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Competition, Concentration, Efficiency, and their Relationship in the Polish Banking Sector

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Abstract[1]

European banking sectors have been subject to various forms of deregulation, liberalization, as well as dramatic improvements in information technology (IT). As the result of the creation of the European Union's Single Market, the financial institutions are transforming themselves in response to fundamental changes in regulation and technology. Many of these changes have vast implications for competition, concentration and the efficiency of the financial sectors. This paper examines the impact of increasing concentration and new technologies, linked with the mergers and acquisitions (M&A) process, on the degree of competition and technical efficiency of the Polish commercial banks. The goal of this paper is to check whether, during the analyzed period (1997-2002), the concentration of the commercial banks had a negative impact on the competition in the Polish banking sector. In order to carry out a quantitative assessment of changes in the market structure and technical efficiency of the Polish banking sector, the study estimates competitive behavior in the Polish banking system by applying the method developed by Panzar and Rosse (1987). Moreover, this study assesses the technical efficiency and productivity in the Polish banking sector by applying the method of Data Envelopment Analysis (DEA).

The empirical results, for the analyzed period of 1997-2002, have shown that in Poland there is monopolistic competition. It seems that foreign entry, connected with the M&A process, and rapid changes in IT in Polish commercial banks, is one of the reasons for the improving technical efficiency measures and productivity indices. It has also influenced the level of competition in the Polish banking sector.

JEL Classification: F36; G2; G21; G34; L1.

Keywords: Competition; Concentration; Efficiency; Panzar-Rosse model; DEA; Mergers and Acquisitions; Market Structure.

[1] The views expressed in this paper do not necessarily represent those of the NBP. An earlier version of this paper was presented at 25th SUERF Colloquium in Co-operation with the Bank of Spain "Competition and Profitability in European Financial Services: Strategic, Systemic and Policy Issues" (Madrid, October 2004).

Introduction

In the current era, market structure and competition in the European financial system are major economic policy issues. The degree of competition in the financial sector may influence the efficiency of the production of the financial services. Relationships between competition, banking system performance, efficiency, and stability have been extensively analyzed in theoretical literature as well as in empirical research. In general, in a competitive environment, only the most efficient and innovative firms survive. However, for the financial sector there might be instances in which competition may have a negative impact on stability, as the least efficient firms may have an incentive to increase their risk exposure in order to reach the industry profitability level. If these firms are large enough, the financial stability of the firms may be may be threatened[2].

Banking competition is a crucial issue for the new members of the EU. The most important change in the business environment of the Polish banking sector, after joining the EU, is the possibility of new banks entering using a "single banking license"[3]. The most important change for clients using banking services, should be to lower transaction costs and to have better access to lending in the Single Banking Market. However, accession to the EU also creates additional challenges for Poland's banking industry. The solutions and likely ways to survive in a competitive environment for domestic financial institutions in the EU, are the improvement of their efficiency and competitiveness by mergers and acquisitions (which will contribute to a reduction of operating costs), further development of products for households and small and medium sized businesses, outsourcing, and engagement in the servicing of niche markets. Those processes are supported by new technologies as well as by the Internet.

A number of analysts, who have investigated the trade-off between competition and concentration, have found that there is no evidence that the banking sector concentration relates negatively to competition (Claessens and Laeven (2003), Gelos and Roldos (2002), Hempell (2001)).

This paper examines the impact of the increasing concentration and new technologies, linked with the M&A process, on the degree of competition and technical efficiency of Polish commercial banks in the period of 1997-2002. In order to carry out a quantitative assessment of the changes in the degree of competition, market structure and technical efficiency of the Polish banking sector, this study has been structured into two investigations:

Firstly, it estimates the competitive behavior in the Polish banking system, by applying the non-structural **Panzar and Rosse** approach (1987), based on panel data for Polish commercial banks for the period of 1997-2002. The above methodology enables to identify the nature of the market structure, i.e. monopoly or perfectly collusive oligopoly, monopolistic competition and perfect competition, by applying the elasticity of total interest revenues function with respect to changes in the banks' input prices, called the **H-statistic.**

Secondly, based also on the above mentioned panel data, this study estimates the technical efficiency, the scale efficiency and the productivity changes in the Polish banking sector, by applying the **Data Envelopment Analysis** (DEA). Additionally, by applying the DEA method, the paper also examines the impact of M&A on the technical efficiency and the productivity of Polish commercial banks in the period of 1997-2002. This investigation tries to check whether M&A

[2] See *Group of Ten Report on consolidation in the financial sector* (January 2001), which can be obtained through the websites of the BIS, the IMF and the OECD: www.bis.org, www.imf.org, www.oecd.org, p. 267.

[3] Banks that are licensed in any EU country have the right to open new branches and conduct operations in any other Member State without submitting to licensing procedures. That way the Polish banks are subjected to stiffer competitive pressure: domestic banks have higher levels of general expense than banks in the EU countries. New branches of foreign banks may enjoy a competitive edge over the domestic banks due to lower costs (resulting from the use of their parent bank's IT systems, for example), see: Financial Stability Report, June 2001-December 2002, NBP, p. 23.

increased the efficiency and productivity of these banks. Productivity growth has been analyzed via the Malmquist productivity index (M).

Based on the micro-data of the banks' balance sheets and profit and loss accounts for the years 1997-2002, monopolistic competition has been found (as confirmed by the fact that the values of the H statistic lay clearly between zero and one). However, despite the decrease in the number of banks in Poland during the investigated period and a slight increase in concentration during that time, there have been no indications of lower competition at the end of the analyzed period. Moreover, a slight increase in efficiency and productivity has been observed in the Polish banking sector between 1997-2002.

1
Changes in the structure of the banking system in Poland

Due to the increase in M&A during the period (1997-2002) there was a significant reduction in the number of Polish commercial banks. The number of commercial banks fell from 83 at the end of 1997, to 62 at the end of 2002. Moreover, the M&A process was strictly connected to the process of privatization, based mostly on foreign capital. The M&A taking place in 1997-2002 were a natural consequence of privatization and foreign investments in the Polish banking sector, and were influenced by international consolidation of foreign shareholders-parent banks of Polish subsidiaries[4].

Foreign capital penetration in Polish commercial banks rose from 15% at the end of 1997, to 67% at the end of 2002. There were 47 banks with majority foreign equity at the end of December 2002. By contrast, there were only 29 at the end of December 1997.

In the period 1997-2002, consolidation processes resulted in an increase in the concentration of the banking sector as measured by concentration indices: Herfindahl-Hirschman (HHI)[5] and CR_5, CR_{10}, CR_{15}[6]. The development of these indicators also clearly demonstrates an increasing concentration level in the Polish banking sector. At the end of 2002, the market share of the five largest banks accounted for 56% of assets and more than 56% of deposits (see Table 1).

Table 1 Polish Banking Sector's Concentration Level – 1997-2002 (%)

Herfindahl-Hirschman Indices (HHI)	1997	1998	1999	2000	2001	2002
For loans	0.051	0.045	0.066	0.061	0.076	0.077
For assets	0.074	0.067	0.079	0.076	0.089	0.087
For deposits	0.088	0.077	0.082	0.080	0.094	0.093
5 Largest Banks (CR_5)	1997	1998	1999	2000	2001	2002
For loans	40.37	36.07	43.01	43.71	53.95	53.43
For assets	48.08	44.60	49.58	48.32	57.10	56.17
For deposits	51.53	47.40	49.72	49.14	57.80	56.89
10 Largest Banks (CR_{10})	1997	1998	1999	2000	2001	2002
For loans	60.71	56.83	65.09	63.99	77.30	77.31
For assets	68.41	64.78	70.43	69.35	80.92	80.44
For deposits	69.94	66.80	70.84	70.01	62.20	81.39
15 Largest Banks (CR_{15})	1997	1998	1999	2000	2001	2002
For loans	74.19	72.06	78.06	78.22	83.15	84.13
For assets	80.39	78.07	82.17	81.94	86.02	86.68
For deposits	81.14	79.01	83.33	83.23	86.96	87.31

Source: own analysis.

A deterioration of all profitability ratios in 1998 with comparison to 1997 was the consequence of the banking crisis in Russia. Moreover, a significant slow-down in economic growth in Poland in 2000, followed by lower creditworthiness of businesses, has also resulted in a decrease

[4] E.g. the merger of Powszechny Bank Kredytowy SA with Bank Przemysłowo Handlowy SA as a result of the merger of thier shareholders - *Bank Austria Creditanstalt* and *HypoVereinsbank*, resulting in the creation of the third largest bank in Poland.

[5] HHI is calculated as the sum of squared market shares of each firm in a market in the terms of assets, deposits, and loans. Herfindahl-Hirschman indices in the range below 0.1 show a very low concentration, in the range 0.11 - 0.18 show a moderate concentration, in the range above 0.18 show a very high concentration of the banking system, whereas the index value equal to 1 shows a full concentration.

[6] These indices are calculated as market share of the five, ten and the fifteen largest banks.

Table 2 Commercial Banking Sector's Efficiency Indicators – Poland 1997-2002 (%)

Efficiency Ratios	1997	1998	1999	2000	2001	2002
Profit before tax over average assets (ROA) (%)	2.1	0.7	0.9	1.1	1.0	0.5
Profit before tax over tier 1 equity (ROE) (%)	37.2	9.2	12.9	14.5	12.7	5.2
Net interest margin (NIM)[1] (%)	5.2	4.6	4.1	4.3	3.4	3.3
Non-performing loans (NPL)[2] (%)	10.8	10.9	13.2	14.9	17.8	21.2

Note:
[1] Net interest margin (NIM) = net interest income (interest income minus interest expenses) over average assets.
[2] The share of loans in assets which are classified as: substandard, doubtful and loss.
Source: NBP.

in profitability in the Polish banking sector. This was reflected in a deterioration at the end of 2002 (compared to 2000) of the following ratios: gross profitability was 4.0%, net profitability was 2.4%, return on assets (ROA) was 0.5%, return on equity (ROE) was 5.2% (see Table 2). The decrease in net interest margin (NIM) to 3.3% in 2002 was a result of the decrease in net interest income and an increase in competition.

However, during the 1997-2002 period, the Polish banking sector was undergoing intense transformation and development. The modernization of distribution channels and the implementation of new technologies have increased the availability of services and the effectiveness of banks' operation.

2
Competition in the Polish banking industry in 1997-2002

Measuring bank competition

This study estimates competitive behavior in the Polish banking sector by investigating the degree of competition. There are two major schools of thought in the methodology of assessing competition among banks: the structural approach and the non-structural approach. The structural approach is based on the more conventional views of the relation between competition and market structure, and embraces the **structure-conduct-performance paradigm** (SCP) and **the efficiency hypothesis** (ES), as well as a number of formal approaches. The two most common non-formal structural approaches measure the impact of concentration on competition (Reid, 1987, Scherer and Ross, 1990). The SCP paradigm (relates structure and conduct to performance) would suggest that more concentrated markets tend to be more collusive. The efficiency hypothesis, developed by Demsetz (1973) and Peltzman (1977) offers a competing explanation of the relation between market structure and performance. This theory states that if banks enjoy a higher degree of efficiency than their competitors, they can: increase shareholder value or will gain market share by reducing prices. Also, concentration ratios are often used in structural models explaining competitive performance in the banking industry as the result of market structure (Bikker 2004, p. 63).

In reaction to the theoretical and empirical deficiencies of structural models[7], **non-structural** models of competitive behavior have been developed: the Iwata model (1974), the Bresnahan model (1982), the Lau model (1982), and the Panzar and Rosse (1987) approach. These non-structural approaches do not take into account explicite the impact of concentration on competition.

The Panzar and Rosse Methodology

This study assesses the **non-structural approach** for the banking industry developed by Panzar and Rosse (1987) using bank level data. This test was derived from a general banking market model[8], which determines the equilibrium output and the equilibrium number of banks, by maximizing profits at both the bank level and the industry level.

In order to identify the nature of the market structure (monopoly or oligopoly, monopoly competition or perfect competition) **the Panzar and Rosse model** (P-R) provides a measure called **the H-statistic**. Panzar and Rosse have shown that the sum of the elasticity of the total interest revenues, with respect to changes in banks' input prices (w_i), allows inference about the banks' competitive conduct[9] (see equation (1))[10].

$$H = \sum_{k=1}^{m} \frac{\partial R^*_i}{\partial w_{ik}} * \frac{w_{ik}}{R^*_i} \qquad (1)$$

where: R^*_i – revenue function in equilibrium, w_i – factor of input prices of banks.

[7] For more see: Hempell (2002, p. 9).
[8] Cournot oligopoly model with profit maximinization by collusive Cournot oligopolies.
[9] For more formal specification see: Bikker (2004, p. 85).
[10] The above methodology entails various assumptions, for example, that banks are acting exclusively as financial intermediaries, or that higher input prices are not associated with higher quality services that generate higher revenues, and finally, given the volatile economic environment in the economies covered by this study, that one needs to be observing banks in a long-run equilibrium. For more information see: Gelos and Roldos (2002, p. 13) and see: Bikker (2004, pp. 85-86).

Table 3 Interpretation of the Panzar-Rosse the H-statistics

Values of H	Competitive Environment
$H \leq 0$	Monopoly or perfectly collusive oligopoly
$0<H<1$	Monopolistic competition
$H=1$	Perfect competition, natural monopoly in a perfectly contestable market, or sales maximizing firm subject to a break-even constraint
Values of H	**Equilibrium test**
$0<H$	Disequilibrium
$H=0$	Equilibrium

Source: Hempell (2000, p. 8), Bikker (2004, p. 87).

The estimated value of the H-statistic ranges between -∞ and 1. Moreover, Panzar and Rosse (1987) have shown that in market equilibrium, **perfect competition** is indicated by the H-statistic equal to unity. Due to the fact that, under perfect competition an increase in input prices and thus in average costs should lead to a proportional price increase and (at the firm level) to a proportional rise in revenues. Under **monopoly**, an increase in input prices will increase marginal costs, reduce equilibrium output and consequently reduce total revenues and the H-statistic is negative or equal to zero. If the market structure is characterized by **monopolistic competition,** the H-statistics will lie between zero and unity[11] (see Table 3).

A critical feature of the H-statistic is that the tests must be undertaken on observations that are in a long-run equilibrium[12]. To test for an equilibrium, one can calculate the Panzar and Rosse H-statistic using the return on assets (ROA) as the dependent variable in place of the interest revenue function in the regression equation (2). A value of $H<0$ would show non-equilibrium, whereas $H=0$ would prove an equilibrium (see Table 3).

The nature of the estimation of the H-statistic, means that we are especially interested in understanding how interest revenues react to variations in the cost figures. We assume that banks use three inputs (i.e. funds, labor, and capital), which is consistent with the intermediation approach.

In order to estimate the **H-statistic** for the Polish banking sector the following reduced form revenue equation has been estimated[13]:

$$\ln(IR) = c + a_1 * \ln w_l + a_2 * \ln w_p + a_3 * \ln w_k + d * oth \qquad (2)$$

where:

Dependent variable:

IR – *interest revenue function* which was defined in the following way: $\frac{\text{interest revenue}}{\text{total assets}}$,

Three factor prices:

w_l – *unit price of labor* which was defined in the following way: $\frac{\text{personnel expenses}}{\text{total assets}}$,

w_p – *unit price of funds* which was defined in the following way: $\frac{\text{interest expenses}}{\text{total assets}}$,

w_k – *unit price of capital* which was defined in the following way : $\frac{\text{other expenses}}{\text{fixed assets}}$,

[11] For more see: Bikker (2004, pp. 86-87).
[12] The empirical test for an equilibrium is justified on the grounds that competitive capital markets will equalize the risk-adjusted rate of returns across banks such that, in an equilibrium, rates of return should not be correlated statistically with input prices.
[13] See also Gelos and Roldos (2002, p. 14).

Other bank specific variables:

oth – *the size of nonperforming loans* (NPL),

and c – constant.

In this study, which uses panel data for Polish commercial banks and applies the equation (2) among the different panel regression techniques, *fixed effects* estimations have been used. The sum of the factors prices function (denoted with the coefficients a_1, a_2 and a_3) of the reduced-form of revenues (see equation (2)) constitutes the value of **the H-statistic** for the Polish banking sector.

The Panzar and Rosse approach also has some limitations: general limitations are the assumptions made as well as the resulting biases when applying this technique to real world (bank) data (see Hempell 2000, p. 9). Despite these limitations, the model's special advantages, make it a valuable tool in assessing market conditions. The P-R methodology analyses directly the competitive conduct of banks, based on the comparative static properties of reduced form of revenue function, without employing any structural measures (see Koutsomanoli-Fillipaki and Staikouras (2004, p. 16)).

The data

The panel data for this analysis comprises all Polish commercial banks covered by the National Bank of Poland's balance sheet as well as profit and loss accounts statistics. These statistics consist of annual data from all banks reporting to the National Bank of Poland and cover the period from 1997:Q4 to 2002:Q4.

Empirical Results

For the Polish banking sector the **H-statistic** has been estimated for each year of the analyzed period 1997-2002, as well as for two sub-periods: 1997-1999 and 2000-2002. An equilibrium test is provided for the period 1997-2002, after replacement of the dependent variable by the ROA ratio. The hypothesis of equilibrium (H=0) is confirmed for the Polish banking sector. The performed Wald test[14] could not reject the hypothesis of equilibrium at conventional statistical levels (see Statistical Annex Table A5). Also, the hypothesis of equilibrium was confirmed for 10 new EU countries by Koutsomanoli-Fillipaki and Staikouras (2004, p. 31).

The empirical results with respect to the yearly H-statistic in the period 1997-2002, listed in Table 4, have shown monopolistic competition[15] as a characteristic of the analyzed banks' behavior

Table 4 Estimation results of the yearly H-statistics

		Overall sample
1997 – 1998	H	0.75*
	p(F-test)	(0.000)
1998 – 1999	H	0.78*
	p(F-test)	(0.000)
1999 – 2000	H	0.60*
	p(F-test)	(0.000)
2000 – 2001	H	0.65*
	p(F-test)	(0.000)
2001 – 2002	H	0.84*
	p(F-test)	(0.000)

Note: *H=0 and H=1 rejected (level of confidence 99.9 per cent).
Source: own analysis.

[14] Wald coefficient restriction test.
[15] The values are in the range of above zero and below unity and The Wald tests reveal that H differs significantly from both 0 and 1, and therefore rejects the hypotheses of both monopoly and perfect competition for Polish banking sector at the 1% significance level.

Table 5 Estimation results of the H-statistics (H_1 and H_2) for two periods: 1997-1999 and 2000-2002

		Overall sample
1997 - 1999	H_1	0.66*
	p(F-test)	(0.000)
2000 - 2002	H_2	0.69*
	p(F-test)	(0.000)
H: $H_1 = H_2$	p(F-test)	(0.3398)

Note: *H=0 and H=1 rejected (level of confidence 99.9 per cent).
Source: own analysis.

for each analyzed year. The details of the above estimation have been presented in Table A3 of the Statistical Annex. There is a slight upward tendency in the yearly H-statistics values between 1997-2002. The increase in competition has also resulted in squeezed profit margins in the Polish banking sector (see Table 2).

The share in total assets, in loans and in deposits of the five, ten and the fifteen largest banks and the HHI indices, increased in the period 1997-2001 and decreased slightly in 2002 (see Table 1).

Additionally the level of foreign bank participation grew in the period 1997-2002. However, the share of banks with a majority foreign equity, stabilized between 2000 and 2002. For that reason, the other estimation concerned two periods: 1997-1999 and 2000-2002[16]. The details of the above estimation have been presented in Table A4 of the Statistical Annex. The results of the estimation (H_1 and H_2) have shown a slight increase in the H statistic between two periods: 1997-1999 and 2000-2002 (see Table 5). However, the test for significance of the differences in the H-values between the two periods has shown that there is no significant difference between H_1 and H_2.

The estimation results of the H-statistics for each year as well as for the two periods have shown a slight increase in competition in the period 1997-2002. Moreover, the positive correlation[17] between the H-statistics and the measure of foreign bank participation between 1997-1999 and 2000–2002, supports the argument that foreign competition has helped to attenuate any reductions in the competitive intensity resulting from consolidation. It might mean that the increasing participation of foreign banks in the Polish banking sector have prevented a decline in competitive pressures.

Additionally, based on equation (2), the degree of competition has been estimated, for banking sectors in the Czech Republic and Hungary, for the period 1997-2001. Data for the Czech Republic and Hungary were obtained from BankScope[18].

Monopolistic competition[19] has also been found for those countries (see Table 6). For more details of this estimation see Table A9 and Table A10 in the Statistical Annex.

Table 6 Estimation results of the H-statistics for the Czech Republic and Hungary for 1997-2001

		Czech Republic	Hungary
1997 – 2001	H-statistic	0.58*	0.65*
	p(F-test)	(0.000)	(0.000)

Note: *H=0 and H=1 rejected (level of confidence 99.9 per cent).
Source: own analysis.

16 The panel data consists of 208 bank observations for the years 1997-1999, and 144 observations for the years 2000-2002, the estimations were made with the use of EViews 4.1.
17 The results of correlation for the two sub-periods: 1 and 0.63, respectively.
18 The panel data for the period 1997-2001 consists of 33 yearly bank observations for the Czech Republic, and 42 observations for Hungary. The estimations were made with EViews 4.1. The Wald test performed could not reject the hypothesis of equilibrium at conventional statistical levels (see Statistical Annex Table A10) for the Czech Republic. However the Wald test for Hungary indicated that H is significantly different to zero (see Statistical Annex Table A10). It should be noticed that results for the Czech Republic and Hungary are tentative.
19 The H-statistics are statistically different from both zero and unity.

Also, a number of analysts who have investigated competition in the EU countries using the P-R approach have found that European banks were operating under conditions of monopolistic competition (e.g. Bikker (2004), Koutsomanoli-Fillipaki and Staikouras (2004)).

Table 7 Estimation results of the H-statistics for the EU-15 and 10 new EU countries for 1998-2002

	Dependent Variable	EU-15	New EU Countries
1998 – 2002	Interest Income/Assets	*H-statistic* = 0.54	*H-statistic* = 0.78
1998 – 2002	Total revenues/Assets	*H-statistic* = 0.61	*H-statistic* = 0.46

Source: Koutsomanoli-Fillipaki and Staikouras (2004, p. 37 and p .39).

The econometric results[20] based on the Panzar-Rosse methodology obtained by Koutsomanoli-Fillipaki and Staikouras for the EU-15 and 10 new EU countries for 1998-2002, have been presented in Table 7.

[20] Koutsomanoli-Fillipaki and Staikouras (2004, pp. 29-30) have found that lower barriers to entry in the examined period, such as allowing increased participation of foreign banks in the new EU banking sectors, appear to have prevented a decline in competitive pressures, see also Gelos and Roldos (2002, p. 21).

3
Efficiency in the Polish banking industry in 1997-2002 – non-parametric approach

Measuring bank efficiency

Efficiency is a broad concept that can be applied to many dimensions of a firm's activities and there are many definitions of efficiency. This paper will deal with two definitions of efficiency: **technical efficiency** and **scale efficiency**. **Technical efficiency** is related to the production of outputs given some inputs: a production plan is technically efficient if there is no way to produce the same output(s) with less input(s) or to produce more output(s) with the same inputs[21]. **Scale efficiency** is defined relatively to the form of the locus of technically efficient production plans[22]. Technical efficiency considers scale and scope economies[23]: an efficient firm is the one that reaches the optimal size.

The definitions of efficiency call for different measurement methodologies. The most common efficiency estimation techniques are non-parametric and parametric. There are two main non-parametric approaches: Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH). There are three main parametric frontier approaches: Stochastic Frontier Approaches (SFA), Thick Frontier Approach (TFA) and Distribution-Free Approach (DFA). Non-parametric methods generally yield slightly lower mean efficiency estimates and seem to have a greater dispersion than the results of the parametric models[24].

In this paper, Data Envelopment Analysis (DEA) has been used to analyze efficiency in the Polish banking sector. DEA is a non-parametric linear programming technique that computes a comparative ratio of outputs to inputs for each unit, which is reported as the relative efficiency score[25].

This method is considered to be suitable, and could be successfully applied, to banking systems in transition countries[26].

Investigation of all technical efficiency measures of banks is a very important issue due to that fact that all the technical efficiency measures, i.e. technical efficiency, scale efficiency and scope efficiency, are considered as factors of a bank's competitiveness[27].

The process of changes of technical and scale efficiency and productivity growth in the Polish commercial banks in 1997-2002 was analyzed by comparing the technical efficiency measures e_crs, e_vrs, e_nirs[28] and the Malmquist output-oriented productivity indices[29]. In order to identify types of return to scale effects the NIRS DEA model has been used[30].

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21 See: Favero and Papi (1995, p. 38).
22 See: Favero and Papi (1995, p. 38).
23 In this paper we consider only economy of scale, without prices.
24 Berger and Humphrey (1997, pp. 175-212).
25 Charnes, Cooper and Rhodes (1978, pp. 429-444).
26 See: Grigorian and Manole (2002, p.18).
27 Rogowski (1998, p. 58).
28 The following symbols have been applied in this paper: e_crs – measure of efficiency under constant returns to scale assumption (CRST), e_vrs - measure of efficiency under variable returns to scale assumption (VRST), e_nirs – measure of efficiency under non-increasing returns to scale assumption (NIRST).
29 Malmquist output-based productivity index (M) which was divided into technical efficiency change (E) and technological change (TC).
30 The NIRS model identifies in which region the entity is functioning: increasing, decreasing or constant returns to scale.

The data

The panel data for this analysis comprises all Polish commercial banks covered by the National Bank of Poland's balance sheet as well as profit and loss accounts statistics. These statistics consist of annual data for the period 1997:Q4 to 2002:Q4.

Technical efficiency, scale efficiency and Malmquist productivity indices have been calculated for individual banks for each year. Furthermore, the average of the above measures has been calculated for the entire sample group of banks[31].

Empirical Results

In the analyzed period progressive M&As had an impact on the banking sector efficiency. In 1997-2001, a slight improvement of efficiency in the Polish commercial banking sector was noticed (see Table A11 in Statistical Annex), as a result of an increase in the value of the average measures of technical efficiency (e_crs) and scale efficiency (e_s). The increase in the scale efficiency measure (e_s) reflects the positive effects of scale economies taking place in the Polish banking sector[32]. In 2002, an economic slowdown resulted in a slight decrease in all technical efficiency measures. It means that the advantage of M&A is not able to balance disadvantages of a slowdown in the Polish economy.

The benchmark of the banks with regard to assessed technical and scale efficiency measures, shows that a majority of the analyzed banks were operating within increasing and constant returns to scale region[33]. It means that there is always room for new M&A in the Polish banking sector, which allows for a rise in efficiency and competitiveness of Polish banks.

All technical efficiency measures are relative. To determine if efficiency improvement is achieved at a certain time, the Malmquist productivity index must be analyzed.

Following the results of the Malmquist productivity index estimation (see Table A12 in Statistical Annex), it can be seen that productivity increased in the period 1997-1999 and leveled off in 2000. In the period 2000-2002, the value of the average Malmquist index (M) slightly increased. That was caused by the deterioration in relative efficiency (E) and a slight technological progress (TC).

There is evidence of M&A exploiting technical efficiency, scale efficiency and productivity in the Polish banking sector during the analyzed period. All the banks involved in the M&A processes have significantly improved their efficiency measures and productivity indices[34]. The above results of the assessment of technical efficiency measures, have suggested that Polish banks improved their competitiveness during the analyzed period.

Additionally, for the Czech Republic, Hungary and Poland, the technical efficiency of the banking sector using variable returns to scale technology (VRST) has been investigated based on a dataset compiled by BankScope[35]. The highest value of technical efficiency (e_vrts) has been found for Hungary (see Figure 1).

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[31] Measuring efficiency and productivity requires the specific description of inputs and outputs. There is no consensus amongst researchers about bank inputs and outputs. In the literature on this subject, one can identify five approaches to the input-output specification: the production approach (PA), the intermediation approach (IA), the asset approach (AA), the user cost approach (UCA) and the value added approach (VAA).In this study, input-output specification has been developed specially for the Polish banking system and, four output variables were chosen: net loans, current deposits, time deposits, net fees and commissions, and three input variables: labour (number of employees), fixed assets, non-performing loans. For more explanation see: Pawłowska (2003, p. 14).

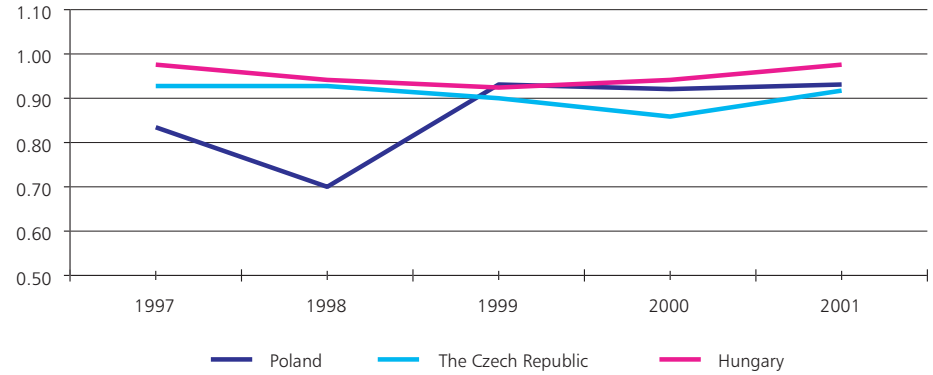
[32] Pawłowska (2003, p. 18).

[33] For the three efficiency measures (e_crs, e_nirs, e_vrs), the following property also holds: $0 < e\_crs \leq e\_nirs \leq e\_vrs \leq 1$ see: Löthgren and Tambor (1996, p. 5). If e_crs = e_nirs this means that a firm is not scale efficient and is operating with increasing returns to scale.

[34] Pawłowska (2003, p. 18).

[35] I have defined three inputs: labor, fixed assets, interest expenditures and three outputs: deposits, net loans, liquid assets, see: Grigorian and Manole (2002, p. 10).

Figure 1 DEA Indicators for the Czech Republic, Hungary and Poland



Source: own analysis.

One of the reasons, of such results may be that banks in Hungary had the lowest share of the non-performing loans in their credit portfolio in 1997-2001 (see Table A8 in Statistical Annex).

4
Conclusion

The empirical results, for the analyzed period of 1997-2002, have shown:

Firstly, that in Poland there is monopolistic competition. Furthermore, despite the decrease in the number of banks during the investigated period and a slight increase in concentration measures during that time, there are no indications of a less competitive behavior of commercial banks in the second half of this period. On the contrary, we have noticed a slight increase in the degree of competition between 1997 and 2002. It means that the process of consolidation in the Polish banking system, which results in a slight increase in concentration measures, has not yet translated into a decline in competitive pressures. Apparently, as confirmed by a positive correlation between the *H statistics* and measures of foreign bank participation, foreign participation may have preserved competitive pressures. Similar conclusion for new EU banking sectors, has been fund by Gelos and Roldos (2002, p. 20) for the period 1994-2000 and by Koutsomanoli-Fillipaki and Staikouras (2004, p. 29-30) for the period 1998-2002.

Secondly, the benchmark classification resulting from technical efficiency investigation for the analyzed period, shows that the majority of banks are operating with increasing returns to scale. It means that there is always room for new M&A. The positive results obtained from the assessment of M&A conducted by commercial banks show that these processes should be continued.

Thirdly, it seems that foreign entry in the Polish financial market (which brings know-how and implementation of new solutions), connected with the M&A process and a rapid growth of IT in Polish commercial banks, is one of the reasons for improving technical efficiency measures and productivity indices. It has also resulted in the increasing level of competition in the Polish banking sector.

However, the EU's biggest success has been the Single Market which has meant more consumers, more competitors, more opportunities for business and less restrictive regulation. It has been a mechanism for increasing competition, for delivering more choice, lower prices and higher quality to consumers. Furthermore, the upcoming Basel Accord on capital requirements and a new regulatory regime for banks, are developments which will affect competition, consolidation and efficiency in the banking industry. The effect of these changes currently seems to be difficult to predict.

5
Statistical Annex

Table A1 Credit Institutions in Poland (1997- 2002)

Financial Institution	Number of Institutions					
	1997	1998	1999	2000	2001	2002
1. Banks	1378	1272	858	754	713	667
1.1 Commercial banks	83	83	77	74	71	62
1.2 Cooperative banks	1295	1189	781	680	642	605
2. Credit Unions	198	220	228	147	141	124
	Assets (in PLN billion)					
	1997	1998	1999	2000	2001	2002
1. Banks	251.6	320.7	365.2	430.4	471.7	469.1
1.1 Commercial banks	240.3	307.0	349.8	412.3	450.2	445.7
1.2 Cooperative banks	11.3	13.7	15.4	18.1	21.5	23.4
2. Credit Unions	0.4	0.6	0.9	1.2	1.8	2.52
	Financial Sector Assets as Percentage of GDP (%)					
	1997	1998	1999	2000	2001	2002
1. Banks	53.3	58.0	59.2	60.4	63.0	61.0
1.1 Commercial banks	50.9	55.5	56.7	57.9	60.1	57.9
1.2 Cooperative banks	2.4	2.5	2.5	2.5	2.9	3.1
2. Credit Unions	0.1	0.1	0.1	0.2	0.2	0.3

Source: NBP, National Association of Credit Unions.

Table A2 Ownership Structure of the Banking Sector (1997- 2002)

	Number of Banks[1]					
	1997	1998	1999	2000	2001	2002
1.Commercial banks	83	83	77	74	71	62
1.1.Banks with majority of state ownership	15	13	7	7	7	8
1.2.Private sector banks of which	68	70	70	67	64	54
1.2.1.Banks with majority Polish equity	39	39	31	20	16	7
1.2.2.Banks with majority foreign equity	29	31	39	47	48	47
2.Cooperative banks	1295	1189	781	680	642	605
Total (1+2)	1378	1272	858	754	713	667
	The Banking Sector Assets (%)					
	1997	1998	1999	2000	2001	2002
1.Commercial banks	95.5	95.7	95.8	95.8	95.4	95.0
1.1.Banks with majority of state ownership	49.3	45.9	23.9	22.9	23.5	25.3
1.2.Private sector banks of which	46.2	49.8	71.8	72.9	71.9	69.7
1.2.1.Banks with majority Polish equity	30.9	33.2	24.6	3.4	3.2	2.5
1.2.2.Banks with majority foreign equity	15.3	16.6	47.2	69.5	68.7	67.2
2.Cooperative banks	4.5	4.3	4.2	4.2	4.6	5.0
Total (1+2)	100	100	100	100	100	100
	Loans[2] to Non-Financial Sector (%)					
	1997	1998	1999	2000	2001	2002
1.Commercial banks	94.5	95.0	94.9	94.6	94.2	93.5
1.1.Banks with majority of state ownership	43.2	23.2	20.5	21.2	20.5	21.4
1.2. Private sector banks of which	51.3	72.4	73.7	73.4	73.7	72.1
1.2.1.Banks with majority Polish equity	33.1	3.2	2.4	3.2	2.4	1.6
1.2.2.Banks with majority foreign equity	18.2	21.9	50.9	70.2	71.3	70.5
2.Cooperative banks	5.5	5.0	5.8	5.4	5.8	6.5
Total (1+2)	100	100	100	100	100	100
	Deposit of Non-Financial Sector (%)					
	1997	1998	1999	2000	2001	2002
1.Commercial banks	94.8	94.8	95.5	94.8	94.4	93.8
1.1.Banks with majority of state ownership	58.0	53.6	23.2	28.9	28.7	30.5
1.2. Private sector banks. of which	36.8	41.2	72.4	65.9	65.7	63.3
1.2.1.Banks with majority Polish equity	24.1	27.5	20.1	2.4	1.8	1.1
1.2.2.Banks with majority foreign equity	12.7	13.7	45.6	63.5	63.9	62.2
2.Cooperative banks	5.2	5.2	4.0	5.2	5.6	6.2
Total (1+2)	100	100	100	100	100	100

Note:
[1]The number of commercial banks includes all banks (and also, banks declared bankrupt or under liquidation).
[2]Loans net of loan loss provisions.
Source: NBP, National Association of Credit Unions.

Table A3 Estimation results of the yearly H–statistic

Dependent Variable: LOG(IR)				
Method: Pooled Least Squares				
Sample: 1997-1998				
Number of cross-sections used: 77				
Total panel (unbalanced) observations: 144				
Cross sections without valid observations dropped				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LOG(WLAB)	0.617216	0.074402	8.295738	0.0000
LOG(WFUN)	0.083596	0.027210	3.072261	0.0032
LOG(WCAP)	0.050947	0.070864	0.718939	0.4749
Sample: 1998-1999				
Number of cross-sections used: 78				
Total panel (unbalanced) observations: 138				
Cross sections without valid observations dropped				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LOG(WLAB)	0.683764	0.128518	5.320382	0.0000
LOG(WFUN)	0.177585	0.042690	4.159850	0.0001
LOG(WCAP)	-0.074801	0.052288	-1.430550	0.1582
Sample: 1999-2000				
Number of cross-sections used: 65				
Total panel (unbalanced) observations: 121				
Cross sections without valid observations dropped				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LOG(WLAB)	0.627015	0.067815	9.245902	0.0000
LOG(WFUN)	0.025177	0.025459	0.988901	0.3274
LOG(WCAP)	-0.054243	0.049586	-1.093915	0.2791
Sample: 2000-2001				
Number of cross-sections used: 60				
Total panel (unbalanced) observations: 104				
Cross sections without valid observations dropped				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LOG(WLAB)	0.606051	0.096030	6.311071	0.0000
LOG(WFUN)	0.077542	0.058641	1.322309	0.1938
LOG(WCAP)	-0.034266	0.054008	-0.634457	0.5295
Sample: 2001-2002				
Number of cross-sections used: 50				
Total panel (unbalanced) observations: 87				
Cross sections without valid observations dropped				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LOG(WLAB)	0.560041	0.141177	3.966944	0.0004
LOG(WFUN)	0.366480	0.052663	6.959023	0.0000
LOG(WCAP)	-0.075174	0.125953	-0.596838	0.5548

Note:
Dependent variable: interest income/total assets - is sign as „IR".
Unit factor prices: w_l – unit price of labor is sign as "WLAB", w_p – unit price of funds is sign as "WFUN", w_k - unit price of capital is sign as "WCAP". *H-statistic* is the sum of elasticities of interest rate revenues.
Source: own analysis.

Table A4 Estimation results of H-statistics for two periods: 1997-1999, 2000-2002

Dependent Variable: LOG(IR)				
Method: Pooled Least Squares				
Sample: 1997-1999				
Number of cross-sections used: 81				
Total panel (unbalanced) observations: 208				
Cross sections without valid observations dropped				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LOG(WLAB)	0.580025	0.060926	9.520115	0.0000
LOG(WFUN)	0.139551	0.024571	5.679490	0.0000
LOG(WCAP)	-0.062570	0.037459	-1.670363	0.0974
Sample: 2000-2002				
Number of cross-sections used: 63				
Total panel (unbalanced) observations: 144				
Cross sections without valid observations dropped				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LOG(WLAB)	0.451061	0.091086	4.952032	0.0000
LOG(WFUN)	0.363647	0.039597	9.183704	0.0000
LOG(WCAP)	-0.124258	0.060526	-2.052973	0.0435

Note: Dependent variable: interest income/total assets - is sign as „IR".

Unit factor prices: w_l – unit price of labor is sign as "WLAB", w_p – unit price of funds is sign as "WFUN", w_k - unit price of capital is sign as "WCAP". *H-statistic* is the sum of elasticities of interest rate revenues.
Source: own analysis.

Table A5 Equilibrium Test for Polish Banking Sector (1997-2002)

Wald Test for H=0:			
Test Statistic	Value	df	Probab.
F-statistic	0.000845	(1, 213)	0.9768
Chi-square	0.000845	1	0.9768
Null Hypothesis Summary:			
Normalized Restriction (=0)	Value	Std. Err.	
H-statistic	-0.018177	0.625189	

Note: In linear regression on equation (1) a dependent variable has been used ROA. H<0 is disequilibrium while H=0 is equilibrium. Equilibrium is confirmed for the Polish banking sector (level of confidence 99.9 per cent).
Source: own analysis.

Table A6 Net interest margin (NIM) for Banking Sectors in the Czech Republic and Hungary (%)

	1997	1998	1999	2000	2001
Czech Republic	2.19	3.47	2.83	2.55	2.62
Hungary	4.5	4.5	4.1	3.9	4.1

Source: the National Bank of Hungary, the Czech National Bank.

Table A7 Numbers of Banks, by Country, 1997-2001

	997	1998	1999	2000	2001
Czech Republic	50	45	42	40	38
Hungary	46	45	44	43	42

Source: the National Bank of Hungary, the Czech National Bank.

Table A8 Non-performing loans (NPL) for Banking Sectors in the Czech Republic and Hungary (%)

	1997	1998	1999	2000	2001
Czech Republic	20.8	20.3	21.5	19.4	13.8
Hungary	6.8	8.2	4.6	3.3	3.4

Source: the National Bank of Hungary, the Czech National Bank.

Table A9 Estimation results of H-statistics, by Country

Dependent Variable: LOG(IR)				
Method: GLS (Cross Section Weights)				
Hungary				
Sample: 1997-2001				
Number of cross-sections used: 16				
Total panel (unbalanced) observations: 42				
One-step weighting matrix				
Cross sections without valid observations dropped				
Variable Coefficient Std. Error t-Statistic Prob.				
LOG(WLAB)	0.019008	0.071031	0.267608	0.7914
LOG(WFUN)	0.601972	0.027997	21.50158	0.0000
LOG(WCAP)	0.032347	0.012351	2.618946	0.0153
The Czech Republic				
Sample: 1997-2001				
Number of cross-sections used: 8				
Total panel (unbalanced) observations: 33				
One-step weighting matrix				
Cross sections without valid observations dropped				
Variable Coefficient Std. Error t-Statistic Prob.				
LOG(WLAB)	0.124841	0.037871	3.296467	0.0033
LOG(WFUN)	0.466126	0.066066	7.055416	0.0000
LOG(WCAP)	-0.009576	0.025052	-0.382254	0.7059

Note: Dependent variable: interest income/total assets is sign as „IR".
Unit factor prices: wl – unit price of labor is sign as "WLAB", wp – unit price of funds is sign as "WFUN", wk - unit price of capital is sign as "WCAP". H-statistic is the sum of elasticities of interest rate revenues.
Source: own analysis.

Table A10 Equilibrium Test for the Czech Republic and Hungary (1997-2001)

Wald Test:			
Hungary			
Test Statistic	Value	df	Probability
F-statistic	1.278381	(1, 24)	0.2694
Chi-square	1.278381	1	0.2582
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
H-statistic		0.707163	0.625445
The Czech Republic			
Test Statistic	Value	df	Probability
F-statistic	0.000163	(1, 24)	0.9899
Chi-square	0.000163	1	0.9898
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
H-statistic		-0.002919	0.228739

Note: In linear regression on equation (1) as dependent variable has been used ROA. H<0 is disequilibrium while H=0 is equilibrium. Equilibrium is confirmed for the Czech Republic (level of confidence 99.9 per cent).
Source: own analysis.

Table A11 Average Technical Efficiency, Scale Efficiency, in Period 1997-2002

Year	Statistic	e_crs	e_vrs	e_s	e_nirs
1997	**Average**	**0.64**	**0.76**	**0.85**	**0.75**
	standard deviation	0.30	0.30	0.18	0.30
	min value	0.10	0.10	0.44	0.10
	Number of efficient banks	13	22	13	22
1998	**Average**	**0.66**	**0.79**	**0.84**	**0.79**
	standard deviation	0.29	0.29	0.18	0.28
	min value	0.09	0.10	0.41	0.10
	Number of efficient banks	12	25	12	24
1999	**Average**	**0.72**	**0.82**	**0.89**	**0.80**
	standard deviation	0.27	0.26	0.14	0.27
	min value	0.16	0.18	0.53	0.18
	Number of efficient banks	18	28	17	25
2000	**Average**	**0.73**	**0.81**	**0.90**	**0.78**
	standard deviation	0.25	0.23	0.12	0.24
	min value	0.31	0.33	0.53	0.31
	Number of efficient banks	18	20	15	21
2001	**Average**	**0.74**	**0.81**	**0.93**	**0.79**
	standard deviation	0.25	0.25	0.10	0.26
	min value	0.13	0.19	0.67	0.13
	Number of efficient banks	16	21	16	21
2002	**Average**	**0.72**	**0.83**	**0.87**	**0.77**
	standard deviation	0.25	0.25	0.10	0.26
	min value	0.13	0.19	0.67	0.13
	Number of efficient banks	11	20	11	16

Source: own analysis. See Pawłowska (2003, p. 32).

Table A12 Average Changes of the Malmquist Productivity Index (M), Technical Efficiency Change (E) and Technological Change (TC) in Period 1997-2002

Years	Statistic	E	TC	M
1997/1998	**Average**	**1.10**	1.11	1.24
	Number of banks that increase productivity	26	32	30
	Number of banks that decrease productivity	19	17	19
	Lack of change	8	3	3
1998/1999	**Average**	**1.28**	0.91	1.06
	Number of banks that increase productivity	27	16	25
	Number of banks that decrease productivity	16	31	22
	Lack of change	9	5	4
1999/2000	**Average**	**1.08**	0.90	0.96
	Number of banks that increase productivity	22	6	20
	Number of banks that decrease productivity	16	37	23
	Lack of change	13	10	8
2000/2001	**Average**	**1.03**	0.99	1.01
	Number of banks that increase productivity	19	20	23
	Number of banks that decrease productivity	16	20	17
	Lack of change	12	7	7
2001/2002	**Average**	**0.92**	1.00	0.92
	Number of banks that increase productivity	8	18	13
	Number of banks that decrease productivity	23	21	25
	Lack of change	9	2	2

Source: own analysis. See Pawłowska (2003, p. 33).

6
Glossary

Data Envelopment Analysis (DEA) – A non-parametric linear programming technique that computes a comparative ratio of outputs to inputs for each unit, which is reported as the relative efficiency score. The efficiency score is usually expressed as a number between 0 and 1. This method assumes that there are decision-making units (DMUs) to be evaluated. Each DMU consumes varying amounts of *m* different inputs to produce *s* different outputs. A decision-making unit with a score of less than 1 is deemed inefficient relative to other units. An efficient DMU depicts the efficient frontier that represents achieved efficiency. The mathematical programming approach to the construction of production frontiers, and the measure of efficiency relative to the constructed frontiers, is frequently given the descriptive title of data envelopment analysis.

e_crs – This measure of efficiency is defined under constant returns to scale assumption (CRST).

e_nirs – This measure of efficiency is defined under non-increasing returns to scale assumption (NIRST).

e_s – This measure of efficiency is defined as result of dividing: e_crs/e_vrs. This is scale efficiency.

e_vrs – This measure of efficiency is defined under variable returns to scale assumption (VRST).

Malmquist productivity index – This index is defined as the geometric mean of a pair of ratios of output distance functions. The first ratio compares the performers of data from periods *t* and *t+1* relative to production possibilities existing in period t, and the second compares the performance of the same data relative to production possibilities existing in period *t+1*. This index is divided into two components: technical efficiency change (E), technological change (TC). That is, an increase in productivity from one year to the next may be due to improved technical efficiency (E), technological progress (TC), or a combination of both (M).

NIRTS model – In order to identify types of return to scale effects, the NIRTS DEA model is used. This model identifies in which region the entity is functioning: increasing, decreasing or constant returns to scale.

Panzar and Rosse model (PR) **–** Panzar and Rosse (1987) formulated simple a non-structural model in order to identify the nature of the market structure: oligopoly or monopoly, monopolistic competition or perfect competition. Panzar and Rosse define a measure of competition **H** as the sum of the elasticity of the reduced-form revenues with respect to the firm's input prices:

$$H = \sum_{k=1}^{m} \frac{\partial R^*_i}{\partial w_{ik}} * \frac{w_{ik}}{R^*_i}$$

where: R^*_i – revenue function in the equilibrium,

w_i – factor of input prices of banks.

Scale efficiency – Scale efficiency is defined relative to the form of the locus of technically efficient production plans.

Technical efficiency – Technical efficiency is related to the production of outputs given some inputs: a production plan is technically efficient if there is no way to produce the same output(s) with less input(s) or to produce more output(s) with the same input(s). Technical efficiency considers scale and scope economies.

7
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