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Causal effect of mergers and acquisitions on EU bank productivity

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Abstract

This paper examines the causal effect of mergers and acquisitions (M&A) on bank productivity (Q) in 23 European Union countries and the short- and long-term relationship among fixed assets ($k1$), liquid assets ($k2$), and labour (L) over the period 1990–2013 for a sample of 156 commercial banks, of which 60 entities have acquired at least one other entity. Granger causality tests on our results reveal unidirectional causality from liquid assets to fixed assets. However, the causality between $K2$ and L is unobservable, and the linkage between fixed assets and labour is bidirectional. The error correction term (ECT) is negative and statistically significant for all models, which denotes the presence of bidirectional relationship among all selected variables and long-term unidirectional causality from mergers and acquisitions to bank productivity. Our long-term dynamic panel estimates indicate that the strategic fit of mergers and acquisitions has the potential to create long-term productivity improvement.

Keywords: Mergers and acquisitions (M&A), Productivity, Panel cointegration techniques

JEL Classification: L11, G15, G21, G24

1 Introduction

Over the last two decades, bank consolidation has been a frequent event in the financial sector in developing and developed countries, particularly in the European Union (Pozzolo 2009). Considering the subprime crisis, which negatively affected many advanced and emerging economies, particularly in the banking sector of the European Union, various solutions, such as mergers and acquisitions (M&A), have appealed to these countries. M&A represent external growth and approximately 80% of global foreign direct investment (FDI) flows (Klimek 2014). M&A as a form of banking integration in the EU are one of many strategies of external growth; other strategies include trade agreements, conventions, and cooperation. Furthermore, it is recognized that productivity gains are primarily influenced by external growth, such as mergers and acquisitions (M&A). However, none of these choices is considered as an ideal substitute in an emergency. Thus, many concerns have been raised, including the maximum level of cooperation. But the only consensus is that the larger the bank, the greater the need for cooperation. Nevertheless, the cooperation among commercial banks in the European Union is justified by efficiency gains in terms of profit or profitability. Yet, bank consolidation is

not compatible in terms of cost for the financial sector of these consolidated banks. This paper examines the causal effect of mergers and acquisitions (M&A) on bank productivity in 23 European Union nations and the short- and long-term relationships between fixed assets, liquid assets, and labour for a sample of 156 commercial banks, of which 60 entities have undergone at least one acquisition or merger.

This survey is the first interpretive analysis of causality between mergers and acquisitions and bank productivity in the EU. In addition, the analysis examines the causal links between productivity, liquid assets, fixed assets, and labour. The empirical results reveal that the strategic fit of mergers and acquisitions has the potential to create long-term productivity improvement over the period of study.

This study has the following structure. Section 2 tests the short- and long-term effects of mergers and acquisitions on EU bank productivity. Section 3 describes the econometric methods used. Section 4 discusses the results of empirical testing. Finally, Sect. 5 presents the principal conclusions and offers recommendations.

2 Literature review

Among the desired effects of mergers and acquisitions (M&A), we can confidently cite the research on economies of scale. Such economies involve reducing the average cost and surveying the market share of different entities. Empirical studies have focused on this topic, e.g. Cavallo and Rossi (2001) and Vannet (1994), who found economies of scale in the banking sector for the post-merger and acquisition (M&A) period.

However, the research of Berger and Mester (1997), Allen and Rai (1996), and Altunbas and Molyneux (1996) includes a heterogeneous sample of banks from a variety of countries, such as the US and European Union members. Using panel data, Barth et al. (2004) also support the presence of economies of scale for acquired US banks and take into account the strong regulation in the banking sector.

In addition, it should be noted that several studies that have concentrated exclusively on the effects of mergers and acquisitions (M&A) on bank productivity find controversial results compared to M&A studies that focus on the effects on or effectiveness, assets, or economies of scale of the newly merged entity for a variety of countries. Generally, most research has demonstrated that mergers and acquisitions (M&A) generate productivity earnings. In fact, on the one hand, increases in bank size can occur during a merger and acquisition (M&A), and on the other hand, the technological gains that are obtained can increase production factors. In addition, the new strategies that will be maintained by the new managers can result in better allocation of economic resources (efficiency *X*) and optimize the costs of banks in times of crisis. Finally, Nurboja and Košak (2017) discuss cost efficiency in EU and non-European countries. Their findings show that institutional adjustments outside EU countries should continue to abide by the same EU standards because EU banking systems tend to dominate in terms of measured cost efficiency. In emerging countries, empirical results indicate that merger and acquisition (M&A) efficiency gains are generally weak except when implemented separately (Du and Sim 2016). Because of strong international competition, the challenge for transition countries is to pursue bank mergers and acquisitions (M&A) and public sector privatization as the only solution. Therefore, the banking markets in emerging economies are heavily dominated by foreign capital (Bonin and Wachtel 2003).

Several other studies examine efficiency gains in productivity in the EU after deregulation, particularly for the period 1980 to 1990, in anticipation of the level market (Brissimis et al. 2008). The empirical results reveal that EU banks realized average productivity gains after this deregulation, which occurs towards the end of the reform process for countries that become European Union members. Lichtenberg (1992) concluded that mergers and acquisitions (M&A) could improve a company's effectiveness following a takeover. In fact, the process used is to argue for the improvement of the total productivity factor for the period of 14 years (7 years before and 7 years after) following a takeover in the bank productivity sector. The findings show that in the pre-merger period, the target framework has a total productivity factor considerably less than other firms. In addition, in the post-merger period, the gap decreases progressively over time. After 7 years of mergers and acquisitions (M&A), the difference between the productivity of acquired entities and non-acquired entities is more important. This gain in productivity is partly due to new management strategies to reorganize the newly merged entities (e.g. a decrease in total occupation, the new organism of economic resources). Conyon et al. (2002) tested the impact of mergers and acquisitions by foreign banks on the bank productivity and wages of consolidating banks in the UK for the period 1989–1994. These authors conclude that these mergers generated a positive and significant effect on wages (i.e. a 3.4% increase) and increased productivity 13%.

Haynes and Thompson (1999) reported the results of an empirical survey of the impact of mergers and acquisitions (M&A) on productivity by using an augmented production function approach covering the period 1981 to 1993. These authors argue for a positive impact of mergers on productivity using financial intermediation activities. They note that the merged gains tend to increase gradually in the post-merger and acquisition period, during which significant cost minimization is observed.

Rezitis (2008) discusses the effect of acquisition activity on output and Greek bank productivity. The empirical results are comparatively contradictory with respect to the theoretical hypothesis. In fact, the author reveals that the effects of M&A on Greek banks are relatively negative with respect to technical output and productivity. It is argued that the reduction in total productivity for the merged bank is due to two main factors: first, the technical short comings of the merged bank increase in the post-merger period; second, economies of scale are lost.

Oberhofer and Pfaffermayr (2013) confirmed evidence of a significant positive impact of acquisitions on employment at acquired businesses. This study examines the post-acquisition growth of acquired businesses and employment and concludes that the acquired targets increase their employment growth rate after the transaction, which for the author is evidence of efficiency gains.

Vennet (1996) examines the effect of mergers and acquisitions (M&A) on the performance of banking entities. His empirical research examined 422 national institutions and 70 multinationals spanning the period 1988 to 1993. The study produced two fundamental results. First, domestic mergers between entities of identical size significantly increased the performance of the merged banks. Second, these mergers and acquisitions (M&A) generated savings for national and multinational firms in the post-merger period. Furthermore, Shams and Gunasekarage (2019) examined the acquisition deals in Australia between public and private acquires firms. The empirical dealings show that

public target improved performance in the long run when acquiring a significant holding stake in target firms.

Toumi et al. (2016) examine the dynamic effects of mergers and acquisitions (M&A) on the performance of credit institutions in the EU for the period 2005 to 2013. Their empirical findings reveal that time has negative effects on efficiency gains. However, the composite effects of dummy variables of mergers and acquisitions (M&A) over time generated a positive effect on bank performance. In the case of the EU, Ayadi et al. (2013) analyse the effects of mergers and acquisitions (M&A) on productivity for the period 1996 to 2003. Their empirical results reveal a positive and significant effect of M&A on consolidating banks. Amewu and Alagidede (2018) examine the relation between the stockholder dividends and the announcement of mergers and acquisitions of African banks. Their empirical findings demonstrate a positive relationship between bank productivity and merger and acquisition (M&A) notification. In addition, Alarco (2018) examines the effect of merger and acquisition on production in Latin America for the period 1990–2014. Using an economic model with a production function, the study finds that mergers and acquisitions have the potential to create economic development in selected countries. In addition, bank mergers create added value with respect to the profitability of clients firms (Montgomery and Takahashi 2018). Montgomery and Takahashi's findings demonstrate that client entities of Japanese banks involved in mega-mergers do not enjoy welfare growth.

2.1 Data

Our survey involves annual data for the period 2005–2013, whereby bank productivity (Q) is assessed by the sum of loans, headlines, and shares, labour (L) is represented by the number of equivalent full-time employees, fixed assets ($K1$) represent the value of the (non-financial) fixed assets of the commercial banks, and liquid assets ($K2$) are represented by deposits and shares. The data are drawn from the balance sheets of commercial banks in the European Union (Bankscope database) (Appendix: Table 11). We perform econometric analyses based on a panel of 23 European countries: Portugal, the Czech Republic, Cyprus, Denmark, Ireland, Poland, Malta, Latvia, Belgium, Hungary, Germany, Finland, Estonia, Romania, Slovakia, Sweden, Spain, Greece, Bulgaria, France, the UK, Luxembourg, and Austria.

At this stage of the analysis, it is important to emphasize that our sample offers diverse reasons for adopting the type of analysis introduced in this study. Our study considers that the sample is sufficiently homogeneous to reveal the long-term effect of mergers and acquisitions on bank productivity (and is as homogeneous as those typically considered in other mergers and acquisitions studies). In contrast, the banking entities of the European Union should increase their likelihood of success to ensure a positive long-term productivity gain. Our sample is selected from the balance sheet of each bank using the intermediation (Table 1) approach of Sealey and Lindley (1977).

Table 1 summarizes the common sample descriptive statistics. We can detect that the Q distribution is approximately symmetric, whereas the $K1$ and L distributions are highly skewed. The common means of Q is (21.81032), $K1$ is (16.67719), $K2$ is (21.11658), and L is (6.204740). In addition, the coefficient of variation (measured by the ratio: Std. Dev/Mean) for Q is (0.12005), for $K1$ (0.1711), for $K2$ (0.1168), and for L (0.3407) in the

Table 1 Descriptive statistics (data in logarithms)

	Q	*K*1	*K*2	*L*
Mean	21.81032	16.67719	21.11658	6.204740
Median	21.59996	16.43291	20.98228	5.872118
Maximum	28.23852	24.18647	27.92952	11.92702
Minimum	8.588505	11.51293	14.07787	1.386294
Std. dev.	2.618492	2.853540	2.467150	2.114379
Skewness	0.235322	0.213156	0.095960	0.573195
Kurtosis	2.711278	2.275420	2.784411	2.833520
Jarque–Bera	17.94905	41.61038	4.901516	79.00583
Probability	0.000127	0.000000	0.086228	0.000000
Sum	30817.99	23564.87	29,816.62	8767.298
Sum sq. dev.	9681.379	11,497.48	8588.517	6312.487
Observations	1413	1413	1413	1413

23 European Union nations. The normality distributions for these variables of different models of the 156 selected banks in the EU are rejected under the null hypothesis, as confirmed by the Jarque–Bera test.

3 Conclusion and policy implications

This paper examined the causal effect of mergers and acquisitions (M&A) on bank productivity in 23 European Union nations (Q) and the short- and long-term relationship between fixed assets ($k1$), liquid assets ($k2$), and labour (L) over the period 1990–2013 for a sample of 156 commercial banks, of which 60 entities have acquired at least one other entity.

Our short-run Granger causality tests reveal bidirectional short-term causality between ln$k1$, ln$k2$, ln$L$, and ln$Q$, significant at 1% and 5%, and similar causality between ln$k1$ and ln$L$. Unidirectional short-term causality from liquid assets to fixed assets was significant at 1%. Bidirectional short-term causality was found between ln$k1$ and ln$L$. The short-term causality between ln$k2$ and ln$L$ was unobservable. The error correction term (ECT) was negative and statistically significant for all selected models at 1%, which indicates a bidirectional relationship among all selected variables and long-term unidirectional causality from mergers and acquisitions (M&A) to bank productivity.

The FMOLS and DOLS long-run estimates support a long-term relationship between all selected variables. The total productivity of commercial banks in the European Union reveals an adjustment process for this productivity of 22%.

In the short- and long-term models, capital and labour well explain the productivity of commercial banks in the European Union, while the gain effects of mergers and acquisitions are unobservable in the short term but apparent in the long term. As we move away from the time of merger, the banks make more productivity gains. This outcome is explained by the positive and significant coefficients associated with the dummy variables (A_0, A_3, and A for FMOLS) and (A_3 and A for DOLS).

As a policy implication of our results, EU countries should encourage their foreign investment banks to increase their merger and acquisition activity. Increasing the strategic fit of the merged banks will help them reduce their dependence and promote capital

stock security. In addition, mergers and acquisitions have been a frequent response in European Union countries, and good management has contributed to the success of the integration process.

4 Method

The aims of our study are to determinate the short- and long-term effects of mergers and acquisitions on productivity and to analyse the causal links among production function, liquid assets, fixed assets, and capital–labour.

In the first step, we apply different unit root tests for the series to determine the order of integration. When selected series include a unit root, the second step is to investigate the long-term relationship between all considered variables using panel cointegration tests. Finally, we study the long-term relationship and causality linkages between all variables by the appropriate dynamic approach of panel cointegration using fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS).

In our sample, we adopt fictitious variable quads that explain the event of the merger and acquisition as follows: A_0 indicates that the merger has occurred; A_1 indicates that the merger occurred 1 year previously; A_2 indicates that the merger occur 2 years previously; A_3 indicates that the merger occur 3 years or more previously; A indicates that the merger can occur at any time.

4.1 Unit root test

The existence of a unit root for selected variables is evaluated by several tests, such as the test of Levin et al. (2002), LLC, IPS, Fisher-ADF, and Fisher-PP. LLC, Fisher-ADF, and Fisher-PP assess the homogeneity of dynamic autoregressive distribution coefficients for all selected variables. However, IPS supposes a heterogeneous unit root in compliance with an alternative hypothesis.

The panel unit root tests assume all of the variables are not stationary at the level of intercept or trend (Table 2). However, all variables in the table of the panel unit root test with respect to the initial difference (Table 3) are stationary. Thus, we conclude that Q, $k1$, $k2$, and L are integrated in order one I (1). Therefore, the FMOLS and DOLS techniques are appropriate for the entire series.

4.2 Cointegration test

The findings of the panel unit root test for productivity, liquid assets, fixed assets, and labour indicate that these four variables are integrated in the order I (1). One can observe that all selected variables are stationary with respect to first differences. Therefore, we can apply panel cointegration methods to examine the long-term relationships between Q, $K1$, $k2$, and L. The alternative of the long-term cointegration relationship is mentioned by Pedroni (1999, 2004) and Kao et al. (1999). The panel PP-statistic and panel ADF-statistic for each dimension and the group PP-statistic and group ADF-statistic are less than 1% (Table 4). In addition, according to Kao, the ADF test is less than 1% (Table 5). Thus, the cointegration procedure reveals long-term relationships between bank productivity, liquid assets, fixed assets, and labour for the European Union countries.

Table 2 Panel unit root results: series in level

	Q		*K*1		*K*2		*L*	
	Intercept	**Trend**	**Intercept**	**Trend**	**Intercept**	**Trend**	**Intercept**	**Trend**
LLC	− 14.8049 (0.998)	− 7.7687 (0.9702)	− 19.345 (0.9703)	12.27 (1.000)	− 5.95 (0.9231)	− 14.80 (0.9175)	− 20.14 (0.9713)	6.71 (1.000)
IPS	− 2.63342 (0.9742)	1.88676 (0.9704)	− 5E+11 (0.084)	− 1.4419 (0.074)	0.18198 (0.5722)	1.52 (0.9367)	− 35.705 (0.8702)	− 2.2E+14 (0.9611)
Fisher-ADF	437.081 (0.2664)	330.812 (0.2464)	405.71 (0.3701)	320.834 (0.2686)	337.89 (0.1693)	287.320 (0.8385)	568.34 (0.4513)	318.47 (0.4191)
Fisher-PP	518.68 (0.999)	219.59 (1.000)	546.804 (0.9992)	238.81 (0.9994)	552.56 (0.9847)	245.88 (0.9982)	746.68 (0.1252)	344.36 (0.1149)

The statistics of the panel unit root tests. The values in brackets are the corresponding *p* values

Table 3 Panel unit root test results: series in first difference

	Δ *Q*		Δ *K*1		Δ *K*2		Δ *L*	
	Intercept	**Trend**	**Intercept**	**Trend**	**Intercept**	**Trend**	**Intercept**	**Trend**
LLC	− 59.67 (0.000)	− 114.16 (0.000)	− 18.3504 (0.000)	− 40.208 (0.000)	− 39.86 (0.000)	− 42.34 (0.000)	175.777 (0.000)	− 891.38 (0.000)
IPS	− 13.43 (0.000)	− 7.0138 (0.000)	− 11.04 (0.000)	− 8.12 (0.000)	− 13.65 (0.000)	− 3.03 (0.001)	− 47.0599 (0.000)	− 3610.1 (0.000)
Fisher-ADF	649.95 (0.000)	564.90 (0.000)	644.02 (0.000)	609.17 (0.000)	779.11 (0.000)	521.12 (0.000)	714.519 (0.000)	499.755 (0.000)
Fisher-PP	681.77 (0.000)	880.90 (0.000)	732.76 (0.000)	855.04 (0.000)	919.70 (0.000)	890.87 (0.000)	627.780 (0.000)	671.58 (0.000)

The statistics of the panel unit root tests. The values in brackets are the corresponding *p* values

Table 4 Results of Pedroni panel cointegration test

	Within dimension					Between dimension	
	Statistic	Prob.	Statistic	Prob.		Statistic	Prob.
Panel *v*-statistic	− 5.9432	1.000	− 5.2869	1.000	Group rho-Statistic	13.1839	1.000
Panel *ρ*-statistic	6.4660	1.000	7.2590	1.000	Group PP-Statistic	− 18.3821	0.000***
Panel PP-statistic	− 12.1488	0.000***	− 10.301	0.000***	Group ADF-Statistic	− 8.46885	0.000***
Panel ADF-statistic	− 10.3151	0.000***	− 8.4927	0.000***			

*** Statistical significance at the 1% level

Table 5 Kao et al. (1999) residual cointegration test results

	t-Statistic	Prob.
ADF	− 4.8708	0.000***
Residual variance	0.4482	
HAC variance	0.2486	

*** Statistical significance at the 1% level

4.3 Model specification

The fundamental objective of our econometric model is to analyse the causal linkage of merger and acquisition with commercial bank productivity in the European Union. Therefore, we estimate a Cobb–Douglas production purpose, where *k*1, *k*2, and *L* represent the input variables and *Q* represents the output. The principal purpose of this framing is rather simple, and it is performed to demonstrate the theoretical relationship between merger and acquisition and commercial bank productivity. The output (*Q*) of commercial European banks i at time t can be expressed as follows:

$$Q_{\mathrm{it}} = \mathrm{tech} L_{\mathrm{it}}^{\alpha} K_{\mathrm{it}}^{\beta} \tag{1}$$

where *L* and *K* are the different factors of production, tech is a parameter that describes the developmental level of the technology of the commercial European banks, and α and β are coefficients that denote the effect of various factors on total production. To estimate the model, it is important to linearize it in logarithmic form. Model (1) appears as follows:

$$\mathrm{Ln}(Q_{\mathrm{it}}) = \mathrm{Ln}(\mathrm{tech}) + \alpha \mathrm{Ln}(L_{\mathrm{it}}) + \beta \mathrm{Ln}(K_{\mathrm{it}}) \tag{2}$$

A benefit of this method is that the econometric model can include the impact of technological change in the effect of mergers and acquisitions on the productivity of commercial banks in the European Union. Thus, we can observe the effect of mergers and acquisitions on productivity when banks are consolidated by inserting dummy variables (i.e. A_0, A_1, A_2, A_3 and A). Therefore, model (2) can be expressed as follows:

$$\mathrm{Ln}(Q_{\mathrm{it}}) = \mathrm{Ln}(\mathrm{tech}) + \alpha \mathrm{Ln}(L_{\mathrm{it}}) + \beta \mathrm{Ln}(K_{\mathrm{it}}) + \sum_{j} \gamma_j \mathrm{merger} j_{i,t} \tag{3}$$

where *i* denotes the bank (1; 2;...; 157), j denotes the number of years post-merger and acquisition (j = 0, 1..., 3 and more), and t denotes the year (t = 2005..., 2013). α, β are

the parameters to be estimated and measure the influence of the variables of the model (labour and capital), and γ_j measures the effect of mergers and acquisitions. To analyse the temporal effect of mergers and acquisitions on bank productivity in our sample, we adopt the following formalization:

$$\mathrm{Ln}(Q_{\mathrm{it}}) = \mathrm{Ln}(\mathrm{tech}) + \alpha \mathrm{Ln}(L_{\mathrm{it}}) + \beta \mathrm{Ln}(K_{\mathrm{it}}) + \sum_{j=0}^{j=3} \gamma_j Aj_{it} + \alpha_i + u_{it}, \tag{4}$$

where i denotes the bank (1, 2..., 157), j denotes the number of years post-merger and acquisition ($j=0$, 1..., 3 and more) and t denotes the year ($t=2005\ldots 2013$). α, β are the parameters to be estimated and measure the influence of the variables of the model (labour and capital), γ_j measures the effect of mergers and acquisitions, and Aj_{it} is a dummy variable that reflects the time horizon in which the dynamics of mergers and acquisitions are realized. For example, $A_{11(t=2005)}$ indicates that in 2005 banks ($i=1$) were 1 year post-merger. α_i is the bank fixed effect. Table 6 provides the number of sample banks by country and the banks that performed mergers and acquisitions.

4.4 Granger causality test

Granger causality is used to analyse the causal links among variables. Engle and Granger (1987) observe that if two variables that share a unit root are integrated, a vector autoregression (VAR) on first differences will be poorly specified. In this research, ln$Q$, ln$K1$, ln$K2$, and ln$L$ are integrated in order I (1) and therefore have a long-term association. To analyse this association, we adopt an empirical model with an error correction term (ECT) augmented with a lagged period. The Granger causality test is based on the following representation:

$$\begin{aligned}\Delta \ln Q_{it} = \alpha_i &+ \sum_{j=1}^{q} \beta_{1i} \Delta \ln K1_{it-j} + \sum_{j=1}^{q} \beta_{2i} \Delta \ln K2_{it-j} \\ &+ \sum_{j=1}^{q} \beta_{3i} \Delta \ln L_{it-j} + \sum_{j=0}^{j=3} \gamma_j Aj_{it} + \delta_{1i} \mathrm{ECT1}_{it-1} + \varepsilon_{it},\end{aligned} \tag{5}$$

with:

$$\mathrm{ECT1}_{it} = \ln Q_{it} - \widehat{\beta_{1i}} \ln k1_{it} - \widehat{\beta_{2i}} \ln K2_{it} - \widehat{\beta_{3i}} \ln L_{it} - \gamma_j Aj_{it}, \tag{6}$$

where Δ represents the first difference of the variable and q indicates the lag order automatically specified by the Schwarz information criterion (SIC) and the Akaike information criterion (AIC). The outcome of this lagged vector autoregression (VAR) indicates that all the criteria exhibit a maximum lag equal to the unit (VAR ($q=1$)). The ECT is obtained from the long-term cointegration relationship (Eq. 4), Aj_{it} represents the dummy variables of mergers and acquisitions, and ε is the random error term.

Table 7 presents the results of a short-run Granger causality test (pairwise Granger causality tests). The results suggest bidirectional short-term causality among ln$k1$, ln$k2$, ln$L$, and ln$Q$, significant at 1% and 5%, and similar causality between ln$k1$ and ln$L$. Unidirectional short-term causality from liquid assets to fixed assets is significant

Table 6 Number of acquisitions and number of sample banks by country

Country	Number of banks	Banks that performed mergers and acquisitions	Average size
Portugal	1	1	3281,652
Czech Republic	2	2	57153,872
Cyprus	2	0	6150,965
Denmark	1	0	1543,140
Ireland	6	1	16423,690
Poland	1	0	2313,865
Malta	3	0	1713,338
Latvia	4	1	263,284
Belgium	5	2	15656,358
Hungary	5	3	2000,940
Germany	3	1	1295,544
Finland	1	1	176972,937
Estonia	2	0	3628,529
Romania	10	2	2159,378
Slovakia	2	0	1159,598
Sweden	1	1	340611,302
Spain	3	1	2861,071
Greece	4	3	22756,081
Bulgaria	8	1	3250,130
France	14	8	766,420
UK	37	10	18954,012
Luxembourg	32	18	3542,045
Austria	6	4	1489,711
Total	157	60	–

"Average size" is average assets in millions of euro for banks in each country for the period 2005–2013

at 1%. Bidirectional short-term causality is found between ln$k1$ and ln$L$. The short-term causality between ln$k2$ and ln$L$ is unobservable.

With respect to Eq (5), the error correction term (ECT) is negative and statistically significant for all models at 1% (Table 8), which implies a bidirectional relationship between all variables and a long-term unidirectional relationship between mergers and acquisitions (M&A) and bank productivity.

Table 8 describes the results of short- and long-run Granger two-step causality tests between all selected variables. The total productivity of commercial banks in the European Union exhibits an adjustment process for this productivity of 22% because the values of the ECT are negative and statistically significant at 1%.

The coefficient of the dummy variable (A_0) is positive and significant at 5%. Thus, mergers and acquisitions (M&A) had a positive effect on total productivity. Thus, the merged banks experienced efficiency gains in productivity at the moment of acquisition.

However, the effects of the dummy variables (A_1, A_2, A_3, A) were all non-significant. This outcome implies that at the moment of acquisition the banks were starting to develop new strategies to restructure their new labour and capital stocks and adopting new organizational strategies and human resources management. Therefore, it would be

Table 7 Panel pairwise granger causality tests

Null Hypothesis	Obs	F-Statistic	Prob.
ln*K*1 does not Granger Cause ln*Q*	1099	23.6069	9. E−11***
ln*Q* does not Granger Cause ln*K*1	4.92614	0.0074**	
ln*K*2 does not Granger Cause ln*Q*	1099	19.4910	5. E−09***
ln*Q* does not Granger Cause ln*K*2	8.62601	0.0002***	
ln*L* does not Granger Cause ln*Q*	1099	10.9973	2. E−05***
ln*Q* does not Granger Cause ln*L*	4.73764	0.0089**	
ln*K*2 does not Granger Cause ln*K*1	1099	0.88350	0.4136
ln*K*1 does not Granger Cause ln*K*2	8.66642	0.0002***	
ln*L* does not Granger Cause ln*K*1	1099	3.59800	0.0277**
ln*K*1 does not Granger Cause ln*L*	15.5165	2. E−07***	
ln*L* does not Granger Cause ln*K*2	1099	1.29441	0.2745
ln*K*2 does not Granger Cause ln*L*	1.96337	0.1409	

***, ** Significance at the 1 and 5% levels, respectively

difficult in the short term to attribute an efficiency gain in productivity only to the fact that the banks experienced mergers and acquisitions (M&A).

Regarding the size effect, which is essentially expressed by the factors of production (ln$K1$, ln$K1$, and ln$L$), we note that these factors are positive and significant. In fact, mergers enable banks to benefit from an increase in size because this increase means they will have more resources in terms of capital and labour. However, despite this improvement, in the short term, all production factors are unaffected.

Therefore, the scale of bank productivity cannot be revised by changing the quantity of all production factors. These findings are similar to those of Carbó and Molyneux (2009), who examined a Spanish sample over the period 1986–2000 and concluded that approximately one-third of Spanish savings banks benefited from significant cost reductions due to mergers. Our results indicate that productivity improvements are not general but heavily dependent on the identity of the merged banks.

4.5 Long term with FMOLS and DOLS

For all selected variables with the same order of integration I (1) for different models, we estimate the long-term coefficients by using the fully modified ordinary least squares (FMOLSs) and dynamic ordinary least squares (DOLSs). For the panel data, FMOLS was developed by Pedroni (2001, 2004), while the DOLS approach was developed by Kao and Chiang (2001) and Mark and Sul (2003). These two techniques are used in the event of a unique long-term cointegration vector. The results of long-run estimates using these two techniques are reported in Tables 9 and 10. The coefficients of the long-term elasticities are approximately similar according to the two techniques.

The long-term elasticity of productivity with respect to capital stock is on average 0.196 and higher than the short-term elasticity (0.191). However, the case of the labour stock is different. Here, the long-term productivity elasticity is on average 0.28 and lower than the short-term elasticity (0.35). Thus, we can conclude that in the short- and long-term models, capital and labour well explain the productivity of commercial banks in the European Union, while the gain effect of mergers and acquisitions is unobservable in the

Table 8 Granger causality test results

	Short run								Long run
	$\Delta lnk1$	$\Delta \ln k2$	$\Delta \ln L$	A_0	A_1	A_2	A_3	A	ECT_{t-1}
ΔlnQ	0.193 (0.000)***	0.324 (0.000)***	0.349 (0.000)***	0.181 (0.039)**	–	–	–	–	− 0.227 (0.000)***
ΔlnQ	0.191 (0.000)***	0.325 (0.000)***	0.354 (0.000)***	–	− 0.003 (0.992)	–	–	–	− 0.228 (0.000)***
ΔlnQ	0.191 (0.000)***	0.325 (0.000)***	0.355 (0.000)***	–	–	− 0.666 (0.288)	–	–	− 0.228 (0.000)***
ΔlnQ	0.191 (0.000)***	0.325 (0.000)***	0.354 (0.000)***	–	–	–	− 0.084 (0.7033)	–	− 0.228 (0.000)***
ΔlnQ	0.191 (0.000)***	0.325 (0.000)***	0.354 (0.000)***					0.059 (0.4442)	− 0.227 (0.000)***

***, ** Significance at the 1 and 5% levels, respectively

Table 9 Long-run estimates with FMOLS

	ln*k*1	ln*k*2	ln*L*	A_0	A_1	A_2	A_3	*A*
ln*Q*	0.272 (0.093)*	0.774 (0.000)***	0.187 (0.321)	0.074 (0.761)	–	–	–	–
ln*Q*	0.853 (0.000)***	0.070 (0.398)	1.004 (0.000)***	–	− 0.191 (0.039)**	–	–	–
ln*Q*	− 0.250 (0.135)	1.100 (0.000)***	0.470 (0.014)**	–	–	− 1.296 (0.013)**	–	–
ln*Q*	0.049 (0.236)	0.164 (0.000)***	0.443 (0.000)***	–	–	–	0.326 (0.000)***	–
ln*Q*	0.400 (0.000)***	0.590 (0.000)***	0.305 (0.000)***	–	–	–	–	0.056 (0.033)**

***, **, and * Significance at the 1, 5, and 10% levels, respectively

Table 10 Long-run estimates with DOLS

	ln*k*1	ln*k*2	ln*L*	A_0	A_1	A_2	A_3	*A*
ln*Q*	0.196 (0.000)***	0.381 (0.000)***	0.284 (0.000)***	0.090 (0.406)	–	–	–	–
ln*Q*	0.196 (0.000)***	0.381 (0.000)***	0.285 (0.000)***	–	0.030 (0.939)	–	–	–
ln*Q*	0.196 (0.000)***	0.381 (0.000)***	0.284 (0.000)***	–	–	− 0.262 (0.570)	–	–
ln*Q*	0.190 (0.000)***	0.275 (0.000)***	0.293 (0.000)***	–	–	–	0.144 (0.000)***	
ln*Q*	0.419 (0.000)***	0.693 (0.000)***	0.019 (0.163)					0.155 (0.033)**

***, ** Significance at the 1 and 5% levels, respectively

short term. Therefore, short-term effects (i.e. A_1: 1 year after the merger and acquisition; A_2: 2 years after the merger and acquisition) are negative and statistically insignificant.

As we progress away from the time of acquisition or merger, the banks make more productivity gains. This outcome is explained by the positive and significant coefficients associated with the dummy variables (i.e. A_0, A_3, and A for FMOLS and A_3 and A for the DOLS). Consequently, we can state fairly confidently that these mergers and acquisitions do not generate dynamic efficiency (expressed in terms of productivity gains) until the third year post-merger and acquisition. We can also note that as the merged or integrated banks progress from the time of acquisition they become more productive. This statement is supported by the fact that the coefficients associated with capital and labour 3 years post-merger are relatively higher than those associated with previous years.

Based on our results, we can assume that mergers and acquisitions create banks' productivity improvements in the EU. As previously mentioned, one reason for this result could be related to the resolution of the problems that the banking entities face during the long-term integration of the culture of the merged entities and organizational issues. These findings are similar to those of Amel et al. (2004).

Finally, the deregulation process in the banking industry that has occurred in most developed countries, particularly in the European Union, with the subsequent increase in the level of competition, forced banking entities to react to a new competitive scenario. Mergers and acquisitions were a frequent response in many European countries, and good management of the integration process and the consolidating banks clearly contributed to the success of mergers and acquisitions. In fact, problems related to the integration process may be more similar in a sample with a high level of homogeneity (as in this paper) than in heterogeneous samples. Nagano and Ushijima (2018) examined the effect of the deregulation process on an interregional bank branch in Japan over the period 2000–2012. Their empirical findings show that geographical distance increases the probability of interregional branch closure.

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Appendix

See Table 11.

Table 11 Data from Bankscope databases

Country	Banks that performed acquisitions	Time of M&A	Acquired or merged banks
Portugal	Deutsche Bank (Portugal) SA	2011	On 1 August 2011, Deutsche Bank (Portugal) SA was absorbed by Deutsche Bank Europe GmbH.
Czech Republic	UniCredit Bank Slovakia AS	2013	On 1 December 2013, UniCredit Bank Slovakia AS was absorbed by UniCredit Bank Czech Republic and Slovakia AS
	UniCredit Bank Czech Republic and Slovakia AS	1999/2001/2007/2013	On 1 January 1999, Vereinsbank (CZ) AS absorbed Hypobank CZ AS On 1 October 2001, Vereinsbank (CZ) AS absorbed Bank Austria Creditanstalt Czech Republic On 5 November 2007, HVB Bank Czech Republic AS absorbed Zivnostenska banka, AS On 1 December 2013, UniCredit Bank Czech Republic AS absorbed UniCredit Bank Slovakia AS
Ireland	Ulster Bank Ireland Limited	2010	In 2010, Ulster Bank Ireland Limited absorbed First Active PLC
Latvia	Jsc Latvian Development Financial Institution Altum	1997	In 1997, Jsc Latvian Development Financial Institution Altum absorbed Latvian Agricultural Finance Company
Belguim	Record Bank SA/NV	1995/2005/2006	In 1995, absorbed Sofibanque SA In May 2005, absorbed Mercator Bank nv In June 2006, absorbed Eural SA/NV
	ING Belgium SA/NV-ING	1975/2003/2006/2006	On 30 June 1975, as a result of the merger between Banque Lambert and Banque de Bruxelles. On 5 May 2003, absorbed Caisse Privée Banque. In June 2006, absorbed ING Bank (France) SA. In September 2006, absorbed ING Securities Bank (France) SA.
Hungary	Banco Popolare Hungary Bank Zrt	2013	In 2013, Banco Popolare Hungary Bank Zrt was absorbed by MagNet Magyar Koezoessegi Bank Zrt
	Calyon Bank Magyarorszag Zrt-Calyon Bank Hungary	2007	In October 2007, absorbed by Credit Agricole Corporate and Investment Bank
	Erste Bank Hungary Nyrt	1996/2004	In January 1996, absorbed Agrobank RT On 31 August 31 2004, absorbed Postbank and Savings Bank Corp
Germany	Mizuho Corporate Bank (Germany) AG	2009	On 30 November 2009, in liquidations
Finland	Nordea Bank Finland Plc	2000/2001/2002	In December 2000, absorbed Merita Plc On 30 September 2001, absorbed Merita Bank Plc Demerged on January 2002 into five new companies
Romania	Intesa Sanpaolo Bank Romania SA	2012	Absorbed Banca CR Firenze Romania SA
	Banca Comerciala Romana SA-Romanian Commercial Bank SA	1999	In October 1999, absorbed Banca Romana de Comert Exterior SA—Bancorex

Table 11 (continued)

Country	Banks that performed acquisitions	Time of M&A	Acquired or merged banks
Sweeden	Nordea Bank Sweden AB (publ)	1994/2002/2004	On 1 October 1994, absorbed Gota Bank In December 2002, absorbed Postgirot Bank On 1 March 2004, Nordea Bank Sweden AB (publ) was absorbed by Nordea Bank AB (publ)
Spain	Banco de Credito Local d'España	1999/2009	In March 1999, absorbed Dexia Banco Local On 17 June 2009, Banco de Crédito Local de España was absorbed by Banco Bilbao Vizcaya Argentaria SA
Greece	Emporiki Bank of Greece SA	2013	On 28 June 2013, Emporiki Bank of Greece SA was absorbed by Alpha Bank AE.
	Agricultural Bank of Greece	2012	On 30 July 2012, Agricultural Bank of Greece was absorbed by Piraeus Bank SA
	National Bank of Greece SA	1998/2002	In August 1998, National Bank of Greece SA absorbed National Mortgage Bank of Greece SA In December 2002, absorbed National Investment Bank for Industrial Development SA—ETEBA
France	KBL Richelieu Banque Privée	2008	On 1 November 2008, the activity of KBL Richelieu Banque Privée ceased
	Banque Saradar France	2005	In April 2005, Banque Saradar France was absorbed by Banque Audi Saradar France SA
	Aareal Bank France SA	2010	In April 2010, Aareal Bank France SA was absorbed by Aareal Bank AG
	Banque Audi Saradar France SA	2005	In April 2005, Banque Audi France SA absorbed Banque Saradar France
	Credit Suisse (France)	1997	On 31 December 1997, Credit Suisse (France) SA absorbed Banque Hottinguer
	Banca Intesa (France) SA	2003/2008	On 1 September 2003, Banca Commerciale Italiana (France) absorbed CPR In September 2008, absorbed by Intesa Sanpaolo
	UBS Wealth Management (France) SA (in 2003 took the name UBS (France) SA)	2003	On 1 November 2003, absorbed UBS (France) SA
	HSBC France	2002/2008/2010	In April 2002, absorbed HSBC CCF Investment Bank (France) On 31 July 2008, absorbed HSBC Hervet, HSBC de Baecque Beau SA, HSBC UBP and HSBC Picardie In June 2010, absorbed HSBC Financial Products (France) SNC
UK	Citibank International Plc	2000	On 28 April 2000, Citibank International Plc absorbed Citibank Portugal S.A.
	Clydesdale Bank Plc	2004	In December 2004, Clydesdale Bank Plc absorbed Yorkshire Bank Plc
	Co-operative Bank Plc (The)	2009	On 1 August 2009, Co-operative Bank Plc absorbed Britannia Building Society
	Alliance and Leicester Plc	2001/2011	In December 2001, Alliance and Leicester PLC absorbed Alliance and Leicester Group Treasury Plc In 2011, transferred to Santander UK Plc.

Table 11 (continued)

Country	Banks that performed acquisitions	Time of M&A	Acquired or merged banks
	Santander UK Plc	1944/1996	In 1944, as The Abbey National Building through the merger of Abbey Road Building Society and The National Building Society In 1996, absorbed National and Provincial Building Society
	National Westminster Bank Plc—NatWest	1968/1970	In 1968, as the result of the merger between The Boards National Provincial and Westminster Bank On 1 January 1970, merging of the District Bank, National Provincial Bank, and Westminster Bank into National Westminster Bank
	Standard Chartered Bank	2008	In September 2008, Standard Chartered Bank absorbed American Express Bank Ltd.
	Bank of Scotland Plc	2001/2007/2010	In November 2001, Bank of Scotland absorbed Bank of Wales Plc On 17 September 2007, Bank of Scotland absorbed Halifax Plc, HBOS Treasury Services Plc and Capital Bank Plc and changed its name to Bank of Scotland Plc On 31 December 2010, Bank of Scotland Plc absorbed Bank of Scotland (Ireland) Limited
	Royal Bank of Scotland Plc (The)	1969	In April 1969, merged with National Commercial Bank of Scotland
	Abbey National Plc	1996	In 1996, absorbed National and Provincial Building Society
Luxembourg	Hauck and Aufhäuser Banquiers Luxembourg SA	2013	In October 2013, the activity of Hauck and Aufhäuser Banquiers Luxembourg SA ceased
	VP Bank (Luxembourg) SA	2001	On 31 December 2001, absorbed Banque Baumann and Cie SA.
	Banco Itau Europa Luxembourg	2009	On 25 August 2009, Banco Itau Europa Luxembourg absorbed Unibanco—Uniao de Bancos Brasileiros (Luxembourg) SA
	Kaupthing Bank Luxembourg SA	2009	On 10 July 2009, Kaupthing Bank Luxembourg SA was dissolved without liquidation
	Banque Degroof Luxembourg SA	2006	In January 2006, Banque Degroof Luxembourg SA absorbed Banque Nagelmackers (Luxembourg) SA
	Credit Agricole Luxembourg SA	1997/1999/2005/2008	On 1 December 1997 (effective as of 1 July 1997) absorbed Banque Indosuez Luxembourg SA and its name changed to Crédit Agricole Indosuez Luxembourg SA On 30 April 1999, absorbed Banque de Gestion Privée de Luxembourg On 1 July 2005, absorbed Crédit Lyonnais Luxembourg SA and changed its name to Crédit Agricole Luxembourg SA On 26 April 2008, absorbed Crédit Agricole Luxembourg Bank
	Credit Suisse (Luxembourg) SA	2002	On 1 January 2002, Crédit Suisse (Luxembourg) SA absorbed Banque Leu (Luxembourg) SA
	JP Morgan Bank Luxembourg SA	1998	On 1 December 1998, Chase Manhattan Bank Luxembourg SA absorbed Morgan Stanley Bank Luxembourg In November 2001, changed its name to JP Morgan Bank Luxembourg SA

Table 11 (continued)

Country	Banks that performed acquisitions	Time of M&A	Acquired or merged banks
	Dresdner Bank Luxembourg SA	2010	In April 2010, Dresdner Bank Luxembourg SA was absorbed by Commerzbank International SA
	Landsbanki Luxembourg SA	2008	In December 2008, the District Court of Luxembourg has ordered the dissolution and winding-up of Landsbanki Luxembourg SA
	Deutsche Bank Luxembourg SA	1999	In December 1999, absorbed Bankers Trust Luxembourg
	UBS (Luxembourg) SA	1996/1998/2002	as Union de Banques Suisses (Luxembourg) SA In 1996, absorbed Société de Banque Suisse (Luxembourg) SA On 29 May 1998, merged with Swiss Bank Corporation (Luxembourg) Ltd. In August 2002, absorbed Banque Ferrier Lullin (Luxembourg) SA
	DekaBank Deutsche Girozentrale Luxembourg SA	2002	On 1 January 2002, Deutsche Girozentrale International SA absorbed DekaBank (Luxemburg) SA
	ING Luxembourg	2003	In May 2003, absorbed ING Bank (Luxembourg) SA
	KBL European Private Bankers SA	2005	On 1 January 2005, Krediet Bank SA Luxembourgeoise KBL absorbed Banque Continentale du Luxembourg SA
	UniCredit Luxembourg SA	1998	On 1 November 1998 through the merger between Vereinsbank International SA and Hypobank International SA
	Banque Internationale Luxembourg SA	2001/2002	In November 2001, absorbed Dexia Direct Bank SA. In November 2002, absorbed Dexia Nordic Private Bank SA
	BNP Paribas Luxembourg	2001/2006/2007/2010	In July 2001 through the merger of Banque Nationale de Paris (Luxembourg) SA BNP and Paribas Luxembourg In April 2006, BNP Paribas Luxembourg absorbed United European Bank (Luxembourg) SA On 31 March 2007, absorbed Banca Nazionale del Lavoro International SA On 5 October 2010, BNP Paribas Luxembourg was absorbed by BGL BNP Paribas
Austria	Arab Bank (Austria) AG	2006	In 2006, the business of Arab Bank (Austria) AG was transferred to Europe Arab Bank Plc.
	Valartis Bank (Austria) AG	1998	In October 1998, Anglo Irish Bank (Austria) A.G absorbed Crédit Lyonnais Bank (Austria) AG
	Kommunalkredit Austria AG	2009	On 28 November 2009, Kommunalkredit Depotbank AG acquired the banking business of KA Finanz AG and changed its name to Kommunalkredit Austria AG
	UniCredit Bank Austria AG-Bank Austria	1997/2000/2002	On 31 May 1997, absorbed Westdeutsche Landesbank (Austria) AG In November 2000, absorbed Sparkasse Stockerau AG On 12 August 2002, absorbed Creditanstalt AG
Bulgaria	Eurobank Bulgaria AD-Postbank	2007	On 1 November 2007, Bulgarian Post Bank JSC absorbed DZI Bank AD

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