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Sustainability and Efficiency of the European Banking Market after the Global Crisis: The Impact of Some Strategic Choices

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Abstract: In the last few years, financial managers, supervisors and policy makers have been collectively engaged on the role of the banking and financial sector in relation to environmental and sustainability issues. The efficiency level that characterizes the production process of banks and financial intermediaries is strictly interconnected with sustainability so that, from a long term perspective, cost and profit efficiency reveals to be one of the most important premises for sustainability. This work aimed to analyze the level of efficiency achieved by European banking groups to verify if some key drivers of efficiency deriving from strategic choices outlined by literature on single banks (i.e., size, number of branches, cost income ratio and geographical location) are the same when considering banking groups. The study is focused on the period 2011–2016 that is characterized by, at least, two critical events that occurred after the sub-prime crisis. The level of efficiency of each banking group was measured with the Stochastic Frontier Approach and then the units were clustered into three homogeneous sets. Observing these clusters, the results show that the groups belonging to some specific countries appear to be more efficient with respect to others. Moreover, the banking groups characterized by many branches and a high level of cost income ratio exhibit a medium level of efficiency. Eventually, the biggest banking groups are the least efficient.

Keywords: X-efficiency; Stochastic Frontier Approach; cost efficiency; banking groups; multivariate analysis; sustainability

1. Introduction

In the last few years, financial managers and policy makers have been collectively engaged on the role of finance in relation to environmental and broader sustainability issues. Banking supervisors and regulators have also demonstrated growing awareness of the materiality of sustainability issues. The rapid growth of the green bonds market is a well-known example of the banking sector's engagement in sustainability issues. A growing amount of literature is nowadays focused on the relationship and the interconnectedness between banking and sustainability [1]. Recent literature [1] defines a sustainable bank as "a bank that not only understands and manages the risks that arise because of sustainability issues, but also perceives the strategic dimension of these issues". Addressing sustainability issues requires responsibilities and actions to be taken at all levels and across all the key functions of banks. More broadly, leading companies pursue sustainability because it has a material financial impact, since it contributes to generate revenues, cut costs and attract talents [2]. The same argument applies to banks too. In some ways, sustainability reveals to be a source of competitive advantage because banks involved in sustainability issues can improve their reputation and credibility,

both outside and inside the organization, since they are able to increase motivation and retention, as employees react positively to the opportunity to weave environmental and social dimensions into their work. Otherwise, banks cannot remain position-less on this matter because the risk of inaction is twofold: first, they could lose business opportunities and financing options, and second they could face risks to reputation, credibility and image.

Sustainability is also an important topic for the risk management function within financial intermediaries, because identifying and quantifying environmental and social risks should be part of the normal process of risk assessment and management. Previous literature [3] shows that, while the identification and control of environmental and social issues in the core banking practices is becoming more common, the integration of sustainability criteria in lending and investment banking activities still requires significant improvement, if banks aim to protect the value of their assets in the short and longer term.

Then, the choices of bank managers have a strong relationship with the sustainability policies and, at the same time, sustainability issues can influence the management's behavior. Therefore, the efficiency level that characterizes the production process of banks and financial intermediaries is strictly interconnected with sustainability; from a long-term perspective, cost and profit efficiency reveals to be one of the most important premises for sustainability.

In the last decades, the Euro Area was involved in an important process of harmonization of the financial system, the combination of services offered by the financial intermediaries and the supervision rules. This phenomenon, combined with a high level of globalization, emphasized the problem of international competitiveness among intermediaries and, in particular, among banks. An important restructuring process involved the banking system to exploit economies of scale and scope.

Thus, the banking system is now characterized by the presence of multi-functional groups made up of many entities specialized in different activities; then, to evaluate the level of efficiency, it is essential to look at the group as a whole. By focusing on groups, rather than on banks, it is also possible to remove some distortionary effects caused by accounting policies and intra-group operations since these phenomena are netted out upon consolidation [4–7].

Even though it is better to look at banking groups instead of single banking units, there are few studies that analyze efficiency at the group level. In our opinion, this lack could also depend on the database construction, which is quite tricky, because it needs continuous revisions due, for example, to the numerous merger and acquisition (M&A) processes that characterize the banking sector.

This work contributes to fill the gap of the lack of works dealing with groups and tries to verify if some key drivers of efficiency deriving from strategic choices outlined by the literature on single banks (i.e., size, number of branches, cost income ratio and geographical location) still have the same relevance when considering banking groups. Moreover, the answer to the previous question was obtained through a delicate database construction, merging different types of information (accounting and ownership aspects).

For this aim, this work starts comparing the level of efficiency of the most important banking groups of the Euro Area during 2011–2016 through the implementation of the Stochastic Frontier Approach. We decided to focus on this period to analyze the banking system reaction to three different events as outlined in the Bank for International Settlements annual reports: the consequences of the sub-prime crisis (early 2011), the sovereign debt crisis (second part of 2011 and 2012) and the explosion of the non-performing loans (2014–2016).

The element of innovation is attributable to the fact that we analyzed Euro Area banking groups in a period marked by a sequence of critical events and in a context characterized not only by a general increase in risks and competitiveness, but also by a strong commitment with sustainability issues.

This analysis is useful to point out the recent development of the European banking sector; the results should be quite interesting for different categories of stakeholders, such as managers, shareholders and regulatory authorities, since they reveal the relative importance of the key factors that drive the banking business and their impact on the overall business.

The paper is organized as follows. In Section 2, there is a review of the previous literature about bank efficiency measurement. Section 3 is a summary of the methodology implemented in this work. Section 4 illustrates the results of the empirical analysis. Section 5 is a discussion of the obtained results.

2. Literature Review

The issue of X-efficiency was introduced for the first time by Farrell [8] who defined inefficiency as the distance of a firm from the so-called frontier that is the benchmark able to represent the optimal production or cost function. During the 1990s, this concept, together with the concept of productivity, was extended to the studies dealing with financial intermediaries (for a literature review about the efficiency of financial intermediaries different from banks, see [9,10]). Then, the literature divided into two main strands: (1) the works dealing with methodological issues such as the shape of the production/cost frontier, the choice between parametric and non-parametric approaches [11–17]; and (2) studies focused on empirical issues related to efficiency. Among these works, some studies focused on the relationship between efficiency and some environmental variables or managerial variables. The main contributions studied the banking system in France [18], Germany [19], Italy [20–24], Spain [25], Greek [16], United Kingdom [26], America [12,27–32], Australia [33], China [34] and Japan [35,36]. Other studies tried to compare the banking system of different countries [37–44]. In particular, this branch of research grew as a consequence of the internationalization process and gave birth to different techniques of comparison; the first is based on the implementation of different stochastic frontiers, one for each country involved in the analysis [45–47], and the second is based on a single frontier for all the units regardless from the country [48–54].

The evolution of the supervision scheme issued by the Basel Committee and the introduction of the Single Supervisory Mechanism in the Euro Area pushed up a new branch of research that studied the relationship among efficiency, supervisory models and degree of independence of the Central Authority [55–58]. Similarly, with the introduction of new rules dealing with risk and corporate governance, other works focused on the impact of risk management on efficiency. The main topics analyzed concern the link between efficiency and asset quality [25,27,59,60], the evaluation of credit risk weighted efficiency scores [27,48,61–64] and the relationship between efficiency and default risk [24,65–67].

As stated before, we found only few works dealing with the relationship between efficiency and the business model, the strategic choices and the complexity of the banking groups. This could also be due to the reasons mentioned above. Some authors studied the level of efficiency of banking groups' holdings [68,69], other works focused on the structure of the distribution network [70] and only one author compared cost and profit efficiency of financial intermediaries belonging to conglomerates with the same measures referred to universal banks [71]. Three other works analyzed efficiency and productivity of Italian financial conglomerates [72,73] or Luxembourgian conglomerates [74].

Our paper tries to fill this gap with a comparative analysis about the efficiency level of European banking groups in the period 2011–2016.

3. Methodology

The discussion about the different methodologies that can be adopted to measure the efficiency level and about the best choices that could be done in terms of inputs and outputs of the banks and financial intermediaries production process have been much debated over time so that there is a huge amount of literature about these topics [8,10,13,14,52,70,75–83].

Although we deeply analyzed these issues in previous works [9,10], this paper lies outside the analysis of these particular topics from a theoretical and methodological point of view. Thus, we decided to adopt the most common and widely used approaches of the mentioned literature on empirical research to measure the efficiency level and to define/identify what must be meant by inputs and output for banks.

With more detail, to evaluate the level of efficiency of the European banking groups, a parametric approach was employed since it is considered more flexible and more easily adaptable to data. These approaches are very popular then there is the possibility to compare our results with previous literature. In particular, we chose the Stochastic Frontier Approach [79–84] because it can distinguish the component of efficiency due to random factors, measurement errors or different financial reporting standards, from the component which represents the ability of the manager. This result is achieved by structuring in a particular way the error term which results from the sum of two components:

$$\varepsilon_k = v_k - u_k \quad (1)$$

It represents the distance of the output (in the case of production function) or the cost (in the case of cost function) of the k-th unit from the frontier. This distance is the sum of the two above mentioned components: the random element (v_k) and the level of technical inefficiency (u_k). The first term is symmetrical and it is distributed as a normal random variable $v \sim N(0; \sigma_v^2)$. The second term is positive in case of production function and negative in case of cost function and it follows a one side normal distribution ($N^+(0; \sigma_u^2)$). In addition, v and u are independent such that $\mathrm{cov}(v_k, u_k) = 0, \forall k$.

In this work, banking groups were compared based on their cost efficiency so the difference between the total cost of each unit and the total cost of the best practice group to produce the same quantity of output under the same conditions will be measured.

To define outputs and inputs, the Intermediation Approach [83,85] was adopted introducing three output variables (loans, securities and off-balance sheet items) and four inputs (human capital, liabilities, fixed assets and the amount of equity) [62,63]. Table 1 illustrates the proxies that were used for inputs and outputs.

Table 1. Inputs and Outputs proxies.

Variables	Proxies
TC = total costs of production	Personnel expenses Interest expenses Operating expenses
Outputs	
Q1 = Loans Q2 = Securities Q3 = Off-balance sheet items	Net loans Total securities Off-balance sheet items
Inputs	
F1 = Human capital	$\frac{\text{personnel expenses}}{\text{total assets}}$
F2 = Financial capital	$\frac{\text{interest expenses}}{\text{total liabilities}}$
F3 = Fixed capital	$\frac{\text{other operating expenses}}{\text{fixed assets}}$
F4 = Equity	total equity

To define the algebraic formulation of the cost frontier, which represents the technology used by each unit to transform inputs into outputs, there are different possibilities: previous literature offers many formulas that differ in terms of flexibility and ability to represent different production technologies and to respect some fundamental properties [86,87]. Among the best known, there are the Cobb–Douglas, the Constant Elasticity of Substitution (CES), and the Trans-logarithmic (Transcendental Logarithmic or translog). The first two functions are not very common in the recent literature because of their low flexibility, so the translog function was employed to have the possibility to compare the obtained results with the most recent studies. This function is characterized by convex cost curves

and variable elasticity of production and substitution between different inputs. Our trans-logarithmic function will appear as follows:

$$\ln TC = \alpha_0 + \sum_{i=1}^{m} \alpha_i \ln Q_i + \sum_{j=1}^{n} \beta_j \ln F_j + \sum_{i=1}^{m} \sum_{j=1}^{n} \rho_{ij} \ln Q_i \ln F_j + \frac{1}{2}\left[\sum_{i=1}^{m} \delta_{ii} \ln Q_i \ln Q_i + \sum_{j=1}^{n} \gamma_{jj} \ln F_j \ln F_j\right] + \varepsilon \quad (2)$$

where TC represents the total production cost of each banking group during each year in the observed period; Q_i (with i = 1, . . . , m) represents output quantities for each unit in each year; and Fj (with j = 1, . . . n) are inputs employed by each group in each year. α, β, ρ, δ, and γ are the parameters to be estimated. In this work, three outputs (i = 1, 2, 3) and four input factors (j = 1, 2, 3, 4) were considered, as shown in Table 1.

To calculate the efficiency values for each banking group for each year, the values of the variables were deflated (to improve the comparison between groups belonging to different countries) and then standardized (to avoid any problem related to scale) by means of the usual transformation into z-scores.

The geographical and dimensional distribution of the groups is presented as well as some descriptive statistics of the main variables employed in the study. Then, the evolution of the efficiency scores for the whole set of banking groups and for the banking groups split with respect to country and group size, and the trend of the average efficiency score of the banking groups in the period 2011–2016 with respect to the country and to the size of each group are illustrated.

In relation to the size, the classification was assessed with a two steps procedure. First, the importance of each single banking group within the whole Euro Area was measured by means of a ratio between the total assets of the observed unit and the total asset of the European Banking system. Secondly, based on this value, the importance of each group within the set under analysis was evaluated: groups that show an importance greater than 1% were considered large, groups with an importance lower than 0.1% were considered small and all the other were considered in the mids.

To provide a complete representation of the dynamics of efficiency during the observed period, in compliance with the degree of asymmetry of the annual distributions of the efficiency scores and with the yearly observations number, in relation to each year, the banking groups were divided into classes according to the efficiency degree reached. Each class will be labeled using a numeric value.

Then, both a classification coincidence and a co-graduation analysis of the vectors of these new values for each year were done to highlight whether the banking groups had an up-grade in performance, in terms of efficiency, during time.

Finally, a cluster analysis of banking groups based on the efficiency levels reached during the whole period was performed to verify if some key drivers of efficiency deriving from strategic choices and/or business model outlined by literature on single banks (i.e., size, number of branches, cost income ratio and geographical location) are the same when considering banking groups.

4. Data and Results

The set of European banking groups involved in our work is made up of 70 units. They represent the whole set of active banking groups in the Euro Area with the exception of Cyprus, Sweden, Finland, Greece, Ireland, Lithuania, Luxemburg, Latvia, Malta, Slovenia, and Serbia. For comparability reasons, we decided to work on a balanced data set, so we dropped those banking groups for which the variables involved in this study had missing values in the observed period.

All data came from Orbis Bank Focus (Bureau Van Dijk) except for the GDP deflators that were extracted from the World Bank Database.

The efficiency values for each banking group for each year were evaluated via STATA 14. Table 2 illustrates the geographical and dimensional distribution of the groups, while Table 3 shows some

descriptive statistics of the main variables employed in this study. Both tables are referred to the latest information.

Table 2. Geographical and dimensional distribution of European banking groups at the end of 2016.

	N. of Groups	TOTAL ASSETS (Millions of €)					
		Mean	Median	St. Dev.	Min	Max	c.v.
AT	10	26,402.40	7879.26	53,842.52	344.76	186,495.27	2.04
BE	2	207,918.00	207,918.00	45,307.86	162,610.13	253,225.86	0.22
DE	5	469,775.30	436,333.41	526,799.56	2620.28	1,444,496.54	1.12
ES	6	417,999.75	178,162.12	465,312.69	37,887.51	1,323,857.96	1.11
FR	19	314,455.91	22,559.96	582,874.67	8925.22	1,977,452.40	1.85
IT	21	104,195.78	26,281.79	211,083.76	1111.77	804,539.48	2.03
NL	5	367,464.50	377,331.29	323,277.43	3635.04	808,339.81	0.88
PT	2	62,235.35	62,235.35	26,088.45	36,146.91	88,323.80	0.42
All groups	70	223,732.88	26,068.68	416,883.12	344.76	1,977,452.40	1.86

Table 3. Descriptive statistics of the main variables at the end of 2016.

	Millions of €					
	Mean	Median	St. Dev.	Min	Max	c.v.
Liquidity	58,458.44	2416.35	133,118.15	41.45	591,471.00	2.28
Net Loans	105,270.77	19,739.43	174,188.69	314.60	780,966.00	1.65
Total Securities	73,958.67	5878.43	167,565.42	24.86	843,315.00	2.27
Fixed Assets	1852.13	306.70	4380.89	0.46	22,523.00	2.37
Total Liabilities	222,971.83	25,123.20	417,225.18	354.28	1,980,169.00	1.87
Total Equity	13,139.16	2764.70	22,660.03	24.31	102,699.00	1.72
Net Income	376.04	83.49	2367.10	−11,326.31	8115.00	6.29
	% data					
ROAE	−1.19%	4.92%	17.51%	−80.56%	16.79%	14.73
ROAA	0.02%	0.32%	1.16%	−5.15%	2.00%	52.56
Cost Income Ratio	74.29%	69.11%	22.88%	23.51%	179.60%	0.31

Table 4 shows the evolution of the efficiency scores for the whole set of banking groups and the change in the mean value of efficiency from 2011 to 2016. Tables A1 and A2 split the same information with respect to country and group size.

Table 4. Efficiency scores for the whole set of banking groups.

	2011	2012	2013	2014	2015	2016
Mean	0.977	0.920	0.943	0.953	0.928	0.875
Median	0.978	0.928	0.947	0.957	0.935	0.907
Dev.st.	0.004	0.072	0.027	0.020	0.032	0.109
Min	0.962	0.678	0.842	0.886	0.811	0.558
Max	0.986	0.997	0.981	0.983	0.976	0.987
c.v.	0.004	0.079	0.029	0.021	0.035	0.125
	Δ 2011–2016					−0.10

Figure 1 illustrates the trend of the average efficiency score of the observed banking groups in the period 2011–2016 with respect to the country, while Figure 2 shows the same information with respect to the size of each group.

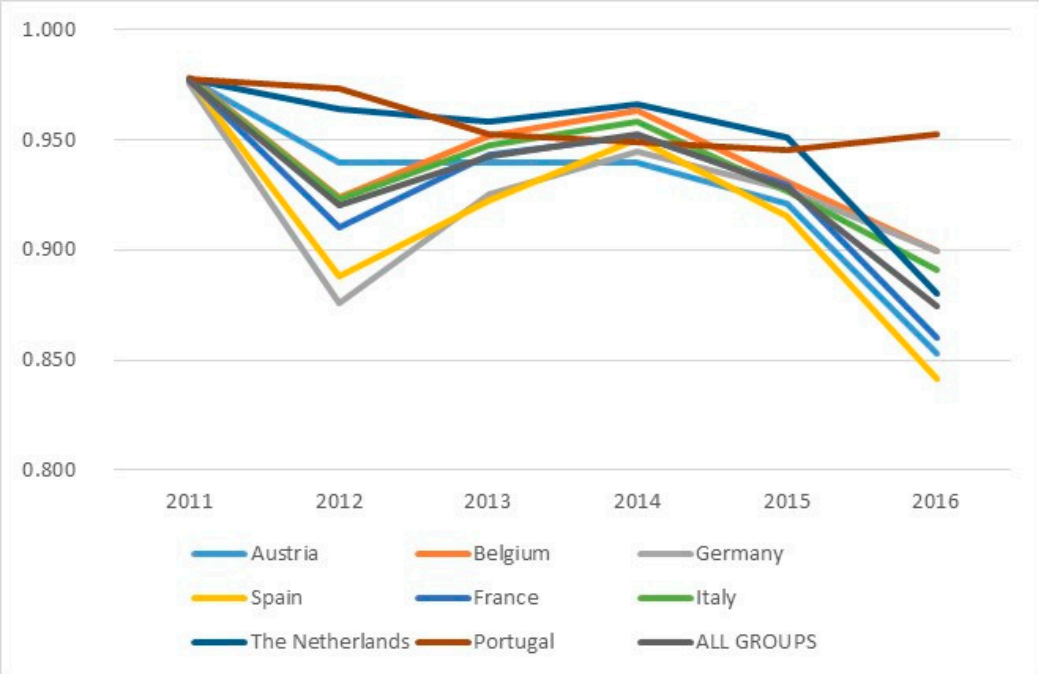

Figure 1. Average efficiency score by country in the period 2011–2016.

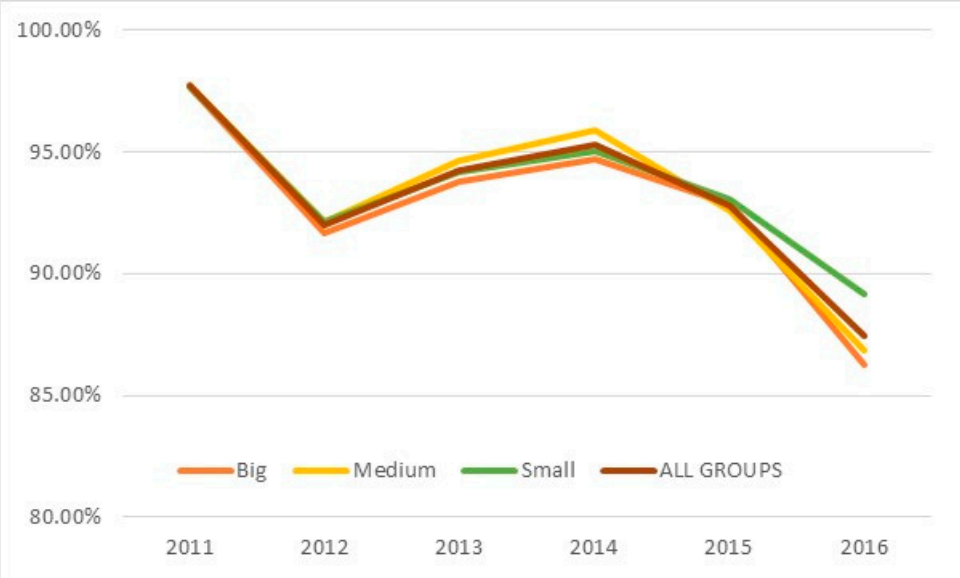

Figure 2. Average efficiency score by size in the period 2011–2016.

Both figures clearly show the decline of the degree of efficiency over time with two minimums peaks in 2012 and 2016 and a moderate recovery in 2013 and 2014. In Figure 2, small groups exhibit a smaller lack of efficiency during the last two years, while large groups seem to suffer much more than others. This is probably a consequence of the high level of complexity of a large group where the reaction to external changes is slow. Otherwise, the overall path confirms our initial hypothesis and it is the consequence of the events that affected the European banking system during the period considered. In particular, the decline recorded in 2012 could be traced back to the effects of the sovereign debt crisis and the sudden widening of the spread in the main continental countries. On the contrary, the two-year period that followed is characterized by a slight recovery due to the overcoming of the debt crisis and the sub-prime crisis generally speaking. On the other hand, the last two years exhibit a

strong discontinuity compared to the previous period; this fact is the consequence of the well-known problem of non-performing loans. During these years, the Supervisory Authority went into a deep monitoring of the health of the credit portfolio held by financial institutions (see, for example, the Asset Quality Review Process that started in November 2013) and forced the banks with a high percentage of non-performing loans to sell those assets. Consequently, these kind of loans generated significant impairments with immediate fallouts on the income statements.

Based on efficiency scores year by year obtained, since the distribution of these scores was quite symmetrical in each year (data are available on request) and considering the number of observations, banking groups were divided into three classes. The partition was done according to the following criteria:

- The first class extends from the minimum value to the score equal to the mean minus the standard deviation. This was encoded with 3 and represents low efficiency groups.
- The second class includes the groups whose score was in between the mean value minus the standard deviation and the mean value plus the standard deviation. This was encoded with 2.
- The third class includes groups with efficiency scores greater than the mean plus the standard deviation. This was encoded with 1 and represents the best groups in terms of efficiency.

To analyze the degree of persistency of efficiency scores, we observed the correspondence of the rankings for each year and their level of co-graduation (by means of the Spearman coefficient) [10]. Our results show that, on average, the banking groups changed their classification during the observed period. The mean of the coincidence percentages is equal to 71%, while the mean of the Spearman co-graduation indexes for different years is only 49%. In particular, further examinations revealed that, despite the reduction in the overall level of efficiency from 2011 to 2016, on average, 84% of the groups showed an upgrade with an improvement rate of approximately 73%.

Considering the efficiency scores of each group for each year, we implemented a cluster analysis over the entire period to divide the banking groups into homogeneous sets. All the input variables employed in the cluster analysis revealed to be significant. To be sure of the robustness of the classification, we tried different methods. We employed both a k-medium algorithm (which organizes the groups into disjoint subsets so that each cluster is associated with a centroid and each banking group is assigned to the cluster whose centroid is closer) and various hierarchical methods, which organize the units on a tree (dendrogram) built based on a matrix of similarities/distances between the objects obtained according to a particular criterion.

The dendrogram analysis, as well as some related tests, highlighted as the best banking groups partition the subdivision in three clusters, respectively, characterized by high, mid or low level of efficiency. The results of the cluster analysis are shown in Table A3.

5. Discussion and Conclusions

Sustainability is a relatively new topic in the banking business, but it is gaining more and more attention from managers, stakeholders and regulators. The concept of sustainability is strongly linked to that of efficiency since they can influence each other being both depending on the strategic choices of the manager.

Given this relationship, we decided to go into a deeper examination of the dynamics of cost efficiency of European banking groups during the period 2011–2016 to verify if some key drivers of efficiency deriving from strategic choices outlined by literature on single banks (i.e., size, number of branches, cost income ratio and geographical location) are the same when considering banking groups.

Thus, this paper differs from previous contributes of the literature in the following ways:

(i). It focuses on the whole group as an entity instead of individual banks (thus, it is possible to remove some distortionary effects caused by accounting policies and intra-group operations since these phenomena are netted out upon consolidation).

(ii). It considers an extended period after the sub-prime crisis in which other dramatic events (among others, the sovereign debt crisis and the explosion of the amount of non-performing loans (NPL) in bank portfolios) took place in a context characterized not only by a general increase in risks and competitiveness, but also by a strong commitment with sustainability issues.

Even though it should be better to look at banking groups instead of single banking units for the reason mentioned above, few studies analyze efficiency at the group level. Thus, the analysis in the paper, that is useful to point out the recent development of the banking sector in Europe, also tries to fill this gap in literature.

The obtained results should be quite interesting for different categories of stakeholders, such as managers, shareholders and regulatory authorities, since they reveal the relative importance of the key factors that drive the European banking market and their impact on the overall business.

The results achieved (in line with previous literature [43,47,88]) highlight the impact of the mentioned dramatic events. In particular, the year 2012 is marked by a sudden decrease of the mean efficiency level because of the impact of the sovereign debt crisis on the most of continental Europe. The following period is instead characterized by a recovery followed by another collapse due to the consequences of the NPL explosion in bank portfolios.

In line with other studies [39,88], the banking groups that exhibited the highest efficiency values during 2011–2016 (such as the banking groups belonging to Cluster 1 in Table A3) are largely Italian and French institutions (37% and 26% of the cluster, respectively). The same groups reveal the less dramatic lack of efficiency too. On the contrary, the groups that suffered the most during the whole period were those operating in Germany and Spain.

Even though this result may seem surprising, it is useful to consider some facts to understand the reasons behind these data. In the case of Italy, for example, it is known that, during the Sovereign Debt Crisis, the financial system suffered for a strong speculative attack that caused a dramatic widening of the spread on Government Bonds. The whole system recovered in a few weeks thanks to the banks that proved to be really robust: they were able to use their liquidity reserves (and additional liquidity from the Central Bank) to buy a huge amount of Treasury Bonds thus stopping their price fall and letting the spread to reduce to the previous level. Another remark that is useful to explain the results referred to the last part of the observed period, when the explosion of NPLs seriously damaged the balance sheets of many banks, is referred to the problem of the evaluation of Risk Weighted Assets. As stated by some researchers and some institutions [89,90], most of the banks of southern Europe adopted the Standardized Approach to evaluate their Risk Weighted Assets (RWA) for capital ratios purposes. On the other hand, in the northern part of Europe, the opposite situation was observed, since many banks adopted Internal Rating Based (IRB) methods. Now, it is well known that the two approaches produce different results even if applied to the same entities and, in particular, the risk weighted assets coming from IRBs are lower. This means that, even if the capital ratios of southern Europe banks may seem lower, they do not reflect a real riskier situation; it is only an algebraic result, which is why Italian and French banks revealed better results than expected. Finally, many statistics about NPLs employed in international comparisons are based on the value of gross loans. In the case of Italy, a deeper look into the banking accounts reveal that the high level of NPLs is counterbalanced by a likewise high level of provisions so that the coverage ratio of these banks' loans is higher than the European average [77]. These observations might be able to explain the high level of efficiency of Italian and French banks in this work.

The banking groups that exhibited mean efficiency (i.e., the banking groups belonging to Cluster 2 in Table A3) are characterized by a very high number of branches—that is, a high level of complexity—and high values of cost income ratio. These items are probably connected because a big organization often reveals to be expensive because of its complexity [10].

Finally, the banking groups of the third cluster in Table A3 (low efficient groups) are the biggest in terms of size (measured by total assets). Moreover, our data show that large groups suffered the worst decrease in terms of efficiency, while small groups revealed to be more virtuous. This result is in

line with previous literature [17] that pointed out as larger banks were more severely hit by the global financial crisis.

A further improvement of this work would consider the variables that revealed a positive or negative impact on the efficiency score. In particular, we would like to analyze whether the most efficient banking groups are actually characterized by a strategy and by a business model that aim to reach appropriate levels of liquidity and lending activity. This is extremely important because, on a low level, they represent an opportunity cost, while, on the contrary, if too high, they should turn into a remarkable source of risk or into an adverse selection problem.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Efficiency scores for the whole set of banking groups by country.

		2011	2012	2013	2014	2015	2016
Austria	mean	0.978	0.94	0.94	0.94	0.921	0.853
	median	0.978	0.974	0.946	0.953	0.931	0.884
	st.dev.	0.006	0.087	0.036	0.029	0.039	0.13
	min	0.967	0.701	0.852	0.886	0.85	0.583
	max	0.986	0.996	0.981	0.97	0.963	0.986
	c.v.	0.01	0,092	0.038	0.031	0.043	0.152
	Δ						−0.127
Belgium	mean	0.978	0.924	0.952	0.963	0.931	0.9
	median	0.978	0.924	0.952	0.963	0.931	0.9
	st.dev.	0.001	0.07	0.023	0.019	0.02	0.025
	min	0.977	0.854	0.929	0.944	0.911	0.875
	max	0.979	0.994	0.975	0.983	0.951	0.925
	c.v.	0.001	0.076	0.025	0.02	0.022	0.028
	Δ						−0.08
Germany	mean	0.975	0.876	0.926	0.945	0.928	0.899
	median	0.977	0.83	0.949	0.955	0.931	0.912
	st.dev.	0.008	0.103	0.046	0.029	0.013	0.076
	min	0.962	0.739	0.842	0.888	0.908	0.802
	max	0.986	0.997	0.972	0.971	0.947	0.982
	c.v.	0.008	0.118	0.05	0.031	0.014	0.085
	Δ						−0.078
Spain	mean	0.978	0.888	0.922	0.95	0.916	0.841
	median	0.978	0.886	0.926	0.949	0.908	0.856
	st.dev.	0.002	0.035	0.018	0.009	0.024	0.09
	min	0.975	0.835	0.893	0.935	0.884	0.708
	max	0.981	0.944	0.943	0.964	0.953	0.978
	c.v.	0.002	0.039	0.02	0.01	0.026	0.107
	Δ						−0.139
France	mean	0.977	0.911	0.943	0.952	0.93	0.86
	median	0.977	0.924	0.945	0.95	0.926	0.884
	st.dev.	0.005	0.079	0.023	0.018	0.023	0.107
	min	0.965	0.678	0.886	0.904	0.891	0.636
	max	0.986	0.996	0.98	0.982	0.976	0.984
	c.v.	0.005	0.086	0.025	0.019	0.025	0.124
	Δ						−0.12

Table A1. *Cont.*

		2011	2012	2013	2014	2015	2016
Italy	mean	0.977	0.923	0.948	0.959	0.927	0.891
	median	0.978	0.923	0.95	0.963	0.939	0.938
	st.dev.	0.003	0.052	0.02	0.014	0.041	0.11
	min	0.972	0.829	0.909	0.935	0.811	0.558
	max	0.982	0.996	0.977	0.981	0.966	0.987
	c.v.	0.003	0.056	0.021	0.014	0.044	0.124
	Δ						−0.088
The Netherlansds	mean	0.978	0.964	0.958	0.966	0.951	0.88
	median	0.977	0.994	0.958	0.967	0.951	0.976
	st.dev.	0.002	0.047	0.009	0.004	0.014	0.121
	min	0.976	0.875	0.947	0.958	0.936	0.714
	max	0.981	0.996	0.972	0.97	0.975	0.979
	c.v.	0.002	0.048	0.01	0.005	0.014	0.137
	Δ						−0.10
Portugal	mean	0.978	0.973	0.953	0.949	0.945	0.953
	median	0.978	0.973	0.953	0.949	0.945	0.953
	st.dev.	0.004	0.023	0.019	0.021	0.009	0.021
	min	0.974	0.95	0.934	0.927	0.937	0.932
	max	0.982	0.996	0.972	0.97	0.954	0.974
	c.v.	0.004	0.023	0.02	0.022	0.009	0.022
	Δ						−0.025

Table A2. Efficiency scores for the whole set of banking groups by size.

		2011	2012	2013	2014	2015	2016
Large	mean	0.977	0.917	0.938	0.947	0.029	0.863
	median	0.977	0.928	0.944	0.948	0.928	0.875
	st.dev.	0.005	0.069	0.033	0.026	0.023	0.097
	min	0.962	0.739	0.842	0.888	0.884	0.636
	max	0.986	0.997	0.975	0.983	0.976	0.98
	c.v.	0.005	0.076	0.035	0.027	0.025	0.113
	Δ						−0.117
Medium	mean	0.978	0.921	0.947	0.959	0.926	0.868
	median	0.978	0.914	0.947	0.963	0.935	0.911
	st.dev.	0.004	0.069	0.024	0.014	0.038	0.121
	min	0.965	0.678	0.886	0.927	0.811	0.558
	max	0.982	0.996	0.98	0.982	0.967	0.987
	c.v.	0.004	0.074	0.025	0.014	0.041	0.139
	Δ						−0.112
Small	mean	0.977	0.922	0.942	0.95	0.93	0.892
	median	0.978	0.943	0.948	0.956	0.03	0.937
	st.dev.	0.004	0.079	0.026	0.02	0.031	0.102
	min	0.967	0.701	0.852	0.886	0.844	0.652
	max	0.986	0.996	0.981	0.976	0.975	0.986
	c.v.	0.005	0.086	0.027	0.021	0.033	0.114
	Δ						−0.088

Table A3. Cluster results.

Cluster 1 Banking Groups with the higher efficiency scores	Société Générale SA Caisse régionale de crédit agricole mutuel de l'Ille-et-Vilaine SA-Crédit Agricole de l'Ille-et-Vilaine Crédit Agricole S.A. ABN AMRO Group N.V. Caisse régionale de crédit agricole mutuel de Paris et d'Ile-de-France SC-Crédit Agricole d'Ile-de-France BPIFrance Financement SA Commerzbank AG Deutsche Bank AG Caisse Régionale de Crédit Agricole Mutuel du Languedoc SC Unione di Banche Italiane Scpa-UBI Banca Caisse régionale de crédit agricole mutuel d'Aquitaine SC-Crédit Agricole d'Aquitaine Caisse régionale de crédit agricole mutuel de Normandie-Seine Caisse Régionale de crédit agricole mutuel Atlantique Vendée SC-Crédit Agricole Atlantique Vendée Sanfelice 1893 Banca Popolare Societa Cooperativa Per Azioni Cassa di Risparmio di Bolzano SpA-Suedtiroler Sparkasse Cassa di risparmio di San Miniato SpA Oppure Carismi Spa Banca Monte dei Paschi di Siena SpA-Gruppo Monte dei Paschi di Siena Banca Popolare di Milano SCaRL Banco Popolare - Società Cooperativa-Banco Popolare Van Lanschot Kempen NV ING Groep NV Caixa Geral de Depositos Bankinter SA Caisse Régionale de Crédit Agricole Mutuel Toulouse 31 SC-Crédit Agricole Mutuel Toulouse 31 CCI Banca Piccolo Credito Valtellinese-Credito Valtellinese Soc Coop Banco di Desio e della Brianza SpA-Banco Desio BPER Banca S.P.A. Allgemeine Sparkasse Oberösterreich Bank AG Oberbank AG Caisse régionale de credit agricole mutuel Sud Rhône -Alpes SC-Credit Agricole Sud Rhône Alpes BKS Bank AG Banco BPI SA Credito Emiliano SpA-CREDEM Banca Popolare di Sondrio Societa Cooperativa per Azioni Hauck & Aufhaeuser Privatbankiers KGaA Intesa Sanpaolo Cassa di Risparmio di Ravenna SpA Banca Agricola Popolare di Ragusa SCARL Banco Santander SA Banca Popolare di Bari Soc. Coop.P.A Sparkasse Eferding-Peuerbach Waiznkirchen eV KBC Groep NV/KBC Groupe SA-KBC Group Autobank AG
Cluster 2 Banking Groups with medium efficiency scores	Caisse régionale de crédit agricole mutuel Loire Haute-Loire SC-Crédit Agricole Loire Haute-Loire BNP Paribas Liberbank SA Veneto Banca scpa Cooperatieve Rabobank U.A. Banco Popular Espanol SA Caisse Régionale de Crédit Agricole Mutuel Brie Picardie SC-Crédit Agricole Brie Picardie

Table A3. *Cont.*

Cluster 2 Banking Groups with medium efficiency scores	Caisse régionale de crédit agricole mutuel Loire Haute-Loire SC-Crédit Agricole Loire Haute-Loire BPCE SA La Banque Postale Volksbank Vorarlberg e.Gen. Raiffeisen-Holding Niederösterreich-Wien registrierte Genossenschaft mit beschränkter Haftung BinckBank NV Banca Popolare di Vicenza Societa per azioni Bank für Tirol und Vorarlberg AG-BTV (3 Banken Gruppe) UniCredit SpA
Cluster 3 Banking Groups with the lower efficiency scores	Caisse régionale de Crédit Agricole mutuel du Morbihan SC-Crédit Agricole du Morbihan DZ Bank AG-Deutsche Zentral-Genossenschaftsbank Caisse régionale de crédit agricole mutuel Nord de France SC-Crédit Agricole Nord de France Banca Carige SpA Banco Bilbao Vizcaya Argentaria SA-BBVA Banco de Sabadell SA Bankhaus Lampe KG Caisse régionale de credit agricole mutuel d'Alpes-Provence SC-Credit Agricole Alpes Provence Raiffeisenverband Salzburg eGen Banca Sella Holding SpA Erste Group Bank AG Belfius Banque SA/NV-Belfius Bank SA/NV

References

1. UNEP Finance Initiative Banking Commission Board. *Guide to Banking and Sustainability*; United Nations Environment Programme: Nairobi, Kenya, 2016.
2. Bonini, S.; Swartz, S. Profits with purpose: How organizing for sustainability can benefit the bottom line. In *McKinsey on Sustainability & Resource Productivity*; McKinsey Company: New York, NY, USA, 2014.
3. KPMG; WWF. *Ready or Not? An Assessment of Sustainability Integration in the European Banking Sector*; KPMG: Amsterdam, The Netherlands, 2015.
4. Beaver, W.H.; Cascino, S.; Correia, M.; McNichols, M.F. Group affiliation and default prediction. In *Forthcoming at Management Science*; Social Sciences Research Network (SSRN): New York, NY, USA, 2018.
5. Shroff, N.; Verdi, R.; Yu, G. Information environment and the investment decisions of multinational corporations. *Account. Rev.* **2014**, *89*, 759–790. [CrossRef]
6. Leuz, C. Different approaches to corporate reporting regu3lation: How jurisdictions differ and why. *Account. Bus. Res.* **2010**, *40*, 229–256. [CrossRef]
7. Bonacchi, M.; Marra, A.; Zarowin, P. *Earnings Quality of Private and Public Firms: Business Groups vs. Stand-Alone Firms*; Social Sciences Research Network (SSRN): New York, NY, USA, 2017.
8. Farrell, M.J. The measurement of productive efficiency. *J. R. Stat. Soc. Ser. A* **1957**, *120*, 253–290. [CrossRef]
9. Borello, G.; Pampurini, F. Una stima del livello di efficienza delle Società di Gestione del Risparmio operanti in Italia. *Bancaria* **2012**, *7–8*, 25–42.
10. Quaranta, A.G.; Raffoni, A.; Visani, F. A multidimensional approach to measuring bank branch efficiency. *Eur. J. Oper. Res.* **2018**, *266*, 746–760. [CrossRef]
11. Allen, L.; Rai, A. Operational efficiency in banking: An international comparison. *J. Bank. Financ.* **1996**, *20*, 655–672. [CrossRef]
12. Berger, A.N.; Mester, L.J. Inside the black box: What explains differences in the efficiencies of financial institutions. *J. Bank. Financ.* **1997**, *21*, 895–974. [CrossRef]
13. Bauer, P.W.; Berger, A.N.; Ferrier, G.D.; Humphrey, D.B. Consistency Conditions for Regulatory Analysis of Financial Institutions: A Comparison of Frontier Efficiency Methods. *J. Econ. Bus.* **1998**, *50*, 85–114. [CrossRef]

14. Coelli, T.J.; Rao, D.S.P.; Battese, G.E. *An Introduction to Efficiency and Productivity Analysis*; Norwell Kluwer Academic Publishers: Boston, MA, USA, 1998.
15. Beccalli, E.; Casu, B.; Girardone, C. Efficiency and Stock Performance in European Banking. *J. Bus. Financ. Account.* **2006**, *33*, 245–262. [CrossRef]
16. Halkos, G.E.; Tzeremes, N.G. Estimating the degree of operating efficiency gains from a potential bank merger and acquisition: A DEA bootstrapped approach. *J. Bank. Financ.* **2013**, *37*, 1658–1668. [CrossRef]
17. Tsionas, E.G.; Assaf, A.G.; Matousek, R. Dynamic technical and allocative efficiencies in European banking. *J. Bank. Financ.* **2015**, *52*, 130–139. [CrossRef]
18. Jimborean, R.; Brack, E. *The Cost-Efficiency of French Banks, Bankers, Markets and Investors*; MPRA Paper No. 23471; Ludwig Maximilians University: Munich, Germany, 2010.
19. Koetter, M. The stability of bank efficiency rankings when risk preferences and objectives are different. *Eur. J. Financ.* **2008**, *14*, 115–135. [CrossRef]
20. Resti, A. Evaluating Cost-Efficiency of the Italian Banking System, What Can Be Learned from the Joint Application of Parametric and Non-Parametric Techniques. *J. Bank. Financ.* **1997**, *21*, 221–250. [CrossRef]
21. Girardone, C.; Molyneaux, P.; Gardener, E.P.M. Analysing the determinants of bank efficiency: The case of Italian banks. *Appl. Econ.* **2004**, *36*, 215–227. [CrossRef]
22. Romano, G.; Ferretti, P.; Quirici, M.C. Corporate Governance and Efficiency of Italian Bank Holding Companies during the financial crisis: An empirical analysis. In *Evolution of Corporate Governance in Banks*; Mizuno, M., Pizzo, M., Kostyuk, A., Eds.; Virtusinterpress: Sumy, Ukrayina, 2012.
23. Durante, G.; Fornero, E.; Micheli, F.; Prosperetti, L.; Treu, T. Bank's profitability and efficiency as key drivers of job policies. *Bancaria* **2013**, *9*, 66–81.
24. Fiordelisi, F.; Mare, D.S. Probability of default and efficiency in cooperative banking. *J. Int. Financ. Mark. Inst. Money* **2013**, *26*, 30–45. [CrossRef]
25. Pastor, J. Efficiency and risk management in Spanish banking: A method to decompose risk. *Appl. Financ. Econ.* **1999**, *9*, 371–384. [CrossRef]
26. Duygun, M.; Sena, V.; Shaban, M. Shumpeterian competition and efficiency among commercial banks. *J. Bank. Financ.* **2013**, *37*, 5176–5185. [CrossRef]
27. Berger, A.N.; De Young, R. Problem loans and cost efficiency in commercial banking. *J. Bank. Financ.* **1997**, *21*, 849–870. [CrossRef]
28. De Young, R. Bank Mergers, X-Efficiency, and the Market for Corporate Control. *Manag. Financ.* **1997**, *23*, 32–47.
29. Barr, R.S.; Killgo, K.A.; Siems, T.F.; Zimmel, S. Evaluating the productive efficiency and performance of US commercial banks. *Manag. Financ.* **2002**, *28*, 3–25. [CrossRef]
30. Akhigbe, A.; McNulty, J.E. The Profit Efficiency of Small U.S. Banks. *J. Bank. Financ.* **2003**, *27*, 307–325. [CrossRef]
31. Elyasiani, E.; Wang, Y. Bank holding company diversification and production efficiency. *Appl. Financ. Econ.* **2012**, *22*, 1409–1428. [CrossRef]
32. Harris, O.; Huerta, D.; Ngo, T. The impact of TARP on bank efficiency. *J. Int. Financ. Mark. Inst. Money* **2013**, *24*, 85–104. [CrossRef]
33. Sathye, M. Measuring productivity changes in Australian banking: An application of Malmquist indices. *Manag. Financ.* **2002**, *28*, 48–59. [CrossRef]
34. Wang, K.; Huang, W.; Wu, J.; Liu, Y.N. Efficiency measures of the Chinese commercial banking system using an additive two-stage DEA. *Omega* **2014**, *44*, 5–20. [CrossRef]
35. Assaf, A.G.; Barros, C.P.; Matousek, R. Productivity and efficiency analysis of Shinkin banks: Evidence from bootstrap and Bayesian approaches. *J. Bank. Financ.* **2011**, *35*, 331–342. [CrossRef]
36. Homma, T.; Tsutsui, Y.; Vchida, H. Firm growth and efficiency in the banking industry: A new test of the efficient structure hypothesis. *J. Bank. Financ.* **2014**, *40*, 143–153. [CrossRef]
37. Radić, N.; Fiordelisi, F.; Girardone, C. Efficiency and risk-taking in pre-crisis investment banks. *J. Financ. Serv. Res.* **2012**, *41*, 81–101. [CrossRef]
38. Bellavite-Pellegrini, C.; Pellegrini, L.; Romelli, D. The stability and efficiency of the European cooperative banks: Evidence in Italy and Germany during the period 2006–2009. *Credito Pop.* **2012**, *19*, 119–147.
39. Ferreira, C. Banking Efficiency and European Financial Integration. *Appl. Econ. Q.* **2013**, *59*, 99–124. [CrossRef]

40. Mirzaei, A. Bank performance during the financial crisis 2007–2010. *Int. J. Bus. Econ.* **2013**, *12*, 27–44.
41. Kalyvas, A.; Mamatzakis, E. Does business regulation matter for banks in the European Union? *J. Int. Financ. Mark. Inst. Money* **2014**, *32*, 278–324. [CrossRef]
42. Kontolaimou, A. An efficiency analysis of European banks considering hierarchical technologies. *Appl. Econ. Lett.* **2014**, *21*, 692–696. [CrossRef]
43. Degl'Innocenti, M.; Kourtzidis, S.A.; Sevic, Z.; Tzeremes, N.G. Bank productivity growth and convergence in the European Union during the financial crisis. *J. Bank. Financ.* **2017**, *75*, 184–199. [CrossRef]
44. Degl'Innocenti, M.; Matousek, R.; Sevic, Z.; Tzeremes, N.G. Bank efficiency and financial centres: Does geographical location matter? *J. Int. Financ. Mark. Inst. Money* **2017**, *46*, 188–198. [CrossRef]
45. Beccalli, E. Cross-country comparisons of efficiency: Evidence from the UK and Italian investment firms. *J. Bank. Financ.* **2004**, *28*, 1363–1383. [CrossRef]
46. Lozano-Vivas, A.; Pastor, J.T. Do performance and environmental conditions act as barriers for cross-border banking in Europe? *Omega* **2010**, *38*, 275–282. [CrossRef]
47. Matousek, R.; Rughoo, A.; Srantis, N.; Assaf, A.G. Bank performance and convergence during the financial crisis: Evidence from the 'old' European Union and Eurozone. *J. Bank. Financ.* **2015**, *52*, 208–216. [CrossRef]
48. Pastor, J. Credit risk and efficiency in the European banking system: A three-stage analysis. *Appl. Financ. Econ.* **2002**, *12*, 895–911. [CrossRef]
49. Casu, B.; Molyneaux, P. A comparative study of efficiency in European banking. *Appl. Econ.* **2003**, *35*, 1865–1876. [CrossRef]
50. Girardone, C.; Nankervis, J.C.; Velentza, E. Efficiency, ownership and financial structure in European banking: A cross-country comparison. *Manag. Financ.* **2009**, *35*, 227–245. [CrossRef]
51. Kenjegalieva, K.A.; Simper, R.; Weyman-Jones, T.G. Efficiency of transition banks: Inter-country banking industry trends. *Appl. Financ. Econ.* **2009**, *19*, 1531–1546. [CrossRef]
52. Delis, M.D.; Papanikolaou, N.I. Determinants of bank efficiency: Evidence from a semi-parametric methodology. *Manag. Financ.* **2009**, *35*, 260–275. [CrossRef]
53. Casu, B.; Girardone, C. Integration and efficiency convergence in EU Banking Market. *Omega* **2010**, *38*, 260–267. [CrossRef]
54. Chortareas, G.E.; Girardone, C.; Ventouri, A. Bank supervision, regulation, and efficiency: Evidence from the European Union. *J. Financ. Stab.* **2012**, *8*, 292–302. [CrossRef]
55. Gaganis, C.; Pasiouras, F. Financial supervision regimes and banks efficiency: International evidence. *J. Bank. Financ.* **2013**, *37*, 5463–5475. [CrossRef]
56. Barth, J.R.; Lin, C.; Ma, Y.; Seade, J.; Song, F.M. Do bank regulation, supervision and monitoring enhance or impede bank efficiency? *J. Bank. Financ.* **2013**, *37*, 2879–2892. [CrossRef]
57. Doumpos, M.; Gaganis, C.; Pasiouras, F. Central bank independence, financial supervision structure and bank soundness: An empirical analysis around the crisis. *J. Bank. Financ.* **2015**, *61*, S69–S83. [CrossRef]
58. Fiordelisi, F.; Ricci, O. Whatever it takes: An Empirical Assessment of the Value of Policy Actions in Banking. *Rev. Financ.* **2016**, *12*, 2321–2347. [CrossRef]
59. Kwan, S.; Eisenbeis, R. Bank risk, capitalization and operating efficiency. *J. Financ. Serv. Res.* **1997**, *12*, 117–131. [CrossRef]
60. Altunbas, Y.; Carbo, S.; Gardener, E.P.M.; Molyneux, P. Examining the relationships between capital, risk and efficiency in European banking. *Eur. Financ. Manag.* **2007**, *13*, 49–70. [CrossRef]
61. Berg, S.; Førsund, F.; Jansen, E.S. Malmquist indices of productivity growth during the deregulation of Norwegian banking 1980–1989. *Scand. J. Econ.* **1992**, *94*, S211–S228. [CrossRef]
62. Hughes, J.P.; Mester, L. A quality and risk-adjusted cost function for banks: Evidence on the 'too-big to-fail' doctrine. *J. Product. Anal.* **1993**, *4*, 293–315. [CrossRef]
63. Hughes, J.P.; Lang, W.; Mester, L.; Moon, C. Efficient banking under interstate branching. *J. Money Credit Bank.* **1996**, *28*, 1045–1071. [CrossRef]
64. Asmild, M.; Zhu, M. *Bank Efficiency and Risk during the Financial Crisis: Evidence from Weight Restricted DEA Models*; MSAP Working Paper Series; University of Copenhagen: Copenhagen, Danmark, 2012.
65. Koutsomanoli-Filippaki, A.; Mamatzakis, E.; Staikouras, C. Structural reforms and banking efficiency in the new EU States. *J. Policy Model.* **2009**, *31*, 17–21. [CrossRef]
66. Fiordelisi, F.; Marques-Ibanez, D.; Molyneux, P. Efficiency and risk in European banking. *J. Bank. Financ.* **2011**, *35*, 1315–1326. [CrossRef]

67. Delis, M.D.; Iosifidi, M.; Tsionas, M.G. Endogenous bank risk and efficiency. *Eur. J. Oper. Res.* **2017**, *260*, 376–387. [CrossRef]
68. Rangan, N.; Zardhooki, A.; Kolari, J.; Fraser, D. Production Costs for Consolidated Multibank Holding Companies Compared to One-Bank Organisational Form. *J. Econ. Bus.* **1989**, *6*, 317–325. [CrossRef]
69. Conigliani, C.; De Bonis, R.; Motta, G.; Parigi, G. Economie di scala e di diversificazione nel settore bancario. In *Temi di Discussione*; Banca d'Italia: Roma, Italy, 1991; Volume 150.
70. Elyasiani, E.; Mehdian, S. A Non-Parametric Approach to Measurement of Efficiency and Technological Change: The Case of Large US Commercial Banks. *J. Financ. Serv. Res.* **1990**, *2*, 157–168. [CrossRef]
71. Vander Vennet, R. Cost and profit efficiency of financial conglomerates and universal banks in Europe. *J. Money Credit Bank.* **2002**, *34*, 231–245. [CrossRef]
72. Casu, B.; Girardone, C. A comparative study of the cost efficiency of Italian bank conglomerates. *Manag. Financ.* **2002**, *28*, 3–23. [CrossRef]
73. Casu, B.; Girardone, C. Financial conglomeration: Efficiency, productivity and strategic drive. *Appl. Financ. Econ.* **2004**, *14*, 687–696. [CrossRef]
74. Curi, C.; Lozano-Vivas, A.; Zelenyuk, V. Foreign bank diversification and efficiency prior to and during the financial crisis: Does one business model fit all? *J. Bank. Financ.* **2015**, *61*, S22–S35. [CrossRef]
75. Balk, M. On the relation between gross-output and value-added based productivity measures. The importance of the Domar factor. *Macroecon. Dyn.* **2009**, *13*, 24–267. [CrossRef]
76. Ferrier, G.D.; Lovell, C.A.K. Measuring Cost Efficiency in Banking. *J. Econom.* **1990**, *46*, 229–245. [CrossRef]
77. Sealey, C.W.; Lindley, J.T. Inputs, Outputs and Theory of Production and Costs at Depository Financial Institutions. *J. Financ.* **1977**, *32*, 1251–1266. [CrossRef]
78. Avkiran, N.K. Association of DEA super-efficiency estimates with financial ratios: Investigating the case for Chinese banks. *Omega* **2011**, *39*, 323–334. [CrossRef]
79. Aigner, D.J.; Lovell, C.A.K.; Schmidt, P. Formulation and Estimation of Stochastic Frontier Production Function Models. *J. Econom.* **1977**, *6*, 21–37. [CrossRef]
80. Forsund, F.; Lovell, C.A.K.; Schmidt, P. A Survey of Frontier Production Functions and of their Relationship to Efficiency Measurement. *J. Econom.* **1985**, *13*, 5–25. [CrossRef]
81. Battese, G.E.; Coelli, T.J. A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. *Empir. Econ.* **1995**, *20*, 325–332. [CrossRef]
82. Coelli, T.J.; Rao, D.S.P.; O'Donnell, C.J.; Battese, G.E. *An Introduction to Efficiency and Productivity Analysis*; Springer: Berlin/Heidelberg, Germany, 2005.
83. Berger, A.N.; Humphrey, D.B. Efficiency of financial institutions: International survey and directions for future research. *Eur. J. Oper. Res.* **1997**, *98*, 175–212. [CrossRef]
84. Meusen, W.; Van Der Broeck, J. Efficiency Estimating from Cobb-Douglas Production Function with composed error. *Int. Econ. Rev.* **1977**, *18*, 435–444. [CrossRef]
85. Fethi, M.D.; Pasiouras, F. Assessing bank efficiency and performance with operational research and artificial intelligence techniques: A survey. *Eur. J. Oper. Res.* **2010**, *204*, 189–198. [CrossRef]
86. Pacelli, V.; Pampurini, F. L'impatto della crisi sull'efficienza dei gruppi bancari: Prevalgono i vantaggi della diversificazione o gli oneri della complessità? *Bancaria* **2016**, *1*, 26–52.
87. Quaranta, A.G. Segmentazione delle filiali di una banca in classi di produttività. *Banche e Banchieri* **2017**, *2*, 187–208.
88. Fujii, H.; Managi, S.; Matousek, R.; Rughoo, A. Bank efficiency, productivity, and convergence in EU countries: A weighted Russell directional distance model. *Eur. J. Financ.* **2018**, *24*, 135–156. [CrossRef]
89. Associazione Bancaria Italiana (ABI). *Beyond Restructuring: The New Agenda*; European Banking: London, UK, 2017.
90. Resti, A. Bank internal ratings: Are capital floors a suitable tool to restore their credibility? *J. Financ. Manag. Mark. Inst.* **2016**, *4*, 179–194.