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Financial deregulation and total factor productivity change: An empirical study of Turkish commercial banks

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Abstract

In January 1980, a new liberal economic policy was adopted in Turkey to promote financial market development and increase the efficiency and productivity of the financial sector by fostering competition among banks. As a result of this policy, the Turkish banking system witnessed a series of legal, structural and institutional changes throughout the 1980s. To enhance their competitive viability, Turkish banks responded by streamlining their operations and investing in new technology. Utilizing a DEA-type Malmquist Total Factor Productivity Change Index, we examine productivity growth, efficiency change, and technical progress in Turkish commercial banks during the deregulation of financial markets in Turkey. We found that all forms of Turkish banks, although in different magnitudes, have recorded significant productivity gains driven mostly by efficiency increases rather than technical progress. Efficiency increases, however, were mostly owing to improved resource management practices rather than improved scales. Our results also indicate that private banks began to close their performance gap with public banks in the new environment.

JEL classification: G21; G28
Keywords: Efficiency; Technology; Productivity; Turkish banks; Deregulation; Liberalization; DEA

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1. Introduction

Almost all financial transactions taking place in both money and capital markets in Turkey are conducted by banks, which have been the key instrument of the government-orchestrated economic development policy for years. As anywhere else in the world, banking in Turkey has been a highly regulated industry, commensurate with its importance in the financial system. Market entry and exit, capital adequacy, reserve and liquidity requirements, asset portfolio allocation, number of branches, deposit insurance, interest rates on deposits and loans have been heavily regulated by the state. With these restrictions, the regulators tried to prevent "excessive competition" for funds, and thereby providing *rents* to banks. The rationale was arguably to enhance the safety and soundness of banks by increasing their profitability. Under such strong patronage and protection, Turkish banking has been traditionally and until recently a closed system, characterized and controlled by a few giant banks, immune to the disciplinary forces of competition, sluggish and careless in terms of innovations, and yet very profitable.

However, the Turkish financial system has undergone strong legal, structural and institutional changes in recent years. Throughout the 1980s, a series of financial reforms were introduced, whose main objectives were to boost the efficiency and productivity of banks by limiting state interventions and enhancing the role of market forces. Also, Turkey's determination to be a permanent member of the European Union (EU) has motivated its banking authorities to ensure that their regulations are in harmony with those in the union. In this context, interest and foreign exchange rates were freed. Starting in 1984, foreign exchange deposits could be opened by residents and non-residents, providing extra business for banks. New entrants to the banking system and new types of financial institutions and products were permitted. [2] The first attempt to sell treasury securities through periodic auctions started in 1985. The Istanbul Stock Exchange (ISE) and Interbank Money Market were established in 1986 to provide liquidity in the financial system. Most directed credit programs and preferential rates were eliminated, contributing to more efficient resource allocation (Denizer, 1997). The Turkish Privatization Law was enacted in 1986 to undertake the privatization of state economic enterprises in priority order (Altunbas et al., 1994). Open market operations, auditing of banks by independent external auditors, unified accounting principles and a standard reporting system were adopted in 1987. Foreign Exchange and Foreign Banknote Markets were established in April 1989. Banks enriched their service portfolios by asset-backed securities, mutual funds, interest and currency rate forwards and swaps, trading in government and private securities, repo transactions, consumer credits and financial consultation. Turkish banks also took an interest in doing business abroad either by purchasing foreign banks or opening branches and representative offices. [3]

[2] Special finance houses, doing business according to Islamic banking principles, were also welcomed to the system beginning in 1984.

[3] As of 1996, Turkish banks have individual or joint equity participations in 48 banks and/or other financial institutions in different parts of the world.

The changes in both internal and external conditions of banking have altered the way in which Turkish banks do business and put the spotlight on input saving. The most obvious external change in the past two decades is the liberalization of the financial markets, while the most apparent internal change is the heavy investment in technology. Most certainly, Turkish financial institutions today operate under more liberal conditions than they did before the 1980s (Akkurt et al., 1992; Atiyas and Ersel, 1994; Zaim, 1995; Denizer, 1997). Product and territorial competition has increased as the domestic market opened up. In response, Turkish banks have taken measures to reduce their branches and personnel and terminate their unprofitable ventures. Also, advances in communication and processing technology have reduced the franchise value of operating extensive branching networks, which have decreased the minimum efficient size for potential entries to compete effectively with established banks. Thus, we expect that heavy investment in automation and computerization projects, substantial entries from inside and outside of the country and increased bank costs following deregulation have stimulated banks to use their resources more rationally and/or expand their products and services more eagerly. Accordingly, we *hypothesize* that heightened competitive pressures created strong incentives for Turkish banks to streamline their operations, which improved their ratio of outputs to inputs, thereby increasing their efficiency and productivity.

Berger et al. (1993), and Berger and Humphrey (1997) caution that although significant financial changes were taking place all around the globe, efficiency and productivity studies have not kept pace with these changes because most of them were related to the institutions of the industrialized countries (mostly US). Very few productive efficiency studies have been conducted regarding the financial institutions of emerging and mixed economies (Beim and Calomiris, 2001). As Benston (1972) points out, to explore the impact of environmental changes on bank performance, it is essential to determine the production (cost) function in banking, which is estimated by assuming constant technology. However, banking technology is subject to shifts owing to such factors as experience, increased knowledge, new innovations and better production techniques and heightened competition (Hunter and Timme, 1986). In this context, no empirical work has studied the impact of the new liberal policies put into effect in the 1980s on the productivity, technology and efficiency growth of Turkish banks. Thus, one empirical question to address is whether technology, as well as efficiency, of the Turkish banks has improved following the relaxed regulation.

In this study, we purport to investigate the performance of the Turkish banks in a dynamic setting, with a particular emphasis on how such regulatory transformation influenced the technological progress, efficiency change and productivity growth in the banking sector. Thus, this study considers both productivity growth at the frontier and spread of the productivity levels as well as the diffusion of technology across the banking industry. To detect any improvement in bank performance after deregulation, estimation over longer time periods is needed but this has not yet been demonstrated (Berger and Humphrey, 1997). Thus, the first contribution of this paper is to use an unprecedented long chain of ex-post performance indices. Secondly, unlike earlier efficiency studies on Turkish banking, we take into account certain bank

outputs such as off-balance sheet activities, loans to special sectors, inter-bank funds, and investment securities, which consume a large portion of bank resources to produce. Thirdly, employing a data envelopment analysis (DEA)-type Malmquist Index, this study examines *total factor productivity change* in Turkish banking during the deregulation episode, along with its mutually exclusive and exhaustive components: *Change in efficiency* (catching-up or falling behind) and *change in technology* (innovation or shock). Also, we elaborate efficiency change in Turkish banking further by studying its sources: *Pure technical efficiency change* (improvement in management) and *scale efficiency change* (improvement towards optimal size). Fourthly, we study the changes in the returns to scale of Turkish banks over time by ownership. Finally, we explore the likely impact of omitting non-traditional financial services on bank performance.

Berger et al. (1995), Bhattacharya et al. (1997), and Wheelock and Wilson (1999) maintain that deregulation and technical change could result in differential impacts on banks of different forms. Supporting their proposition, our results indicate that all types of commercial banks operating in Turkey experienced a gain in their productivity on average but in notably varying magnitudes. Also, the productivity gains were lower in the beginning, but in parallel with the acceleration of the reforms, productivity has substantially improved. The dominant source driving productivity was efficiency increases, i.e., efforts of the inefficient banks to catch up with the efficient ones. Moreover, efficiency increases were due to improved managerial practices rather than improved scales.

The paper is structured as follows. Following the literature review, we discuss the liberalization of markets in Turkey in Section 3. We explain the methodology in Section 4 and present the empirical setting and data in Section 5. In Section 6, we analyze the managerial efficiency of the Turkish banks. We examine the impact of the reforms on the productivity change of the sector in Section 7 and conclude in Section 8.

2. Literature review

The *theory of the firm* considers a production environment in which managers, operating in the most efficient manner possible, try to maximize firm profits and consequently shareholder wealth. In an increasingly competitive environment, efficiency and productivity of financial institutions has become critically important. The competitive model posits that capital markets will penalize an under-performing firm by depressing its share price and subjecting it to takeover. In a perfectly competitive and contestable environment, inefficient firms will be either acquired or eventually driven out of the market by efficient ones. However, inefficient firms may continue to survive or even prosper if entry barriers or regulations weaken competitive forces. Accordingly, the *market discipline hypothesis* implies that weakening competitive pressures may induce deviations from the profit maximization goal as managers find that they do not need to operate very efficiently to stay in business or as they seek to maximize their own wealth (Evanoff and Israilevich, 1991).

Bank regulators are responsible for the well-functioning and competitive viability of the banking system along with its soundness and security. In fact, these goals are not mutually exclusive, provided that banks are run efficiently. Enhanced efficiency in banking can result in better resource allocation, which will benefit society by leading to greater and more appropriate innovations, improved profitability, greater amounts of funds intermediated, better prices and service quality for consumers, and greater safety and soundness in the financial system. Financial services industries have been deregulated in many parts of the world, such as the removal of interest rate ceilings in the US in the 1980s and the harmonization and unification of banking markets in Europe in the 1990s (Molyneux et al., 1994). Deregulatory policies are typically aimed at increasing competition in the markets and in turn boosting efficiency and productivity of institutions by disciplining them in resource management and putting them in a case where their survival and success will depend on their ability to adapt and operate efficiently in the new environment. Despite the expectations, however, empirical studies to date have presented mixed results.

Shyu (1998) reported upgraded operating efficiency in the Taiwanese banking system after deregulation, as did Leightner and Lovell (1998) for Thai banks in a more liberal financial environment. Liberalization in India has resulted in higher efficiency in the entire banking system but foreign banks have prospered the most in the new environment (Bhattacharya et al., 1997). Norwegian banks' productivity and efficiency first declined but eventually improved following deregulation (Berg et al., 1992). Gilbert and Wilson (1998) found that along with privatization, deregulation of interest rates improved potential output as well as productivity among Korean banks. On the contrary, banking *efficiency* in the US has remained relatively unchanged after the deregulation of the early 1980s (Bauer et al., 1993; Elyasiani and Mehdian, 1995). In fact, bank *productivity* declined during the post-deregulation era in the US (Humphrey, 1993; Grabowski et al., 1994; Humphrey and Pulley, 1997). Although not focused explicitly on the impact of the deregulatory changes, a recent study by Wheelock and Wilson (1999) also reported declining productivity among US banks between 1984 and 1993, a trend that was associated more with small banks than large banks. Most probably deregulation of the scale and scope of banking benefited larger banks more than small banks. Similarly, efficiency and productivity in Spanish banking has diminished in the deregulated environment (Grifell-Tatje and Lovell, 1997; Lozano, 1995). A recent study by Khumbakar et al. (2001) also reported declining efficiency among Spanish saving banks after deregulation.

Apparently deregulation resulted in a reduction in measured performance rather than an improvement in some episodes, indicating that short-run impacts of financial deregulation may be discouraging. According to Berger and Humphrey (1997), industry conditions prior to deregulation, such as prevailing excess loan demand in Norway, intense competition for rapidly expanding market share in Spain, or competitive scramble to pay higher deposit interest rates in the US, may explain these unexpected consequences. However, it appears that more recent geographical deregulation and consolidation in the US seem to have improved bank efficiency (Hughes et al., 1996; Berger and Mester, 1997; DeYoung et al., 1998).

Employing a non-stochastic approach, Zaim (1995) analyzed the efficiency of Turkish commercial banks at two points in time, one in 1981 (pre-liberalization) and the other in 1990 (post-liberalization). He found that efficiency in 1990 was higher than that in 1981. However, he did not address if the production frontier has expanded or contracted (technological progress or regress); if the average Turkish bank has become able to produce more or less outputs from the same amount of inputs (productivity growth or fall); or if the proximity of the banks to the current as well as past frontiers has increased or decreased (efficiency increase or decrease) within the more liberal environment. Moreover, he used only one year after deregulation to assess the impact of the reforms on bank efficiency, which is insufficient to capture the long-term trends in bank performance (Berger and Humphrey, 1997). Using the structure–conduct–performance paradigm, Denizer (1997) investigated the effects of financial liberalization and new bank entry on market structure and competition in Turkey. His results suggest that market structure is an important factor in explaining bank profitability in the Turkish banking market. In a recent paper, Isik and Hassan (2002) examine the *correlates* of input/output efficiency in Turkish banks in the post-liberalization era. They report that efficient banks are riskier, publicly traded, relatively small, highly engaged in international operations and run as joint ventures between Turkish and foreign investors. Moreover, they find that efficient banks operate under the umbrella of a holding company structure, have a board where the chairman of the board is *not* also the CEO of the operations, and produce more loans relative to inefficient banks.

3. Descriptive statistics of the Turkish banking industry

Financial deregulation in Turkey began in the early 1980s and accelerated afterwards as Turkish banking has moved towards the model of a free-market business. The main goal of the policy makers was to increase the efficiency and productivity of the financial system by fostering competition among the banks. This was to be accomplished through deregulation and promoting entry into the system. We constructed Table 1 to provide a synopsis of the changes in banking behavior after deregulation. It appears that the reforms realized one of their major targets, to attract new banks into the system. While there were *no* new entries into the system between 1975 and 1980, the number of banks operating in Turkey has increased noticeably afterwards. For instance, as there were only four foreign banks operating in the market between 1977 and 1980, the number jumped to 23 in 1990. The existing traditional banks seem to have found themselves in a heightened competition not only with recently established domestic banks, but also with foreign banks. To increase the speed, quality and efficiency of their services and in turn strengthen their competitive viability, Turkish banks began to concentrate on expensive automation and computerization projects in the early years of liberalization.

Before liberalization, there were interest rate ceilings on deposits paid by Turkish banks and real interest rates were negative due to a high level of inflation. Driven by

Table 1
Descriptive statistics of the Turkish banking industry during the pre- and post-deregulation periods

	All banks	State banks	Private banks	Foreign banks
Market structure				
Number of banks				
1970	41	10	26	5
1975	37	10	22	5
1980	37	9	23	4
1985	44	8	20	15
1990	56	8	25	23
Average number of branches				
1970	79	149	61	22
1975	126	183	120	23
1980	163	257	142	26
1985	142	307	166	8
1990	116	371	138	5
1993	107	500	96	5
Average number of employees				
1970	1567	3158	1148	370
1975	2530	4263	1905	429
1980	3303	5977	2556	461
1985	3095	7892	3125	177
1990	2714	10,103	2726	131
1993	2444	12,759	1961	120
Share in total assets (TA)				
1970	1.000	0.621	0.344	0.035
1975	1.000	0.522	0.443	0.035
1980	1.000	0.503	0.467	0.030
1985	1.000	0.509	0.453	0.037
1990	1.000	0.497	0.465	0.038
5-Bank concentration in TA				
1970	0.66			
1980	0.64			
1989	0.58			
1996	0.49			
Cost structure				
Total cost/TA				
1970–1975	0.077	0.078	0.075	0.073
1976–1980	0.096	0.105	0.088	0.075
1981–1985	0.173	0.145	0.206	0.141
1986–1990	0.210	0.208	0.237	0.202
Interest expense/total cost				
1970–1975	0.347	0.330	0.366	0.394
1976–1980	0.353	0.321	0.392	0.387
1981–1985	0.712	0.697	0.727	0.631
1986–1990	0.696	0.737	0.629	0.590

(*continued on next page*)

Table 1 (*continued*)

	All banks	State banks	Private banks	Foreign banks
Personnel expense/total cost				
1970–1975	0.357	0.361	0.355	0.320
1976–1980	0.400	0.386	0.418	0.378
1981–1985	0.156	0.155	0.156	0.164
1986–1990	0.099	0.083	0.113	0.101
Income structure				
ROA				
1970–1975	0.006	0.005	0.008	0.010
1976–1980	0.008	0.009	0.008	0.013
1981–1985	0.015	0.016	0.012	0.040
1986–1990	0.022	0.017	0.025	0.040
ROE				
1970–1975	0.083	0.045	0.219	0.301
1976–1980	0.167	0.117	0.302	0.512
1981–1985	0.209	0.171	0.244	0.787
1986–1990	0.378	0.322	0.376	0.566
Interest spread				
1970–1975	0.044	0.013	0.071	0.081
1976–1980	0.043	−0.003	0.087	0.084
1981–1985	0.137	0.051	0.236	0.156
1986–1990	0.223	0.141	0.294	0.234

these conditions, banks started a race to open branches all across the country. Evidently, between 1970 and 1980, the average number of branches rose by 106% and the average number of employees increased by 111%. The surge in expansionary efforts by banks is more striking if one considers that the number of banks remained practically unchanged during the 1970s. These efforts resulted in heavy investments in costly human capital and brick-and-mortar branch offices and contributed to the overwhelming overhead costs and scale problems whose adverse impacts on Turkish banking have continued to the present. Apparently, when interest rates were regulated by the state, banks could compete with each other for scarce savings by increasing convenience to customers, i.e., more bank offices or employees per capita or per area. This resulted in an over-utilization of physical capital relative to other factor inputs in Turkish banking. However, attractiveness and value of an extensive branching network has declined in parallel with the structural changes in banking and developments in the communication technology. To cope with deepening over-branching and over-employment problems, banks have reversed their expansionary plans, which resulted in substantial reductions in the average number of bank branches and employees during the 1980s.

The evolution of competition in banking has primarily featured the de-concentration process in the market. There has been a steady decrease in the market share of the five largest banks in total assets (e.g., 66% in 1970, 64% in 1980, and 49% in 1996). It seems as though the financial reforms, which reduced the barriers to the

new entries, have constantly reduced concentration in the system. [4] However continuous the fall is, the five largest banks still account for 50% of the industry's assets. As observed in other countries, there were also sharp increases in interest rates in Turkey following deregulation. Interest expenses more than doubled in the early 1980s with respect to the 1970s. The increased cost of funding along with expensive technological build-up led to substantial increases in total banking costs. Turkish banks, as mentioned above, responded swiftly to increased costs by trimming excess personnel and closing unprofitable branches. Consequently, the share of personnel expenses in total costs on average declined tremendously, from 40% between 1976 and 1980 to less than 10% between 1986 and 1990. Moreover, to keep interest costs low, large banks entered into the so-called "gentlemen's agreement", which is in reality an open collusion (Denizer, 1997). Despite the increased costs, Turkish banks have been able to record phenomenal profits during the 1980s owing to high interest spreads. [5] During the deregulatory process, there was an increased volatility in interest rates, with effects on the stability of the financial system. Concerns with the stability of the system led to re-regulations, occasional setbacks, and partial reversal of the reforms. Hence, it is a matter of empirical endeavor to see whether the reform agenda has achieved its desired ends despite the counterbalancing forces.

4. Methodology

Following Berg et al. (1992), Elyasiani and Mehdian (1992), Fare et al. (1994), Zaim (1995), Bhattacharya et al. (1997), Leightner and Lovell (1998), Wheelock and Wilson (1999), among others, we use a non-parametric method, DEA, in measuring bank performance. We adopt the DEA because of the expressed interest in the Turkish banking industry to control costs in recent years after the liberal policies. Through input-oriented DEA, we can dwell on the sources of input waste in Turkish banking and draw some policy conclusions. Stochastic models necessitate a large sample size to make reliable estimations. However, the DEA is relatively less data demanding, i.e., it works well with a small sample size and does not require knowledge of the proper functional form of the frontier, error and inefficiency structures (Evanoff and Israilevich, 1991; Grifell-Tatje and Lovell, 1997; Bauer et al., 1998; Wheelock and Wilson, 1999). Although our sample contains the universe of the Turkish banks, the total number of banks in the sample is relatively small (e.g., 38 in 1981 and 56 in 1990), motivating the use of the DEA in this study.

[4] The systematic fall in the share of large banks is also associated with the efforts of small and medium size banks to grow by expanding their deposit base.

[5] The source of bank profits could be market power as suggested by Denizer (1997) or alternatively some other market or regulatory distortions as suggested by Isik and Hassan (2002): Persistent state budget deficits, along with a fast growing economy, create abundant profit opportunities for Turkish banks, offsetting increases in banking costs and hence lessening the impact of competitive pressures on banks.

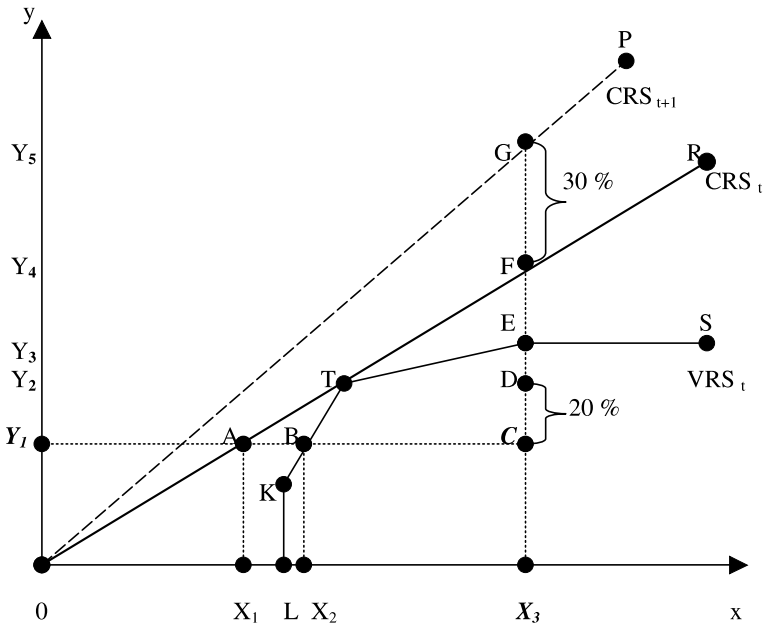

Fig. 1. Efficiency and productivity concepts.

With a simple case of single-input (x) and single-output (y), Fig. 1 illustrates efficiency and productivity concepts based on the DEA. Assuming that all firms are operating at an optimal scale (i.e., one corresponding to the flat portion of the long-run average cost curve), we obtain a constant returns to scale (CRS) frontier (CRS_t: 0ATFR or CRS_{t+1}: 0GP). However, firms in practice might face either economies or diseconomies of scale because of imperfect competition, constraints on finance, etc. Relaxing the CRS assumption and introducing convexity restriction, Banker et al. (1984) proposed a variable returns to scale (VRS) frontier (VRS_t: LKBTES). The VRS_t technology indicates increasing returns to scale (IRS) to the left of point T, decreasing returns to scale (DRS) to the right of T and CRS at point T. The frontiers constructed are, however, not static but subject to change over time due to innovation (technological progress), shocks (financial crises), changes in market structure (higher concentration due to M&As) and regulatory policies (financial deregulation).

Assume the following: The technology is one of CRS, and has not changed from year t to year $t+1$ and a bank was observed at point C in year t, ($\boldsymbol{X}_3$, $\boldsymbol{Y}_1$) and at point D in year $t+1$, ($\boldsymbol{X}_3$, $\boldsymbol{Y}_2$). Both observations, C and D, represent feasible but technically inefficient production points because they are interior to the CRS_t frontier. In Farrell (1957), output-oriented technical inefficiency (TIE_o) is represented by the distance CF at time t (DF at time $t+1$). Thus, the TIE_o at point C is simply the amount by which output could be proportionally increased (from Y_1 to Y_4) without a rise in input (X_3). Alternatively, input-oriented TIE_i at point C

can be represented by the distance AC. Efficiency scores are generally stated in percentage terms. For instance, the $\mathrm{TIE_i}$ of the firm is AC/Y_1C, which reflects the percentage by which input usage could be reduced (from X_3 to X_1) without reducing the level of output (Y_1). Following the input orientation, the *technical efficiency* (TE) at point C is given by: $\mathrm{TE} = 1 - \mathrm{TIE_i} = 1 - (AC/Y_1C) = Y_1A/Y_1C$. Adopting VRS assumption, we can calculate the pure technical efficiency (PTE) at point C: Y_1B/Y_1C. The firm becomes technically efficient by moving to point B, because given the VRS frontier this is the point where input usage is minimized to produce Y_1. However, the point B is *not* scale efficient, i.e., this is an incorrect scale for cost minimization. The firm can reduce its input usage further (from X_2 to X_1) if it can attain the CRS. Thus, the firm's *scale efficiency* (SE) is Y_1A/Y_1B, that is, the firm can produce its current level of output (Y_1) with fewer inputs if it operates at the 'right' size. If TE = PTE, then SE = 1 (fully scale efficient), because overall technical efficiency, TE = PTE × SE.

Using Farrell's (1957) distance functions and Fare et al.'s (1994) definition of productivity, we specify the Malmquist total factor productivity change (TFPCH) index, $\boldsymbol{M}$, simply as the product of efficiency change (EFFCH), which is how much closer a bank gets to the efficient frontier (*catching-up effect* or *falling behind*), and technological change (TECHCH), which is how much the benchmark production frontier shifts at each bank's observed input mix (*technical innovation* or *shock*): [6]

$$\boldsymbol{M}(t,t+1) = \overbrace{\underbrace{\frac{D_{t+1}^{\mathrm{VRS}}(x_{t+1},y_{t+1})}{D_t^{\mathrm{VRS}}(x_t,y_t)}}_{\mathrm{PEFCH}} \times \underbrace{\left[\frac{D_{t+1}^{\mathrm{CRS}}(x_{t+1},y_{t+1})/D_{t+1}^{\mathrm{VRS}}(x_{t+1},y_{t+1})}{D_t^{\mathrm{CRS}}(x_t,y_t)/D_t^{\mathrm{VRS}}(x_t,y_t)}\right]}_{\mathrm{SECH}}}^{\mathrm{EFFCH}} \times \underbrace{\left[\frac{D_t^{\mathrm{CRS}}(x_{t+1},y_{t+1})}{D_{t+1}^{\mathrm{CRS}}(x_{t+1},y_{t+1})} \times \frac{D_t^{\mathrm{CRS}}(x_t,y_t)}{D_{t+1}^{\mathrm{CRS}}(x_t,y_t)}\right]^{1/2}}_{\mathrm{TECHCH}}. \tag{1}$$

TFPCH ($\boldsymbol{M}$) index can attain a value greater than, equal to, or less than unity depending on whether the bank experiences productivity growth, stagnation or productivity decline, respectively, between periods t and $t+1$. EFFCH index takes a value greater than 1 for an *efficiency increase*, 0 for *no efficiency change*, or less than 1 for an *efficiency decrease*. Similarly, TECCH attains a value greater than 1 for *technical progress*, 0 for *technical stagnation*, or less than 1 for *technical regress*. Fare et al. (1994) also decomposed the (CRS) TE change into SE and PTE changes components (EFFCH = PEFFCH × SCH). This requires the calculation of distance functions under VRS (rather than CRS) technology. [7] To understand this decomposition, reconsider the example in Fig. 1, in which the firm located at point C moves

[6] $\boldsymbol{M}$ is the productivity of the production point (x_{t+1}, y_{t+1}) with respect to the production point (x_t, y_t) according to both years' technologies.

[7] For further explanation of the efficiency and TFPCH indices, please refer Fare et al. (1994); Wheelock and Wilson (1999).

to point D from year t to year $t+1$, but the estimated CRS_t and VRS_t frontiers remain the same. From Eq. (1), $\text{EFFCH} = (X_3D/X_3F)/(X_3C/X_3F) > 1$ and $\text{TECCH} = [((X_3D/X_3F)/(X_3D/X_3F)) \times ((X_3C/X_3F)/(X_3C/X_3F))]^{1/2} = 1$, thus, $\text{TFPCH} > 1$, indicating productivity growth. In moving from point C to point D, not only does the firm become more efficient but also more productive. In the new location, using the same level of input (X_3), the firm increases its output from Y_1 to Y_2. The cause of the productivity growth is the catching-up effort (EFFCH) of the firm rather than an innovation in technology (TECCH). It seems that the efficiency increase ($\text{EFFCH} > 1$) is driven by increases both in PTE ($\text{PEFCH} = (X_3D/X_3E)/(X_3C/X_3E) > 1$) and SE ($\text{SECH} = ((X_3D/X_3F)/(X_3D/X_3E))/((X_3C/X_3F)/(X_3C/X_3E)) > 1$).

Efficiency by itself can bias the measurement of a production unit's performance, especially of those operating in an industry facing technological and regulatory changes. Hence, efficiency studies based on cross-sectional data may not contribute to explaining productivity growth (Berg et al., 1992). A technological advance adopted by a few banks, but not the average bank, could expand the estimated production frontier. A bank that fails to take advantage of technological advances will be increasingly inefficient relative to banks adopting the new technology (Wheelock and Wilson, 1999). Thus, productivity growth does not always imply an efficiency increase. To see this, consider once again the bank located at point C. By moving to point D, we saw that the bank became more productive. If we say $\text{TFPCH} = 1.2$, i.e., the firm became able to produce 20% more output with the same level of input (X_3). Now assume that at the same time CRS_t frontier shifted outward to CRS_{t+1}; i.e., technical progress allowed banks to produce 30% more output from the same amount of input (X_3). Despite the increased productivity, the bank still experiences technical inefficiency (measured as proximity to the frontier) by 10%. [8]

The hypothesis. We hypothesize in this study that due to the deregulatory policies implemented throughout the 1980s to foster competitive pressures on banks to use resources more rationally, Turkish banks will record improved TE (TE_{t+1}, PTE_{t+1} and $\text{SE}_{t+1} > \text{TE}_t$, PTE_t and SE_t), along with increased productivity over time after liberalization [$\text{TFPCH} > 1$ because of $\text{TECCH} > 1$ (an upward shift in production frontier due to technological investments and advances) and/or $\text{EFFCH} > 1$ (closure of the performance gap between the best- and worst-practice banks owing to better resource management ($\text{PEFCH} > 1$) and/or movement toward optimal size ($\text{SECH} > 1$))].

5. Data and empirical setting for efficiency and productivity measurement

We obtained the data on Turkish banks from the Banks Association of Turkey (BAT). Our sample contains the universe of Turkish commercial banks, i.e., all banks operating in Turkey during the 1981–1990 period. However, we had to omit

[8] Like Resti (1997), to estimate efficiency and productivity indices, we use the DEAP version 2.1, developed by Tim Coelli of University of New England.

six bank observations due to no report of outputs or inputs. One bank (Caybank/Derbank), for an unknown reason, did not report to the BAT between 1988 and 1989. Consequently, our unbalanced panel data consist of 458 net observations out of 465 total observations, which span the time horizon of 1981 through 1990. We adopt an "intermediation approach" or "asset approach" to define bank inputs and outputs (Sealey and Lindley, 1977). Accordingly, we use three *inputs*: (1) *labor*: The number of full-time employees on the payroll; (2) *capital*: The book value of premises and fixed assets and (3) *loanable funds*: The sum of deposit and non-deposit funds. As for *outputs*, we use: (1) *short-term*, and (2) *long-term loans*: The loans with less than and more than a year maturity, respectively; (3) *risk-adjusted off-balance sheet items*: Guarantees and warranties (letters of guarantee, bank acceptance, letters of credit, guaranteed pre-financing, endorsements and others), commitments, foreign exchange and interest rate transactions as well as other off-balance sheet activities, and (4) *other earning assets*: Loans to special sectors (directed and specialized loans), inter-bank funds sold and investment securities (treasury and other securities). Since data limitations do not allow us to analyze managerial performance with using off-balance sheet items as an output for the entire period, we present the efficiency results dichotomously, one based on a portfolio of three outputs, between 1981 and 1990 (short-and long-term loans, and other earning assets but *without* off-balance sheet activities), and one based on a portfolio of four outputs between 1986 and 1990 (the three outputs above *with* off-balance sheet activities). [9]

Most of the bank loans as well as deposits in Turkey's high inflationary environment lie in a short-term maturity class (BAT, 1990). This indicates that short- and long-term loans are effective substitutes, i.e., economic units are not indifferent between them as issuing long-term loans is substantially riskier and costlier than issuing short-term loans within this volatile environment, leading us to treat them as two distinct bank outputs as done by Berg et al. (1992), Zaim (1995), Isik and Hassan (2002). Repo transactions as well as other off-balance sheet activities rose substantially during the more liberal environment of the 1980s. In notional values, Turkish banks' off-balance sheet items began to exceed their on-balance sheet items at least by a factor of three (BAT, 1996). We risk-adjusted off-balance sheet items using the Basel Accord risk weights to obtain their on-balance sheet equivalents, i.e., to provide conformity with other bank outputs in terms of credit risk. Ignoring off-balance sheet items, as in most previous bank efficiency and productivity models, does not reflect the changes in the marketplace as banks continuously embrace non-traditional activities. Thus, omission of such items could affect derived efficiency and productivity estimates statistically and economically to a great extent by seriously understating actual output (Siems and Clark, 1997).

[9] The format of balance sheets and income statements has changed after 1980, disallowing us to extend the study to the pre-1980 period. Also, Turkish banks began to report off-balance sheet activities to the BAT in 1986. Thus, we are able to utilize such activities in our model only after 1986. Accordingly, we report the results both with and without off-balance sheet activities between 1986 and 1990 to investigate the impact of such activities on the estimates.

To demonstrate the dynamics of productivity and efficiency change in Turkish banking during the liberalization, we report the results for the full 10 years between 1981 and 1990. Although the *New Economic Policy* was launched in 1981, Denizer (1997) chose 1986 as the beginning of the post-liberalization period while studying the effects of financial liberalization and new bank entry on market structure and competition in Turkey. The transformation into full price competition was not effective and over until the mid-1980s, despite the fact that reforms started in the early 1980s (Celasun, 1998). In our analysis, we take these views into account and treat 1986 as an alternative reference year to 1981 for the beginning of the deregulation era. [10] In this perspective, one could assume the 1981–1986 period as the adjustment period for the banks to changes in the environment and for the reforms to exert their impact on banking behavior, and the 1987–1990 period as the time to reap the benefits of the reforms. Thus, we report the results for three periods, *infancy phase* (1981–1986), *maturity phase* (1987–1990) and *entire phase* (1981–1990) of the deregulation.

6. The impact of the deregulation on the managerial (technical) efficiency of Turkish banks [11]

In this part of the analysis, we examine managerial performance in Turkish banking according to the results from the DEA linear programming problems solved for each bank. In Table 2, we report the mean technical efficiency for all (Panel A), state (Panel B), private (Panel C), and foreign banks (Panel D). The mean efficiency measures in Table 2 and mean productivity change indices in Table 4 (below) for each year are compared to the mean of the beginning base year (81^{base} for the measures *without* off-balance sheet activities and 86^{base} for the measures *with* such items) and the average of the annual means for the 1987–1990 period is compared to that for the 1981–1986 period to determine whether the increases or decreases in efficiency and total factor productivity change scores across time are statistically significant. [12]

Either *with* off-balance sheet activities (first section of each panel) or *without* (second section of each panel), the results indicate that the average managerial efficiency in Turkish banks has substantially improved after deregulation. Consequently,

[10] Zaim (1995) chose 1981 and 1990 as the representative years of pre- and post-liberalization eras in his analysis.

[11] Whether foreign and domestic commercial banks operating in Turkey posses the same banking technology may be questionable. Using the parametric (ANOVA) and non-parametric (Mann–Whitney, Kruskal–Wallis and Kolmogorov–Smirnov) tests outlined in Aly et al. (1990), Elyasiani and Mehdian (1992), we tested the null hypothesis that domestic and foreign banks have identical technologies. We failed to reject the null hypothesis, suggesting that it is appropriate to construct a common frontier by pooling data. Thus, the rest of the study continues with the results computed relative to common frontier.

[12] It should be noted that in this section, we analyze managerial performance of *all banks* operating in each year, whether they entered or exited from the population in any year between 1981 and 1990. Therefore, for any specific year, the number of banks whose efficiency measures are summarized in Table 2 is greater than or equal at most to the number of banks whose productivity change measures are reported in Table 5. Simply, a growth measure dictates the existence of a bank in each of the two years in question.

Table 2
Average managerial efficiency (TE) of Turkish commercial banks during financial deregulation (1981–1990)

Years	Panel A: All banks				Panel B: State banks				Panel C: Private banks				Panel D: Foreign banks			
	A.1 Without off_B/S activities				B.1 Without off_B/S activities				C.1 Without off_B/S activities				D.1 Without off_B/S activities			
	#	TE	PTE	SE	#	TE	PTE	SE	#	TE	PTE	SE	#	TE	PTE	SE
81[base]	38	0.664	0.754	0.881	9	0.821	0.843	0.974	23	0.636	0.718	0.886	6	0.537	0.756	0.710
1982	38	0.677	0.732	0.925	9	0.814	0.817	0.996	21	0.618	0.650	0.951	8	0.678	0.853	0.795
1983	38	0.644	0.775	0.831	9	0.760	0.851	0.893	19	0.617	0.717	0.861	10	0.592	0.818	0.724
1984	40	0.585	0.729	0.802	9	0.840	0.899	0.934	18	0.483[b]	0.581[c]	0.831	13	0.549	0.817	0.672
1985	44	0.605	0.775	0.781	9	0.773	0.850	0.909[c]	20	0.490[b]	0.703	0.697[a]	15	0.658	0.827	0.796
1986	49	0.574[c]	0.781	0.735	9	0.585[a]	0.904	0.647[a]	23	0.496[b]	0.717	0.692[a]	17	0.673	0.802	0.839
1987	50	0.605	0.816	0.741	9	0.626[b]	0.924	0.677[a]	24	0.431[b]	0.746	0.578[a]	17	0.768[c]	0.859	0.894[c]
1988	52	0.714	0.840	0.850	8	0.703	0.902	0.779[a]	25	0.622	0.732	0.850[a]	19	0.840[b]	0.891[c]	0.943[b]
1989	53	0.748[c]	0.859	0.871	8	0.783	0.933	0.839[b]	24	0.667	0.822[c]	0.812[b]	21	0.831[b]	0.873[c]	0.952[a]
1990	56	0.803[a]	0.876	0.917	8	0.725	0.852	0.851[a]	25	0.754[b]	0.857[b]	0.880	23	0.888[a]	0.906[c]	0.980[a]
Mean																
81–86[base]		0.625	0.758	0.825		0.766	0.861	0.889		0.557	0.681	0.817		0.615	0.812	0.757
87–90		0.718[a]	0.848[a]	0.846		0.709[c]	0.903	0.786[b]		0.619[a]	0.789[a]	0.784[b]		0.832[a]	0.882[b]	0.943[a]
81–90		0.662	0.794	0.834		0.743	0.878	0.847		0.581	0.724	0.803		0.701	0.840	0.835
	A.2 With off_B/S activities				B.2 With off_B/S activities				C.2 With off_B/S activities				D.2 With off_B/S activities			
86[base]	49	0.652	0.839	0.777	9	0.594	0.922	0.644	23	0.573	0.769	0.745	17	0.789	0.891	0.886
1987	50	0.629	0.848	0.742	9	0.629	0.934	0.673	24	0.497	0.772	0.644[c]	17	0.814	0.908	0.896
1988	52	0.755[b]	0.905[c]	0.834	8	0.704[c]	0.915	0.769[c]	25	0.682[c]	0.896[b]	0.761	19	0.873	0.914	0.955[c]
1989	53	0.768[a]	0.879	0.874[b]	8	0.783[b]	0.936	0.837[a]	24	0.681[c]	0.843	0.808	21	0.867	0.901	0.962[c]
1990	56	0.805[a]	0.890[c]	0.904[a]	8	0.725[c]	0.853	0.850[a]	25	0.755[a]	0.884[b]	0.854[c]	23	0.892[c]	0.912	0.978[b]
Mean																
86[base]		0.652	0.839	0.777		0.594	0.922	0.644		0.573	0.769	0.745		0.789	0.891	0.886
87–90		0.739[a]	0.881	0.840[c]		0.710[c]	0.910	0.781[b]		0.654[c]	0.849[c]	0.770		0.861[c]	0.909	0.948[c]
86–90		0.722	0.872	0.828		0.687	0.912	0.753		0.638	0.833	0.766		0.847	0.905	0.936

TE measure indicates a proportional reduction in input usage that can be attained if the bank operates on the efficient frontier. The DEA also permits one to decompose the TE further into its distinct components, PTE, a proportional reduction in input usage if inputs are not wasted, and SE, a proportional reduction if the bank attains CRS. The TE, PTE and SE measures take values between 0 and 1 for the least and the most efficient units in the sample, respectively. According to ANOVA tests, [a,b,c] indicate that the statistical difference between the means of the base year (period) and respective year (period) is significant at 1%, 5%, and 10% level, respectively. For example the difference between the average TE in 1986 and 1981 (base year) is statistically significant at 10% level. Likewise, the mean annual efficiency for the 1987–1990 period is significantly different from the mean efficiency for the 1981–1986 period at 1% level.

average input waste in banking has declined strikingly from about 50% in 1981 to about 24% in 1990. While the mean TE, PTE and SE scores were 63%, 76%, and 83% between 1981 and 1986, they increased to 72%, 85% and 85% between 1987 and 1990, respectively. The differences in efficiency estimates between the two periods are also statistically significant. The results suggest that the TE initially declined as banks try to adapt to the new environment. However, the TE of banks has eventually gained momentum and improved impressively after 1987. Most of the technology investments have been made in the beginning of the era, which increased the capital stock (fixed costs) of the banks substantially. In other words, the decrease in TE from 1984 to 1987 occurred when output volumes were growing at historically normal rates. Therefore, the efficiency decrease of these years is mainly due to strong increases in input volumes. It follows that the rapid productivity and efficiency growth in later years is to some extent due to utilization of the idle capacity created in the advent of deregulation. The lower efficiency levels during the relevant period could be also attributed to the financial distress experienced because of some brokerage house and bank failures between 1983 and 1984 as well as to the following reregulation of the interest rates from 1983 to 1987.

A close inspection of Panels B, C and D reveals that the impact of the deregulation on different banking groups was not uniform. While the mean TE of the private banks averaged 56% between 1981 and 1986, it climbed to 62% between 1987 and 1990. The mean TE of foreign banks demonstrated a striking jump from 62% (1981–1986) to 83% (1987–1990). In contrast, there is a notable decrease in the TE of state banks (e.g., from 77% during 1981–1986 to 71% during 1987–1990). The results indicate that private banks, especially foreign ones, benefited the most from the more liberal and competitive environment than state banks. It seems that foreign and domestic private banks with their small, thus adaptive structure, more qualified personnel and advanced technology, benefited more from the new environment. In the post-liberalization period, emergence of interest rate competition along with full insurance of deposits for all banks (not only for public banks) by the state allowed private banks to compete effectively with public banks. Hence, once the asymmetric treatment, patronage, and protection of the state among banks are reduced, i.e., once the playground has been relatively fair, the above results imply that efficiency differentials between state and private banks tend to disappear.

Since the period of 1987–1990 is common to the results both with and without off-balance sheet items and on the *same* banks, the comparison in this interval is perfectly fair. As we see from both grand averages for all banks (Panel A) and subgroup banks (Panels B, C, and D), the efficiency estimates with such items are all much greater than those without. Moreover, the positive impact of such activities on efficiency is uneven across groups. Improvements in the TE and PTE for state banks were 0.1% and 0.7%; for private banks 3.5% and 6.0%; and for foreign banks 2.9% and 2.7%, respectively. Considering that private and foreign banks are more involved in these activities, the greater impact of such items on their efficiency estimates is evident. These results justify the concern that exclusion of off-balance sheet activities may distort the results especially against the banks that are active in these non-traditional transactions.

The results also suggest that the source of total technical inefficiency in the initial phase of liberalization was mostly scale-related for foreign banks. Scale problems began to dominate the technical inefficiency of domestic banks in the later years of the liberalization. This makes sense, if one considers that foreign banks were new and too small initially to optimally utilize scale-related economics. However, as they got larger over time by expanding their business into the domestic market, their scale has become almost fully optimal in terms of cost saving, as evidenced from significant increases in their SE's taking off from 76% between 1981 and 1986 to 94% between 1987 and 1990. As the demand for banking services increased over time, domestic banks have also gained size, but this led to *diseconomies of scale* given their already large size, as evidenced from the decreases in their scale efficiencies over the period. Table 3 presents the trend in the percentage of Turkish banks (by group) that experience increasing returns (IRS), constant returns (CRS) or decreasing returns (DRS) to scale during the study period. As 35% of the banks on average between 1981 and 1986 were suffering from DRS, the percentage of such banks more than doubled between 1987 and 1990, reaching 71%, confirming the above observation that scale inefficiency in Turkish banking has resulted mostly from excessive size, i.e., diseconomies of scale. While 37% saw IRS in their operations between 1981 and 1986, the percentage of such banks dropped dramatically to 9% between 1987 and 1990, again suggesting that there is a little room for economics of scale in the already oversized Turkish banking industry. The subgroup results exhibit similar patterns. No state bank since 1983 and no private bank since 1988 has ever recorded IRS, while over 90% of them registered DRS between 1987 and 1990. Foreign banks suffer the least from extreme size given their small structure and thus experienced less DRS. In fact, increases in size fostered their efficiency as the number of SE foreign banks rose by 16% between the two periods.

7. The impact of the deregulation on the total factor productivity growth of Turkish banks

Mean annual values of the total factor productivity change (TFPCH) index and its mutually exclusive and exhaustive components (EFFCH and TECCH) are presented in Tables 4 and 5 according to ownership type. The Malmquist Index cannot be constructed without a *reference* technology, which could be the technology of any year in a multi-period setting. To examine the significance of the choice of the reference technology, we report the results relative to the technology fixed at the initial year, Table 4 (1981 for the estimates without *off-balance* sheet items and 1986 for the estimates with *off-balance* sheet items) as well as relative to a succession of technologies (Table 5).

7.1. Total factor productivity growth relative to a fixed reference technology

In Table 4 (A.1), the reference frontier is fixed at 1981, and the results are based on the output set *without* off-balance sheet activities. The data points in each year

Table 3
Developments in the returns to scale (RTS) of Turkish commercial banks during financial deregulation (1981–1990)

Years	Panel A: All banks				Panel B: State banks				Panel C: Private banks				Panel D: Foreign banks			
	A.1 Without off_B/S activities				B.1 Without off_B/S activities				C.1 Without off_B/S activities				D.1 Without off_B/S activities			
	#	IRS (%)	CRS (%)	DRS (%)	#	IRS (%)	CRS (%)	DRS (%)	#	IRS (%)	CRS (%)	DRS (%)	#	IRS (%)	CRS (%)	DRS (%)
1981	38	42	24	34	9	11	56	33	23	52	13	35	6	50	17	33
1982	38	32	50	18	9	0	89	11	21	33	38	29	8	63	37	0
1983	38	32	26	42	9	11	44	43	19	32	16	52	10	50	30	20
1984	40	50	27	23	9	0	67	33	18	56	11	33	13	77	23	0
1985	44	41	18	41	9	0	33	67	20	45	5	50	15	60	27	13
1986	49	24	24	52	9	0	0	100	23	17	26	57	17	47	35	18
1987	50	12	18	70	9	0	0	100	24	8	4	88	17	24	47	29
1988	52	12	21	67	8	0	12	88	25	4	4	92	19	26	48	26
1989	53	6	19	75	8	0	12	88	24	0	0	100	21	14	43	43
1990	56	5	21	74	8	0	0	100	25	0	12	88	23	13	39	48
Mean																
81–86		37	28	35		4	48	48		39	18	43		58	28	14
87–90		9	20	71		0	6	94		3	5	92		19	44	37
81–90		25	25	50		2	31	67		25	13	62		42	35	23
	A.2 With off_B/S activities				B.2 With off_B/S activities				C.2 With off_B/S activities				D.2 With off_B/S activities			
1986	49	22	24	54	9	0	0	100	23	17	22	61	17	41	41	18
1987	50	8	24	68	9	0	0	100	24	8	13	79	17	12	53	35
1988	52	8	29	63	8	0	12	88	25	0	12	88	19	21	58	21
1989	53	9	23	68	8	0	12	88	24	4	0	96	21	19	52	29
1990	56	9	28	63	8	0	0	100	25	0	16	84	23	22	52	26
Mean																
86		22	24	54		0	0	100		17	22	61		41	41	18
87–90		9	26	65		0	6	94		3	10	87		18	54	28
86–90		11	26	63		0	5	95		6	12	82		23	51	26

The RTS is defined as the increases in output stemming from raising the level of all inputs by the same percentage. IRS arise when 1% increase in inputs produces more than 1% increase in outputs, CRS occur when 1% increase in inputs results in exactly 1% increase in outputs, and DRS happen when 1% increase in inputs leads to less than 1% increase in outputs. Both IRS and DRS represent non-optimal output levels, thus scale in efficiencies.

Table 4
Average total factor productivity change in Turkish banking industry during financial deregulation (1981–1990) (with respect to fixed reference frontier)

Period	#	EFFCH	TECCH	PEFCH	SECH	TFPCH
Panel A. All banks						
A.1 Without off_B/S activities						
81–81	–	–	–	–	–	–
82–81[bs]	28	0.970	1.112	0.930	1.044	1.080
83–81	28	0.985	0.869[a]	1.042[c]	0.946[b]	0.857[a]
84–81	28	0.841[b]	0.903[a]	0.919	0.916[a]	0.759[a]
85–81	28	1.027	0.771[a]	1.069[b]	0.961[a]	0.792[a]
86–81	28	1.195[a]	0.656[a]	1.097[b]	1.090[c]	0.784[a]
87–81	28	1.242[a]	0.781[a]	1.114[a]	1.114[c]	0.970
88–81	28	1.182[a]	0.788[a]	1.100[a]	1.074	0.932
89–81	28	1.270[a]	0.891[a]	1.162[a]	1.093	1.132
90–81	28	1.201[a]	0.960[b]	1.134[a]	1.059	1.153[c]
Mean[ar]						
82– 86[bs]		1.004	0.862	1.011	0.991	0.854
87–90		1.224[a]	0.855[c]	1.127[a]	1.085[a]	1.047[a]
82–90		1.102	0.859	1.063	1.033	0.940
A.2 With off_B/S activities						
86–86	–	–	–	–	–	–
87–86[bs]	47	1.041	1.374	1.047	0.995	1.431
88–86	47	1.268[a]	1.001[a]	1.149[c]	1.104[a]	1.270
89–86	47	1.362[a]	1.029[a]	1.162[b]	1.172[a]	1.401
90–86	47	1.428[a]	1.063[a]	1.171[c]	1.219[a]	1.518
Mean[ar]						
87–90		1.275	1.117	1.132	1.122	1.405
Panel B. State banks						
B.1 Without off_B/S activities						
81–81	–	–	–	–	–	–
82–81[bs]	8	0.939	1.044	0.960	0.978	0.980
83–81	8	0.954	0.873	1.061	0.899[c]	0.833
84–81	8	0.987	0.862	1.062[c]	0.930	0.851
85–81	8	1.048	0.799	1.106	0.948	0.838
86–81	8	1.126	0.701[c]	1.115	1.010	0.789
87–81	8	1.205	0.746[c]	1.174	1.027	0.899
88–81	8	1.145	0.764[c]	1.121	1.022	0.875
89–81	8	1.198	0.885	1.198	1.001	1.060
90–81	8	1.032	1.000	1.083	0.953	1.032
Mean[ar]						
82–86		1.011	0.856	1.061	0.953[a]	0.858
87–90		1.145[c]	0.849	1.144	1.000	0.967
82–90		1.071	0.853	1.098	0.974	0.906
B.2 With off_B/S activities						
86–86	–	–	–	–	–	–
87–86[bs]	8	1.085	1.064	1.055	1.028	1.154
88–86	8	1.189[c]	0.928[c]	1.022	1.164[c]	1.103

(*continued on next page*)

Table 4 (*continued*)

Period	#	EFFCH	TECCH	PEFCH	SECH	TFPCH
89–86	8	1.369[b]	0.847[a]	1.072	1.277[a]	1.159
90–86	8	1.211	0.835[b]	0.970[c]	1.249[b]	1.012
Mean[ar]						
87–90		1.213	0.918	1.030	1.179	1.107
Panel C. Private banks						
C.1 Without off_B/S activities						
81–81	–	–	–	–	–	–
82–81[bs]	16	1.017	1.122	0.917	1.109	1.141
83–81	16	1.006	0.859[a]	1.060[c]	0.950[a]	0.864[a]
84–81	16	0.823[b]	0.852[a]	0.872	0.944[a]	0.701[a]
85–81	16	1.040	0.733[a]	1.056[c]	0.984[a]	0.762[a]
86–81	16	1.214[c]	0.624[a]	1.096[c]	1.109	0.758[a]
87–81	16	1.226[c]	0.772[a]	1.096[c]	1.119	0.947[a]
88–81	16	1.188[c]	0.763[a]	1.108[b]	1.072	0.907[a]
89–81	16	1.315[a]	0.897[b]	1.183[a]	1.112	1.180
90–81	16	1.302[a]	0.974[c]	1.199[a]	1.086	1.268[c]
Mean[ar]						
82–86[bs]		1.020	0.838	1.000	1.019	0.845
87–90		1.258[a]	0.852	1.147[a]	1.097[a]	1.075[a]
82–90		1.126	0.844	1.065	1.054	0.948
C.2 With off_B/S activities						
86–86	–	–	–	–	–	–
87–86[bs]	22	0.947	1.426	1.090	0.869	1.351
88–86	22	1.276[a]	0.959[a]	1.255[b]	1.017[a]	1.224
89–86	21	1.446[a]	0.968[a]	1.300[a]	1.112[a]	1.400
90–86	21	1.621[a]	1.015[a]	1.353[b]	1.198[a]	1.645[a]
Mean[ar]						
87–90		1.323	1.092	1.250	1.049	1.405
Panel D. Foreign banks						
D.1 Without off_B/S activities						
81–81	–	–	–	–	–	–
82–81[bs]	4	0.842	1.210	0.921	0.915	1.019
83–81	4	0.955	0.905[c]	0.934	1.023	0.864[c]
84–81	4	0.636	1.187	0.821	0.775	0.755[c]
85–81	4	0.933	0.869	1.047	0.892	0.810
86–81	4	1.251[c]	0.691[c]	1.065	1.175[c]	0.864[c]
87–81	4	1.356[c]	0.888[c]	1.065	1.274[c]	1.204[c]
88–81	4	1.220[c]	0.938[c]	1.026	1.189[c]	1.144
89–81	4	1.213[c]	0.881[a]	1.005	1.207[c]	1.068
90–81	4	1.137[c]	0.825[b]	0.976	1.166[c]	0.938
Mean[ar]						
82–86[bs]		0.923	0.972	0.957	0.956	0.862
87–90		1.231[a]	0.883[c]	1.018[c]	1.209[a]	1.088[b]
82–90		1.060	0.933	0.984	1.068	0.963

Table 4 (*continued*)

Period	#	EFFCH	TECCH	PEFCH	SECH	TFPCH
D.2 With off_B/S activities						
86–86	–	–	–	–	–	–
87–86[bs]	17	1.126	1.453	0.986	1.142	1.637
88–86	17	1.274	1.090[b]	1.073	1.187	1.389
89–86	18	1.244	1.181	1.042	1.194	1.469
90–86	18	1.290[c]	1.221	1.049	1.229[b]	1.575
Mean[ar]						
87–90		1.233	1.236	1.037	1.188	1.517

[a,b,c] indicate that the statistical difference between the means of the base year (period) and respective year (period) is significant at 1, 5, and 10% level, respectively, according to ANOVA tests. [ar] and [g] stand for arithmetic and geometric means, respectively; [bs] refers to the base year (period) with which all other years (periods) are compared statistically.

from 1982 to 1990 are compared to the points in 1981 in the input–output space. When addressing productivity change, one is primarily interested in improvements from a certain period: Whether there has been a rise in performance relative to where we started. The number of banks allowing such a comparison is 28, of which, 8 are state banks (Panel B), 16 are private banks (Panel C), and 4 are foreign banks (Panel D). In Table 4 (A.2), the results are based on the output portfolio *with* off-balance sheet activities and the reference technology is fixed at 1986. There are 47 banks existing between 1986 and 1990, of which, 8 are state banks, 22 are private banks, and 17 are foreign banks. [13]

With respect to 1981, Turkish banks have registered neither productivity growth (except 1982, 1989 and 1990) nor technological progress (except 1982). However, negative productivity growth has become increasingly less negative over time and turned to a positive growth after 1988. This actually suggests that the productivity of Turkish banks, although lower as compared to 1981, has steadily risen since 1982 and eventually exceeded the 1981 level after 1988. In the aggregate, relative to 1981, the average Turkish bank experienced a productivity loss between 1982 and 1986 (by about 15%) and recorded productivity growth between 1987 and 1990 (by about 5%). The decomposition of TFPCH into its components suggests that the source of the productivity growth was an efficiency increase (EFFCH), rather than progress in technology (TECCH). Overall, while there was practically no change in efficiency between 1982 and 1986, there was a 22% increase in efficiency between 1987 and 1990. As the reforms began to show their impact, the performance difference between the best- and worse-practice banks narrowed, i.e., inefficient banks began to *catch-up with* efficient banks as efficient banks experienced stagnancy in their technology. Despite the financial reforms and banks' heavy investment in technology, the finding of no technological progress in Turkish banking is

[13] Fall by one bank in the number of private banks, and rise by one bank in the number of foreign banks between 1989 and 1990 is because of the change in the ownership of a bank (namely, BNP-AK Dresdner Bank AS).

Table 5
Average total factor productivity change in Turkish banking industry during financial deregulation (1981–1990) (with respect to changing (previous year) frontier)

Period	#	EFFCH	TECCH	PEFCH	SECH	TFPCH
Panel A. All banks						
A.1 Without off_B/S activities						
81–80	–	–	–	–	–	–
82–81[bs]	33	0.993	1.074	0.971	1.023	1.067
83–82	36	1.058	0.936	1.091	0.969	0.990
84–83	37	1.028	0.953	0.988	1.040	0.980
85–84	39	1.143	0.963	1.168	0.978	1.100
86–85	43	1.369[b]	0.742[b]	1.136	1.205	1.016
87–86	49	1.094	1.163[c]	1.131	0.967	1.272[b]
88–87	48	1.252[b]	0.823[c]	1.092	1.147	1.030[c]
89–88	52	1.109	1.038	1.045	1.060	1.151
90–89	53	1.130[c]	0.940	1.028	1.099	1.062[c]
Mean[g]						
82–86[bs]		1.111	0.927	1.068	1.040	1.030
87–90		1.145[c]	0.983	1.074	1.066	1.125[a]
82–90		1.126	0.951	1.071	1.051	1.071
A.2 With off_B/S activities						
86–85	–	–	–	–	–	–
87–86[bs]	49	0.981	1.343	1.074	0.914	1.318
88–87	48	1.275[a]	0.778[a]	1.131	1.127[a]	0.992
89–88	52	1.061	1.042[a]	0.985[c]	1.077[a]	1.106
90–89	53	1.101[b]	0.959[a]	1.019	1.081[a]	1.056
Mean[g]						
87–90		1.100	1.011	1.051	1.046	1.112
Panel B. State banks						
B.1 Without off_B/S activities						
81–80	–	–	–	–	–	–
82–81[bs]	9	0.984	0.949	1.008	0.977	0.934
83–82	9	1.017	1.060	1.132	0.898[c]	1.078
84–83	9	1.146	0.882	1.057	1.083[c]	1.010
85–84	9	0.960	1.100	0.991	0.969	1.056
86–85	9	1.163	0.784	1.070	1.087[c]	0.912
87–86	9	1.073[c]	1.057[c]	1.030	1.042	1.134[c]
88–87	8	1.109	0.853	0.969	1.145[b]	0.946
89–88	8	1.181	0.930	1.036	1.139[c]	1.099
90–89	8	1.098	0.875	0.924	1.189[a]	0.960
Mean[g]						
82–86[bs]		1.051	0.948	1.050	1.000	0.996
87–90		1.115	0.925	0.989	1.127[a]	1.032
82–90		1.079	0.938	1.022	1.055	1.012
B.2 With off_B/S activities						
86–85	–	–	–	–	–	–
87–86[bs]	9	1.056	1.066	1.019	1.037	1.126
88–87	8	1.106	0.854[b]	0.967	1.144	0.945[b]

Table 5 (*continued*)

Period	#	EFFCH	TECCH	PEFCH	SECH	TFPCH
89–88	8	1.178	0.930	1.029	1.145	1.096
90–89	8	1.098	0.875[a]	0.919[c]	1.194[c]	0.960[b]
Mean[g]						
87–90		1.109	0.928	0.983	1.128	1.029
Panel C. Private banks						
C.1 Without off_B/S activities						
81–80	–	–	–	–	–	–
82–81[bs]	20	1.028	1.108	0.962	1.069	1.139
83–82	19	1.085	0.879[c]	1.244[c]	0.872[a]	0.953[c]
84–83	18	0.849	0.965	0.814	1.042	0.820[a]
85–84	18	1.122	0.933	1.311	0.856[a]	1.047
86–85	21	1.368[a]	0.700[a]	1.147[c]	1.193[c]	0.958[c]
87–86	23	1.029	1.174	1.186	0.868[a]	1.208
88–87	23	1.353[b]	0.730[a]	1.103	1.226[b]	0.988[c]
89–88	24	1.147	1.024[c]	1.074	1.068	1.174
90–89	24	1.177[c]	0.961[a]	1.047	1.124	1.132
Mean[g]						
82–86[bs]		1.078	0.907	1.079	0.999	0.977
87–90		1.171	0.958	1.101	1.063[c]	1.122[b]
82–90		1.118	0.929	1.089	1.027	1.039
C.2 With off_B/S activities						
86–85	–	–	–	–	–	–
87–86[bs]	23	0.884	1.369	1.127	0.784	1.210
88–87	23	1.413[a]	0.680[a]	1.207	1.170[a]	0.961[c]
89–88	24	1.063[c]	1.018[a]	0.961	1.106[a]	1.082
90–89	24	1.159[a]	0.984[a]	1.057	1.096[a]	1.140
Mean[g]						
87–90		1.114	0.983	1.084	1.027	1.095
Panel D. Foreign banks						
D.1 Without off_B/S activities						
81–80	–	–	–	–	–	–
82–81[bs]	4	0.839	1.195	0.939	0.893	1.002
83–82	8	1.040[b]	0.943[c]	0.812	1.281	0.980
84–83	10	1.244[a]	0.998	1.247	0.997	1.241[b]
85–84	12	1.310	0.926[c]	1.123	1.167	1.213[c]
86–85	13	1.511[a]	0.782[a]	1.157	1.306	1.181[c]
87–86	17	1.194[b]	1.200	1.124[b]	1.062[c]	1.432[a]
88–87	17	1.182[b]	0.952	1.138[b]	1.039[c]	1.126[c]
89–88	20	1.034[c]	1.107[c]	1.013[c]	1.020[c]	1.144[b]
90–89	21	1.089[b]	0.939	1.051[c]	1.036[c]	1.022[c]
Mean[g]						
82–86[bs]		1.165	0.959	1.043	1.117	1.118
87–90		1.123[b]	1.044[c]	1.080[c]	1.039	1.172[a]
82–90		1.146	0.996	1.060	1.082	1.142

(*continued on next page*)

Table 5 (*continued*)

Period	#	EFFCH	TECCH	PEFCH	SECH	TFPCH
D.2 With off_B/S activities						
86–85	–	–	–	–	–	–
87–86[bs]	17	1.074	1.459	1.048	1.024	1.566
88–87	17	1.167	0.905[a]	1.101	1.060	1.056[b]
89–88	20	1.011	1.125[b]	0.998	1.013	1.138[b]
90–89	21	1.037	0.962[a]	1.015	1.022	0.998[a]
Mean[g]						
87–90		1.071	1.093	1.040	1.030	1.170

[a,b,c] indicate that the statistical difference between the means of the base year (period) and respective year (period) is significant at 1, 5, and 10% level, respectively, according to ANOVA tests. [ar] and [g] stand for arithmetic and geometric means, respectively; [bs] refers to the base year (period) with which all other years (periods) are compared statistically.

unexpected. Taking into account the long-term (L-T) nature of technology investments, the lag in technology may be attributed to the idle capacity created by banks in the beginning of the deregulation on the expectation that the new environment would soon allow them to utilize this capacity. The introduction of the "Golden Points" by some private banks to share their ATMs is a good example of the idle capacity created in Turkish banks. Hence, more time might be needed to collect the benefits of the L-T technology investments. However, the results based on off-balance sheet activities in Table 4 (Panel A, A.2) indicate that *with respect to 1986*, all banks recorded productivity growth each year. On average, productivity grew by an impressive 41% during the period. Over this time, banks displayed technical progress on average, by 12%, as well. However, the efficiency increase was again stunning during the period, 28%, confirming again the predominance of the efficiency increase in driving the productivity growth. Unlike the results *without* off-balance sheet items, the results *with* such items suggest technical progress in Turkish banking. It may be that the measures based only on traditional *on*-balance sheet activities may not have captured an accurate picture of technical change as Turkish banks embraced non-traditional activities within the more liberal environment.

According to the results *without* off-balance sheet activities, private and foreign banks, except for state banks, experienced increasing productivity mainly owing to increasing efficiency. While private domestic banks have registered 7.5% productivity growth, foreign banks have shown 8.8% productivity growth between 1987–90. State banks lost productivity by about 4% in the same period mainly due to the regress in their technology. Efficiency increases in each type of banks seem to be driven by the improvement in PTE rather than SE, implying that the management of banking operations has improved for these banks. With respect to the results with off-balance sheet items, each group's productivity grew between 1987 and 1990 relative to 1986. The growth again was mostly due to the catching-up effect (EFFCH) rather than innovation (TECHCH).

7.2. Total factor productivity growth relative to successive reference technologies

To account for a possible survivorship bias, Table 5 reports the geometric means of the annual productivity change index (i.e., marginal productivity between two successive years) and its components relative to successively changing reference technologies. In doing so, we are also able to study the performance of more banks each year. The prior analysis relative to the fixed technology helped us understand the change in productivity by studying the behavior of the *same* banks during deregulation, i.e., the *banks* were the same, but the *periods* were different. However, this method reduced the number of banks in our analysis. Moreover, the year chosen as a reference could be an extremely good or bad year. Although this would not inhibit the detection of either an upward or downward trend in productivity, it would obscure the absolute levels of productivity and its components.

The results in Table 5 (Panel A, A.1) suggest that over the entire period, 1982–1990, the productivity of Turkish banks grew by 7.1% on average. The mean efficiency increase in the system was 12.6%, with a pure efficiency increase of 7.1%, and a SE increase of 5.1%. However, there was technical regress by 4.9% on average between 1982–1990, although in a few years (e.g., 1982, 1987 and 1989) the Turkish commercial banks demonstrated technical progress. Overall, the average productivity change for the two successive years was constantly positive throughout the period (except for 1982 and 1983). In addition, the magnitude of productivity growth has climbed over time, implying a level of shift in marginal productivity as reforms began to show their impact on Turkish banking. [14] Between 1987 and 1990, the average productivity growth for the sector amounted to 13%, while it was a mild 3% between 1982 and 1986. Likewise, the efficiency increase rose to 15% between 1987 and 1990, whereas it was 11% between 1982 and 1986. These results conform to the results according to fixed technology summarized above (Table 4). However, average productivity and efficiency growth became acute and salient once we included the new banks into the analysis (Table 5). This implies that new entries benefited the banking industry notably despite their small share in the market because these banks mostly came from more advanced countries and were equipped with new technology, more qualified manpower and professional management, along with access to international markets. The inclusion of off-balance sheet items yields similar results for the period of 1987–1990. [15] Either with or without off-balance sheet activities, the results indicate that all types of banks benefited from the liberal policies as evidenced by

[14] To control for the adverse impact of extreme observations on our results, we exclude four observations (2 from 1982, 1 from 1985 and 1 from 1986) whose TFPCH indices were two and half standard deviations away from the average of the respective year. Furthermore, we also extend our analysis with using the *number* of banks rather than averages (in Tables 6 and 7). The results based on the *number* of banks are less sensitive to extreme observations by construction.

[15] However, on average, such activities did not change the productivity results as they did in the managerial efficiency results (Table 2). For example, for the entire period, the productivity change of all banks without off-balance sheet items was 12.5%, and 11.2% with such items. Moreover, incorporation of off-balance sheet activities resulted in technical progress of 1.1% rather than 1.7% regress in their absence.

the increases in their productivity and efficiency. Foreign banks flourished the most in this environment followed by domestic private banks. During the entire period, *without* off-balance sheet items, the average productivity growth was 1.2% for state banks (Table 5, Panel B, B.1), 3.9% for private banks (Table 5, Panel C, C.1), and 14.2% for foreign banks (Table 5, Panel D, D.1). [16] The measures *with* off-balance sheet items give similar results and the levels of the indices are comparable.

In order to control for possible extreme observations, we constructed Table 6, which presents the trend in the number of Turkish banks that experienced a productivity gain or loss during the deregulation period, relative to successively changing reference technologies. [17] Looking at Table 6, we see that only 41% of the all banks experienced productivity growth, while the majority, 59%, experienced productivity loss in the early phase of the liberalization (1982–1986). However, in the maturity phase (1987–1990), the percentage of banks with productivity growth increased substantially, reaching 61%, while the percentage of banks with productivity loss decreased notably to 39%. The results also show that the percentage of banks that recorded technical progress (regress), efficiency increase (decrease), pure efficiency increase (decrease), and SE increase (decrease) has notably risen (fallen) between 1987 and 1990 with respect to that between 1982 and 1986, suggesting that deregulation indeed improved the performance of the average Turkish bank. The results, with and without off-balance sheet activities, are comparable for the period, 1987–1990. The subgroup results indicate that the percentage of all types of banks that experience improvement (worsening) in productivity, technology, and efficiency has tremendously increased (decreased) over time. [18] The bank group with the highest percentage of banks that experienced productivity growth between 1987 and 1990 is private banks (63%), followed by foreign banks (60%), and then by state banks (57%). Based on changing reference technologies, Table 7 displays the main sources of productivity and efficiency change for the industry. [19] The percentage of banks with *productivity growth* mainly due to an *efficiency increase* accounted for 25% (1982–1986), 39% (1987–1990), and 31% (1982–1990) of all banks in the sample, whereas the banks with *productivity growth* mainly due to *technical progress* accounted for 15% (1982–1986), 22% (1987–1990), and 18% (1982–1990). As shown, the dominant source of the *productivity growth* in Turkish banking is an *efficiency increase* rather than *technical progress* according to the results without off-balance sheet items. Over the entire period and sub-periods, the major source of a *productivity loss* was *technical regress* rather than an *efficiency decrease*. On the other hand, the banks with an *efficiency increase* mainly due to a PTE increase accounted for 29% (1982–1986), 22% (1987–1990), and 26% (1982–1990) of all the banks, while the banks with an *efficiency increase* mainly due to SE increase accounted for 16% (1982–1986), 35% (1987–1990), and 25% (1982–1990). As observed, the dominant

[16] Foreign banks are the only banks that record technical progress without off-balance sheet activities.
[17] The results according to fixed reference technology are available upon request.
[18] The results for subgroup banks are available upon request from the authors.
[19] The results based on the fixed reference technology and subgroup banks are available upon request.

Table 6
Development in the percentage of Turkish banks with productivity gain or loss/efficiency increase or decrease during deregulation (1981–1990) all banks (with respect to changing (previous year) frontier)

Period	#	Productivity change (TFPCH)			Technology change (TECHCH)			Efficiency change (EFFCH)			Pure efficiency change (PEFFCH)			Scale efficiency change (SCH)		
		Growth (%)	Loss (%)	No Δ (%)	Progress (%)	Regress (%)	No Δ (%)	Increase (%)	Decrease (%)	No Δ (%)	Increase (%)	Decrease (%)	No Δ (%)	Increase (%)	Decrease (%)	No Δ (%)
A.1 Without off_B/S activities (1981–1990)																
82–81	33	36	64	0	61	39	0	39	42	18	33	45	21	39	33	27
83–82	36	36	64	0	42	58	0	31	47	22	39	31	31	19	58	22
84–83	37	27	73	0	46	54	0	30	54	16	19	54	27	49	35	16
85–84	39	59	38	3	46	54	0	54	31	15	51	21	28	26	56	18
86–85	43	44	56	0	7	93	0	70	16	14	47	23	30	74	12	14
87–86	49	65	35	0	76	24	0	43	47	10	43	29	29	35	55	10
88–87	48	40	60	0	13	88	0	67	19	15	33	40	27	65	21	15
89–88	52	73	27	0	79	21	0	52	37	12	38	37	25	60	29	12
90–89	53	66	34	0	25	75	0	70	21	9	42	28	30	74	17	9
Mean																
82–86		41	59	1	40	60	0	45	38	17	38	35	27	42	39	20
87–90		61	39	0	48	52	0	58	31	11	39	33	28	58	30	11
82–90		50	50	0	44	56	0	51	35	15	38	34	28	49	35	16
A.2 With off_B/S activities (1986–1990)																
87–86	49	76	24	0	84	16	0	29	57	14	35	33	33	24	61	14
88–86	48	33	67	0	10	90	0	69	15	17	42	27	31	65	19	17
89–86	52	67	33	0	71	29	0	44	40	15	25	40	35	58	27	15
90–86	53	62	38	0	28	72	0	64	23	13	38	21	42	68	19	13
Mean																
87–90		60	40	0	48	52	0	51	34	15	35	30	35	54	31	15

Banks are categorized according to the following: Productivity growth: Malmquist Index (TFPCH) > 1, productivity loss: TFPCH < 1, productivity stagnation: TFPCH $= 1$; technical progress: TECCH > 1, technical regress: TECCH < 1, technical stagnation: TECCH $= 1$; efficiency, pure and scale efficiency increase: EFFCH, PEFFCH, and SCH > 1; efficiency, pure and scale efficiency decrease: EFFCH, PEFFCH, and SCH < 1, no change in efficiency, pure and scale efficiency: EFFCH, PEFFCH, and SCH $= 0$.

Table 7
Major source of productivity growth or loss/efficiency increase or decrease in Turkish commercial banking during financial deregulation (with respect to changing frontiers)

Period	#	Productivity growth mainly due to:		Productivity loss mainly due to:		No productivity Δ	Efficiency increase mainly due to:		Efficiency decrease mainly due to:		No efficiency Δ
		Efficiency increase (%)	Technological progress (%)	Efficiency decrease (%)	Technological regress (%)		PTE increase (%)	SE increase (%)	PTE decrease (%)	SE decrease (%)	
A.1 Without off_B/S items											
82–81	33	16	21	30	33	0	27	13	33	9	18
83–82	36	17	19	33	31	0	28	3	22	25	22
84–83	37	14	13	43	30	0	11	19	43	11	16
85–84	39	36	22	13	26	3	44	10	16	15	15
86–85	43	42	2	7	49	0	33	37	14	2	14
87–86	49	23	43	22	12	0	24	16	13	37	10
88–87	48	31	8	13	48	0	19	47	13	6	15
89–88	52	46	27	23	4	0	21	31	21	15	12
90–89	53	55	11	6	28	0	25	45	15	6	9
Mean											
82–86		25	15	25	34	1	29	16	26	12	17
87–90		39	22	16	23	0	22	35	16	16	12
82–90		31	18	21	29	0	26	25	21	14	15
A.2 With off_B/S items											
87–86	49	14	61	20	4	0	14	14	12	45	14
88–87	48	25	8	8	58	0	23	46	10	4	17
89–88	52	31	37	21	12	0	13	31	25	15	15
90–89	53	47	15	8	30	0	21	43	15	8	13
Mean											
87–90		29	30	14	26	0	18	34	16	18	15

Table presents the major sources of the developments in the productivity and efficiency of the Turkish banks. Definition of the sources is as follows: Productivity growth because of technological progress: TFPCH > 1, and TECCH > 1 and EFFCH; productivity growth because of efficiency increase: TFPCH > 1, and EFFCH > 1 and TECCH; productivity loss because of technological regress: TFPCH < 1 and TECCH < 1 and EFFCH; productivity loss because of efficiency decrease: TFPCH < 1, and EFFCH < 1 and TECCH; efficiency increase because of PTE increase: EFFCH > 1, and PEFFCH > 1 and SCH, efficiency increase because of SE Increase: EFFCH > 1, and SCH > 1 and PEFFCH; efficiency decrease because of PTE decrease: EFFCH < 1 and PEFFCH < 1 and SCH, efficiency decrease because of SE decrease: EFFCH < 1, and SCH < 1 and PEFFCH.

source of an *efficiency increase* in Turkish banking was a *PTE increase* rather than a *SE increase* over the entire period.

8. Conclusion

Employing a DEA-type Malmquist Total Factor Productivity Change Index approach, we investigated the impact of financial reforms introduced in the 1980s on the productivity, efficiency and technology of Turkish commercial banks between 1981 and 1990. We *hypothesized* that bank performance measured by various efficiency and productivity scores will rise during the more liberal and competitive environment. Our results suggest that the performance of all types of banks recorded significant improvements after deregulation, whereas their technology has not advanced as expected. Productivity growth in Turkish banking was mainly driven by efficiency increases, i.e., the inefficient banks' efforts to catch up with the best-practice banks rather than technical progress. However, accounting for non-traditional banking activities such as off-balance sheet items produced some evidence of technical progress.

Improvement in the productivity and efficiency of the Turkish banks was low in the early years of liberalization, which may be attributed to the idle capacity created in the advent of deregulation. This suggests that while the performance gap between the worst- and best-practice banks diminished in Turkey, more time might be needed to reap all potential benefits of the long-term technological investments. Efficiency increases recorded were mainly due to better management practices rather than improvements in scale. Based on this finding, we also studied the returns to scale in Turkish banking. The results indicate that most of the domestic banks in recent years have experienced scale inefficiency mainly due to *diseconomies of scale*, i.e., excessive production. The demand for banking services and products has surged recently because of the growing Turkish economy and large funding needs of the state. Although there were several bank entries during liberalization, they mostly concentrated on trade and corporate financing. Thus, the excess demand for banking services has been absorbed mostly by the existent banks, which seems to have exacerbated the scale problems of these already large banks. More reforms such as privatization of state enterprises, taxation reforms and an end to state subsidies that will allow the government to end its fiscal reliance on the financial sector can augment bank performance further.

As a side analysis, we also investigated the effect of the off-balance sheet activities on the efficiency and productivity measures. We found that exclusion of off-balance sheet items significantly deteriorated the average efficiency and productivity scores of the entire industry. However, the extent of the bias was uneven across different banking groups. The private banks, which are more active in these types of non-traditional activities, experienced much more deterioration in their scores than the less active public banks. This observation justifies the importance of appropriate definition of inputs and outputs in measuring bank performance.

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