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Abstract

This study examines whether and to what extent European bank profitability converges during the years of preparation and implementation of the Single Supervisory Mechanism (SSM). The sample consists of 247 banks over the years 2011-2017 and as profitability indicators Return on Assets and Return on Equity are employed. We use the Phillips and Sul (2007) panel convergence methodology and conduct the tests for β- and σ- convergence as an alternative approach. The main findings suggest the presence of profitability convergence, especially for banks within the remit of the SSM and banks located in the euro area periphery. These results provide support to the hypothesis of integration of the EU financial sector after the introduction of the SSM.

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1. Introduction

Financial integration has been among the main objectives of the European Union (EU) from its early stages with the implementation of the First Banking Co-ordination directive in 1977. Since then, EU legislation aims at facilitating the creation of an integrated EU financial sector[1]. The most recent development directed towards financial integration started with the establishment of the Single Supervisory Mechanism (SSM) in 2014 as the first pillar of the broader institutional reform of the EU financial sector, namely the European Banking Union. The second pillar, the Single Resolution Mechanism became functional in 2016, while the third pillar, the common European Deposit Guarantee Scheme is still unfinished. Still, after moving towards a more integrated institutional framework with these reforms, an interesting question to examine is the way in which the banks involved are affected.

Recent literature provides some evidence regarding the implications of the introduction of the SSM for the euro area banks, focusing on important aspects such as the market reaction and stock returns (Carboni et al., 2017; Abad et al., 2020; García-Olalla and Luna, 2020), lending behavior and capitalization (Fiordelisi et al., 2017), market power (Okolelova and Bikker, 2020), productivity, efficiency and technology (Tziogkidis et al., 2020). In Avgeri et al. (2021) there is evidence of a positive effect on the directly supervised banks and this effect was found to be stronger for the banks located in countries of the euro area periphery. Furthermore, in Avgeri et al. (2022) there is evidence of a robust positive effect of the SSM for the directly supervised banks that lie within the lower quantiles of the profitability distribution.

In this study we conduct a formal examination of profit convergence of euro area banks during the years of the preparation and implementation of the banking union related reforms. We use returns on assets (ROA) and return on equity (ROE) as alternative profitability indicators, both of which are related to the quantitative measures of financial integration[2].We also expand our analysis by examining the Z-score, which represents the number of standard deviations that a bank's rate of ROA has to fall for the bank to face insolvency. We use the panel convergence methodology developed by Phillips and Sul (2007), which allows for heterogeneity in the individual transition paths

[1] For a more thorough presentation of other significant regulatory developments see Goddard et al. (2013).
[2] More on the indicators of financial integration can be found in Adjaoute and Danthine (2003); ECB (2007).

relative to the panel average over time. The main findings indicate converging behavior for both ROA and ROE, providing support to the hypothesis of integration of the EU financial sector after the introduction of the SSM. Conducting convergence analysis using the alternative methodology of β-convergence and then expanding to σ-convergence, provides further support to our main conclusions.

Our study will add to the Banking Union related literature as it examines an essential issue as the Banking Union is moving towards its completion, using a recently developed panel convergence methodology, which, to the best of our knowledge has not been employed enough to analyze profit convergence after the SSM introduction. The rest of this paper is structured in the following way: Section 2 provides a brief overview of the weaknesses of the European financial sector revealed by the crisis and the rationale of the creation of the SSM. Section 3 presents a review of the literature related to convergence and financial integration. Section 4 describes the data, the variables and the methodology used. Section 5 provides the results of the main econometric analysis. Section 6 provides results for the Z-score. Section 7 presents the estimation results for the period after the introduction of the SSM. Section 8 presents the estimated results of the conditional convergence tests and section 9 concludes.

2. Weaknesses and needs of the European financial sector revealed by the crisis

Since the early years of EMU, adequate regulation and supervision in the European financial sector along with effective crisis management have been significant policy issues. The European banking sector grew rapidly in the years leading up to the financial crisis, mainly because of the emergence of financial innovations and complex financial products. As a result, financial institutions started to expand their activities, even without equally strong growing deposits. Furthermore, the E.U. banking sector went through continuous consolidation, leading to the emergence of global financial institutions, large in size and scope and with complex organizational structure. Consequently, governance and control mechanisms of banks proved to be inefficient when the financial crisis came, failing to contain the excessive risk-taking. Supervision and monitoring became more challenging.

For the European banks the crisis revealed that deposit guarantee schemes were inadequate. The available funds were quickly used up making the intervention of governments to guarantee deposits indispensable. Furthermore, additional measures, such as a harmonization of the insured deposits across the EU, were necessary in order to protect consumers and restore their confidence in the European banking sector. Other capital market instruments also faced liquidity issues. Discrepancies between cash and index markets emerged, as banks proceeded to large-scale asset sales trying to increase cash. The spread between corporate bond interest rates and their respective credit default swaps (CDSs) widened, while the equity option market faced liquidity issues as well. Investment banks underwent a sudden exposure to large basis risk and faced vast losses.

Before the recovery of real economy, the burden of high sovereign debt levels became a pressing matter for Europe in 2010 and regulatory efforts to restore confidence in European banks proved insufficient. For a large number of European banks, capital markets remained closed. Moreover, U.S. money market funds withdrew funds from Europe. The EBA recapitalization initiative and the ECB's Long Term Refinancing Operations (LTRO) in 2011 and 2012 eased the situation without removing the link between sovereign debt and bank solvency.[3]

The financial crisis uncovered the need to restructure the EU financial supervisory and regulatory institutions. As described in Quaglia et al., (2009), national-level responses to the crisis revealed the necessity of a more comprehensive supervision at the European level to replace the uncoordinated regimes of different member states. It also weakened the mechanisms of institutional stability. The severity of the crisis made the initial flaws of the Maastricht Treaty even more perceptible. Glöckler et al. (2017) argue that even though several gradual institutional innovations occurred before and during the crisis, all further-reaching attempts to shift bank supervision at the European level failed due to strong political resistance.

In addition, the crisis uncovered the important distinction between micro- and macro-prudential supervision and how they are interlinked both in substance and in operational terms. Micro-prudential supervision, which aims to limit the distress of individual financial institutions, ensuring customers' protection, has been the centre of the

[3]More on the European financial structure before and after the eruption of the financial and economic crises and the waves of implications for the EU banking sector can be found in Liikanen et al. (2012).

attention of supervisors around the world, often neglecting the fact that the financial system as a whole could be exposed to common risks. Nevertheless, micro-prudential supervision had attempted to reduce the risk of contagion and the negative externalities in case a financial institution failed. Macro-prudential supervision, on the other side, focuses on common or correlated shocks, especially to the parts of the financial system that may trigger contagious effects that in turn could cause distress to the financial system as a whole and affect the overall economy (Davis et al., 2022). The cooperation of the two was thought to be necessary, since macro-prudential supervision cannot be meaningful if it has no impact on the micro-level, while micro-prudential supervision cannot protect financial stability without considering the macro-level developments.[4]

The European Commission proposed first the SSM as an important step towards strengthening the EMU, which would increase the ability to prevent systemic risk, improve the monitoring of financial activities and protect depositors. With the European Central Bank (ECB) undertaking responsibility of specific supervisory tasks and cooperating with national supervisors for day-to-day supervision, it was expected that the diversity of practices and regulatory inconsistencies would end. The SSM, by centralizing prudential supervision, would ensure that the single market rules are applied consistently. It also aimed at breaking the link between sovereigns and their banks. Furthermore, the SSM as an independent mechanism, was proposed in order to separate supervision from monetary policy within the ECB and to ensure the accountability of the ECB to the European Parliament for supervisory decisions.[5]

The main objective of the implemented reforms was to restore confidence in the euro area banks and create a harmonized and integrated financial sector. A strong regulatory and supervisory framework would provide significant support to the banking sector, especially in times of uncertainty, which has been found to hinder bank performance and threaten financial stability.[6] Examining bank profitability, and in particular the convergence of profitability indices, can provide indications of whether financial conditions became more favorable for this goal to be achieved.

[4] The de Larosière Group report (2009).
[5] European Commision (2012).
[6] A thorough analysis on how bank profitability is affected by uncertainty shocks can be found in Dang and Nguyen (2022).

3. Literature review

The expansion and evolution of the EU has attracted considerable attention from empirical researchers who tried to identify possible links between the framework of a single market and convergence of the banking sector towards improved overall performance. Many studies have focused on the integration of cost structure and banking efficiency. Mamatzakis et al. (2008) analyzed convergence in cost and profit efficiency of ten new EU member states during 1998-2003, estimated using the stochastic frontier approach. Applying β-and σ-convergence criteria they find indications of convergence in cost efficiency, while profit efficiency does not appear to converge. Casu and Girardone (2010) analyze the cost efficiency of the EU-15 banking markets between 1997 and 2003.They used data envelopment analysis (DEA) as well as GMM and convergence analysis. According to their main findings there is evidence of convergence towards a European average, even though it might not translate into improved efficiency, since there are indications that the observed convergence can be attributed to "lagging behind" instead of "catching up" with best practice.

On the other hand, evidence in favor of improved efficiency is provided by Weill (2009), who applies β-and σ- convergence analysis on cost efficiency scores of banks operating in 10 EU countries during 1994-2005. According to his main findings there is an increase in the banking efficiency of all examined countries, even though significant discrepancies among countries are observed. In addition, there is evidence of convergence and of a "catching up" process in banking efficiency. Matousek et al. (2015) study the convergence of efficiency of 400 European banks over the period 2005-2012. To estimate efficiency, they use a parametric distance function approach and to test convergence they employ the Phillips and Sul (2007) methodology. Their main findings provide indications that bank efficiency does not converge within the group of EU-15 or within the euro area as a whole, a result that can be attributed to the impact of the financial crisis on European banks.

In a more recent study, Tziogkidis et al. (2020) examine a sample of banks regulated by the SSM, during 2011-2017, and proposing a new approach for testing dimension-specific β-convergence in productivity, efficiency and technology. They provide evidence of convergence towards a common frontier rather than local equilibria, especially after the introduction of the SSM. Another study that examines the evolution of technical efficiency and productivity was conducted by Fujii et al. (2018) who

examine 927 European banks during 2005-2014 and assess the integration process of the EU banking sector by testing for convergence in productivity growth and in the individual bank inputs. For productive efficiency estimation methods, DEA and the weighted Russell directional distance model (WRDDM) are employed, while for convergence the dynamic Phillips and Sul (2007) methodology is adopted. According to their main conclusion efficiency, productivity and convergence displayed significant differences across the banks of the sample. Regarding convergence in particular, their findings suggest that banks from the 28 EU countries are integrating with respect to technical change. In addition, banks from the new EU countries are caching up with their counterparts from the old EU countries.

Several studies also examined banking productivity and convergence incorporating in the analysis the effect of the financial crisis. Casu et al. (2016) study the productivity of the euro area banks from the beginning of the EU until the years of the financial crisis and the regulatory reforms that followed as well as the impact of integration in terms of technological spillovers. After evaluating productivity growth over the period 1992-2014 using a parametric meta-frontier Divisia index, they employ convergence analysis to examine the existence of convergence towards the meta-frontier. Their main findings provide evidence that the euro area countries experienced productivity growth driven by technological improvements, which also led to convergence towards the best available technology. However, convergence was not complete and regulatory reforms and technological progress appeared to increase differences in the euro area bank productivity. Degl'Innocenti et al. (2017) examine bank productivity and convergence patterns of 539 European banks during the U.S. subprime crisis (2007-2008), the global financial crisis (2009-2010) and the sovereign debt crisis (2010-2012). They use two-stage data envelopment analysis and β-and σ-convergence analysis. According to their findings there is evidence of productivity growth during the U.S. subprime crisis followed by a decline in productivity during the global financial crisis. Regarding convergence there is evidence of productivity growth convergence during the financial crisis.

Another way to analyze convergence in the banking sector is through competition since enhancement of banking competition is associated with increased integration. Fernández de Guevara et al. (2007) focus on the evolution of convergence of interest rates and competition of the European banking sector during 1993-2001. Their findings indicate that interest rates converge, possibly due to the convergence of inflation rates and the

reduction of nominal interest rates. Analyzing the Lerner index as an indicator of competition, they find evidence of important inequalities in the level of competition among the EU countries. To investigate this result even further they use the Theil index, finding evidence that the observed inequality increased during the period under examination. Weill (2013) studies the evolution of bank competition in the 27 EU countries during 2002-2008. He employs the Lerner index and the Rosse-Panzar model to estimate bank competition measures and then applies β-and σ-convergence tests. The main findings provide evidence that bank competition increased during that period but to a different extent across countries. In addition, there was evidence of convergence for the measures of competition under examination. Karadima and Louri (2020) study the evolution and convergence of bank competition and credit risk, focusing on all euro area countries as well as core and periphery countries separately. Using a sample that spans from 2005 to 2017 and employing the Theil inequality index and β-and σ-convergence analysis, they find evidence of fragmentation and diverging trends within and/or between core and periphery countries.

Finally, several studies have examined integration in the banking sector by focusing on profitability and the structure of the banks' financing activities. Goddard et al. (2013) analyze the determinants and convergence of profitability of 4787 European banks over the period 1992-2007 using a dynamic panel model. In addition, they conduct separate estimations for the periods before and after the introduction of the euro and the implementation of the Financial Services Action Plan. The estimated results suggest an increase in the speed at which excess profits are eliminated through competition, which is consistent with the hypothesis of improved competitiveness and integration of financial markets. Evans et al. (2008) examine the impact of the European regulatory actions on the convergence of performance of the banking sector of 14 European countries during 1979-1997. Their main findings indicate converging trends regarding the asset-liability management indicators, cost effectiveness and profitability indicators. Murinde et al. (2004) explore convergence focusing on the structure of the financial system and on the patterns of corporate financing activities by banks, bond markets, stock markets, and nonfinancial corporations (NFCs) through retained earnings. They use a dataset from 7 EU countries over the years 1972-1996 and they apply GMM estimation of a dynamic fixed effects model for convergence. According to their findings there is no evidence in favor of convergence towards the use of bank debt for

financing new investment, while there is evidence of convergence in terms of the use of equity finance by NFCs.

On the other hand, there is no significant evidence of convergence regarding an increase in the relative share of the bond market in the overall financing of new investment by NFCs. In addition, their results suggest the NFCs of the examined countries displayed convergence in terms of the use of internal funds (e.g., retained earnings) for financing new investment. Rughoo and Sarantis (2012) study the convergence of the European retail banking sector focusing on the deposit and lending rates with varying maturities to non-financial corporations (NFCs) during the period 1995-2008. Employing the Phillips and Sul (2007) panel convergence methodology they find evidence that retail banking for NFCs display convergence in most of the examines cases. Their results also suggest that convergence is faster for short-term and medium-term deposit and lending rates than for rates with long-term maturity.

The current study aims at adding to the literature pertaining to financial convergence focusing on bank profitability and incorporating the recent institutional developments towards the establishment of the European Banking Union, using a new set of data and employing alternative and suitable methodologies and tests.

4. Data and empirical methodology

4.1 Data

We use bank-specific and macroeconomic annual data for the period 2011-2017 from 18 member countries of the euro area.[7] Our sample is composed of the group of the directly supervised banks, which in 2014 were classified as significant and their supervision was transferred to the ECB (SSM banks), and the indirectly supervised group[8], which are still supervised by the National Competent Authorities (NCAs) with the ECB having an oversight role (these banks from now on will be denoted as NCA

[7] We examine banks from Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain. We excluded banks from Luxembourg because of differences in business models.

[8] We exclude from the NCA group specialized governmental credit institutions, investment and trust corporations, clearing and custody institutions, real estate and mortgage banks, finance companies, securities firms, private banking and asset management companies, cooperative banks and investment banks.

banks). For a bank to be categorized as significant it needs to fulfill one of the following criteria:[9]

1. The total value of its assets exceeds €30 billion.
2. The ratio of the bank's total assets to GDP of the member state, in which it is located, exceeds 20%, unless the total value of its assets is below €5billion.
3. The bank is one of the three most significant financial institutions of the member state in which it is located.

From the collected sample we exclude banks for which we have missing observations on the dependent variable for the years of the policy effect estimation. Hence, our sample comprises 247 banks, with 78 of them belonging to the directly supervised group of banks. The group of the indirectly supervised banks is composed of 169 commercial and savings banks. The source for the bank-specific data is the BankFocus database provided by Bureau van Dijk. Table 1 presents the variables included in our analysis and the year-by-year summary statistics.

Table 1: Summary statistics

	ROA					ROE				
YEAR	N	MEAN	MEDIAN	SD	CV	N	MEAN	MEDIAN	SD	CV
2011		-0.03	0.22	1.66	-53.04		1.99	3.73	32.25	16.23
2012		0.07	0.22	1.33	18.99		-1.72	3.42	56.54	-32.78
2013		0.10	0.21	1.58	15.16		0.92	3.49	24.02	26.25
2014		0.24	0.24	0.81	3.40		3.22	3.54	12.75	3.96
2015		0.28	0.30	1.04	3.76		3.89	4.27	12.76	3.28
2016		0.37	0.29	0.87	2.34		4.46	4.20	9.61	2.16
2017		0.35	0.29	0.62	1.79		4.20	4.32	7.77	1.85
TOTAL	1715	0.199	0.24	1.19	5.98	1711	2.42	3.86	27.45	11.33

Analyzing the evolution of the standard deviation (SD) and the coefficient of variation (CV) calculated at the bank level of the full sample, could provide indications towards the existence of convergence or the increase of inequalities of the profitability indices

[9]ECB (2014).

during the examined period, an approach also used by Fernández de Guevara et al. (2007). The observed decrease of SD and CV for both ROA and ROE after the introduction of the SSM, could be an indication of decreased inequality of bank profitability within the euro area financial sector.

In what follows, we examine the sample as a whole and we also split it into subgroups. Splitting the sample can also work as a robustness check (Degl'Innocenti et al., 2017). First, we split it into two subgroups: one is composed of the SSM supervised banks, while the other contains the NCA supervised banks. Using this separation of the sample, we attempt to ensure that the results are not driven by the inclusion of banks that have been directly affected by the SSM introduction.

Next, we split the sample into banks located in the EU core countries and banks located in the EU periphery countries. The core countries comprise Austria, Belgium, Estonia, Germany, Finland, France, Netherlands and Slovakia and the group of periphery countries includes Cyprus, Greece, Ireland, Italy, Malta, Portugal, Slovenia and Spain. This separation was based on the European Commission's identification of distinct groups of EU Member States, with respect to their levels of bank risk, as presented in Magnus et al. (2017). The core and periphery groups contain both directly and indirectly supervised banks. However, there are significant differences among core and periphery countries and their financial sectors are affected differently by the changing macroeconomic conditions, hence we expect their converging behavior to differ as well. The left panel of Figure 1 depicts the evolution of the mean ROA for the whole sample, for the subgroup of the SSM banks and the subgroup of the NCA banks. The right panel of Figure 1 illustrates the evolution of the mean ROA for the whole sample, for the subgroup of banks located in the EU core countries and the subgroup of banks located in the EU periphery countries. Similarly, Figure 2 depicts the evolution of mean ROE.

Figure 1
The evolution of ROA

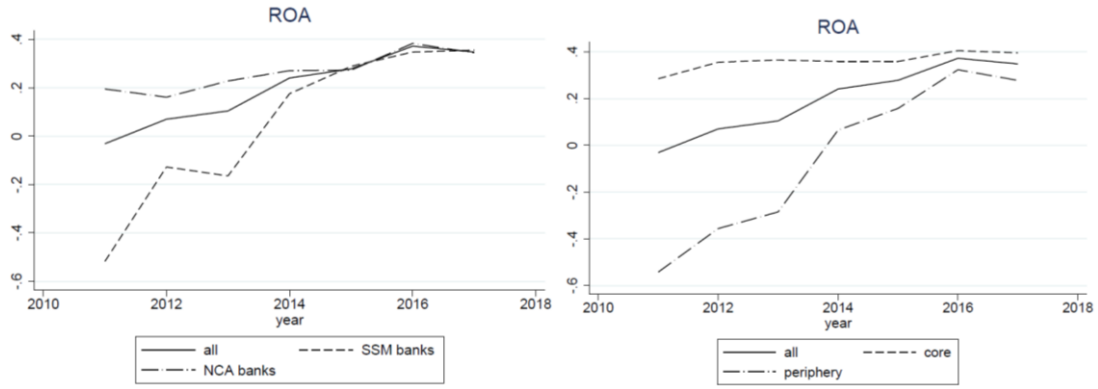
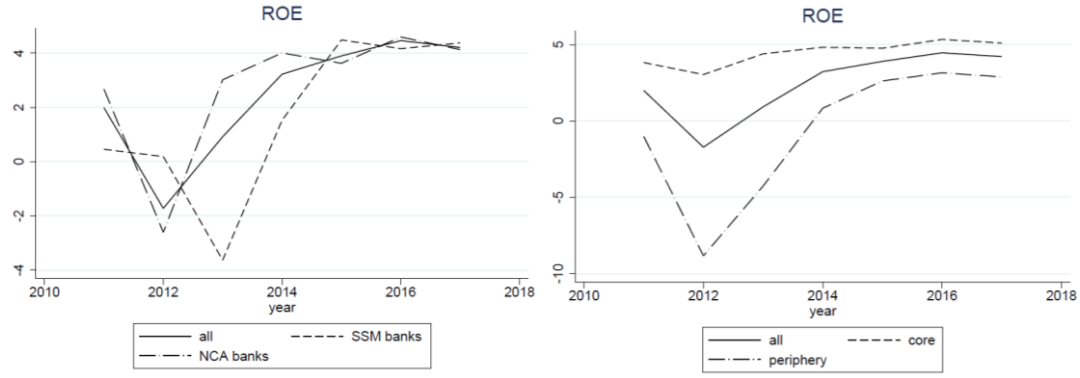


Figure 2
The evolution of ROE



In Figures 1 and 2 we observe a converging behavior for all of the examined groups, both for ROA and ROE. Furthermore, we see that after the introduction of the SSM in 2014 the least profitable banks display increased profitability, therefore the observed convergence can be interpreted as an indication of improved efficiency, i.e. the least profitable banks are "catching-up" with the more profitable ones.

As a further support of the aforementioned converging pattern, we apply to the whole sample and the subgroups of interest the Theil inequality index[10], which belongs to the Generalized Entropy class of inequality indices. The Theil index, denoted by GE(1), can be written:

$$GE(1) = \frac{1}{n}\sum_i \frac{y_i}{\bar{y}} \log \frac{y_i}{\bar{y}} \qquad (1)$$

[10] More information on inequality measures can be found in Shorrocks (1980).

where y_i is the profitability index for bank i and $\bar{y}$ is the mean value of the profitability of each sample. Tables 2 and 3 report the Theil inequality index regarding the bank profitability of the whole sample and of the subgroups of interest. As we see there are indications that during the years after the introduction of the SSM there is a decrease in the inequality of the profitability of the euro area banks. This result is observed in all the examined cases, which supports the hypothesis of profit convergence and financial integration of the euro area. This motivates us to examine the issue of financial integration using convergence analysis.

Table 2
Theil index of profitability indices
of different groups of banks

	ROA			ROE		
	ALL	SSM	NCA	ALL	SSM	NCA
2011	0.45	0.64	0.34	0.94	1.33	0.43
2012	0.47	0.48	0.47	1.06	1.44	0.48
2013	0.51	0.58	0.46	0.53	0.55	0.51
2014	0.38	0.35	0.40	0.42	0.21	0.50
2015	0.37	0.27	0.41	0.31	0.16	0.38
2016	0.50	0.31	0.59	0.39	0.19	0.49
2017	0.36	0.29	0.38	0.31	0.19	0.37

Note: SSM indicates the SSM banks and NCA indicates banks supervised by the National Competent Authorities (NCAs).

Table 3
Theil index of profitability indices
of banks located in different groups of countries

	ROA			ROE		
	ALL	CORE	PERIPHERY	ALL	CORE	PERIPHERY
2011	0.45	0.54	0.27	0.94	0.42	0.48
2012	0.47	0.49	0.44	1.06	0.34	1.52
2013	0.51	0.36	0.63	0.53	0.28	0.74
2014	0.38	0.37	0.39	0.42	0.30	0.56
2015	0.37	0.32	0.41	0.31	0.27	0.36
2016	0.50	0.34	0.66	0.39	0.30	0.51
2017	0.36	0.30	0.43	0.31	0.27	0.37

4.2 Empirical Methodology

The model proposed by Phillips and Sul (2007) provides a framework to study the behavior of an individual transition path relative to the panel average, allowing for individual heterogeneity. The first step to illustrate the method's structure is through a single factor model:

$$Y_{i,t} = \delta_{i,t}\mu_t + \varepsilon_{i,t} \quad (2)$$

where $\delta_{i,t}$ measures the idiosyncratic distance between some common factor μ_t and the systematic part of $Y_{i,t}$. Within this framework the systematic idiosyncratic element can evolve over time, allowing for heterogeneous agent behavior and evolution in that behavior through the varying factor loading coefficient $\delta_{i,t}$.This method further allows $\delta_{i,t}$ to have a random component that absorbs $\varepsilon_{i,t}$ providing the possibility of converging behavior in $\delta_{i,t}$ over time in relation to the common factor μ_t:

$$Y_{i,t} = \delta_{i,t}\mu_t \quad (3)$$

For the case of panel data $Y_{i,t}$ can be decomposed into the systematic components, $g_{i,t}$,which include the common components, and the transitory components, $a_{i,t}$:

$$Y_{i,t} = g_{i,t} + a_{i,t} \quad (4)$$

This specification may contain both common and idiosyncratic components. In order to separate them in the panel, (3) can be transformed in the following way:

$$Y_{i,t} = \left(\frac{g_{i,t}+a_{i,t}}{\mu_t}\right)\mu_t = \delta_{i,t}\mu_t, \text{ for all } i \text{ and } t, \quad (5)$$

By focusing on $\delta_{i,t}$ this method allows for the case where individual behavior may be transitionally divergent, which can be examined through the transition coefficient $h_{i,t}$. This coefficient is directly constructed from the data $Y_{i,t}$ and is a functional of $\delta_{i,t}$, allowing to measure the temporal evolution of $\delta_{i,t}$. The relative loading or transition coefficient can be expressed as:

$$h_{i,t} = \frac{Y_{i,t}}{\frac{1}{N}\sum_{i=1}^{N} Y_{i,t}} = \frac{\delta_{i,t}}{\frac{1}{N}\sum_{i=1}^{N} \delta_{i,t}} \quad (6)$$

This measures the loading coefficient $\delta_{i,t}$in relation to the panel average at time *t*.

In this setting Phillips and Sul (2007) proposed the *log t* regression test for convergence. The null hypothesis of convergence is:

H_0: $\delta_i = \delta$ and $a \geq 0$, against the alternative H_a: $\delta_i \neq \delta$ for all I or $a < 0$.

The first step of the proposed procedure is to construct the cross-sectional variance ratio H_1/H_t, where:

$$H_t = \frac{1}{N}\sum_{i=1}^{N}\left(h_{i,t} - 1\right)^2 \quad (7)$$

The second step is to run the following regression:

$$log(H_1/H_t) - 2logL(t) = \hat{a} + \hat{\beta} logt + \hat{u}_i \quad (8)$$

where $t = [rT], [rT]+1, \ldots, T$ with $r > 0$ and $L(t) = \log(t+1)$. The fitted coefficient of log *t* is $\hat{b} = 2\hat{a}$, where $\hat{a}$ is the estimate of a in H_0. In this regression the data start at $t = [rT]$ for some $r > 0$. Based on their Monte-Carlo simulations results the recommended choice by Phillips and Sul (2007) is $r = 0.3$.

The third step is an autocorrelation and heteroskedasticity robust one-sided *t-test* of the null hypothesis $a > 0$ using $\hat{b}$ and heteroskedasticity and autocorrelation consistent (HAC) standard error. The null hypothesis of convergence is rejected, using the 5% significance level, if the test statistic is < - 1.65.

For robustness checks, following the specification applied by Matousek et al. (2015), we conduct the test for *β*-convergence. Then, to attain a complete image of the possible converging patterns, we expand our analysis to *σ*-convergence. This type of convergence analysis has been developed by Barro and Sala-i-Martin (1992; 1995). The following equation illustrates the regression for β-convergence of the profitability indices:

$$\ln\left(Y_{i,t}\right) - \ln\left(Y_{i,t-1}\right) = a + \beta \ln\left(Y_{i,t-1}\right) + A_i + \varepsilon_{i,t} \quad (9)$$

where $Y_{i,t}$ represents the profitability indices ROA and ROE of bank *i* at period *t*, $Y_{i,t-1}$ represents the profitability indices ROA and ROE of bank *i* at period *t*-1, A_i represent the bank fixed effects and $\varepsilon_{i,t}$ is the error term. If the coefficient β is negative and statistically significant, *β*-convergence is present, while a positive estimated coefficient provides indications of divergence. In economic growth literature, convergence indicates that low-income countries experience faster per capita growth rate than high-

income ones. (Barro and Sala-i-Martin, 1992). This interpretation can be adjusted to the case of profit convergence by arguing that weaker banks increase their effort to manage their resources more efficiently in order to improve their overall performance, and as an indirect consequence their profitability growth is higher.

Then we examine the presence of σ-convergence regarding the profitability of the euro area banks, running the following regression:

$$\Delta W_{i,t} = a + \sigma W_{i,t-1} + A_i + \varepsilon_{i,t} \quad (10)$$

where $W_{i,t} = \ln(Y_{i,t}) - \ln(\bar{Y}_{i,t})$ of bank *i* at period *t*, with $\bar{Y}$ representing the mean of the profitability indices, ROA and ROE. In addition, $\Delta W_{i,t} = W_{i,t} - W_{i,t-1}$, A_i represents the bank fixed effects, and $\varepsilon_{i,t}$ is the error term. According to the related literature, a negative and statistically significant coefficient indicates the presence of convergence towards the average level of profitability. The σ-convergence indicates how quickly the individual profitability change is converging to the average profitability change. Equations for β- and σ-convergence are estimated using Ordinary Least Squares (OLS) with fixed effects regression and 2-step System GMM (Blundell and Bond 1998)[11].

5. Empirical Results

5.1 Log *t* test

This section presents the results of the empirical analysis conducted using the Phillips and Sul (2007) convergence methodology, regarding both ROA and ROE. The tables of this section report the test statistic and the estimated coefficient $\hat{b}$, which provides information about the rate of convergence. A higher value of $\hat{b}$ indicates higher rate of convergence. Columns (1) and (4) of Table 4 present the estimated results for all of the banks of the sample. The results indicate the existence of convergence at the 5% level for the two profitability indices and, in particular, for ROA $\hat{b} = 3.225$ and for ROE $\hat{b} = 4.541$.

[11] Equations for β- and σ-convergence have also been estimated using Pooled OLS which revealed evidence of convergence. The related tables are presented in the Appendix.

Table 4
Phillips and Sul log *t* convergence test on profitability indices of different groups of banks

	ROA			ROE		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	SSM	NCA	ALL	SSM	NCA
$\hat{b}$	3.225	3.197	0.712	4.541	2.943	1.167
t-stat	4.800*	4.789*	1.004*	4.356*	3.640*	2.688*

Note: SSM indicates the SSM banks and NCA indicates banks supervised by the National Competent Authorities (NCAs).
*Indicates failure to reject the null hypothesis of convergence at the 5% significance level.

In columns (2) and (5) of Table 4 the results regarding the SSM supervised banks suggest the presence of convergence for ROA and ROE. Columns (3) and (6) depict the results for the NCA supervised banks, which also indicate the presence of convergence. It is important to note, however, that the observed convergence of the NCA group is weaker. For the case of ROA the SSM group exhibits $\hat{b} = 3.197$, in comparison to the NCA group, where $\hat{b} = 0.712$. Similarly, for ROE the SSM group exhibits $\hat{b} = 2.943$, while for the NCA group $\hat{b} = 1.167$.

Table 5 reports the results regarding the core and periphery countries. In columns (1) and (4) we see the results for ROA and ROE regarding the whole sample of banks at our disposal (as in columns (1) and (4) of Table 4). For the case of ROA there is evidence of convergence for banks located in both core and periphery countries. However, the observed convergence in core countries is weaker ($\hat{b} = -1.123$) compared to periphery countries ($\hat{b} = 1.781$). Similarly for ROE, even though there is evidence of convergence for the two subgroups, banks in the core countries exhibit weaker convergence ($\hat{b} = -0.115$), compared to banks located in the periphery countries ($\hat{b} = 1.661$).

Table 5
Phillips and Sul log *t* convergence teston profitability indices of banks located indifferent groups of countries

	ROA			ROE		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	CORE	PERIPHERY	ALL	CORE	PERIPHERY
$\hat{b}$	3.225	-1.123	1.781	4.541	-0.115	1.661
t-stat	4.800*	-1.343*	1.256*	4.356*	-0.124*	1.306*

*Indicates failure to reject the null hypothesis of convergence at the 5% significance level.

5.2 Test of β-and σ-convergence

To assess the validity of our findings we examine the convergence of profitability for the euro area banks using as an alternative methodology the test for β-convergence, which indicates whether banks with lower levels of profitability, exhibit faster growth rate of profitability[12]. Then we conduct the test for σ-convergence, which indicates the rate at which individual profitability converges towards the average profitability of the examined group of banks. In this section the sample is initially examined as a whole and then it is split as in the previous section.

Table 6
Test of β-convergence of profitability indices
of different groups of banks

	ROA					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	SSM	NCA	ALL	SSM	NCA
β	-0.992***	-0.962***	-1.007***	-0.823***	-1.013***	-0.660***
	(0.051)	(0.097)	(0.058)	(0.103)	(0.175)	(0.137)
N	1165	337	828	1165	337	828
R^2	0.584	0.561	0.594			
S-H				0.260	0.936	0.014
	ROE					
	OLS			GMM		
	ALL	SSM	NCA	ALL	SSM	NCA
β	-1.017***	-1.015***	-1.018***	-0.814***	-0.936***	-0.665***
	(0.051)	(0.104)	(0.056)	(0.123)	(0.210)	(0.148)
N	1170	341	829	1170	341	829
R^2	0.593	0.566	0.609			
S-H				0.113	0.555	0.005

Note: SSM indicates the SSM banks and NCA indicates banks supervised by the National Competent Authorities (NCAs).
Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step system GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

[12] Following Casu et al. (2016), as a robustness check we conducted the same analysis using levels instead of the natural logarithms, and the main conclusions remain unaltered. In the interest of brevity the related tables are not reported here but can be provided upon request.

Table 6 reports the results for β-convergence, which reveal a negative and statistically significant at the 1% level relation between the growth rate of profitability and the initial level. This indicates the presence of β-convergence for ROA and ROE of the examined sample and the two subgroups of the SSM and NCA supervised banks. The results remain robust irrespective of the estimation method employed.

Table 7
Test of β-convergence of profitability indices
of banks located in different groups of countries

	ROA					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	CORE	PERIPHERY	ALL	CORE	PERIPHERY
β	-0.992***	-0.923***	-1.068***	-0.823***	-0.948***	-0.745***
	(0.051)	(0.074)	(0.063)	(0.103)	(0.166)	(0.146)
N	1165	792	373	1165	792	373
R^2	0.584	0.519	0.646			
$S\text{-}H$				0.260	0.457	0.059
	ROE					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	CORE	PERIPHERY	ALL	CORE	PERIPHERY
β	-1.017***	-0.957***	-1.090***	-0.814***	-0.656***	-0.844***
	(0.051)	(0.075)	(0.062)	(0.123)	(0.128)	(0.188)
N	1170	794	376	1170	794	376
R^2	0.593	0.528	0.658			
$S\text{-}H$				0.113	0.139	0.065

Note: Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step system GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Similarly in Table 7 the results provide evidence towards the presence of β-convergence for the entire sample and for the groups of banks located in core and in periphery countries. The negative and statistically significant at the 1% level relation between the growth rate of profitability and the initial level is observed for both ROA and ROE

using either OLS or 2-step System GMM estimation methods. The findings of this section provide evidence in favor of the validity of our main results.

In Tables 8 and 9 we can see the results for σ-convergence, which also indicate the presence of convergence in all examined cases. Observing the absolute value of the coefficient of σ estimated using OLS, we see in columns (2) and (3) of Table 8, a faster rate of convergence of ROA for the group of SSM supervised banks. Similar results are observed when we use 2-step System GMM (columns 5 and 6). Focusing on ROE, the rate of convergence is found to be faster for the NCA supervised banks, using either one of the two estimation methods.

Table 8
Test of σ-convergence of profitability indices
of different groups of banks

	ROA					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	SSM	NCA	ALL	SSM	NCA
σ	-0.656***	-1.222***	-0.883***	-0.512***	-0.957***	-0.620***
	(0.042)	(0.111)	(0.057)	(0.079)	(0.158)	(0.118)
N	992	187	828	992	187	828
R^2	0.485	0.728	0.507			
S-H				0.014	0.276	0.003
	ROE					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	SSM	NCA	ALL	SSM	NCA
σ	-0.938***	-0.235**	-1.084***	-0.870***	-0.592***	-0.874***
	(0.041)	(0.111)	(0.069)	(0.084)	(0.097)	(0.171)
N	808	233	567	808	233	567
R^2	0.627	0.249	0.692			
S-H				0.024	0.004	0.174

Note: SSM indicates the SSM banks and NCA indicates banks supervised by the National Competent Authorities (NCAs).
Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step system GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

The results presented in Table 9 suggest that, for the case of ROA using OLS, the group of banks located in the core countries (column 2) exhibit faster rate of convergence in comparison to the banks located in the euro area periphery countries (column 3). When we use 2-step System GMM, the results indicate a faster rate of convergence for the group of banks located in the EU periphery countries (columns 5 and 6). For the case of ROE there is evidence that the banks located in periphery countries exhibit faster rate of convergence in comparison to those located in core countries, irrespective of the estimation method.

Table 9
Test of σ-convergence of profitability indices
of banks located in different groups of countries

	ROA					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	CORE	PERIPHERY	ALL	CORE	PERIPHERY
σ	-0.656***	-0.937***	-0.813***	-0.512***	-0.954***	-0.848***
	(0.042)	(0.072)	(0.090)	(0.079)	(0.170)	(0.105)
N	992	792	204	992	792	204
R^2	0.485	0.530	0.667			
S-H				0.014	0.597	0.102
	ROE					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	CORE	PERIPHERY	ALL	CORE	PERIPHERY
σ	-0.938***	-0.879***	-0.988***	-0.870***	-0.688***	-1.152***
	(0.041)	(0.066)	(0.094)	(0.084)	(0.113)	(0.163)
N	808	794	204	808	794	204
R^2	0.627	0.488	0.629			
S-H				0.024	0.107	0.058

Note: Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step system GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

6. Z-score

This section is dedicated to the examination of the Z-score, which represents the number of standard deviations that a bank's rate of ROA has to fall for the bank to face insolvency. Therefore, a higher Z-score indicates a lower probability of insolvency. We repeat the same analysis using the estimation methods presented above, replacing the dependent variable by the Z-score. It is constructed as the sum of the mean rates of ROA (μ_{ROA_i}) and the equity to total assets ratio ($eqta_{i,t}$) divided by the standard deviation of ROA (SD_{ROA_i}):[13]

$$Z\text{-}score_{i,t} = \frac{\mu_{ROA_i} + eqta_{i,t}}{SD_{ROA_i}} \tag{11}$$

Table 10
Phillips and Sul log *t* convergence test on the Z-score

	(1)	(2)	(3)	(4)	(5)
	ALL	SSM BANKS	NCA BANKS	CORE	PERIPHERY
$\hat{b}$	-1.413	-1.220	-1.395	-1.389	-1.360
t-stat	-25.249	-18.026	-22.959	-23.919	-18.496

By applying the Phillips and Sul (2007) methodology no evidence of convergence is identified for the Z-score, as reported in Table 10. In Tables 11 and 12 we see the results of the β-convergence tests, which display mixed patterns, depending on the methodology used. When OLS regression is employed, there is evidence of convergence, while the GMM estimation method reveals no indications of convergence. Similarly for the case of the σ-convergence tests in Tables 13 and 14. Since only the OLS estimation method provides evidence of convergence, our findings suggest the existence of subgroups with diverging patterns. As the Z-score contains the mean and the standard deviation of the entire examined period, it could be averaging out any effects caused by the institutional reforms, which could otherwise have affected the converging behavior of the Z-score.

[13] For more on the approaches related to the construction of the Z-score see Lepetite and Strobel (2013), Lepetite et al. (2021).

Table 11
Test of β-convergence of the Z-score
of different groups of banks

	Z-score					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	SSM	NCA	ALL	SSM	NCA
β	-0.455***	-0.607***	-0.326***	-0.035	0.047	-0.013
	(0.076)	(0.057)	(0.060)	(0.029)	(0.036)	(0.037)
N	1438	455	983	1438	455	983
R^2	0.350	0.374	0.360			
S-H				0.504	0.638	0.326

Note: SSM indicates the SSM banks and NCA indicates banks supervised by the National Competent Authorities (NCAs).
Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step system GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Table 12
Test of β-convergence of the Z-score
of banks located in different groups of countries

	Z-score					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	CORE	PERIPHERY	ALL	CORE	PERIPHERY
β	-0.455***	-0.305***	-0.545***	-0.035	-0.162	-0.010
	(0.076)	(0.073)	(0.072)	(0.029)	(0.170)	(0.055)
N	1438	866	572	1438	866	572
R^2	0.350	0.399	0.352			
S-H				0.504	0.771	0.589

Note: Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step system GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Table 13
Test of σ-convergence of the Z-score
of different groups of banks

	Z-score					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	SSM	NCA	ALL	SSM	NCA
σ	-0.507***	-0.677***	-0.355***	-0.042	0.051	-0.019
	(0.078)	(0.042)	(0.060)	(0.034)	(0.037)	(0.040)
N	1438	455	983	1438	455	983
R^2	0.375	0.405	0.373			
S-H				0.554	0.688	0.293

Note: SSM indicates the SSM banks and NCA indicates banks supervised by the National Competent Authorities (NCAs).
Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step system GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Table 14
Test of σ-convergence of the Z-score
of banks located in different groups of countries

	Z-score					
	OLS			GMM		
	(1)	(2)	(3)	(4)	(5)	(6)
	ALL	CORE	PERIPHERY	ALL	CORE	PERIPHERY
σ	-0.507***	-0.360***	-0.557***	-0.042	-0.160	0.008
	(0.078)	(0.096)	(0.070)	(0.034)	(0.144)	(0.056)
N	1438	866	572	1438	866	572
R^2	0.375	0.412	0.361			
S-H				0.553	0.517	0.582

Note: Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step system GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

These mixed findings motivate us to further isolate the effect of the SSM on profitability convergence, by focusing on a narrower time interval around the introduction of the SSM.

7. Profitability convergence after the introduction of the SSM

In this section we attempt to estimate the effect of the SSM introduction by examining the years 2014-2017 for the full sample of banks.

Table 15
Phillips and Sul log *t* convergence test

	ROA	ROE	Z-score
$\hat{b}$	0.144	-0.339	-2.065
t-stat	4.571*	-5.726	-16.789

*Indicates failure to reject the null hypothesis of convergence at the 5% significance level.

In Table 15 there is evidence of convergence for the case of ROA, while for ROE and for the Z-score no evidence of convergence is identified for the period 2014-2017. Regarding ROE, we see in Tables 16 and 17 that the robustness tests for β-and σ-convergence provide evidence of converging behavior irrespective of the estimation method. This could be attributed to the fact that the β- and σ-convergence methodology is uninformative on the existence of sub-groups within the sample that converge and are possibly affecting the results of the entire group. On the other hand, in the Phillips and Sul (2007) methodology, rejection of the null hypothesis of convergence does not necessarily mean that there are no converging subgroups within the sample. In fact, by applying the Phillips and Sul (2007) methodology for club convergence and clusters we identify the existence of 9 sub-groups with converging patterns, while no clusters with diverging behavior are identified (Appendix Table A5). Regarding the Z-score, in Tables 16 and 17 the tests for β- and σ–convergence reveal evidence of convergence when we use OLS with fixed effects, while the GMM estimation method reveals no evidence of convergence.

Table 16
Test of β-convergence

	ROA	ROE	Z-score
	OLS		
β	-1.227***	-1.279***	-0.751***
	(0.081)	(0.084)	(0.091)
N	614	614	720
R^2	0.748	0.757	0.604
	GMM		
β	-0.889***	-0.986***	-0.096
	(0.143)	(0.164)	(0.101)
N	614	614	720
S-H	0.516	0.657	0.167

Note: Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step system GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Table 17
Test of σ -convergence

	ROA	ROE	Z-score
	OLS		
σ	-1.171***	-1.221***	-0.812***
	(0.074)	(0.078)	(0.093)
N	614	614	720
R^2	0.717	0.738	0.619
	GMM		
σ	-0.891***	-0.971***	-0.095
	(0.133)	(0.158)	(0.092)
N	614	614	720
S-H	0.449	0.643	0.165

Note: Robust standard errors in parentheses. Two-step GMM estimates are Windmeijeier corrected (Windmeijer, 2005). S-H denotes the Sargan-Hansen test of the over-identifying restrictions for the two-step GMM estimators.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

8. Conditional convergence tests

In this section we attempt a final robustness test of our findings, by accounting for conditional convergence, during the entire period under examination. First, we include the total capital adequacy ratio (tcar), a ratio that falls within the supervisory and regulatory powers of the ECB. Then we consider a country-level variable, the real GDP growth. This way we can test whether the profitability of the euro area banks is displaying absolute convergence or whether it is converging towards separate equilibria, due to exogenous factors. As described in Casu et al. (2016), statistically significant estimated coefficients of the additional explanatory variables, along with a negative and statistically significant coefficient of β, indicate conditional convergence. Table 18 reports the results when we include total capital adequacy ratio and Table 19 the results when we control for real GDP growth.[14]

Table 18 provides further indications of absolute convergence for ROA and ROE, using either OLS or GMM estimation methods. The coefficient of β is negative and statistically significant, while the coefficient of total capital adequacy ratio is not statistically different from zero. Similarly, for the σ-convergence test. Regarding the Z-score, the results are once again mixed, depending on the estimation method used.

In Table 19, there is evidence of local equilibria of profitability among banks located in countries with different GDP growth, for the case of ROA. ROE, on the other hand, continues to display indications of absolute convergence. Finally, the results regarding the Z-score, indicate the existence of conditional convergence when we use OLS estimation, while using GMM estimation, there is evidence of absolute convergence.

[14]To preserve space, Tables 18 and 19 report only the results of the estimated coefficients of interest. The full tables are available upon request.

Table 18
Tests of β– andσ– convergence accounting for total capital adequacy ratio

	ROA		ROE		Z-score	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	GMM	OLS	GMM	OLS	GMM
β	-1.005***	-0.772***	-1.015***	-0.782***	-0.547***	0.010
	(0.051)	(0.117)	(0.056)	(0.124)	(0.078)	(0.025)
tcar	0.011	0.018	-0.004	-0.003	0.017***	-0.004***
	(0.007)	(0.007)	(0.009)	(0.005)	(0.004)	(0.001)
R^2/ *S-H*	0.603	0.208	0.596	0.405	0.444	0.570
σ	-0.683***	-0.528***	-0.943***	-0.880***	-0.582***	-0.020
	(0.045)	(0.053)	(0.043)	(0.054)	(0.080)	(0.029)
tcar	-0.003	0.002	-0.006	-0.005	0.015***	-0.004***
	(0.009)	(0.005)	(0.009)	(0.007)	(0.003)	(0.001)
R^2/ *S-H*	0.494	0.000	0.733	0.357	0.454	0.666

Note: Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005).
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Table 19
Tests of β– and σ– convergence accounting for real GDP growth

	ROA		ROE		Z-score	
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	GMM	OLS	GMM	OLS	GMM
β	-0.999***	-0.789***	-1.017***	-0.770***	-0.493***	-0.028***
	(0.049)	(0.096)	(0.051)	(0.133)	(0.084)	(0.011)
GDP	0.029*	0.060**	0.001	0.020	0.022***	0.007
	(0.016)	(0.026)	(0.016)	(0.026)	(0.008)	(0.005)
R^2/ *S-H*	0.587	0.398	0.593	0.082	0.375	0.353
σ	-0.750***	-0.487***	-0.943***	-0.894***	-0.509***	-0.031***
	(0.059)	(0.099)	(0.042)	(0.062)	(0.080)	(0.011)
GDP	-0.140**	-0.044	-0.023	0.021	0.006	0.005
	(0.061)	(0.059)	(0.026)	(0.041)	(0.006)	(0.005)
R^2/ *S-H*	0.521	0.000	0.731	0.035	0.377	0.193

Note: Robust standard errors in parentheses. Two-step system GMM estimates are Windmeijeier corrected (Windmeijer, 2005).
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

9. Concluding Remarks

Financial integration has been among the main objectives of the European Union since its initial steps. Therefore, many institutional developments have been undertaken to facilitate it. This study examines whether the institutional reforms introduced by the establishment of the SSM in 2014, as the first pillar of the European Banking Union, have influenced the convergence of profitability of the euro area banking sector. Since the preparation and implementation of the SSM, European banks have been affected in many ways, some of which encouraged bank profitability while others constrained it. Given that the convergence of profitability is an informative indicator of financial integration, it is important to monitor its evolution along with the steps towards the completion of the European Banking Union, as it would provide useful information for policy makers to consider.

Employing two alternative methodologies for convergence analysis and using a sample of 247 banks supervised either by the SSM or the NCAs over the years 2011-2017, the main findings of this study provide evidence towards the presence of convergence for ROA and ROE. These results remain robust to the different subsamples examined. Splitting the sample in two groups of SSM supervised and nationally supervised banks, we find evidence of stronger converging behavior for the profitability of the SSM banks in comparison to the group of nationally supervised banks. When banks are separated according to their location as banks of the EU core and banks of the EU periphery countries, stronger profitability convergence is observed for banks located in the EU periphery countries.

Assessing to what extent profitability convergence has been attained is a matter of great significance for the EU financial sector, which is in the process of completing a major institutional restructuring designed to contribute to financial integration. It is expected that after the completion of the Banking Union convergence of profitability and overall bank performance will further increase, providing an improved framework for a stable and well-functioning integrated financial market. Whether this objective will be achieved is an interesting issue for future research.

8. References

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APPENDIX

Table A1
Test of β-convergence (Pooled OLS)

	(1)	(2)	(3)	(4)	(5)
	ALL	SSM	NCA	CORE	PERIPHERY
			ROA		
β	-0.298***	-0.308***	-0.294***	-0.243***	-0.401***
	(0.030)	(0.047)	(0.039)	(0.033)	(0.058)
N	1165	337	828	792	373
R^2	0.149	0.173	0.139	0.132	0.184
			ROE		
β	-0.327***	-0.496***	-0.274***	-0.264***	-0.422***
	(0.034)	(0.062)	(0.039)	(0.042)	(0.055)
N	1170	341	829	794	376
R^2	0.158	0.262	0.126	0.126	0.206
			Z-score		
β	-0.019**	-0.058*	-0.007	-0.010*	-0.064**
	(0.009)	(0.033)	(0.005)	(0.005)	(0.029)
N	1438	455	983	866	572
R^2	0.020	0.067	0.004	0.013	0.071

Note: Robust standard errors in parentheses.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Table A2
Test of σ-convergence (Pooled OLS)

	(1)	(2)	(3)	(4)	(5)
	ALL	SSM	NCA	CORE	PERIPHERY
			ROA		
σ	-0.319***	-0.384***	-0.302***	-0.249***	-0.376***
	(0.026)	(0.076)	(0.037)	(0.033)	(0.051)
N	992	187	828	792	204
R^2	0.205	0.217	0.143	0.137	0.224
			ROE		
σ	-0.469***	-0.183**	-0.307***	-0.276***	-0.457***
	(0.032)	(0.074)	(0.042)	(0.041)	(0.057)
N	808	233	567	794	204
R^2	0.321	0.046	0.167	0.134	0.284
			Z-score		
σ	-0.019**	-0.058*	-0.006	-0.010*	-0.065**
	(0.009)	(0.032)	(0.005)	(0.005)	(0.029)
N	1438	455	983	866	572
R^2	0.020	0.068	0.004	0.013	0.071

Note: Robust standard errors in parentheses.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Table A3
Test of β-convergence (Pooled OLS after SSM)

	ROA	ROE	Z-score
	(1)	(2)	(3)
β	-0.309***	-0.335***	-0.017***
	(0.041)	(0.048)	(0.008)
N	614	614	720
R^2	0.165	0.165	0.023

Note: Robust standard errors in parentheses.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Table A4
Test of σ–convergence (Pooled OLS after SSM)

	ROA	ROE	Z-score
	(1)	(2)	(3)
σ	-0.315***	-0.334***	-0.018**
	(0.040)	(0.046)	(0.008)
N	614	614	720
R^2	0.169	0.167	0.023

Note: Robust standard errors in parentheses.
Statistical significance: *, ** and *** at the 10%, 5% and 1% level respectively.

Table A5
Phillips and Sul log *t* club convergence test (ROE)

	Club 1	Club 2	Club 3
$\hat{b}$	-1.115	1.537	0.761
t-stat	-0.285*	1.612*	0.266*
	Club 4	Club 5	Club 6
$\hat{b}$	0.974	0.437	0.572
t-stat	1.963*	0.355*	1.211*
	Club 7	Club 8	Club 9
$\hat{b}$	0.921	-3.788	-5.306
t-stat	0.611*	-1.257*	-0.926*

*Indicates failure to reject the null hypothesis of convergence at the 5% significance level.

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