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Bank Efficiency and Financial Centres: Does Geographical Location Matter?

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Abstract

This paper examines the relationship between bank performance and geographical location with respect to the two major global financial centres, New York and London. It provides new insights on the spatial effects of the 2008-2009 Global Financial Crisis (GFC) on the technical efficiency of the top-1000, world-leading banks in terms of total assets. The results reveal that the distance of banks' headquarters to these financial centres matters. In particular, banks that are located at a bigger distance from New York and London present a lower technical efficiency than banks that are closer to these financial centres. In addition, the results show that the Global Financial Crisis has magnified the effect of distance and the need for banks to be closer to global financial centres during the 'core' of that period.

Keywords: Bank performance; Financial centres; Conditional efficiency; Robust estimators.

1. Introduction

London and New York have historically played an important role as global financial centres within the financial markets and have influenced the formation of the worldwide financial architecture. French et al. (2009) argue that these two financial centres have not been only a catalyst for changes in terms of financial globalization but also in generating the conditions that have led to the Global Financial Crisis (GFC) in 2007-2008 that have spillovered to other countries around the world. Engelen and Grote (2009) express a similar view, noting that the importance of these financial centres was particularly reinforced during the GFC.

The interconnectivity between New York and London and their impact on the global financial markets cannot be compared to any other cities like, for example, Tokyo (see for a comprehensive discussion Wójcik 2013). Cassis (2010) and Wójcik (2013) justify the unique position and importance of London and New York, as financial centres, due to historical complementarities and affinity in terms of the cultural geographies of finance[1] but also due to factors like global trade, financial imbalances with exporter's countries, financial deregulation, and the implementation of the newest technologies.

Despite the relevance of the New York-London axis in the context of the global financial markets, so far it is still unclear how and to what extent proximity to these two financial centres matters for international bank efficiency.

Various empirical studies specifically examine the different forms of bank efficiency, such as, cost, profit, technical and allocative efficiency across different regions and continents (recently, Assaf et al. 2013; Tzeremes 2014). However, these

[1] Media companies are mainly located in global financial centres and they played a significant role in generating hotspots of irrational exuberance in the housing market (Wójcik, 2013).

studies only analyse the bank efficiency in isolated countries or provide a comparative analysis without taking into account the geographical location of banks[2].

The lack of this latter type of research is due to the fact that economic and geographical literature (eg. Storper and Venables 2004; Boschma and Weterings 2005) unambiguously provides anecdotal evidence that the proximity to agglomeration and co-location can boost firm productivity, competition, development of specialized labour pool, knowledge spillover, diffusion of innovation. Following the new economic geography (NEG), this paper draws attention to the wider economic-geographic relations across space and time of the technical efficiency in the banking industry, and uncovers how and to what extent inefficiencies have been transmitted to the banking system worldwide from the New York-London axis. The imposed research question is further supported by empirical research that shows that geographical location remains important for business performance in general (recently, McCauley et al. 2012), and one cannot observe the 'end of geography' despite new technological advantage and new means of communication and information transfer.

Throughout the paper we will show that the current GFC is an optimal laboratory to explore how the geographical location, in particular the proximity (distance) from these two financial centres, affects performance of large international banks. Differently from previous studies on the contagion effect during the GFC (e.g. Eichengreen et al. 1996; Glick and Rose 1999; Ali and Lebreton 2007), the paper contributes to a nuanced understanding of the spatial processes that embedded banks into global markets though global financial centres. Specifically, drawing on the new economic geography approach and spatial selection model proposed by Baldwin and

[2] There are a few exceptions, such as Berger and DeYoung (2001), Berger and DeYoung (2006), Deng and Elyasiani (2008).

Okubo (2006), we ascertain that global financial markets attract a high number of banks that are however the most efficient. In particular, the spatial selection model and the new economic geography framework assists us to examine how and to what extent the bank distance from New York-London axis changes bank efficiency.

To our best knowledge, this is the first paper that attempts to examine the relationship between a bank's performance and geographical location with respect to global financial centres. Moreover, it provides new insights on the spatial effect of the GFC on bank technical efficiency. We use a sample of the top 1000 world leading banks measured in terms of total assets. These banks are more interconnected to each other in the global financial market and subsequently more subject to the effect of global financial centres and economic dynamics than their smaller counterparts. They, therefore, suit the scope of this paper better.

From a methodological viewpoint, we introduce a new non-parametric estimation technique to calculate the technical efficiency of banks.[3] Our model is based on the latest developments of the probabilistic approach of efficiency measurement (Bădin et al. 2012). The advantage of this method is that the probabilistic approach does not impose a separability assumption. Therefore the exogenous variables (i.e. the distance from headquarters[4]) directly influence the shape of the frontier (i.e., a separability condition is not assumed). As a result, the obtained efficiency estimates are determined by the inputs, outputs and the exogenous variable (for details see Simar and Wilson 2011).

We organize the rest of the paper as follows: Section 2 reviews the literature; Section 3 discusses the data sample and the variables used in our empirical analysis;

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[3]For recent applications of the latest advances of nonparametric frontier analysis on the banking sector see the studies by Fukuyama and Matousek, (2011), Tsionas et al. (2015), Tzeremes (2015), Matousek and Tzeremes (2016), Salim et al. (2016) and Wanke et al. (2016).

[4]We calculated the distance of the headquarters to New York and London by using longitude and latitude coordinates.

Section 4 describes the model and method of estimation. Section 5 the empirical results, and Section 6 summarizes our findings and sets out our conclusions.

2. Literature Review

Despite the growth of powerful global financial centres during the financialisation era (Stockhammer 2008), research studies have neglected to investigate the interconnectedness between finance and economic geography.

Whilst several papers have focused on geography and efficiency, as well as the performance of banks (e.g. Berger and De Young 1997; Deng and Elyasiani 2008; Mc Cauley et al. 2012), and geographical distance and the activities of financial intermediaries (e.g. Degryse and Ongena 2005; Carey and Nini 2007), so far no one has explored the effect of the distance of a bank's headquartes from global financial centres on bank efficiency. To come to a better understanding of the effects of financial centres on the efficiency of banks in a global economic system, we make use of the NEG approach which focuses on the development of economic agglomeration, but which has so far has not been systematically applied in the context of global financial centres (Grote, 2008). Engelen and Grote (2009) maintain that NEG considers financial centres to be the net sum of centripetal and centrifugal forces where rational agents pursue 'satisficing' strategies (Simon 1982). Specifically, they explain that these centripetal forces are the "effects of dedicated infrastructure, firms using each other's output as input, specialised labour markets, and knowledge spillovers"; while centrifugal forces are "conceptualised as increasing transportation costs, increasing rents and negative technological effects" (Engelen and Grote 2009, p. 689). The NEG models predict the process of accumulation of firms in specific locations. As argued by Krugman (1998), NEG focuses on the linkages that foster geographical concentration, and these "linkages, which are mediated by transportation costs, are naturally tied to distance" (p.9). In the banking sector geographic proximity to clients represents an important competitive advantage, especially when transaction costs, such as transportation and information costs exist and are non-negligible (e.g. Dell'Ariccia 2001). Physical proximity to other firms is needed to collect information about local economic conditions and customers in the financial markets (Thrift 1994). However, recent technological innovations and communication technologies have facilitated the transmission of information across large distances (Cerqueiro et al. 2009), and may have altered the effects of financial centres in terms of both the concentration of activities and increasing mobility (O'Brien 1992).

Relaxing the assumption of homogeneity of firm-level productivity, Baldwin and Okubo (2006) demonstrate that big markets attract a high number of firms overall, but they also attract the most efficient firms. In line with the spatial selection model proposed by Baldwin and Okubo (2006), we maintain that the most efficient banks are located close to the global financial centres. Therefore, we expect that as the distance from the headquarters of commercial banks to the New York-London axis, as well as the transaction costs, increases, the level of efficiency of those banks declines. The agglomeration forces lead to a concentration of firms in a location in a context of increasing returns, economies of scales and imperfect competition, which can enhance the efficiency of banks (Krugman 1991).

Finally, we also investigate how and to what extent the effect of the 2008-2009 Global Financial Crisis has spread out to banks through the enhancement of their cost inefficiencies. As argued by Wainwright (2012), more studies on the space and scale of the Global Financial Crisis have begun to emerge that underline the spatial dynamics of the crisis in different specific economic, social and political geographical settings. However, the existing literature on finance and space is still scarce, even though it can enhance our comprehension of the origin and aftermath of the crisis (see for example Martin 2010; Wainwright 2012). As concerns our analysis, we expect an intensification of the negative effect of distance from the headquarters of commercial banks to the new York-London axis during and after the 2008-2009 Global Financial Crisis, mainly driven by an increase in transaction costs. After October 2008, the confidence of investors in the banking system has dropped since banks were perceived as opaque entities and even the interbank lending market ‘‘froze’’ because of the increasing uncertainty about counterparty solvency (e.g. Pritsker 2010; Flannery et al. 2013).

3. Data and Variables

We collected our sample of the top-1000 commercial banks around the world using unconsolidated balance sheets from the Bureau van Dijk's Bankscope database. The sample is balanced and includes the top multinational banks which have their headquarters in 80 countries. The data Longitude and latitude coordinates were used to calculate the google map distance between bank headquarters and the financial centres of New York and London. The analysed period spans from 2004 to 2010.

In the banking literature, there has been an extensive discussion of how to model bank production processes. Berger and Humphrey (1992) highlight that there are several approaches that can be used to model the bank production process: the production approach; the user-cost approach; the value added approach; and the dual approach. The standard methods applied in banking are the intermediation and production approaches. Under the intermediation approach, banks use purchased funds together with physical inputs to produce various assets (measured by their value). The production approach assumes that banks use only physical inputs, such as labour and capital, to produce deposits and various assets (measured by the number of deposit and loan accounts at a bank, or by the number of transactions for each product). We adopt the intermediation approach to model bank production and consider banks to be intermediaries of financial services that purchase inputs in order to generate earning assets (Sealey and Lindley 1977). Berger and Humphrey (1997) suggest that the intermediation approach is best suited for evaluating bank efficiency, whereas the production approach is appropriate for evaluating the efficiency of bank branches.

Furthermore, we apply a nonparametric robust frontier analysis in order to measure banks' efficiency levels which does not put any restrictions on the functional form of the relationships between inputs and outputs used. According to Holod and Lewis (2011, p.2802) nonparametric approaches are very appealing for estimating the efficiency of financial institutions that do not have a well-defined production function. In our modelling setting we use three inputs and three outputs for the time period 2004-2010 for data derived from the BankScope database. Table 1 provides the descriptive statistics of the variables used. We use number of employees, total customer deposits[5] and fixed assets (in thousands US dollars) as inputs and gross loans and total securities as outputs (in thousands US dollars). As an external variable (z) we use the summation of the distance in kilometres between the city in which the

[5]According to Holod and Lewis (2011) the treatment of deposits as input or as output in the bank production process has raised a considerable debate amongst scholars. Several studies (Berger et al. 1987; Hunter & Timme 1995; Berger and DeYoung 1997; Devaney and Weber 2002) treat deposits as an output in bank production process since banks provide customers value-added outputs in the form of clearing, record-keeping, and security services, and hence they accept deposits.

bank has its headquarters and the two main financial centres of New York and London.[6]

According to Daraio and Simar (2007, pp. 78) the application of full nonparametric models (DEA-Data Envelopment Analysis and FDH-Free Disposal Hull) can suffer from different problems, such as extreme values/outliers (which provide them with the property of a deterministic nature) and the curse of dimensionality. Therefore, in order to avoid those problems, we apply partial nonparametric frontiers (*order-m*) introduced by Cazals et al. (2002), which will enable us to avoid the main problems when using full nonparametric frontiers and thus to obtain robust results.

Table 1 about here

4. Methodology

To calculate technical efficiency we employed the probabilistic approach of efficiency measurement introduced by Daraio and Simar (2005, 2007) and the latest developments by Bădin et al. (2012). Then we compare the unconditional and conditional efficiency scores by applying the nonparametric test for equality of distributions (Li et al., 2009). According to Black and Smith (2004) and Frölich (2008) the main advantage of the nonparametric method is the fact that it overcomes problems associated with endogenous control variables and omitted variables, and it is consistent when instrumental variables are excluded from the model. In fact, a nonparametric model compares only observations having the same/similar values for the control variable, whereas the parametric regression combines all observations in a

[6] For instance the headquarters of National Bank of Abu Dhabi is 11025 kilometres from New York and 5476 kilometres from London. Therefore our distance factor (z) is equal to 16501 kilometres (i.e. $z_{\text{National Bank of Abu Dhabi}} = 11025_{\text{distance to New York}} + 5476_{\text{distance to London}}$).

unified regression framework. Therefore, the adopted nonparametric framework provides us with the advantage to focus only on the direct effect of distance on bank efficiency excluding any additional variables.

Following Daraio and Simar (2005), a bank's production technology can be characterized by a set of inputs $x \in R_+^p$ which can produce a set of outputs $y \in R_+^q$. Formally banks' production processes can be defined as:

$$\Psi = \left\{ (x, y) \in R_+^{p+q} \middle| x \text{ can produce y} \right\}. \tag{1}$$

Then the Farrell measure of input-oriented efficiency score can be defined as:

$$\theta(x, y) = \inf \left\{ \theta \middle| (\theta x, y) \in \Psi \right\}. \tag{2}$$

Next the production process can be described by the joint probability measure of *(X,Y)* on $R_+^p x R_+^q$. Then, the knowledge of the probability function $H_{XY}(.,.)$ can be defined as:

$$H_{XY}(x, y) = \text{Prob}(X \le x, Y \ge y) \tag{3}$$

For the input oriented case the efficiency scores $\theta(x, y)$ for $(x, y) \in \Psi$ can be defined as:

$$\theta(x, y) = \inf \left\{ \theta \middle| F_{X|Y}(\theta x | y) > 0 \right\} = \inf \left\{ \theta \middle| H_{X|Y}(\theta x, y) > 0 \right\}. \tag{4}$$

Following Cazals et al. (2002) for an input orientation the order-m frontier can be introduced as follows. Having a fixed integer $m > 1$ for a given level of output y we obtain the random production set of the *order-m* units producing more than y as:

$$\Psi_m(y) = \left\{ (x, y') \in R_+^{p+q} \middle| x \ge X_{i,} y' \ge y, i = 1,\dots,m \right\} \tag{5}$$

In addition for any x we can define $\tilde{\theta}_m(x, y) = \inf \left\{ \theta \middle| (\theta x, y) \in \Psi_m(y) \right\}$, (6) and banks' *order-m* efficiency scores can be defined as:

$$\hat{\theta}_{m,n}(x,y) = \hat{E}\left(\tilde{\theta}_m(x,y) \middle| Y \geq y\right). \quad (7)$$

Daraio and Simar (2007) show that the *order-m* efficiency score is the expectation of the input efficiency score of a bank (x,y) when compared to m (in our case 10)[7] banks randomly drawn from the population of banks producing more outputs than the level y. The efficiency scores computed under the *order-m* formulation can take values greater than one. When the estimator has a value greater than one it indicates that the bank operating at the level (x,y) is more efficient than the average of *m* peers. In an input oriented case where a bank has an efficiency score of 0.7, it means that the bank uses 30% more inputs than the expected value of the minimum input level of *m* other banks drawn from the population of banks producing a level of output $\geq y$. Finally, when $m \to \infty$ then $\hat{\theta}_{m,n}(x,y) \to \hat{\theta}_{FDH}(x,y)$.

Following Daraio and Simar (2005), we assume that different variables (exogenous to the production process) $Z \in \Re^r$ can be used to explain the efficiency variations of the production process. In contrast to the traditional two-stage approaches, the probabilistic approach does not impose a separability assumption between Z values and the input-output space (Simar and Wilson, 2011). As described previously, the exogenous variable used in this study is the sum of the kilometric distance between the banks' head office and the two financial centres (i.e New York and London). The idea is to condition the banks' production process to a given value of kilometre distance $Z = z$. The joint distribution (X,Y) conditional on $Z = z$ defines the production process if $Z = z$ as:

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[7]For larger values of *m* the results converge very quickly to the free disposal assumption-FDH efficiency scores (Deprins et al. 1984).

$$H_{XY|Z}(x, y|z) = \text{Prob}(X \leq x, Y \geq y|Z = z). \quad (8)$$

Then bank's input-oriented technical efficiency scores under the effect of the external factor can be obtained as:

$$\theta(x, y|z) = \inf\left\{\theta \middle| F_{X|Y,Z}(\theta x|y, z) > 0\right\}. \quad (9)$$

Thus the conditional *order-m* nonparametric estimator[8] can be obtained as:

$$\hat{\theta}_m(x, y|z) = \hat{E}_{X|Y,Z}(\hat{\theta}_m^z(x, y)|y, z). \quad (10)$$

By following, Bădin et al. (2012) the global influence of Z (i.e. the distance from the two financial centres) on banks' production process can be obtained by comparing the conditional *order-m* frontier (equation 10) to their unconditional equivalents (equation 7). In a univariate case of Z a scatter-plot of the ratios Q_z[9] against Z and its smoothed nonparametric regression line would indicate the global effect of Z on the production process. If the smoothed nonparametric regression increases it indicates that Z is unfavourable to banks' performance levels. When the regression decreases then is favourable[10].

5. Empirical Results

In Table 2, we provide the descriptive statistics of the original efficiency scores and the conditional efficiency scores to distance from the two financial centres. We observe that the mean values of bank efficiency, without including the distance

[8]For the calculation of the conditional efficiency estimates some smoothing and estimation of the appropriate bandwidths is required. This can be obtained by following the least-squares cross-validation criterion-LSCV (Hall et al. 2004; Li and Racine,2004) based procedure introduced by Bădin et al. (2010). For the linear programs required to calculate the conditional estimates, see Daraio and Simar (2005, 2007).

[9] This can be defined as: $Q_z = \hat{\theta}_{m,n}(x, y|z) / \hat{\theta}_{m,n}(x, y)$.

[10]In order to have a visualisation of the effect we apply the nonparametric regression estimator introduced by Nadaraya (1964) and Watson (1964) and we use the LSCV criterion for bandwidth selection.

factor, are relatively stable over the analysed period. We report the efficiency levels through the period are on average terms between 0.63 – 0.65. That means that on average terms, the efficiency levels of the largest multinational banks remain relatively unchanged over 2004 to 2010. That corresponds with the estimated standard deviation values. Standard deviations range from 0.29 to 0.31. However, if the distance is added into the model the results as has been expected change. These results indicate that the distance is an important variable in measuring bank efficiency.

Table 2 about here

This is further supported by our results that we present in Figure 1. We split the banks into two groups; those with the efficiency scores higher or equal to one, and those with efficiency scores higher than the mean efficiency score. The higher the score the more efficient banks are over the examined period for conditional and unconditional measures. Figure 1a lists the bank efficiency scores when we are not taking into account the effect of distance from the two financial centres (sub figure 1a). It can be viewed that we have (on average terms) 72 banks that appear to be efficient over the examined period. Focusing more on the original estimates (subfigure 1a) we realise that after the Global Financial Crisis of 2008 the number of efficient banks started to increase from 65 (in 2007) to 99 (in 2010). Subfigure 1a indicates the number of banks with efficiency values above average (this number includes also the banks with efficiency scores≥ 1). In contrast with our previous finding the number of banks having an efficiency score above samples' average value tends to decrease over the years (from 380 for 2004, to 355 for 2010).

Furthermore, subfigure 1b indicates banks' efficiency levels when taking into account the effect of the distance from banks' headquarters and the two financial centres. When the Global Financial Crisis started in 2007, our findings suggest that 346 banks had efficiency scores above the samples average efficiency score (0.6979). This number decreased in 2008, 2009 and 2010. This indicates that the distance between banks' headquarters and the two financial centres affected banks' overall efficiency levels over the period of the crisis. In contrast, subfigure 1b indicates that after the initiation of Global Financial Crisis the number of banks with efficiency scores ≥ 1 has increased from 118 (in 2007) to 214 (in 2010) indicating a possible divergence of banks' performance having an efficiency value above average, which is attributed to the distance effect.

Figure 1 about here

Next, we test whether distance has a significant influence on banks' efficiency levels. In doing so, we apply the nonparametric test for equality of distributions (Li et al., 2009) between the obtained efficiency scores. In Table 3, we show the results obtained from the applied equality test. The first column lists the results for equality between the unconditional (2004) and conditional (2004c) banks' efficiency scores for the year 2004. Our test statistic is -46.4015 with a p-value <0.001. Based on this result, we have to reject the null hypothesis of equality of distribution and we accept that they are not equal. Therefore, in this particular case, the results indicate that distance has an effect on banks' efficiency levels since the distributions of efficiency measures (both conditional and unconditional) for that year are not the same.

Our findings suggest that we have to reject the null hypothesis of equality of the distributions of the obtained efficiencies (between the unconditional and conditional efficiency scores) for all the years of our analysis, indicating clearly that the distance between bank headquarters and the two financial centres influences banks' performance. Furthermore, we test the equality of distributions among the conditional efficiency scores over the years. We may accept the null hypothesis in several cases. This finding suggest equality of the distributions of banks' conditional efficiency scores between different years.

Table 3 about here

Next, we provide evidence that distance from the two financial centres influences banks' efficiency over the years and in what way this influence is attributed to banks' performance. We use the methodology of the visualisation effect on the influence of distance based on several authors (Daraio and Simar 2005, 2007; Bădin et al. 2012). Figure 2 illustrates several smoothed nonparametric regression lines of the effect of distance on the ratio of conditional to unconditional efficiency scores for every year. As we explained before, if the smoothed nonparametric regression line is increasing it indicates that the distance from the banks' headquarters to the two financial centres is detrimental to banks' efficiency levels acting as an 'extra' undesirable output. By contrast, if the regression line is decreasing then it specifies that distance is conductive to banks' efficiency levels playing the role of 'substitutive' input in banks' production process, giving the opportunity to save the inputs in the activity of banks' production (Daraio and Simar, 2007, pp. 114-115). Figure 2 presents the nonparametric regression line alongside the variability bounds of point-wise error bars using asymptotic standard error formulas (Hayfield and Racine 2008). Subfigures 2a, 2b, 2c and 2d present the effect of distance on banks' efficiency levels for the periods, 2010 (subfigure 2a), 2007 (subfigure 2b), 2004 (subfigure 2c) and the average effect of the overall period (subfigure 2d).[11] The effect of distance on banks' efficiency is highly nonlinear for relative lower distances. It appears that for relative small distances the effect forms a 'W' shape relationship

[11]We have chosen to omit the graphs for the years 2005,2006,2008 and 2009 since the shape of the overall effect does not change. However, the rest of the Figures are available upon request.

indicating an interaction of positive-negative-positive negative effect. This is evident for all the years in our analysis. This result suggests a spatial increase of technical efficiency followed by decline as transaction and transportation costs diminish over time. Furthermore, we have empirical support for the finding that for larger distances the effect is negative on banks where performances are indicated by an increasing regression line. Finally, the subfigure 2d illustrates the effect of distance on banks' performance on average terms. The relation is highly nonlinear but with an increasing trend indicating that the greater the distance from banks' headquarters to the two financial centres, the lower will be banks' performance to distance's negative effect (among other factors).

Figure 2 about here

Our analysis continues in the same way, however, we examine the effect of distance on banks' performance by looking at the effect on banks with a distance to the two financial centres that is lower than the average value (i.e for distances between 5571 to 10540 km) and for banks with distances above the average distance value (i.e. from 10,541 to 33,608 km). This allows us to magnify the effect of distance on banks' performance by breaking up our analysis into two subsamples.

Figure 3 illustrates the effect of distance on banks' performance for distances from the two financial centres from 5,571 to 10,540 km. The effect is highly nonlinear but with a decreasing trend, indicating a positive effect on bank performance. Since our distance measure is the sum of the distance in kilometers from banks' headquarters to the two financial centres it appears that being close to a financial centre (given the fact that the minimum distance value is 5,571– the distance between London and New York) has a positive effect. It appears that 10,000 km is the turning point from which the regression line starts to increase and the effect becomes negative.

Figure 3 about here

When we look at the effect of distance on banks' performance for banks that are furthest from the two financial centres, i.e. for distances from 10,541 km to 33,608 km, we see that the results are different. From Figure 4 we see the effect slightly increases for distances up to 25,000. Beyond that, it increases considerably, indicating a highly negative effect on banks' performance when their headquarters are located far from the two financial centres. Finally, it appears that in all cases the effect becomes highly nonlinear, indicating that distance had an uneven effect on banks that were the same distance from the two financial centres.

Figure 4 about here

6. Conclusions

Our findings show that the location of banks with respect to global financial centres matters for banks' technical efficiency. Applying a fully nonparametric framework we provide evidence that the distance between a bank and the two main world financial centres (i.e New York and London), appears to be a pivotal factor for bank efficiency. In addition, we find that the number of banks with efficiency scores higher than the sample average has decreased over the period of 2004 to 2010, especially during the years after 2008. Finally, we show that the effect of distance on banks' efficiency is highly nonlinear for relative lower distances forming a 'W' shape relationship, while for larger distances the effect is clearly negative.

Using the methodology of the visualisation effect of the influence of distance (Daraio and Simar 2005, 2007; Bădin et al. 2012), we find that the distance from a banks' headquarters to the two financial centres is detrimental to banks' efficiency levels, acting as an 'extra' undesirable output on estimated banks' production function. Finally, our findings show that the 2008-2009 Global Financial Crisis has spread out to banks through the growth of their inefficiencies. The themes emerging from our research are simple, but very powerful: location matters for a bank's performance, and the Global Financial Crisis has widened the inefficiencies of banks more distant from the global financial centres. This paper therefore contributes to the debate on the role of global financial centres, highlighting that the increase of power of global financial centres could potentially amplify the instability of the banking system worldwide through negative technology spillover and increase of economies of scale and size. In accordance with the Efficient Hypothesis, more efficient banks are in fact able to increase their profits and market share because of their low costs (Demsetz 1974). Therefore the proximity to financial centres can also potentially lead to the creation of too many too-big to fail banks.

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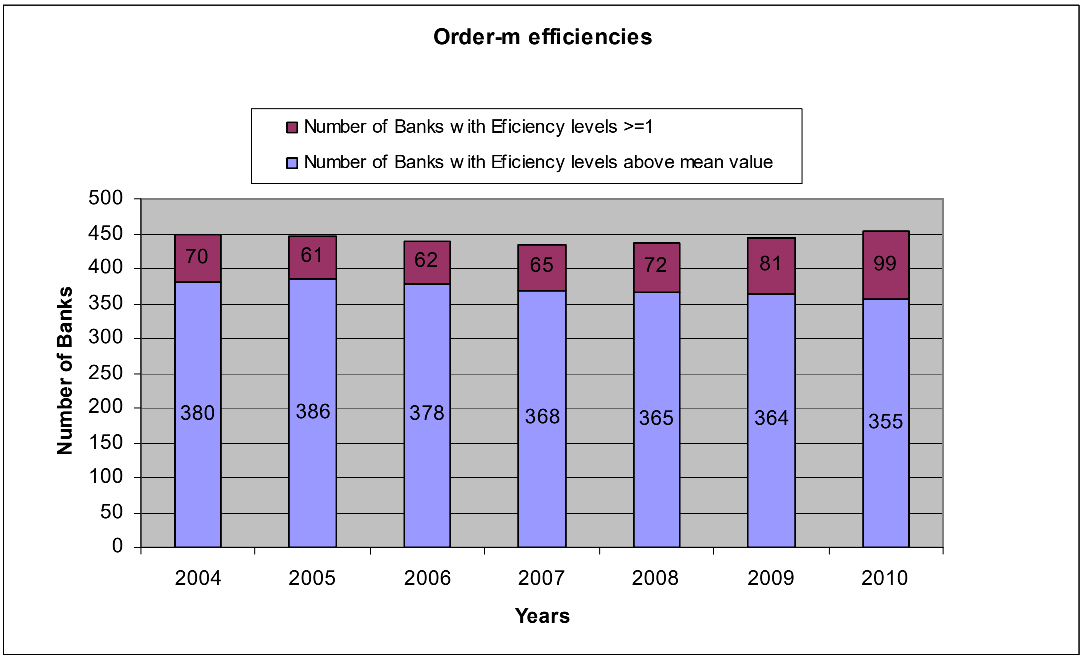
Figure 1: Graphical representations of banks' efficiency levels

1a



1b

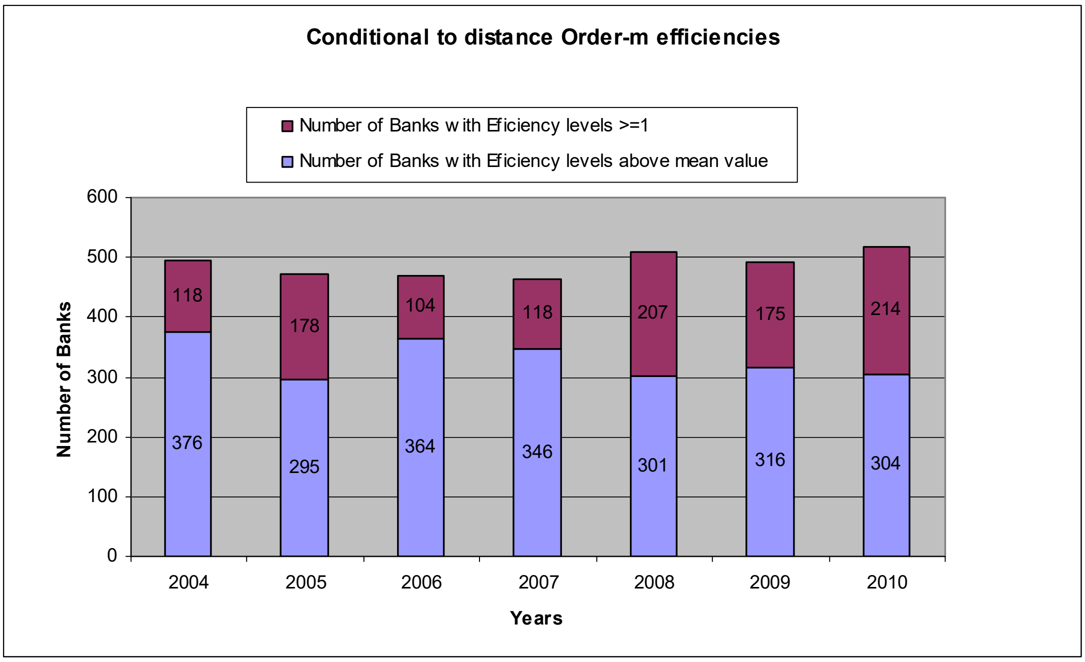
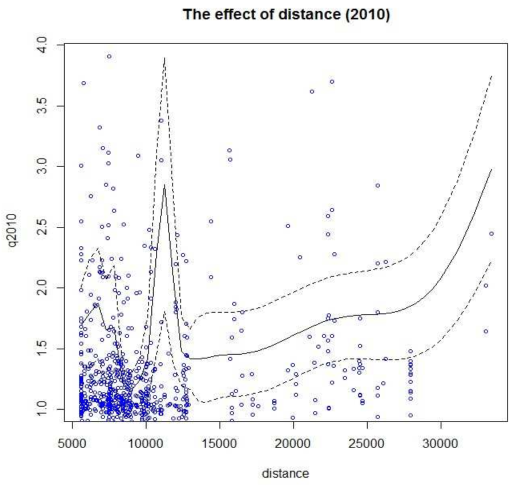
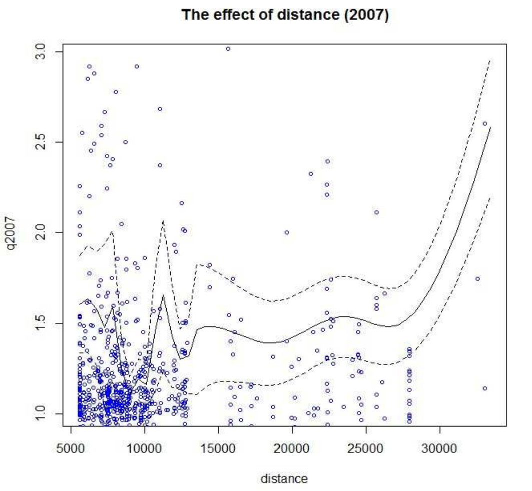


Figure 2: The effect of distance (from 5571 to 33608 km) from the two financial centres on banks' performance

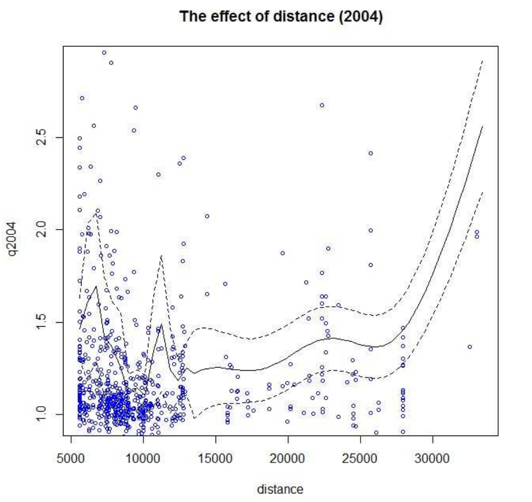
2a



2b



2c



2d

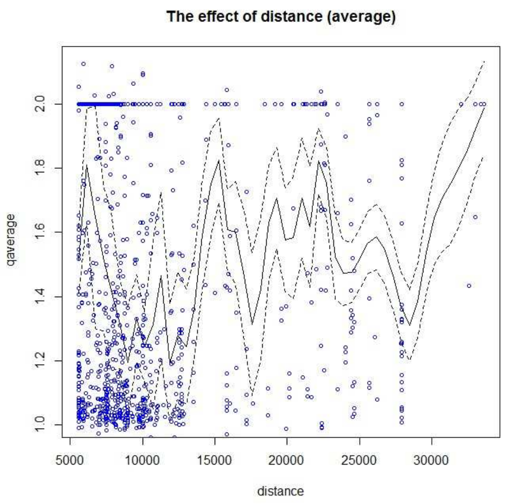


Figure 3: The effect of distance (from 5571 to 10540 km) from the two financial centres on banks' performance

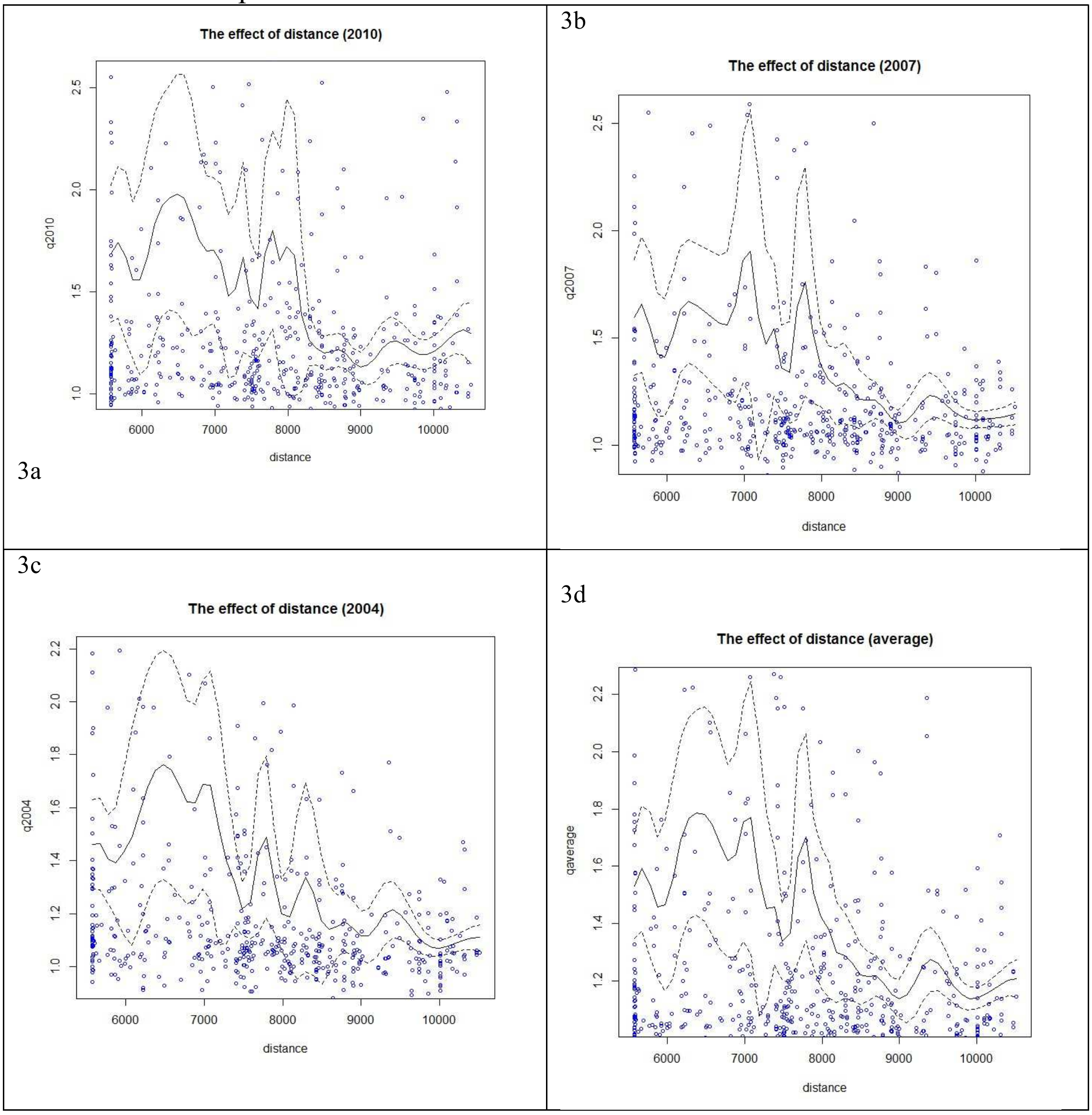


Figure 4: The effect of distance (from 10541 to 33608 km) from the two financial centres on banks' performance

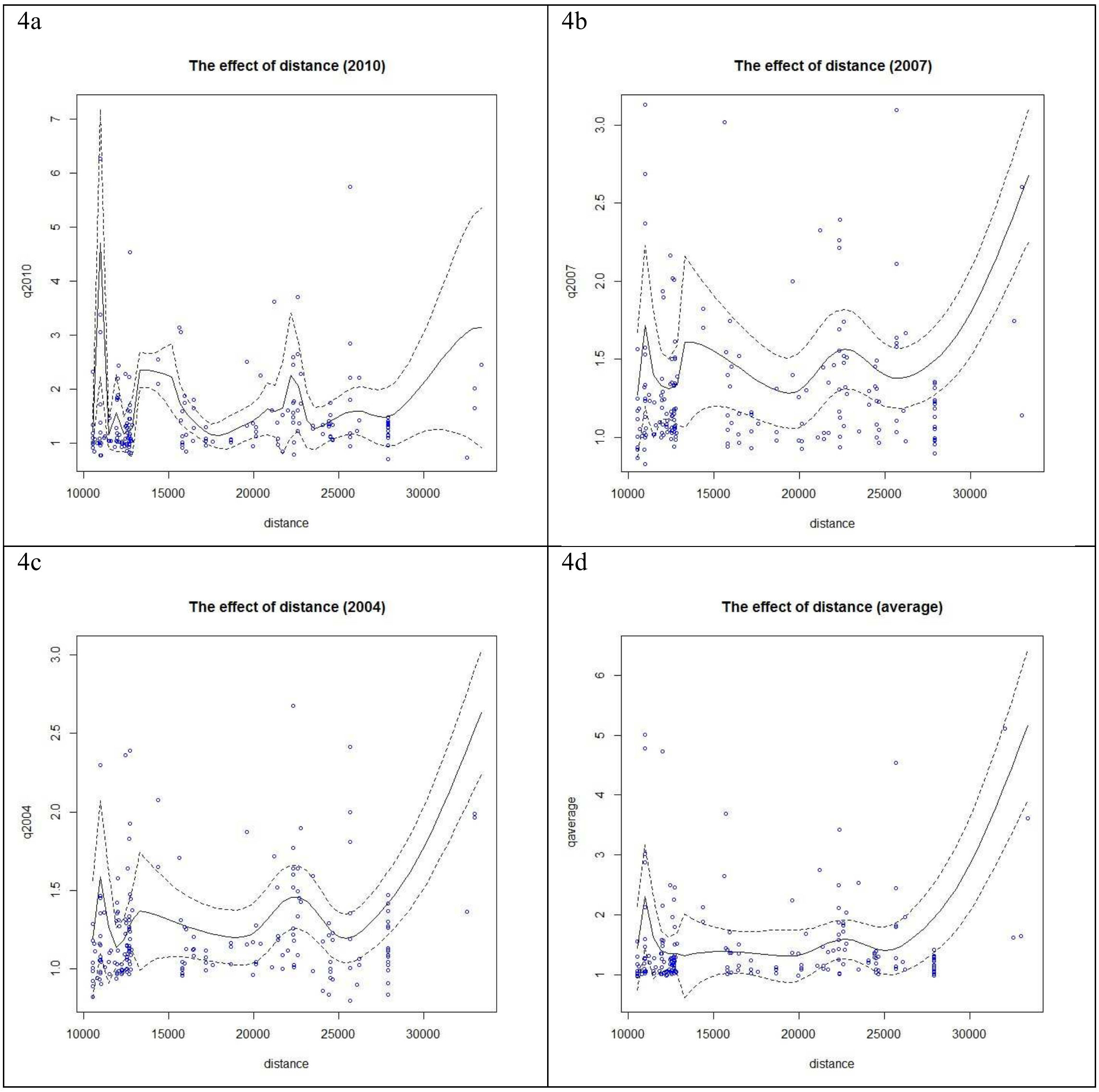


Table 1: Descriptive statistics of the variables used

	INPUTS			OUTPUTS		External variable
	Number of Employees	*Fixed Assets*	*Total Customer Deposits*	*Gross Loans*	*Total Securities*	*Physical Distance (Km)*
			Year 2010			
Std	29233.485	1856636.813	127973919.4	112706506.2	111677075.9	6223.997
Mean	7578.043	466615.802	33477178.95	33217063.12	21723631.43	10540.37
			Year 2009			
Std	28064.156	1862321.129	113508685.5	103926125.3	105196938	
Mean	7375.343	450473.704	30595337.46	31029157.87	20370005.4	
			Year 2008			
Std	27839.935	1655172.127	100654362.5	95732721.71	142871126.7	
Mean	7306.043	408976.963	27408197.46	29021273.33	23394613.72	
			Year 2007			
Std	27190.329	1527275.619	96002366.81	95974172.89	116379944.8	
Mean	7039.204	396474.544	26561473.22	28065688.95	20240870.09	
			Year 2006			
Std	26411.946	1419823.092	81381608.16	77738921.03	88224886.22	
Mean	6714.655	354447.503	22063330.1	22709673.43	15662524.88	
			Year 2005			
Std	26509.204	1260648.092	68134589.57	62912067.16	82058223.37	
Mean	6446.789	320725.872	18642898.62	18639783.03	13616554.78	
			Year 2004			
Std	26627.474	1286278.315	62809269.67	59707226.77	89306912.44	
Mean	6291.153	323555.828	17479987.73	17607719.49	14053127.15	

Table 2: Descriptive statistics of the original and conditional order-m estimators

	2004	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
Original order-m efficiencies							
Mean	0.6496	0.6306	0.6378	0.6316	0.6502	0.6441	0.6578
Std	0.2994	0.2892	0.2914	0.2890	0.2932	0.2990	0.3143
Conditional order-m efficiencies							
Mean	0.7070	0.7863	0.6879	0.6979	0.8124	0.7652	0.8106
Std	0.3185	0.3854	0.3089	0.3160	0.3933	0.3686	0.4001

Table 3: Consistent density equality test for conditional order-m efficiency scores

	Tn value		*2005c*	*2006c*	*2007c*	*2008c*	*2009c*	*2010c*
2004 vs 2004c	-46.4015***	*2004c*	-196.74***	-130.586*	-129.937*	-155.1115***	-143.6456**	-0.1395814***
2005 vs 2005c	-57.7482***	*2005c*		174.8166	174.8273	88.9147	128.4527	320.0294
2006 vs 2006c	-69.5176***	*2006c*			-0.81079	-61.76061*	-33.3785	159.783
2007 vs 2007c	-67.304***	*2007c*				-61.29818**	-32.8031	160.2863
2008 vs 2008c	-47.5852***	*2008c*					35.23381	237.3271
2009 vs 2009c	-54.9931***	*2009c*						199.098
2010 vs 2010c	-16.1412***							

*** p-value < 0.001., ** p-value < 0.05; * p-value < 0.1