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Estonian Banking Sector Performance Analysis Using Malmquist Indexes And DuPont Financial Ratio Analysis

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Abstract

Banks and other financial institutions are a unique set of business firms whose assets and liabilities, regulatory restrictions, economic functions, and operating make them an important subject of research. Banks' performance monitoring, analysis and control needs special analysis in respect to their operation, productivity and performance results from the viewpoint of different audiences, like investors/owners, regulators, customers/clients, and management themselves. In this paper, productivity change in Estonian banking is estimated using the Malmquist productivity index. The data used in this study covers the period from 1999 to 2002. One purpose of this research is to introduce the Malmquist productivity index, which is first used for productivity analysis of Estonian banks. The present study shows that Estonian banks experienced average a 25.6 percent annual productivity growth rate during 1999-2002, what was the result of technological progress. Generally, all Estonian banks have increased productivity as a result of technological progress on this period. Some historical notes on the development of the Estonian banking system and the capital structure of banks are presented in this article. The usage of a modified version of DuPont financial ratio analysis is discussed also in the article. Empirical results of the Estonian commercial banking system performance analysis are presented in the article (1994-2002).

1. INTRODUCTION

The problem of banking and financial system soundness has become more important in all countries over the last years. In the transition countries, the weakness of the banking system is the major factor of delaying expected economic growth. Rapid financial sector reforms and drastic restructuring has been characteristic for all Central and Eastern European transition countries. Based on a newly constructed cross-country database of financial liberalization, Abiad and Mody (2003) examined the experience of 35 countries over the period 1973-1996 to analyze underlying causes of financial sector reforms. They found that liberalization is a combination of discrete changes in response to economic and political "shocks", reinforced by a self-sustaining dynamic (called this as "learning"). They draw five specific conclusions about what produce changes (reform):

- Countries whose financial sectors are fully repressed (non-liberalized) are the ones with the strongest tendency to maintain their policy stance and hence remain closed and highly regulated. But, initial reforms cause changes that make further reforms necessary.
- Regional diffusion effects appear to be important – the further a country's stage of liberalization is from that of the regional leader, the greater is the pressure to liberalize.
- Shocks to the economic environment (a new government; decline in US interest rates) play an important role in weakening the *status quo* and making reforms possible.
- Crises do trigger action, but not always is the direction of reform – balance of payments crises raise the likelihood of reform; banking crises have the opposite effect.
- Among variables representing ideology and structure, only trade openness appears related to the pace of reform. Not important: presidential or parliamentary regimes, right- or left-wing governments, and the legal system proves not to be influential as well.

It is evident that to study results of financial sector reform and restructuring, a profound performance analysis is needed. The traditional financial ratio analysis is mainly used for the bank performance analysis. We can find different versions of this approach from various textbooks about banking and financial institutions. Different versions of DuPont financial ratio analysis (Cole, 1973) seem to be more perspective for banks' and other financial institutions' performance analysis (see Dietrich, 1996). Berger and Humphrey (1997) presented a review of 122 studies in 21 countries about the efficiency and productivity of financial institutions.

There are two basic approaches to the measurement of productivity change: the econometric estimation of a production, cost, or some other function, and the construction of index numbers using non-parametric methods. Pastor (1995) refers to the advantages and disadvantages of both methods. Berger and Humphrey (1997) and Berger and Mester (1997) review applications of this literature to banking. We adopt the construction of index numbers using non-parametric methods because it does not require the imposition of a possibly unwarranted functional form on the structure of production technology as required by the econometric approach. To examine productivity change in the banking industry, we used Malmquist productivity index.

Malmquist firm-specific productivity indexes were introduced by Caves et al, 1982. They named these indexes after Malmquist, who had earlier proposed constructing input quantity indexes as ratios of distance functions (see Malmquist, 1953). There is output-oriented and input-oriented measures of change in productivity. In this study we concentrated on output-oriented Malmquist productivity index, while the output-orientated productivity measures focus on the maximum level of outputs that could be produced using a given input vector and a given production technology relative to the observed level of outputs.

Different indexes can be used for productivity measurements - Fischer, Törnqvist and Malmquist indexes. According to Grifell-Tatjé and Lovell (1996 and 1997), the Malmquist index has some advantages relative to the Fischer and Tornqvist indexes. First, it does not require the profit maximization, or cost minimization, assumption and information on the input and output prices. Also, if the researcher has panel data, it allows the decomposition of productivity changes into two components (technical efficiency change or catching up, technical change or changes in the best practice). Malmquist index main disadvantage is the necessity to compute distance function. It can be mentioned that the Malmquist index is deterministic and does not permit statistical analysis. This problem has been partially solved using bootstrapping techniques to construct confidence intervals (Simar and Wilson, 1996; Lothgren, 1997). However, the data envelopment analysis (DEA) technique can be used to solve this problem.

There are many of different methods that could be used to measure the distance function which make up the Malmquist TFP index. One of the moor popular methods has been the DEA-like linear programming methods suggested by Färe et al. (1994). In this study I use the DEAP computer program to construct Malmquist TFP indexes using DEA-like methods - see Coelli et al., 1998. DEAP is a data envelopment analysis computer program - see Coelli 1996. There have been few studies on banking productivity analysis of Nordic countries (see Berg et. al, 1992 and 1993, Bukh et al., 1995 and Mlima, 1999. The current study is the first productivity analysis of Estonian banks, using Malmquist productivity index.

The focus of financial analysis for the management of any bank (or the banking sector as a whole) should be on the efficiency of performance of the bank measured from the viewpoint of investors/owners' income maximization. Various measures of rates of return are used mainly for that purpose. In this article, we present one of the possible approaches to such financial analysis using the modified version of DuPont analysis (see Cole, 1973), which is similar to Dietrich's (1996) approach. The paper is organized as follows. A short overview of the Estonian banking system recent developments is presented in Section 2. Section 3 presents the methodology of Malmquist productivity index, and Section 4 empirical results of using Malmquist indexes. Section 5 describes methodology of DuPont financial ratio analysis, Section 6 presents the data and the empirical results. The final section gives some concluding remarks.

2. Development of the Estonian Banking System

2.1. Some Historical Notes

The first commercial bank (Tartu Commercial Bank) on the territory of the former Soviet Union was established in Estonia in 1988. This bank went bankrupt and was liquidated in 1992-1993. So, since there was a great demand for banking services by the emerging private sector, the maximum number of commercial banks operating simultaneously in the small Estonian banking market was 42 in 1992. Some of them were liquidated during the banking crises in 1992-1994 and in 1998-1999, and some of them were merged into larger commercial banks. A short history of the Estonian contemporary banking system is presented in Table 1.

Table 1. History of the Estonian Banking Sector (Only Operating Banks, 2003)

	Bank	Established	Organizational Changes
A. Large Banks			
1.	Hansapank	01.07.1991	Merged with the Estonian Savings Bank (which was established 14.04.92 on the basis of former state-owned savings offices and merged with the Estonian Industrial Bank in 1996) in 1998
2.	Union Bank of Estonia	15.12.1992	Established on the basis of 11 smaller regional banks, merged with North-Estonia Bank in 1997 and with the Bank of Tallinn (which was established 21.12.92) in 1998
B. Medium-Sized Banks			
3.	Nordea Bank Plc, branch	20.06.1995	Established on the basis of merging KOP and SYP (Finnish banks) offices
4.	Sampo Bank	30.06.1992	Previous Optiva Pank, former Forexbank, merged with Raepank in 1995 and with Estonian Investment Bank (established 30.06.92) in 1998, Finnish Sampo-owned since 2000
C. Small Banks			
5.	Estonian Credit Bank	10.04.1992	Small niche bank, majority owned by non-resident legal persons
6.	Tallinn Business Bank	09.12.1991	Small niche bank, majority owned by Estonian legal persons
7.	Preatoni Bank	23.09.1999	Oriented to foreign investments, real estate financing and asset management

Source: Bank of Estonia.

Up till 1997, the development of the Estonian banking sector was characterized by a rapid nominal growth of total assets and loan portfolios. 1997 was also the beginning of a new stage in the development of the Estonian financial sector, especially in the international context, which is confirmed by investment grade credit ratings assigned to Estonia: Standard and Poor's BBB+ and Moody's Investors Service's Baa1. It has to be added that from 2001-2002 Estonia has the following credit ratings by rating agencies (Leemets and Reedik, 2003, p. 49): Moody's foreign currency and Estonian crown (EEK) ratings both A1 (from 12.11.2002); Standard&Poor's rating both A- (from 20.11.2001); Fitch foreign currency rating A- and EEK rating A+ (from 30.08.2001). The rapidly growing economy (GDP growth rate in 1997 about 11%) boosted credit demand, and also non-banking financial inter-mediation accelerated. However, implementation of the expected Estonian banks expansion to the other Baltic countries and Russia was only partly realized due to the tightened market situation both in Estonia and internationally. Negative results of the over-optimistic and risky attitude towards the opportunities of the Eastern market and consequences of the bursting of the 1997 stock exchange bubble in Estonia became clearly evident during 1998-1999.

Compared to previous years, the growth rate of nominal indicators in the banking sector slowed down during 1998-2000, partly due to the changes in the external environment. With the deterioration of the economic environment in 1998, wrong economic and management decisions that had been made already earlier, surfaced in 1998 and resulted, for example, in the dropout of three banks from the banking market in July-October. Some of the more important interrelated systematic factors behind wrong management decisions were: the expansive development in previous years, lack of experience in doing business in the changing market conditions, insufficient

transparency of the market, owners' weak control over the activities of executive management, tightened competition in the banking market, insufficient risk hedging and management, and external shocks.

In 1998, a wave of mergers and restructuring took place in the Estonian banking sector. After the completion of these mergers, Scandinavian banks started to show greater interest in the Estonian banking market. As a result, *Swedbank* acquired 56% of *Hansapank* and *Skandinaviska Enskilda Banken* (SEB) acquired 32% of the Union Bank of Estonia. We may conclude that the Estonian banking sector became healthier when Swedish banks and other Nordic investors joined the circle of bank owners, improving the future outlook of the banking system. So that if during the first banking crises in 1992-1994, Estonia had to resolve the problems by itself, then during the second banking crises in 1998-1999, foreign banks also helped and supported to get over the crises.

Smaller banks in Estonia were affected also by the negative developments in Russia. The liquidation of some banks continued in 1999, accompanied by the declaration of the bankruptcy of *EVEA Pank* and *ERA Pank*. On the other hand, the first new banking licence issued since 1993 was granted to the new *Preatoni Pank* in September 1999. *Preatoni Pank* has focused mainly on intermediation of foreign capital into Estonian economy, real estate financing and asset management. During 1999, Swedish banks - SEB and *Swedbank* - increased their participation in the equity capital of the Union Bank of Estonia and in *Hansapank* over 50%.

2.2 Banking Crises and Bank Rehabilitation

Estonia has experienced two serious banking crises during the about 12-years period of its banking sector development and restructuring, the first crisis in 1992-1994 and the second in 1998-1999. The first banking crisis occurred during the hard period of starting drastic economic reconstruction when production output was reducing dramatically and the country underwent a period of hyperinflation. The characteristic feature of the first banking crisis in Estonia was that it was caused by internal reasons and it was overcome with Estonia's own resources and management skills. The main causes of this banking crisis were severe problems in the whole economy, poor bank management and lack of professional skills, weak supervision both from the side of the central bank and owners. The depositors' losses in the banking crisis were large, the money supply decreased, many loans were depreciated, and the trustworthiness of the banking system fell significantly.

The central bank acted quite quickly and resolutely to overcome the banking crisis. The Bank of Estonia brought the prudential requirements into its operation on the basis of international experience for protecting creditors' and clients' interests beginning from January 1993. In April 1993, the Bank of Estonia announced a stabilization period in the banking system, during what the issuance of new banking licenses was frozen and for the existing banks it established a schedule of gradual rise in minimum equity capital. After that, the Bank of Estonia did not renew licenses of 8 banks, 10 banks merged into one bigger bank, a moratorium was declared on 3 banks.

Looking back, it is possible to establish some signs of future banking crisis in 1998-1999:

- Estonian banks took extraordinary high financial risks through investment companies and their subsidiary companies to get big profits via speculating in securities market – rapid fall in prices on the share market in autumn 1997 reduced significantly banks' profits and at the end of 1997 and in 1998 almost all banks operated in losses;
- Banks hold very high negative level of gap (interest rate sensitive liabilities exceeded significantly rate-sensitive assets) for earning excessive profits in the environment were interest rates steadily decreased during the previous years and they were not able to adjust to changed environment with increasing interest rates from the second half-year of 1997;
- Commercial banks absorbed heavily into non-banking business – for example, later bankrupted the Land Bank of Estonia owned seven subordinate establishments and related companies, which dealt with leasing and investing, and with anything else but banking (hotels, processing agricultural products, broadcasting etc), also other banks were absorbed into risky non-banking business;

- The decision to expand to the Eastern market (Russia and other Baltic States), where the interest rates and possible profitability seemed to be higher, was also too risky and premature, especially in the framework of the Russian crisis in 1998;
- There were various disputes and conflicts if interests between the owners and management which led to wrong (mismanagement) decisions Good examples should be the Land Bank of Estonia and the Estonian Investment Bank – for example, the shareholders of the Investment Bank intended to sell the bank to the German Schleswig-Holstein Bank in autumn 1997, but the top executives threatened to hand in a collective resignation and so the bank was sold to them.
- Sometimes there were inadvisable relations between the bank management and political powers, and corresponding political pressure – a typical "political" bank was the Land Bank of Estonia where almost all financial risks were ignored and later the Government lost its deposits in the bank amounting to more than 800 million EEK (more than 50 million euros).

The occasion of starting the second banking crisis was the burst of a market bubble on the Tallinn Stock Exchange in the Autumn 1997, caused partly by the impact of the financial crises in the South-East Asia and supported lately by the Russian crisis in Autumn 1998. In 1998, a wave of mergers and restructuring took place in the Estonian banking sector. We may conclude that Estonian banking sector became healthier when Swedish banks and other Nordic investors joined the circle of owners of banks, improving banking system' future outlook. So, if during the first banking crisis in 1992-1994 Estonia had to resolve the problems by itself then during the second banking crisis in 1998-1999 foreign banks also assisted and supported to get over the crisis.

The authors are on the opinion that the currency board arrangement helped in Estonia to resolve banking crises rapidly and mostly effectively without remarkable rehabilitation costs. The main instruments for anticipating banking crises are tightening of prudential requirements and strengthening of banking supervision. Recent changes in the operational framework for monetary policy and banks' prudential ratios in Estonia were aimed at enhancing financial stability and increasing the liquidity buffers of the financial system. The currency board arrangement supported and strengthened the discipline and responsibility of the main actors – banks, the central bank, depositors, and the Government. A stable currency and presence of respective financial safety net compensated the absence of classical lender-of-last resort facility and ensured development of in general reliable banking sector.

2.3 Structural Developments

The structure of the Estonian banking sector has changed fundamentally during the last years. Today, the banking system is highly concentrated and two Swedish-owned banks dominate in the market (see also Table 1). The consolidation process continued throughout the second banking crisis in 1998-1999 resulting in fundamental bank reorganizations. We can notice all three world-wide trends in the financial consolidation process also in the Estonian market: domestic consolidation, foreign entry and cross-border consolidation, and the formation of financial conglomerates. Some characteristics of the development of the Estonian financial market structure are presented in Table 2.

Some interesting conclusions from Table 2:

- The banking market concentration (the share of three largest banks' assets in total banks' assets) achieved more than 90% already in 1998; it was 90.4% at the end of 2002;
- foreign banks' share in total assets of Estonian commercial banks increased dramatically and was 97.5% at the end of 2002;
- the Estonian financial sector is clearly bank-oriented – the bank assets to GDP ratio was 75.6% and the banks assets share in total financial assets was 45.2% at the end of 2002;
- private credits by banks and other financial institutions increased considerably during the analyzed period – private credits by banks to GDP ratio was 46.2% and overall private credits to GDP ratio 62% in 2002;
- relatively rapidly have grown leasing and factoring portfolio (about four times during 1997-2002) and stock market capitalization (about 5.5 times); total financial assets ratio to GDP has risen to 167% at the end of 2002.

Table 2. Some Indicators of the Estonian Banking and Financial Sector Development, 1997-2002

Indicator	1997	1998	1999	2000	2001	2002	02/97
Number of commercial banks	11	6	7	7	7	7	0.636
Number of private banks	11	5	6	7	7	7	0.636
Number of foreign banks	1	2	2	4	4	4	4.000
Concentration index C3, %	69.7	93.0	92.4	91.1	91.1	90.4	1.297
Concentration index C5, %	83.4	99.4	98.9	98.8	98.9	99.1	1.188
Total assets, EUR m	2594	2620	3008	3695	4372	5221	2.013
Total assets/GDP, %	63.4	55.7	61.7	67.7	71.8	75.6	1.192
Foreign ownership in share capital, %	44.2	60.7	61.6	83.6	85.4	86.7	1.962
Major foreign ownership in total assets, %	2.3	90.2	89.8	97.4	97.5	97.5	42.39
Private credit by banks, EUR m	1362	1527	1704	2189	2601	3193	2.344
Private credit by banks/GDP, %	33.2	32.6	35.4	40.1	42.7	46.2	1.392
Leasing and factoring portfolio, EUR m	315	399	433	644	893	1232	3.911
Leasing and factoring/GDP, %	8	8	9	12	15	18	2.250
Debt market capitalization, EUR m	258	235	204	231	279	211	0.818
Debt market capitalization/GDP, %	6	5	4	4	5	3	0.500
Stock market capitalization, EUR m	837	531	1913	2095	1999	4570	5.460
Stock market capitalization/GDP, %	20	11	39.8	38.4	32.8	66.2	3.310
Insurance gross collected premiums, EUR m	70	81	83	98	112	134	1.914
Gross collected premiums/GDP, %	1.7	1.7	1.7	1.8	1.8	1.9	1.118
Investment funds' assets, EUR m	97	23	73	95	193	280	1.887
Investment funds' assets/GDP, %	2.4	0.5	1.5	1.7	3.2	4.1	1.708
Total financial assets, EUR m	2458	2912	5550	6727	7748	11551	4.699
Total financial assets/GDP, %	60	62	115	123	127	167	2.783
Total private credit, EUR m	n.a.	1902	2106	2777	3395	4308	2.265
Total private credit/GDP, %	n.a.	40	43	50	55	62	1.550
GDP, EUR m	4110	4685	4813	5458	6089	6904	1.680
GDP real growth, %	10.6	4.7	-1.1	6.4	5.3	4.7	n.a.

Source: Bank of Estonia

Notes: (1) Total financial assets consist of the assets of the central bank and other financial institutions, debt securities market, stock market, leasing and factoring portfolio, and insurance gross premiums from; (2) Foreign banks consist of foreign banks' branches in Estonia and the banks majority owned by foreign banks.

The ownership structure of Estonian banks is presented in Table 3. The dependence of the Estonian banking system on the developments in international financial markets and on foreign investors' preferences deepened from year to year. In the course of the restructuring process, foreign banks increased their share in equity capital from 10.3% in 1996 to 79% at the end of 2002. The total share of non-resident owners has risen to 86.7% at the end of 2002.

Table 3. Ownership Structure of Estonian Banks, %

Year	Estonian Owners				Non-Resident Owners			
	Public Sector	Legal Persons	Individuals	Total	Banks	Legal Persons	Individuals	Total
1996	12.0	NA	NA	62.8	10.3	NA	NA	37.2
1997	4.2	41.6	11.3	57.1	22.7	19.6	0.6	42.9
1998	13.6	22.3	8.6	44.5	45.5	9.5	0.5	55.5
1999	11.6	15.2	11.0	37.6	52.6	8.9	0.7	62.2
2000	0.0	6.8	9.3	16.1	67.0	16.7	0.2	83.9
2001	0.0	5.6	8.5	14.1	63.3	22.3	0.3	85.9
2002	0.0	5.2	8.1	13.3	79.0	7.6	0.1	86.7

Source: Bank of Estonia

3. METHODOLOGY OF MALMQUIST PRODUCTIVITY INDEXES

3.1. Output Distance Function

To define an output distance function, consider a sample of K firms using $x^t \in \Re_+^N$ inputs in the production of $y^t \in \Re_+^M$ outputs in time period t = 1,...,T. A multiple inputs and multiple outputs production technology may be defined using the output set, P, which represents the set of all outputs vectors, $y'=(y^t_1,\ldots,y^t_m)$, which can be produced using the input vector, $x^t = (x^t_1,\ldots, x^t_n)$ in time period t = 1,...,T. That is

$$\mathrm{P^t(x^t)} = \left\{ y^t : x^t \text{ can produce } y^t \text{ at time t} \right\} \qquad t=1\ldots T. \tag{1}$$

In an output-based approach, the production technology is completely characterized by the *output distance function* (see Shephard 1970), defined on the output set $P^t(x^t)$ as

$$D^t(x,y) = \min\left\{ \delta \in (0,1] : (y/\delta) \in P^t(x) \right\} \qquad t=1\ldots T. \tag{2}$$

The distance function is less than, or equal to one (i.e. $D(x,y) \le 1$), if and only if output y belongs to the production possibility set of x (i.e. $y \in P(x)$). Note that distance function is equal to unit (i.e. $D(x,y) = 1$) if y belongs to the "frontier" of the production possibility set. A firm is considered as technically efficient if the distance function equals one.

3.2 Prouctivity Indices

Productivity indices explain the role of index numbers in measuring growth in outputs (output-oriented approach) that is net of inputs' growth. One way to measure the change in productivity is to see how much more output has been produced, using a given level of inputs and the present state of technology, relative to what could be produced under a given reference technology using the same level of inputs. An alternative is to measure change in productivity by examining the reduction in input use, which is feasible given the need to produce a given level of output under a reference technology. These two approaches are referred to as the output-oriented and input-oriented measures of change in productivity (see Coelli et al., 1998). There are several papers by Caves et al. (1982), Färe et al. (1997), Førsund (1997), Balk (1997) and Coelli et al. (1998) that provided a theoretical framework for measurement of productivity.

3.3 The Malmquist Productivity Index

In order to identify productivity differences between two firms, or one firm over two time periods, the Malmquist productivity index can be used (see Malmquist, 1953 and Caves et al., 1982). Malmquist index numbers can be defined using either the output-oriented approach or the input-oriented approach. For the moment I concentrate on one firm over two periods output-oriented Malmquist productivity index. The output-orientated productivity measures focus on the maximum level of outputs that could be produced using a given input vector and a given production technology relative to the observed level of outputs. This is achieved using the output distance functions and Caves et al. (1982) showed how distance function can be used to define Malmquist indices of productivity change.

Caves et al. (1982) proposed, that output-based Malmquist productivity index between time periods t and $(t + 1)$ can be defined as:

$$M_{t,t+1}\left(y^t, y^{t+1}, x^t, x^{t+1}\right) = \left[\frac{D^t(y^{t+1}, x^{t+1})}{D^t(y^t, x^t)} \times \frac{D^{t+1}(y^{t+1}, x^{t+1})}{D^{t+1}(y^t, x^t)} \right]^{1/2}, \tag{3}$$

where the notation *D* represents the distance function and a value of *M* is the Malmquist productivity index. The first ratio represents the period *t* Malmquist index. It measures productivity change from period *t* to period *(t+1)* using period *t* technology as a benchmark. The second ratio is the period *(t + 1)* Malmquist index and measures productivity change from period *t* to period *(t* + 1) using period *(t* + 1) technology as a benchmark. A value of *M* greater then one (i.e. *M* >1) denotes productivity growth, while a value less than one (*M* < 1) indicates productivity decline, and *M= 1* corresponds to stagnation.

Färe et al. (1989) showed that the Malmquist productivity index can be decomposed into two components, what is an equivalent way of index (3), as

$$M_{t,t+1}\left(y^{t}, y^{t+1}, x^{t}, x^{t+1}\right) = \underbrace{\frac{D^{t+1}(y^{t+1}, x^{t+1})}{D^{t}(y^{t}, x^{t})}}_{CU_{t,t+1}} \underbrace{\left[\frac{D^{t}(y^{t}, x^{t})}{D^{t+1}(y^{t}, x^{t})} \times \frac{D^{t}(y^{t+1}, x^{t+1})}{D^{t+1}(y^{t+1}, x^{t+1})}\right]^{1/2}}_{TC_{t,t+1}} \quad (4)$$

In this equation the term outside the brackets ($CU_{t,t+1}$) is a ratio of two distance functions, which measures the *change in the output-oriented measure of Farell technical efficiency* between period *t* and *t+1* as a "catching-up to the frontier" effect. The square root term ($TC_{t,t+1}$) in equation (2) is *a measure the technical change* in the production technology. It is the geometric mean of the shift in technology between the two periods, evaluated at x^t and also at x^{t+1}. The term ($CU_{t,t+1}$) is greater than, equal to, or less than 1 if the producer is moving closer to, unchanging, or diverging from the production frontier. The square root term ($TC_{t,t+1}$) is greater than, equal to, or less than 1 when the technological best practice is improving, unchanged, or deteriorating, respectively.

The Malmquist productivity index can be interpreted as a measure *of total factor productivity (TFP)* growth. Improvement in productivity, as well as improvement in efficiency and technology, is indicated by values greater than one, whereas value less than one indicate regress. Malmquist productivity index *M* and its two components are local indices. This feature allows considerable flexibility in explaining the considered model of productivity change, both across producers and over time. Calculation and decomposition of the adjacent period version of the Malmquist index in (2) includes four different *distance functions*, $D^t(y^t, x^t)$, $D^t(y^{t+1}, x^{t+1})$, $D^{t+1}(y^t, x^t)$ *and* $D^{t+1}(y^{t+1}, x^{t+1})$, which are the reciprocal of the Farrel technical efficiency indicators. In this study we have used the DEA-like methods to estimate the frontier functions and a data envelopment analysis computer program DEAP for calculation Malmquist TFP indexes.

4. DATA AND RESULTS OF USING MALMQUIST INDEXES

We contemplate the banking firm as a multi-product organization that produces three outputs (loans, deposits and other banking services) with two different inputs (labor and offices). Variable definition is a serious problem in banking studies. The final solution depends upon the concept of what banks do, on the stated problem, and on the availability of data. We use the inter-mediation approach, and variables are defined as follows. For outputs, y_1 are loans (loans to clients, net provisions), y_2 are deposits (deposits from clients) and y_3 are other bank services (commissions received plus net profit from financial operations). For inputs, x_1 are number of employees and x_2 are number of offices.

We used the data from the banks' annual balance sheets and income statements for 1999 to 2002 in this study. The sample includes all 6 domestic commercial banks operating in Estonia during this period. Table 4 contains some information on the variables used. The columns of Table 4 show the maximum, minimum, average, standard deviation and coefficient of variation (CV) over bank for four years. The data in Table 4 allows an increase in productivity, while the value of bank products (loans, deposits and other banking services) has increased more that the bank inputs (labor and offices number). Reputedly this could be the result of technical efficiency or technological progress.

Table 5 shows correlation between the output and input variables. Strongest correlation is among outputs variables – loans (y_1), deposits (y_2) and other bank services (y_3). Correlation between loans and deposits is 0,9977. Lowest correlation in table 2 is between other bank services (y_3) and number of bank offices (x_2).

Table 4. Summary Information on the Output and Input Variables

	12/99	12/00	12/01	12/02
*(y_1) Loans**				
Max	13770,5	20608,2	23210,2	28183,6
Min	19,6	57,4	68,8	79,1
Average	4052,9	5294,7	6244,0	7493,3
Standard deviation	5753,17	8173,59	9237,00	11168,21
CV	142%	154%	148%	149%
*(y_2) Deposits**				
Max	15396,7	20616,7	24653,3	27514,4
Min	15,9	53,5	91,7	52
Average	4208,3	5492,2	6737,8	7646,9
Standard deviation	6239,11	8238,68	9810,15	10967,26
CV	148%	150%	146%	143%
*(y_3) Other bank services**				
Max	346,7	424,8	457,8	551,7
Min	0,6	0,9	4,2	1
Average	74,6	115,4	126,6	141,3
Standard deviation	134,92	170,87	182,58	219,87
CV	181%	148%	144%	156%
(x_1) Number of employees				
Max	1898	1949	2076	2021
Min	15	14	14	15
Average	604,5	589,5	628,7	631,3
Standard deviation	768,79	764,94	809,83	790,00
CV	127%	130%	129%	125%
(x_2) Number of offices				
Max	129	113	107	92
Min	1	1	1	1
Average	39,5	35,0	33,8	31,3
Standard deviation	53,95	45,80	42,63	37,68
CV	137%	131%	126%	120%

Note: * denotes millions of Estonian crowns (EEK) at original prices.

Table 5. Correlation matrix for the output and input variables

	Y_1	y_2	y_3	x_1	x_2
Y_1					
Y_2	0,9977				
Y_3	0,9824	0,9871			
X_1	0,9637	0,9705	0,9522		
X_2	0,8945	0,9079	0,8868	0,9772	

Table 6 summarizes productivity change results, that is, the evolution of the Malmquist index (M), as well as its catching-up (CU) and technological change (TC) components. The results suggest that Estonian banks experienced average a 25,6 percent annual productivity growth rate (that is M-1) during 1999-2002, a total of 105,4 percent for the period. Productivity increase is mainly the result of a 17,4 percent per year technological progress (68,0 percent for the period).

The average catching-up effect, while positive, is low at only 6,9 percent per year (22,3 percent for the period). The behavior of catching-up effect is mainly due to the poor results of catching-up effect from 2001 to 2002 – CU decrease 14,3 percent. There was also the productivity decrease 2,5 percent for the period 2001-2002.

Table 6. Productivity Change Indexes

Years	Number of Banks	Malmquist Index (M)	Catching Up (CU)	Technological Change
1999-2000	6	1,624	1,223	1,327
2000-2001	6	1,251	1,167	1,072
2001-2002	6	0,975	0,857	1,138
Geometric Average		1,256	1,069	1,174
1999 & 2002	*6*	*2,054*	*1,223*	*1,680*
1999 & 2001	*6*	*2,055*	*1,428*	*1,440*
1999 & 2000	*6*	*1,624*	*1,223*	*1,327*

Note: All indexes are geometric averages.

Table 7 shows productivity scores by different banks. All banks in Estonia show positive productivity growth *(M* > 1) regardless of bank size. That is the result of technological progress *(TC* > 1). For three banks catching up with the best practice is more or equal 1 (with the slight exception of three banks - Eesti Ühispank, Sampo Pank, Tallinna Äripanga AS, where CU<1). Although Eesti Ühispank, Tallinna Äripanga AS and Sampo Pank were relatively similar able to get closer to the efficient production frontier *(CU* < 1), on the same time Tallinna Äripanga AS and Sampo Pank shows lower levels of technological change and have therefore experienced lower levels of productivity change.

Table 7. Malmquist index summary of bank means (1999-2002)

Bank	Malmquist Index (M)	Catching Up (CU)	Technological Change (TC)
Eesti Krediidipank	1,371	1,146	1,196
Eesti Ühispank	1,161	0,972	1,195
Hansapank	1,251	1,000	1,251
Sampo Pank	1,071	0,971	1,103
Preatoni Pank	1,631	1,423	1,146
Tallinna Äripanga AS	1,127	0,972	1,160
Geometric Average	1,256	1,069	1,174

Note: All indexes are geometric averages.

Eesti Krediidipank (B1) and Preatoni Pank (B5) were able to experience highest productivity (M > geometric average M) and trying to catch up with the best practices (CU > geometric average CU). The technological change by different banks, where the best technological change that is 25,1 percent average annual technological change for the period 1999-2002 has Hansapank (B3). For Eesti Krediidipank (B1) it is surprising the evenly high level of technological change (TC > geometric average TC), trying to catch up with the best practices (CU > geometric average CU) and therefore obtained high level of productivity change. The newest and smallest bank in Estonia - Preatoni Pank (B5) exhibit better scores in most indicators on period 1999-2002. This could be partly explained by the fact that new institution was attractive to the public in Estonia and this bank started to work very rationalizing their input usage and so getting closer to the best practice. Maybe the reason, that two biggest banks – Hansapank (B3) and Eesti Ühispank (B2) have high technological change but not the highest productivity, is a result of a strategy aimed at establishing themselves as credible competitors in the market and so they loosed the dependence of clients in the market war. In short, we may conclude that Estonian banks have been able to experience technological progress and some big banks are quicker at improving their production technologies. We cannot say that higher productivity is the clear signal for success, since Hansapank, Eesti Ühispank and Sampo Pank are the three biggest banks in Estonia, but the obtained levels of productivity scores are fairly different.

5. DUPONT FINANCIAL RATIO ANALYSIS: METHODOLOGY

The starting point of the bank performance analysis is to calculate the book rate of return on equity, ROE

$$ROE = \frac{\text{Earnings After Taxes, } EAT}{\text{Book Value of Equity, } BVE} \tag{5}$$

which consists of three components:

- pull-through, U

$$U = \frac{\text{Earnings After Taxes, } EAT}{\text{Earnings Before Taxes, } EBT} \tag{6}$$

- financial leverage, LEV

$$LEV = \frac{\text{Total Assets, } TA}{\text{Book Value of Equity, } BVE} \tag{7}$$

- return on total assets, ROA

$$ROA = \frac{\text{Earnings Before Taxes, } EBT}{\text{Total Assets, } TA} \tag{8}$$

These financial ratios form the multiple factor system

$$ROE = \frac{EAT}{EBT} \times \frac{TA}{BVE} \times \frac{EBT}{TA} = \frac{EAT}{BVE} \tag{9}$$

All these financial ratios are widely used for a bank performance analysis. Pull-through (U) shows success of the bank tax management policy as it may be interpreted as one minus the average corporate tax rate. The financial leverage ratio (LEV) measures how many Estonian crowns (EEK) of assets the bank has per EEK of equity and may be interpreted as a bank's "gearing". Return on total assets (ROA) is one of the most frequently used financial ratio by financial analysts. ROA measures the ability of bank management to generate income after all financial and non-financial costs and expenses for owners.

Changes in ROA are usually the cause of the most important changes in banks' performance and need a more detailed analysis. The other financial ratios such as components of ROE, pull-through (U) and financial leverage (LEV), reflect tax treatment and capitalization rate, and they usually change less. ROA may be divided into the following components:

- bank burden, B

$$B = \frac{\text{Net Non - Interest Revenue, } NNIR}{\text{Total Assets, } TA} = \frac{NIR - NIE}{TA} \tag{10}$$

where *NIR* - non-interest revenue;
NIE - non-interest expense;

- earning assets ratio, EAR

$$EAR = \frac{\text{Earning Assets, } EA}{\text{Total Assets, } TA} \tag{11}$$

- net interest margin, NIM

$$NIM = \frac{\text{Net Interest Revenue, } NIR}{\text{Earning Assets, } EA} = \frac{IR - IE}{EA} \tag{12}$$

where *IR* - interest revenue;
IE - interest expense,
Financial ratios (6-8) form a factor system

$$ROA = \frac{NNIR}{TA} + \frac{EA}{TA} \times \frac{NIR}{EA} = \frac{NNIR + NIR}{TA} = \frac{EBT}{TA} \tag{13}$$

Burden (B) measures a bank management's control of operating expenses. The burden for banks is negative to show the fact that non-interest revenue (fees, earned commissions, other operating income) does not cover labor and other administrative or non-interest expenses. Earning assets ratio (EAR) is usually not an important factor of changes in ROA but it may be interesting to make comparisons between various banks because EAR characterizes different development strategies. Net interest margin (NIM) is a more important and widely used financial ratio in the factor system (13). NIM reflects the interest spread between assets and liabilities, it focuses on the net earnings from investing through borrowed funds and is the major source of profitability for the bank. For a more detailed analysis, NIM may be divided into three following components:

- return on earning assets, REA

$$REA = \frac{\text{Interest Revenue, } IR}{\text{Earning Assets, } EA} \tag{14}$$

- cost of liabilities, COL

$$COL = \frac{\text{Interest Expense, } IE}{\text{Liabilities, } L} \tag{15}$$

- liabilities to earning assets ratio, LEA

$$LEA = \frac{\text{Liabilities, } L}{\text{Earning Assets, } EA} \tag{16}$$

which form the factor system

$$NIM = \frac{IR}{EA} - \frac{IE}{L} \times \frac{L}{EA} = \frac{IR - IE}{EA} = \frac{NIR}{EA} \tag{17}$$

Return on earning assets (REA) connects directly earning assets and interest revenue generated by them. Thus, REA characterizes the average rate of lent funds and earned dividends. The cost of liabilities (COL) may be interpreted as the average price of borrowed capital.

6. BANKING SECTOR PERFORMANCE AND PROFITABILITY (DUPONT ANALYSIS)

It is argued that internationalization, adoption of new banking technologies, deregulation, banking market consolidation and other trends in financial intermediation should result in increasing efficiency. On the other hand, since banks are no longer monopoly suppliers of financial services and products and markets are more contestable (increased competition between banks and new competition from non-bank financial institutions and markets), intermediation margins, net interest income and other income should result in decreasing profitability and efficiency. In any case, elimination of inefficiencies and reducing costs would be a challenge for banks' survival in the rapidly changing market environment. Initial financial information for Estonian banking sector performance analysis is presented in Table 8 on the basis aggregated consolidated financial statements published by the Bank of Estonia.

Table 8. Simplified Consolidated Financial Statements of the Estonian Banking System

Items	1994	1997	2000	2001	2002	02/94	02/01
Income Statement Data							
Interest Revenue, IR	943.6	2658.5	3744.2	4308.1	4253.5	4.508	0.987
Interest Expense, IE	312.8	1217.5	1811.9	2125.7	1883.0	6.020	0.886
Net Interest Revenue, NIR = IR – IE	630.8	1444.1	1932.3	2182.4	2370.5	3.758	1.086
Non-Interest Revenue, NOIR	457.0	3272.0	2065.6	2895.1	2613.4	5.719	0.903
Non-Interest Expense, NOIE	1019.8	3644.4	3384.8	3373.7	3769.1	3.696	1.117
Net Non-Interest Revenue, NNIR = NOIR – NOIE	-562.8	-372.4	-1319.2	-478.6	-1155.7	2.053	2.415
Earnings Before Taxes, EBT = NIR + NNIR	68.0	1068.9	613.1	1703.8	1214.8	17.86	0.713
Earnings After Taxes, EAT	40.9	963.1	613.1	1683.4	1153.2	28.20	0.685
Balance Sheet Data							
Cash and Reserves, R	1527,8	3203.8	6578.0	6212.3	5166.2	3.381	0.832
Earning Assets, EA	6117.8	25817.0	42019.6	53544.0	66827.5	10.92	1.248
Fixed and Other Assets, FA	742.9	2743.1	3847.3	3358.7	3054.9	4.112	0.910
Total Assets, TA = R+EA+FA	8388.5	31763.9	52444.9	63115.0	75048.6	8.947	1.189
Liabilities, L	7667.3	28562.7	45164.2	54936.0	65549.2	8.549	1.193
Book Value of Equity, BE	721.2	3201.2	7280.7	8179.0	9499.4	13.17	1.161

Source: Bank of Estonia, Annual Reports.

The Estonian banking system has grown rapidly in nominal terms. Respective growth rates for 2002/1994 and 2002/2001 are also presented in Table 8. In general, we can see high growth rates in almost all balance sheet and income statement items during the period 1994-2002. A financial ratio analysis is needed for analyzing profitability and efficiency changes in the banking system, using a modified version of DuPont financial ratio analysis technique (see Dietrich, 1996).Using initial data from Table 8 (the balance sheet data are averaged), results of DuPont financial ratio analysis are presented in Table 9.

These results need some comments, focusing on the growth rates of 2002/1994.

- The book rate of return on equity (ROE), which is the most widely used and popular measure of the bank performance results from the viewpoint of owners/investors, increased during the analyzed period from 5.67% in 1994 to 12.14% in 2002, i.e. more than two times. We can also mention very high volatility of profitability ratios (both ROE and ROA) during the analyzed period. Banks after-tax earnings to earnings before taxes ratio (pull-through, U), which characterizes the banks tax management policy efficiency because $(1 - U) = t$ (t - the average tax rate), also increased during this period. Banks were more skilful at

finding various "tax shelters" in 1997 compared with 1994, also later. Banks' financial leverage ratio (LEV) decreased substantially due to the central bank's new equity requirements, which forced banks to raise equity or to merge. Financial leverage rose again in 2001 and 2002. The main factor of ROE change is the increase of the return on total assets (ROTA), which needs a more detailed analysis.

- ROTA rose from 0.81% to 1.62% between 1994 and 2002 was caused by the significant decrease of the Estonian banks' burden (B) due to the improvement of the banks' cost control and services pricing, also due to the substantial increase in the share of interest-earning assets in total assets. However, the net interest margin level (NIM), which reflects the interest rate spread between assets and liabilities for deposit-taking financial institutions and is the major source for the profitability of banks, has decreased substantially, from 10.31% to 3.55 %, i.e. about three times. This phenomenon also needs further analysis.
- We may draw some important and interesting conclusions from the component analysis of the substantial decrease of the NIM level:

(a) The average return on earning assets (REA) has fallen substantially over the recent years due to the overall falling of interest rates in the Estonian banking market, the average cost of liabilities (COL) increased slightly and fell in 2001 and in 2002 compared with 2000;

(b) REA has fallen much faster than COL, i.e. the interest spread decreased considerably over the analyzed period ((15.42% - 4.08%) - (6.37% - 2.87%) = 11.34% - 3.50% = 7.84%), - this change reflects the sharpened competition between banks themselves and with other financial institutions;

(c) liabilities to earning assets ratio (LEA) has also fallen substantially, i.e. Estonian commercial banks intensified their lending and investment activities, and almost all available resources (in 2002, also a part of the equity) have been invested in the earning assets.

Table 9. Financial Ratio Analysis of Estonian Commercial Banks (1994-2002)

Financial Ratio	1994	1997	2000	2001	2002	02/94	02/01
Book Rate of Return, %,ROE = EAT/BVE	5.671	30.09	8.59	20.58	12.14	2.141	0.590
Components of ROE, ROE = U×LEV×ROTA							
Pull-through, %, U = EAT/EBT	60.15	90.10	100.0	98.80	94.93	1.578	0.961
Financial Leverage, LEV = TA/BE	11.63	9.92	7.203	7.717	7.90	0.679	1.024
Return on Total Assets, ROTA = EBT/TA	0.811	3.365	1.192	2.700	1.619	1.996	0.600
Components of ROTA, ROTA = B + EAR×NIM							
Burden, %, B = NNIR/TA	-6.709	-1.172	-2.493	-0.755	-1.540	0.230	2.040
Earning Assets Ratio, %, EAR = EA/TA	72.93	81.28	80.12	84.84	89.05	1.221	1.050
Net Interest Margin, %, NIM = NIR/EA	10.31	5.594	4.599	4.076	3.547	0.344	0.870
Components of NIM, NIM = REA – COL×LEA							
Return on Earning Assets, REA = IR/EA	15.42	10.30	8.921	8.046	6.365	0.413	0.791
Cost of Liabilities, %, COL = IE/L	4.080	4.263	4.012	3.869	2.873	0.704	0.743
Liabilities to Earning Assets Ratio, LEA = L/EA	1.253	1.106	1.075	1.026	0.981	0.783	0.956

Source: Authors' calculations..

7. CONCLUDING REMARKS

The development of the Estonian banking sector can be described by a quite rapid nominal growth of total assets, loan portfolios, net income, and other quantitative financial indicators. Although the Estonian banking market was already quite concentrated, the consolidation process continued. The capitalization of Estonian banks improved, and the share of non-residents in the share capital increased significantly during the analyzed period.

This analysis has measured productivity differences between 6 Estonian domestic commercial banks by Malmquist productivity index and its catching-up and technological change components. The data used in this study covers the period

from 1999 to 2002. Looking at individual years, the highest productivity growth rate over all Estonian banks was observed from 1999 to 2000. There was also the productivity decrease 2,5 percent for the period from 2001 to 2002. The results suggest that Estonian banks experienced a 25,6 percent average annual productivity growth rate during 1999-2002, what was mainly the result of technological progress, while the average catching-up effect was relatively low.

Comparing the banks over period 1999-2002, it is found that Preatoni Bank has experienced the highest productivity growth and the highest catching up with the best practices but lower levels of technological change. Eesti Ühispank, Sampo Pank and Tallinna Äripanga AS had obtained lower levels of productivity change what is mainly the result of the low catching up with the best practices. For Eesti Krediidipank it was surprising the high level of technological change, the high catching up with the best practices and therefore high level of productivity change. Hansabank has experienced the strong productivity growth and the highest technological change levels, suggesting that the biggest Estonian bank has more possibilities investigated in technology. Generally, we may conclude that during 1999 to 2002, Estonian banks have increased productivity as a result of technological progress.

As the Estonian banking system is developing rapidly, both input and output quantitative financial indicators have increased substantially during the analyzed years. There was an overall falling of the market-determined interest rates in the Estonian banking market, the interest spread decreased substantially, which influenced the dynamics of various discussed financial ratios. The rise of the Estonian commercial banking system performance efficiency, which is revealed in the increase of the rate of return indicators such as return on assets (ROA) and return on equity (ROE), was caused mainly by the changes in the proportions between output indicators (for example, the banks' burden has decreased substantially). The traditional output/input-type efficiency ratios (interest or income on assets or on equity ratios) however, decreased substantially during the analyzed period.

8. ENDNOTE

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