and Finance*, 24: 985–1004.
- Evans, P., Hasan, I., & Lozano-Vivas, A. (2008) Deregulation and Convergence of Banking: The EU Experience, *Finnish Economic Papers*, 21(2): 104-117
- Fries, S., & Taci, A. (2005) Cost efficiency of banks in transition: Evidence from 289 banks in 15 post-communist countries, *Journal of Banking and Finance* 29: 55– 81.



- Fung, M. K. (2006) Scale economies, X-efficiency, and convergence of productivity among bank holding companies, *Journal of Banking and Finance* 30: 2857–2874
- Fung, M.K., & Leung, M.K. (2008) X-efficiency and convergence of productivity among the national commercial banks in China, *China economic association (UK) annual conference 2008*
- Fung M. K., & Cheng, A. C. S. (2010) Convergence of total factor productivity among banks: Hong Kong's experience, *Global Finance Journal* 21: 201–210
- de Guevara, J.F., & Maudos, J. (2002) Inequalities in the efficiency of the banking sectors of the European Union, *Applied Economics Letters*, 9: 541-544
- Hasan, I., & Marton, K. (2003) Development and Efficiency of the Banking Sector in a Transitional Economy, *Journal of Banking and Finance*, 27(12): 2249–2271
- Lozano-Vivas, A., & Pastor J. T. (2006) Relating macro-economic efficiency to financial efficiency: A comparison of fifteen OECD countries over an eighteen year period, *Journal of Productivity Analysis*, 25: 67–78
- Lozano-Vivas, A., Pastor, J.T., & Hasan, I. (2001) European bank performance beyond country borders: what really matters?, *European Finance Review* 5 (1–2): 141–165.
- Lozano-Vivas, A., Pastor, J.T., & Pastor, J.M., (2002) An efficiency comparison of European banking systems operating under different environmental conditions. *Journal of Productivity Analysis* 18 (1): 59–77.
- Mamatzakis, E., Staikouras C., & Koutsomanoli-Filippaki A. (2008) Bank efficiency in the new European Union member states: Is there convergence?, *International Review of Financial Analysis* 17: 1156–1172
- Mankiw, N., Romer, D., & Weil, D. (1992) A Contribution to the Empirics of Economic Growth, *Quarterly Journal of Economics* 107: 407-437.
- Mathews, K., & Zhang, N. (2010) Bank productivity in China 1997–2007: Measurement and convergence, *China Economic Review* 21(4): 617-628
- Maudos, J., Pastor, J., Perez, F., & Quesada, J. (2002) Cost and profit efficiency in European banks, *Journal of International Financial Markets, Institutions and Money* 12: 33–58.
- Murinde, V., Agung, J., & Mullineux, AW. (2004) Patterns of corporate financing and financial system convergence in Europe, *Review of International Economics* 12: 693–705.
- Parikh, A., & Shibata, M. (2004) Does trade liberalization accelerate convergence in per capita incomes in developing countries?, *Journal of Asian Economics* 15(1): 33-48
- Sheldon, G. (2001) Efficiency and Scale Economies in European Banking: A Cross-Country Comparison, *Working paper*, University of Basle
- Yildirim, S., & Philippatos, G., (2007), Efficiency of banks: Recent evidence from the transition economies of Europe 1993–2000, *European Journal of Finance* 13: 123–143.
- Vander Venet, R. (2002) Cost and profit efficiency of financial conglomerates and universal banks in Europe, *Journal of Money, Credit and Banking* 34 (1): 254–282.
- Weill, L. (2003) Banking Efficiency in Transition Economies: The Role of Foreign Ownership, *Economics of Transition* 11: 569-592.
- Weill, L. (2009) Convergence in banking efficiency across European countries, *Journal of International Financial Markets, Institutions & Money* 19: 818-833