LISBON
SCHOOL OF
ECONOMICS &
MANAGEMENT
UNIVERSIDADE DE LISBOA

MASTER IN
FINANCE

MASTER'S FINAL WORK
DISSERTATION

THE COST-EFFICIENCY OF JAPANESE BANKS: COMPARATIVE ANALYSIS WITH THE BANKS OF SOME EUROPEAN COUNTRIES

ALEXANDRA GUTU

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The cost-efficiency of Japanese banks:

Comparative analysis with banks of some European countries

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(October 2016)

Abstract

In previous years, Japan was seen as the second richest large economy in the world. Japan, the United States and the Euro area were considered as a triad in the financial world. However, its economic growth ended abruptly.

This paper addresses the issues with the evolution of Japanese banks efficiency, compared to Germany and Switzerland. The analysis is developed by a panel of five of the biggest banks in Japan, Germany and Switzerland, for the time period between 2000 and 2014. In order to investigate the cost-efficiency evolution of banks, this paper will employ the Data Envelopment Analysis (DEA) method. In addition to the efficiency analysis, a study on financial performance ratios will be performed.

The main findings point to the fact that the efficiency evolution of Japanese banks is mostly unstable. Furthermore, the realized analysis alludes that the Japanese banking sector is more efficient than Germany's, but less efficient than Switzerland's.

Keywords: Cost-efficiency; Banking systems; Data Envelopment Analysis, Financial ratios

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Acronyms

CE – Cost-efficiency

CRS - Constant Return to Scale

DEA – Data Envelopment Analysis

DFA - Distribution-free approach

DMU - Decision-making units

FDH - Free Disposal Hull

FSA - Financial Services Agency

PFR - Program for Financial Revival

p.p. – percentage point

ROAA - Return on Average Assets

ROAE - Return on Average Equity

SFA - Stochastic Frontier Analysis

U.K. – United Kingdom

U.S. – United States

1. Introduction

For most of the 1990s, Japan was considered as the second richest large economy in the world. However, its economic growth ended abruptly mostly due to a speculative asset price bubble of massive scale. This was generated by the excessive loan growth quotas dictated on the banks by the Bank of Japan through a policy mechanism.

In fact, Japanese banks lent without taking into consideration the quality of the borrowers, and this helped the bubble economy to take big proportions. After the asset bubble collapsed, Japanese banks faced a serious problem. The recession and corporate bankruptcies increased bad debt, and the decline of land and stock prices additionally affected the banks' balance sheets.

Therefore, the loss of confidence began with the shock to the national psyche following the 1995 Kobe earthquake and the Tokyo subway sarin gas attack, intensified during the 1997–1998 financial crises, and became absolutely entrenched after the 2011 earthquake and the ensuing Fukushima nuclear accident. These events not only affected the Japanese economic growth but surely also the performance of Japanese banks.

Through the banking system analysis, interesting results can be obtained, by which past and actual situation can be examined, as well as even forecast events. Moreover, there is a strand of literature that theoretically and empirically analyses the Japanese problems (the so-called Lost 20 Years). The purpose of this work is to examine the situation of the Japanese banking sector. The questions that are raised are: What is the evolution of efficiency in the Japanese banking sector over the last few years? Are there any improvements in terms of efficiency within Japanese banks after the Lost Decade (1990-2000)? How is the situation of the Japanese banking sector, in comparison with banking sectors of some European countries?

The present study will measure the cost-efficiency of Japanese banks and will compare it to the banks from two European countries. The methodology used is the efficiency frontier. Here, the cost efficiency approach over the period 2000-2014 will be applied, for a sample formed by the main Japanese and the commercial banks of the chosen European countries. We intend to calculate the cost efficiency of commercial banks from Japan and two countries selected in accordance with the Global Rankings 2014 (developed on bank's performance index) which are: Germany, inside of Euro Area, and Switzerland. Moreover, through total assets concentration analysis, the first five banks from each of these countries will be selected. The cost-efficiency of banks will be determined through the Data Envelopment Analysis (DEA) approach. This work assisted by the methodology described in Jimborean and Brack (2010).

Firstly, as in Jimborean and Brack (2010) work, we determine the banks cost-efficiency for each of the selected Japanese banks and for each year by using DEA approach. Subsequently, we will be able to examine the evolution of the efficiency of the major Japanese banks.

Secondly, we will investigate the banks' cost-efficiency for each selected country and for each year using the DEA technique. Also, will be conducted an international comparison between Japanese banks, Swiss banks and German banks.

Thirdly, to complement the analysis of efficiency, we will develop a study on financial performance ratios. The estimation of financial ratios will be performed by using the data provided by BankScope.

The main findings point to the fact that the efficiency evolution of the Japanese banks is mostly unstable. Furthermore, the conducted analysis alludes that the Japanese banking sector is more efficient than Germany's but less efficient than Switzerland's.

This paper is a contribution to the study of the Japanese banks as it entails an international comparison analysis, focused on a cost efficiency analysis, instead of technical efficiency and score efficiency covered in other studies, and covers a significant period of time.

The setup of this paper is as follows. Section 2 contains information about Japanese economy evolution. Section 3 provides a brief literature overview on bank efficiency analysis. Section 4 describes the methodological framework and the data used. Section 5 presents the main results and Section 6 summarizes and concludes.

2. Evolution of Japanese economy

The economic performance in Japan was considered as the world's second largest economy and world's largest creditor country. However, it in the last years was in a continuous decline. The start of the lost decades[2] coincided almost with the death of Emperor Hirohito in 1989.

In the early 1980s, the Japanese stock price index started to rise continually. Then, from 1990 it began a long period of decline with medium-term fluctuations. Therefore, in December of 1990, the value of shares on the Tokyo Stock Exchange plunged, marking the beginning bubble of economies collapse. However, in some studies, it is stated that these asset bubbles were caused by bank deregulation, and in others is viewed as a monetary cause.

In 1995, the Japan was hit by the Kobe earthquake and the Tokyo subway sarin gas terrorist attack. Both events exposed that there is a lack of crisis management capabilities on the part of Japanese authorities. The next major moment came around

[2] Lost decades are the so-called lost 20 years which refers to the period from 1990 to 2010.

1998 when the financial crisis became more severe, and the deflation became structural. In response to the 1997-1998 banking crisis, the Bank of Japan provided ample liquidity and adopted the "zero interest rate policy" which means that the short-term interbank rate will be lowered effectively to zero except for a very small technical margin. Later on, the Bank of Japan tried to close this policy but because of the economy going worse, the policy continued to be applied.

In 2001, the Financial Services Agency (FSA) introduced a special inspection of bank loans. The inspection was limited to loans to large borrowers and to cases where the exposure of bank was high. According to the Fujii and Kawai (2010), this process resulted in the large reclassification of loans to 149 companies. A quarter of the examined loans were reclassified to bad loans. The inspection of the bank loan quality lead to the implementation of an enhanced and extensive policy package in 2002: the so-called Program for Financial Revival (PFR). With the mix of the policy measures the loan classification and loan loss provisioning were strengthened which lead to the Japanese economy improvement.

A noteworthy fact happened in 2007 when the U.S. financial crisis extended becoming a global financial crisis. As employed by Kawai and Takagi (2009), Japan was hit hard by the global financial crisis even though its relatively financial system initially limited the direct impact. In fact, Japan was vulnerable because of the structural changes that occurred over the past decade. In 2008, when the U.S. and most of Europe went into a recession, the Japan's real economy did not seem to be affected materially. However, it was adversely affected in terms of large trade shock with a sharp increase in energy and other commodity prices.

Another key moment represents the earthquake in north-eastern Japan, the tsunami, and the Fukushima nuclear power plant disasters from 2011. These events revealed that the Japanese institutions were not prepared to deal with this kind of problems. In other words, the occurred events revealed that the Japanese Model lacked the capacity to deal with national emergencies. Hereby, the China's power growth and its aggressive diplomatic posture also had an impact on Japan.

The December of 2012 was marked by the inauguration of the second administration of Prime Minister Abe Shinzo and the adoption of the economic measures so-called "Abenomics". The new economic measure has three principal components: first, the Bank of Japan initiated expansive monetary policies including Quantitative Easing; second, an expansive fiscal policy was launched through increased infrastructure spending; and third, Abe promised to modernize the agriculture industry of the country. The Abe administration immediately got to grips with the ramifications of the lost decades, implementing anti-deflationary policies and adopting a strong posture toward Japan's neighbouring countries.

Furthermore, according to Amadeo (2016), there are seven factors that became a hindrance to Japan's economy growth and have to be eliminated in order to improve the country's economy. These seven factors are: Keiretsu (set of companies with interlocking business relationships and shareholdings); guaranteed lifetime employment; the largest net food importer (Japan has just one-third as much arable land per person as China); aging population (the country pays out more retirement benefits than it receives in income taxes from the working population); *yen* carry trade (result of Japan's low interest rates); largest holder of U.S. debt (they keep yen low and the dollar strong to improve its exports); massive debt-to-GDP ratio (country owes more than twice as much as it produces annually).

At this moment is not clear how these policies will affect the Japanese economy. However, at this point, Japan is considered the world's fifth largest economy after China, the European Union, the United States and India. Hereby, the economic growth in Japan would not only benefit residents of Japan, but will also facilitate economic recovery in the rest of Asia. It would dampen political pressures in the trade area that the U.S. is likely to face.

In the next section, will be talked about efficiency concept and will be presented some empirical studies that are related to the bank's efficiency framework.

3. Literature review

3.1 Efficiency concepts

The word "efficiency" signifies a level of performance that describes a process that uses the lowest amount of inputs to create the greatest amount of outputs. In this study context, the efficiency is based on the estimation of efficiency frontiers with the best combination of the different inputs and outputs of the production process and on the analysis of the frontier discrepancy which represents the losses of efficiency.

The study that set the foundation to measure productivity and efficiency at the micro level was Farrell's work (1957). In his work the convex hull concepts that represents the smallest convex subset in a specific space was used, which contains the cloud of points that represents firms. This convex envelops the data and the efficiency measures calculated relative to this surface. The main contribution of his work consisted in the definition of the efficiency and productivity, and the calculation of the benchmark technology and efficiency measures.

In 1978, when Charnes et al. (1978) introduced the terms of data envelopment analysis (DEA) in their work, the Farrell (1957) study was taken into consideration. The introduced DEA techniques have been used first in industrial economy studies and at mid 90's it started to be applied to financial institutions. Thus, the Sherman and Gold's work (1985) was a pioneer in the application of this method to the banks. Hence, the Humphrey and Berger (1997) surveys, an inventory of 130 studies applying efficiency frontier to financial institutions from 21 countries, laid to the growth of interest for banks efficiency determinants. Afterwards, were conducted numerous studies based on banks efficiency.

By also taking the other empirical studies into consideration, it can be stated that on the measurement of bank efficiency there can be adopted either parametric methods, as the Stochastic Frontier Analysis (SFA), or non-parametric methods, in particular, the Data Envelopment Analysis (DEA). By using the available data, this non-parametric method creates an efficient frontier. The DEA frontier presents a linear combination that connects the set of the best practices observations, where the measurement of efficiency is relative to the particular frontier obtained.

The DEA provides an analysis of relative efficiency for multiple input/ output situations, by evaluating each decision-making units (DMU) and measuring its performance relative to an envelopment surface composed of the best practice units. The units that do not lie on the surface are considered inefficient. It also provides efficiency scores even in the presence of relative few observations, which represents a great advantage in comparison with the parametric approach. This way, the method provides a measure of relative efficiency.

The next section presents some empirical studies that were conducted on the DEA methodology, namely in Japan, Germany and Switzerland.

3.2 Empirical studies

There is a limited number of studies focused on the efficiency of Japanese banks. Here, we will be distinguished three categories: studies that focus on Japanese banks; studies that focus on European countries banks, namely Germany and Switzerland; and studies consisting of international comparisons of banks efficiency.

We will start by mentioning some studies related to the *Japanese bank's efficiency*.

Fukuyama (1993) work represents one of the main research article applied on Japanese Banking System. In this article, a Data Envelopment Analysis (DEA) to analyse cost and overall technical efficiency were applied. By using this methodology, it was found that the majority of big banks operated close to their minimum efficiency scale.

Drake and Hall (2003) also used the DEA method to conduct technical and scale efficiency in Japanese banking. Efficiency analysis was developed across individual banks, banks types and bank size groups. Through the analysis were established powerful size-efficiency relationships with respect to both technical and scale efficiency. Additionally, the Fukuyama (1993) findings about the large banks were confirmed. On the contrary of the smaller banks, they operate close to their minimum efficiency scale.

Drake et al. (2009) studied the Japanese banking efficiency by using lacks-based measures which were conducted through DEA method. In addition, the authors extended the comparative bank modelling methodology literature through intermediation and production approaches, together with the profit/ revenue-based

approach. By employing more recent data than Fukuyama (1993), it was observed a drop in Japanese efficiency levels.

Ivan (2015) compares the efficiency scores obtained through DEA approach and Free Disposal Hull (FDH)[3] model by using new data extracted from the main local banks' income statement, for the 2012 fiscal year. The obtained results stated that the Japanese banking systems remained at a level of efficiency similar to the level as it was during the economic bubble at the beginning of the 90s. In addition, it was verified that the large financial institutions (keiretsu banks) are the most efficient banks.

Besides studies oriented toward Japanese banks, there are an important number of studies addressing European banks' efficiency, mostly to German and Swiss banks. So, the following paragraphs will be focused on two representative studies addressing the *European banks efficiency.*

Weill (2004) measured the cost-efficiency of banks from five European countries (France, Germany, Italy, Spain and Switzerland), over the period 1992-1998, by applying three approaches: stochastic frontier approach (SFA), distribution-free approach (DFA) and DEA. The author compares means, correlation coefficients, two public policy issues and the correlation with standard measures of performance. In conclusion, it was stated that there is a lack of robustness among approaches and also was observed some correlation between all frontier approaches and performance standard measures

Afsharian et al. (2011) paper empirically analyses the impact of the degree of efficiency on key performance figures of European banks in the period 2005 – 2009 by using DEA

[3] Free Disposal Hull assumes the free disposability relaxing the convexity assumption in defining the production possibility set from the observations. It is considered as an alternative approach to DEA for efficiency measurement.

technique. The sample utilized in this work was formed by 24 countries of the European Union and Switzerland, Liechtenstein and Norway. The obtained results suggested that an increase in pure technical efficiency is related to more volatile assets, which is reflected in lower market values.

In the following paragraph is mentioned a relevant study that conducted an *International comparison.*

Loukoianova (2008) analysed, using the DEA approach, the cost and revenue efficiency and profitability of Japanese banks from 2000-2006. The obtained results pointed to potential efficiency gains, particularly for regional banks[4] arising from cost-sharing arrangements. In addition, the cost efficiency and profitability level of the Japanese banks are compared with that of banks in other major industrial countries (France, Germany, Spain, Switzerland, U.K and U.S). In cross-country perspective, the City banks were found to be benchmark[5]. Moreover, it appears that Japanese regional banks were slightly more efficient than German and Spanish savings and co-operative banks, but less efficient than Swiss and German regional banks.

[4] In Japan there are four categories of banks: city banks, trust banks, regional banks and tier II regional banks. City banks operate as commercial banks, offering banking services mainly to large corporate customers.

[5] Benchmark, by definition, is the bank segment that has a score of 100%.

Table 1. Some representative Studies on banking efficiency

Authors	Characteristics (method, period)	Country included
Japan		
Fukuyama (1993)	DEA	Japan
Drake and Hall (2003)	DEA, 1997	Japan
Drake et al. (2009)	DEA, 1995-2002	Japan
Ivan (2015)	DEA and FDH, 2012	Japan
Europe (Germany and Switzerland)		
Weill (2004)	DEA, DFA and SFA, 1992-1998	France, Germany, Italy, Spain and Switzerland
Afsharian et al. (2011)	DEA, 2005-2009	24 European Union countries and Switzerland, Liechtenstein, Norway
International comparison		
Loukoianova (2008)	DEA, 2000-2006	Japan, France, Germany, Spain, Switzerland, UK and US

In the following pages, will be presented the efficiency concept and the methodology applied in estimating the efficiency, as well as the used data in this work.

4. Methodology and data

4.1 Measurement

The DEA frontier is formed by the best-practice observations yielding a convex production possibility set. Since the study is focused on the cost side of banking operations, it will be used the approach of an input-orientated constant return to scale (CRS) model and the variable that is computed is the cost efficiency (CE). Through cost-efficiency, it is possible to observe how banks use their inputs to produce a given level of outputs.

In the following lines, it will be provided a brief description of the underlying linear programming model. The linear programming technique is used to find the set of coefficients (*u*'s and *v*'s) that will give the highest possible efficiency ratio of outputs to

inputs for DMUs being evaluated. Following, it is assumed that there are *k* inputs and *r* outputs for every DMU. In the model, the inputs and the outputs are represented by vectors x_{kj} (amount of input *k* used by DMU_j) and y_{rj} (amount of output *r* used by DMU_j). For each DMU it is intended to obtain a measure of the ratio of all outputs over all inputs, where the weight assigned by DEA to *k* inputs and *r* outputs are represented by v_k and u_r.

In order to obtain the DEA input-orientated CRS scores efficiency, the following optimisation problem is solved:

$$\begin{aligned} &min_{\theta,\lambda}\,\theta \\ &s.t.\ \ -y_{ri} + Y\lambda_i \geq 0\,,\ \ r = 1,2,\dots,m; \\ &\theta x_{ki} - X\lambda_i \geq 0,\quad r = 1,2,\dots,s; \\ &\lambda_i \geq 0\,,\quad i = 1,2,\dots,n. \end{aligned} \tag{1}$$

where the $X=[x_1 \dots . x_n]$ is a K*N input matrix with columns x_i and $Y=[y_1 \dots . y_m]$ is a R*N output matrix with columns y_i. The θ is scalar and λ is a N*1 vector of constants. As $0 \leq \theta_i \leq 1$, in case that $\theta = 1$ the DMU is located on the efficiency frontier and it is considered globally efficient. For more information about the DEA model see Coelli (1996) and Sherman and Zhu (2006).

In the following part are presented the data and the variables used in this study.

4.2 Data and variables

The data are sourced from BankScope. The sample is formed of annual data extracted from consolidated accounts of the five commercial banks (so-called city banks) of Japan and two countries selected in accordance with the Global Rankings 2014 (developed on bank's performance index) which are: Germany, that is inside of Euro Area and represent one of the major centre of bank's activities, and Switzerland, that is outside

the Euro Area and, also, of the European Union, being one of the most developed countries (Appendix 1). The five commercial banks have been selected through total assets concentration analysis. The span of time is the interval 2000-2014.

Regarding the variables, there are three approaches generally used in defining the bank's respective inputs and outputs: the asset approach (or intermediation approach), the user-cost approach and the value added approach (or so-called production approach). Considering the advantages and disadvantages of each method, as in Jimborean and Brack (2010) study, will be applied the intermediation approach[6]. Also, as in Grigorian and Manole (2002), it will be assumed that there are no systematic differences among banking systems considered in the analysis, other than the differences explained by macroeconomic indicators and general business environment.

So, it is considered that bank's total costs will depend on three bank outputs: total loans (natural logarithm of the loans), total securities (natural logarithm of the total securities) and other earning assets (difference between total earning assets and total loans); and on inputs, whose prices are utilized in order to estimate the cost frontier: price of borrowed funds, price of physical capital and price of labour (Appendix 2). The same approach has been employed by Weill (2004). However, as there is a lack of information regarding the personnel expenses in Japan's case, the input price of labour cannot be computed.

[6] Intermediation approach assumes that banks intermediate funds between depositors and borrowers and transpose these funds into further investments. It has been equally used by Loukoianova (2008); Drake and Hall (2003).

5. Results and analysis

The obtained results, as well as the interpretation of the cost-efficiency scores for the analysed banks, are presented in this section. Also, here are listed the financial indicators that characterize the banking sector.

5.1 Obtained results and comments

In the table below are displayed the cost-efficiency results of Japanese banks obtained with the DEA Solver program.

Table 2. Cost-efficiency of Japanese banks [7]

Year	The Bank of Tokyo - Mitsubishi UFJ Ltd	Sumitomo Mitsui Trust Bank Limited	Sumitomo Mitsui Banking Corporation	Resona Bank, Ltd	Mitsubishi UFJ Trust and Banking Corporation
2000	23,60%	100,00%	49,20%	43,10%	30,30%
2001	100,00%	100,00%	35,30%	46,40%	71,60%
2002	100,00%	4,10%	7,30%	11,50%	10,20%
2003	100,00%	6,60%	8,30%	13,50%	11,00%
2004	63,50%	18,60%	21,30%	100,00%	20,60%
2005	40,80%	13,60%	22,90%	100,00%	35,30%
2006	52,90%	3,90%	28,00%	12,50%	100,00%
2007	31,50%	25,50%	100,00%	24,40%	23,70%
2008	56,70%	40,70%	100,00%	40,70%	36,30%
2009	14,20%	19,10%	26,00%	47,60%	100,00%
2010	100,00%	52,50%	29,90%	76,80%	79,50%
2011	9,60%	6,70%	100,00%	9,50%	8,00%
2012	19,90%	8,90%	48,60%	100,00%	10,20%
2013	19,10%	33,20%	100,00%	14,80%	9,60%
2014	100,00%	12,50%	20,20%	38,50%	18,00%
Average value for the period	**55,45%**	**29,73%**	**46,47%**	**45,29%**	**37,62%**

Note. This table presents the average scores of cost-efficiency for each year and bank.
Source: Author's calculations developed through DEAP 2.1 software program.

[7] The data used in order to develop the average scores of cost-efficiency for each year and bank were sourced from BankScope in million units.

The results indicate that the efficiency of major Japanese banks is around 50%. This implies that there is a large average gap between the observed input-output combinations and the efficient frontier, particularly in the case of Sumitomo Mitsui Trust Bank Limited bank and Mitsubishi UFJ Trust and Banking Corporation bank.

Moreover, by analysing the evolution of these scores, it can be stated that The Bank of Tokyo - Mitsubishi UFJ, Ltd. is the most efficient from the selected 5 banks. This commercial bank was 100% efficient for three years consecutively (from 2001 to 2003), which indicates that its inputs were used efficiently to produce a given level of outputs.

Also, there is a notable fact regarding this range of years, 2001-2003. One of the reasons for the efficiency improvement of The Bank of Tokyo - Mitsubishi UFJ, Ltd., can reside on the fact that the city banks have the largest share of the market in terms of deposits and loans. So, The Bank of Tokyo - Mitsubishi UFJ, Ltd., represents, in fact, the positive effect of the special inspection of bank loans launched in 2001 by Financial Services Agency (FSA).

According to Fujii and Kawai (2010), the inspection was limited to loans to large borrowers whose market indicators (e.g. share prices and credit ratings) had deteriorated rapidly. This process resulted in the large scale reclassification of loans. The increased regulatory pressure led to a dramatic change in loan classifications by the banks in 2002, and in the beginning of the fiscal year 2003, the loan classification and loan loss provisioning were strengthened.

Concerning the other Japanese banks, it cannot be said the same. Through the obtained findings, it seems that the special inspection of bank loans did not have a positive effect on these four banks. Also, it can be verified that the Sumitomo Mitsui Trust bank has the lowest efficiency score of 30%. Besides, according to Loukoianova (2008), the

commercial banks are more efficient than regional banks and these banks could produce more if they utilized their inputs efficiently.

Additionally, a noteworthy fact can be observed in 2011. This year registered a low score level in terms of banks cost-efficiency almost for all these banks, with an exception for Sumitomo Mitsui bank. This and the following year denote a negative effect of the earthquake and tsunami that occurred in Japan. These events, followed by the nuclear crisis at the Fukushima Nuclear Complex, evacuations, and shortage of electricity, had a large negative economic impact in the country.

The following chapter focuses on the comparison analysis between cost-efficiency of banks from Germany, Switzerland and Japan.

5.2 Comparative analysis

The table below represents the cost-efficiency outcomes of banks from Germany, Switzerland and Japan obtained with the DEA Solver program.

Table 3. Cost-efficiency of banks [8]

Year	Germany	Switzerland	Japan
2000	22,80%	66,30%	100,00%
2001	7,00%	100,00%	2,40%
2002	11,70%	100,00%	3,70%
2003	100,00%	93,40%	16,00%
2004	100,00%	81,00%	100,00%
2005	100,00%	100,00%	38,40%
2006	91,60%	65,90%	100,00%
2007	96,40%	60,60%	100,00%
2008	100,00%	67,70%	90,20%
2009	100,00%	100,00%	57,00%
2010	9,00%	13,00%	100,00%
2011	33,10%	42,70%	100,00%
2012	20,70%	35,50%	100,00%
2013	48,80%	100,00%	16,80%
2014	41,50%	100,00%	15,80%
Average value for the period	**58,84%**	**75,07%**	**62,69%**

Note. This table represents the average scores of cost-efficiency for each year and country.
Source: Author's calculations developed through DEAP 2.1 software program.

Regarding the obtained findings, it can be verified the idea that the Switzerland banking sector is truly efficient reaching an average value of 75,07% for the period 2000-2014.

Surprisingly, according to the obtained data and its graphic illustration (Appendix 3), it can be observed that the situation of Japan banking sector is not as poor as most people think. As the Japanese banks as whole reached 62,69% of efficiency, it implies that the

[8] The data used in order to develop the average scores of cost-efficiency for each year and bank were sourced from BankScope in million units.

average gap between the observed input-output combinations and the efficient frontier is 37,31%.

Therefore, by comparing the five banks of big importance from Germany and from Japan, can be stated that, over this period, the Japan banking sector is doing better in a perspective of banks cost-efficiency. There is a slight difference of 3,85 p.p. between Japan banking sector and Germany banking sector. Regarding the Japanese and Switzerland banking sector, the difference is 12,39 p.p. So, the analysis alludes that the Japanese banking sector is slightly more efficient than Germany's, but less efficient than Switzerland's. In fact, it confirms that the situation of the Japanese banking sector had improved.

This conclusion is quite similar to the conclusion of the Loukoianova's work (2008). In her work, where a smaller sample (data from 2000 to 2006) and different inputs were used, the reached conclusion was referring that the Japanese regional banks were less efficient than the Switzerland regional banks, while in our case it is about commercial banks instead of regional's.

In the next part, we seek to analyse the banking sector of the selected countries, Germany, Japan and Switzerland, through its financial indicators.

5.3 Analysis of banking sector of the selected three countries

In order to complement the analysis of efficiency, it was developed a study on financial performance ratios. Thus, by using the data provided by BankScope, the four ratios were calculated, namely: Return on Average Assets (ROAA), Return on Average Equity (ROAE), Cost-to-Income and the ratio Total expenses over the Total assets (Appendix 4).

The table below contains the obtained outcomes.

Table 4. Synthesis: Average results of financial indicators

	ROAA	ROAE	Cost-to-income	Total expenses / total assets
Germany	0,1347	3,4400	73,0387	0,0368
Japan	0,2100	2,9713	53,1653	0,0138
Switzerland	0,2767	6,9987	132,6533	0,0393

Source: Data sourced from BankScope.

Concerning the ROAA, it is an indicator used to evaluate the assets profitability and it also reflects the efficiency of a company, in our case of banks, in utilizing its assets. In other words, it indicates what a company can do with what it possesses. So, it can be said that the bank with a higher ratio is more efficient. Therefore, as the ROAA is an efficiency indicator, its results must be in line with the cost-efficiency results obtained through DEA Solver.

Thus, through results can be verified that the Switzerland banking sector is more efficient and the Germany banking sector is less efficient. This way, it confirms the veracity of the previous conclusion.

Regarding the time evolution of the banking sector of each country (Appendix 5), there is an outstanding fact: from 2007 to 2008 it is verified a drastic decline in ratio being this an effect of the beginning of a financial crisis. Also, in the following years, the ROAA ratio are fluctuating. Actually, in this situation where the states are trying to recover and to stimulate the economic growth, according to Popovici (2014), a small ROAA ratio is better as a higher ROAA involves high risks and variations in time of crisis.

Further, it was measured the ROAE which can give a clear view on company's corporate profitability. Also, it is considered as a type of management report to its

shareholders. Therefore, as stated by Pasiouras et al. (2005), it can have implications for the bank's creditors in a sense that if the bank has not met its return targets, it will be under pressure to amend its corporate governance policies which can lead to additional financial risks. Thereby, the lower ROAE, which is the Japan case, could signify a warning signal to creditors that there might be deterioration of other ratios.

Concerning the time evolution of the banking sector (Appendix 5), it can be observed that after the financial crisis that started in 2007, the ROAE has registered low values in comparison with the values before the crisis. In fact, it is quite a beneficial situation as it allows reducing financial crisis effects.

Relatively to Cost-to-income, it shows a company's costs in relation to its income. The ratio gives investors a clear view of how efficiently the bank is being managed. The lower the ratio is, the more profitable the bank will be. Thus, through the average results and even by the time evolution of the banking sector (Appendix 5), as the Switzerland banking sector has a high ratio, it can be stated that its banking sector is not managed so well.

Moreover, by the time evolution of the banking sector there is an interesting fact to be highlighted: in 2008, the Cost-to-income ratio went drastically up. This case indicates that in the crisis period the Switzerland banking sector faced some problem regarding the banks' management.

Additionally, it can be verified that, in the Japanese's case, from 2010 to 2014, the ratio is increasing. These changes in the ratio can highlight potential problems. As it increases year by year, it means that costs are rising at a higher rate than income. Almost the same phenomenon can be observed in Germany's case, an increase from 2012 to 2014, and also in Switzerland's case, an increase from 2010 to 2013.

Regarding the ratio of total expenses to total assets, it is possible to state that Japan represents better results than Germany and Switzerland. Concerning time evolution of the banking sector (Appendix 5), there is an interesting fact: after 2007, the beginning of the financial crises, there is a general improvement of the indicator which can be a good signal of future improvement.

6. Conclusion

This study aimed to describe the situation of the Japanese banking system from the efficiency point of view. In contrast to the academic studies which investigated the scale efficiency or technical efficiency of Japanese banks, this paper examines the cost-efficiency of Japanese banks, covering the last 14 years.

The analysis extends the literature on bank costs modelling, using the DEA technique for a sample of main Japanese and European commercial banks, during 2000-2014. It investigates the cost-efficiency evolution for the five largest banks from Japan, Germany and Switzerland. This work follows mostly the methodology described in Jimborean and Brack (2010).

The findings show that the cost-efficiency of Japanese banks in this span of time are mostly unstable, it reveals oscillations reaching extreme points. Thereby, it was verified that The Bank of Tokyo - Mitsubishi UFJ, Ltd., is the most efficient from the Japanese banks. This commercial bank was 100% efficient for three years consecutively (from 2001 to 2003), which indicates that their inputs were used efficiently to produce a given level of outputs.

In a cross-country perspective, according to the findings, it can be stated that the situation of the Japan's banking sector is not as poor as some people think. The

evidence indicates that the Japanese banking sector is slightly more efficient than Germany's, but less efficient than Switzerland's. There is a difference of 3,85 p.p. with Germany banking sector and 12,39 p.p. with Switzerland banking sector respectively. In fact, it confirms that the situation of the Japanese banking sector had improved.

This conclusion is quite similar to the conclusion of the Loukoianova's work (2008), where a smaller sample (data from 2000 to 2006) and different inputs were used. In her work, the reached conclusion was referring that the Japanese regional banks were less efficient than Switzerland regional banks, while in our case is about commercial banks instead of regional's.

In addition to the efficiency analysis, a study on financial performance ratios was performed. The findings confirmed the conclusion that was taken before by analysing the cost-efficiency. Indeed, in comparison with the Germany's banking sector, the Japan's is more efficient, but less efficient than the Switzerland's.

Therefore, regarding the return on average equity findings, the lower ratio of the Japan's banking sector could be a warning signal to creditors that there might be deterioration of other ratios. Moreover, after examination of the cost-to-income ratio, it seems that the Switzerland's banking sector is not managed so well. In addition, after 2007, there is a general improvement of the total expenses over total assets ratio which can be a good signal of future improvement.

In fact, this paper presents several limitations. In the first place, the analysis may suffer from sample selection as the bank's selection was determined by the data availability. In other words, only the banks with available data for the entire period, from 2000 to 2014, were picked. The analysis of a larger sample could provide a different picture of Japanese banking sector.

Further research on this topic could involve other techniques for measuring bank cost-efficiency. It may be interesting to observe the evolution of efficiency scores obtained by a parametric method. Another possible continuation could be the analysis of efficiency evolution of banks from Japan, United States and Euro area.

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Appendix

Appendix 1. Information about the banks in sample.

Five banks of Japan			
Nº	**Name**	**Total assets (2014)**	**Latest net income**
1	Mitsubishi UFJ Trust and Banking Corporation	37,597,100 mil JPY	168,600 mil JPY
2	Resona Bank Ltd	30,201,016 mil JPY	159,266 mil JPY
3	Sumitomo Mitsui Banking Corporation	171,269,300 mil JPY	805,600 mil JPY
4	Sumitomo Mitsui Trust Bank Limited	43,538,800 mil JPY	161,000 mil JPY
5	The Bank of Tokyo - Mitsubishi UFJ Ltd	210,451,800 mil JPY	805,700 mil JPY

Source: BankScope

Five Banks of Germany			
Nº	**Name**	**Total assets (2014)**	**Latest net income**
1	Commerzbank AG	557,609 mil EUR	370 mil EUR
2	Deutsche Postbank AG	155,447 mil EUR	279 mil EUR
3	Deutsche Bank Privat-und Geschaftskunden AG	114,020 mil EUR	287 mil EUR
4	Santander Consumer Bank AG	42,124 mil EUR	547 mil EUR
5	UniCredit Bank AG	300,342 mil EUR	958 mil EUR

Source: BankScope

Five Banks of Switzerland			
Nº	**Bank's name**	**Total assets (2014)**	**Latest net income**
1	Bank Coop AG	16,212 mil CHF	81 mil CHF
2	Habib Bank AG Zurich	9,804 mil CHF	78 mil CHF
3	Migros bank AG-BANQUEMIGROS	40,847 mil CHF	225 mil CHF
4	Neue Aargauer Bank AG	23,823 mil CHF	138 mil CHF
5	UBS AG	1,062,327 mil CHF	3,649 mil CHF

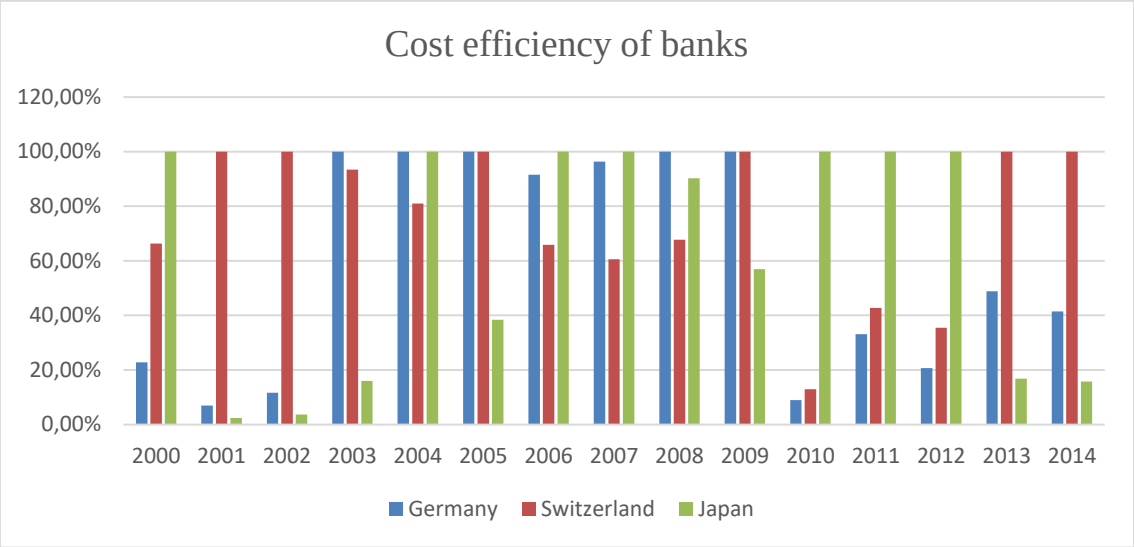
Source: BankScope

Appendix 2. List of inputs and outputs used

Inputs price	
Price of borrowed funds	Natural logarithm of the ratio interest expenses over the sum of deposits
Price of physical capital	Natural logarithm of the ratio non-interest expenses over fixed assets
Outputs	
Total loans	Natural logarithm of the loans
Total securities	Natural logarithm of the total securities
Other earning assets	Natural logarithm of the difference between the total earning assets and the total loans

Source: Author

Appendix 3. Graphical illustration of banks cost -efficiency



Source: Author's calculations developed with the obtained results.

Appendix 4. Financial key ratios

Financial Indicators	
Return on Average Assets (ROAA)	Ratio net income over the average of total assets. The final ratio is expressed as a percentage of total average assets.
Return on Average Equity (ROAE)	Ratio net income over the average equity.
Cost-to-Income	Ratio operating costs over operating income
Total expenses over Total assets	Ratio total expenses over total assets

Source: Author

Appendix 5. Financial indicators of the selected countries

Financial indicators result of Japanese banks				
Year	ROAA	ROAE	Cost-to-income	Total expenses/ Total assets
2000	-0,0500	-0,9900	55,6300	0,0192
2001	-0,5400	-13,3100	52,0100	0,0175
2002	-0,5300	-15,2200	50,1300	0,0142
2003	-0,2100	-5,7400	50,8100	0,0129
2004	0,0200	0,4100	47,7700	0,0125
2005	0,7400	15,1600	48,3700	0,0117
2006	0,6500	11,2800	51,1400	0,0183
2007	0,4800	8,3000	52,9400	0,0195
2008	-0,0900	-1,9100	54,2600	0,0159
2009	0,3200	6,1900	55,8800	0,0121
2010	0,4700	8,1900	54,1300	0,0111
2011	0,4500	7,9600	54,2300	0,0108
2012	0,5000	8,5500	55,3900	0,0107
2013	0,4700	7,8500	57,3300	0,0101
2014	0,4700	7,8500	57,4600	0,0102
Average value for the period	**0,2100**	**2,9713**	**53,1653**	**0,0138**

Source: Data sourced from BankScope.

Financial indicators result of Germany banks				
Year	ROAA	ROAE	Cost-to-income	Total expenses/ Total assets
2000	0,2300	7,4100	73,0400	0,0476
2001	0,1000	3,0000	75,4400	0,0535
2002	-0,0800	-2,6800	76,9800	0,0482
2003	-0,4000	-15,0600	87,5800	0,0416
2004	-0,0900	-3,1200	69,0000	0,0375
2005	0,2800	8,9700	72,1000	0,0323
2006	0,6400	19,8100	65,4900	0,0350
2007	0,6700	19,4400	64,4100	0,0415
2008	-0,0800	-2,0900	80,4900	0,0382
2009	-0,2200	-5,8700	73,4800	0,0318
2010	0,2500	6,2300	68,7500	0,0295
2011	0,1700	4,0900	68,0300	0,0304
2012	0,1900	4,2000	67,3000	0,0288
2013	0,1900	3,9600	73,4200	0,0289
2014	0,1700	3,3100	80,0700	0,0264
Average value for the period	**0,1347**	**3,4400**	**73,0387**	**0,0368**

Source: Data sourced from BankScope.

Financial indicators result of Switzerland banks				
Year	ROAA	ROAE	Cost-to-income	Total expenses/ Total assets
2000	0,8000	19,9100	68,1800	0,0622
2001	0,4600	11,2500	74,5600	0,0578
2002	0,3200	8,6100	75,0800	0,0472
2003	0,4700	14,8800	71,8200	0,0337
2004	0,5200	20,4100	71,7700	0,0315
2005	0,7600	30,2900	69,7900	0,0383
2006	0,5700	22,1500	69,1300	0,0480
2007	-0,1800	-7,8500	110,4000	0,0603
2008	-0,9800	-45,9500	874,2000	0,0432
2009	-0,1000	-3,5900	89,5300	0,0304
2010	0,6300	15,9300	74,5600	0,0280
2011	0,3400	8,4400	83,8600	0,0236
2012	-0,1300	-3,2800	85,4200	0,0267
2013	0,3000	6,6900	83,7500	0,0298
2014	0,3700	7,0900	87,7500	0,0287
Average value for the period	**0,2767**	**6,9987**	**132,6533**	**0,0393**

Source: Data sourced from BankScope.