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Awdeh, Ali

Lebanese university

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Impact of financial deregulation on bank productivity: Evidence from a panel of Arab banks

Ali Awdeh

Faculty of Economics and Business Administration, Department of Finance

The Lebanese University, Lebanon

Email: ali.awdeh@ul.edu.lb

Abstract

This paper investigates the effect of financial deregulation and liberalisation on the productivity growth and efficiency of eleven Arab banking sectors (6 GCC banking sectors and 5 non-GCC banking sectors) over the period 2000-2010. The Data Envelopment Analysis method and the Malmquist total factor productivity index are used to measure the productivity developments and to decompose it into: technical efficiency, technological change, scale efficiency, and total factor productivity. The empirical results show an overall improvement in technical efficiency of all Arab banking sectors under study. Conversely, we observe deterioration in technological and scale efficiencies for the majority of these banking systems over the studied period, which is translated into deterioration in overall productivity. We also find that whereas GCC banking sectors show stability in scale efficiency over the studied period, the non-GCC banking sectors recorded deterioration coupled with volatility in this measure. By comparing the two groups, we notice that GCC banks record – on average – higher technical and scale efficiency measures than non-GCC banks. Conversely, non-GCC banks record – on average – higher technological progress and total factor productivity measures. These results suggest that GCC banks have higher organisational and managerial efficiency and operate at the appropriate size. On the other hand, non-GCC banks have better ability to use technological advances in their production process.

Keywords: Efficiency; Productivity; Data Envelopment Analysis; Malmquist Index.

JEL classification: G21; D24.

1. Introduction

Over the past twenty years, the Arab banking sectors have undergone substantial changes aiming at enhancing solvency and improving performance. This was done through boosting capital bases, implementing more efficient organisational structures, developing IT infrastructures, adopting more advanced risk management systems, introducing greater variety of services, and better exploitation of scale and scope economies. This was coupled with the implementation of reform processes conducted by the authorities, including restructuring and privatising state-owned banks, closure of insolvent banks, adopting new prudential regulation and tighter supervision, and improving disclosure standards. In parallel, the Arab banking systems have witnessed a wave of deregulation and liberalisation represented by – among other things – removing most price controls and quantitative controls (e.g. liberalisation of deposit and lending rates), removing restrictions on the entry of foreign institutions, and eliminating exchange controls. These reforms aimed to increase the efficiency and productivity of banking sectors, to increase international competitiveness and to achieve more competitive operational environment. These measures have radically altered the environment of Arab banks, and the competition for funding and lending amplified and the entrance of foreign banking increased market contestability.

This paper aims to study the evolution of productive efficiency of Arab commercial banks during a period of financial deregulation and liberalisation, using a broad dynamic indicator, the total factor productivity growth index as a measure of performance. The results of this paper show that deregulation and financial liberalisation had beneficial effects on the technical efficiency of Arab Banks, however there is still a room for further improvement. Conversely, technological change scores show deterioration in technological proficiency for seven out of eleven Arab banking sectors, which may be evidence of excess investment on technology not accompanied with identical increase in productivity. Moreover, five out eleven Arab banks have recorded a decrease in scale efficiency scores, which may suggests that those banks are operating at inadequate size. Finally, the Malmquist total factor productivity index results show an improvement in productivity only in three out the eleven markets under study.

The paper proceeds as follows. We present an overview of the Arab banking sector in section 2. A review of literature is presented in section 3. The empirical methodology is illustrated in section 4. We present and explain the data in section 5. The empirical results are presented and analysed in section 6.

2. Overview of the Arab banking sectors

The Arab financial sector and in particular the banking sector, realised astonishing growth and development over the past few decades. This development led to an expansion and diversification in the Arab banking base. The sector is formed of a wide base of commercial and investment banking institutions, specialised banks, and Islamic banking institutions. A large number of Arab banks have established subsidiaries dealing with medium and long-term finance, capital market activities, leasing, insurance, and Islamic finance.

The Arab banking sector consists currently of about 430 banking institutions, which manages assets equivalent to about $2.7 trillion (equal to 105% of the size of the Arab region nominal GDP), with a deposit base of $1.6 trillion (about 65% of the Arab region nominal GDP).[1]

Most Arab countries started reforming their financial sectors in the 1990s, far later than other regions such as counties in Latin America and East Asia, who initiated such reform processes as early as 1970s and 1980s. Banking systems are generally large in the Arab region (by asset size), except in countries where state institutions lead the financial system. Arab banking systems are generally well capitalised and have shown resilience to the 2008 international financial crisis that shook other regions' banks.

Table 1: characteristics of Arab financial sector, by country group

	GCC	Non-GCC with private-led banking systems	Non-GCC with state-led banking systems
Per capita income	High	Low to middle	Middle
Size of banking system	Large	Moderate to large	Moderate
Share of state banks	Small to moderate	Small to moderate	Large
Size of nonbank financial institutions	Small	Small	Small
Size of equity markets	Large capitalisation, high bank share	Moderate/large capitalization, high bank share	Small capitalisation
Size of private fixed-income markets	Negligible	Negligible	Negligible
Access to finance	Moderate to restricted	Generally restricted	Generally restricted

Source: World Bank Database.
Non-GCC with private-led banking systems includes Djibouti, Egypt, Jordan, Lebanon, Morocco, Tunisia, West bank and Gaza, Yemen. Non-GCC with state-led banking systems includes Algeria, Iraq, Libya, and Syria.

The development of banking institutions differs considerably among the Arab countries. While some countries, such as the GGC countries, Jordan and Lebanon have developed banking systems, other countries in the region are still characterised by the domination of public sector banks. Within the GCC area, UAE and Qatar have a sizable share of state banks, whereas Bahrain, Kuwait, and Oman have private-led banking systems. In contrast to GCC countries, the market share of state banks in the non-GCC Arab countries declined significantly over the past years.

Arab countries that early privatised their banking institutions have also opened up their markets to foreign participants. For instance, Lebanon took the lead in late 1960s in welcoming foreign banking. Afterwards, similar policies have been adopted by Bahrain and

[1] Source: the Arab central banks and the IMF database (the World Economic Outlook).

Jordan. During the past few years, many Arab countries witnessed an era of privatisation, bank de-regulation and liberalisation. This deregulation of Arab banking systems included increased openness to foreign-owned banks, with an intention of improving the competitiveness and the efficiency of these financial systems. Bank foreign ownership in the region reached 20% of total bank assets in 2008 (Farazi et al., 2011). In the non-GCC Arab sectors, foreign banks increased their presence in countries like Egypt, Morocco, and Syria.

Despite the increase in foreign banking entry, the integration of non-GCC banking systems with the global financial system is still limited. For instance, between 2006 and 2011, the ratio of foreign liabilities to total liabilities in these banking systems was below 5% for state-led banking systems and a little above 10% for private-led systems (Farazi et al., 2011). Capital controls, large domestic deposit base, and the modest loan growth, have all limited the demand for foreign borrowing. Conversely, the GCC banks have stronger links with the international financial systems and are more integrated with the global financial system.

Islamic banking is growing quickly in the Arab region, where Islamic banks gained ground quickly in the GCC in the last decade and started to penetrate other non-GCC countries. Consequently, the number of Islamic banks has grown rapidly, but their presence differs significantly across Arab countries. The most developed Islamic banking sectors are found in the GCC countries, particularly in Bahrain, Kuwait, and UAE. Other Arab countries have also witnessed a development in Islamic banking during the past few years.

Over the past three decades, banking sectors in most Arab countries witnessed significant increase in concentration mainly due to a process of consolidation. By the end of 2011, the concentrations in some of the Arab banking sectors (top 5 banks' assets divided by total sector assets) were as follows: Egypt 52.1%, Kuwait 90.7%, Qatar 77.7%, Oman 77.0%, Lebanon 67.4%, UAE 58.5%, KSA 67.1%, Morocco 89.9%, Bahrain 48.5%, Algeria 64.3%, and Tunisia 50.9%. Consequently, bank competition in most Arab banking sectors is still weaker than in most other regions.

3. Literature Review

Past studies performed to detect the effects of deregulation on the efficiency and productivity of banks have come up with conflicting results. Among studies that found an improvement in productivity, Berg et al. (1992) stated that the Norwegian banks recorded an increase in efficiency and productivity after deregulation. Isik and Hassan (2003) examine productivity growth, efficiency change, and technical progress in Turkish commercial banks during the deregulation of financial markets in Turkey. They found that all Turkish banks have recorded significant productivity gains driven mostly by efficiency increases rather than technical progress. Besides, bank efficiency increases were mostly due to improved resource management practices rather than improved scales.

Avkiran (2000) investigated the productivity of Australian banks in the deregulation period of 1986-1995. The author observed an overall rise in total productivity driven more by technological progress than technical efficiency. Kumbhakar and Lozano-Vivas (2005) examined a panel of Spanish banks and found that deregulations contributed positively to total factor productivity growth for savings and commercial banks, and that deregulation measures helped Spanish banks increase their performance. Rezitis (2006) investigated productivity growth and technical efficiency in the Greek banking industry for the period 1982-1997, and compared productivity growth before and after 1992, when the Greek banking industry experienced a rapid acceleration of liberalisation and deregulation. The authors found that after 1992, pure efficiency was higher, but scale efficiency is lower, indicating that although banks achieved higher pure technical efficiency, they moved away from optimal scale. Zhao et al. (2009) examine the impact of regulatory reform on total factor productivity growth for Indian banks in 1992-2004. They claimed that Indian banking industry experienced sustained productivity growth driven mainly by technological progress.

Lee et al. (2010) measured productivity, technological change and efficiency gains for Singaporean banks over the period 1995–2005. Their findings reveal some total factor productivity growth associated with deregulation. Andries and Capraru (2013) analyse the impact of financial liberalisation and reforms on the banking performance in 17 Central and Eastern European countries over the period 2004–2008 and found that banks with higher level of liberalisation and openness have been able to increase cost efficiency and to offer cheaper services to clients.

Many other studies found no significant improvement or even deterioration in productivity following deregulation. For instance, in the U.S., the deregulation of interest rates had a resulted in increased competition among banks and this led them to pay higher interest rates on deposits. This phenomenon was not accompanied by a corresponding reduction in banking services or an increase in deposits. Thus, the productivity benefits that could have been obtained by banks went to depositors, leading to a decrease in bank productivity (Humphrey, 1991; Humphrey, 1993; Humphrey and Pulley, 1997). Reddy (2005) examined the changes in Indian bank productivity growth and found that overall total productivity growth of banks was almost stagnant during the study period. Similarly, Abbott et al. (2009) analysed the levels of and the changes in the efficiency and productivity of Australian banks during the 1980s. They found little improvement in performance after deregulation.

4. Methodology

4.1 Traditional measures of bank performance

The traditional measures of bank performance fall into two categories: accounting-based techniques and economics-based techniques. Accounting-based studies of bank performance use information from financial statements to identify the determinants of bank performance, as measured by return on assets (ROA) or return on equity (ROE). Economics-based studies focus on efficiency, which is calculated by the distance separating a bank from an ideal frontier measured relative to the lowest cost or highest profit bank in the sample under study.

The concept of productive efficiency allows studying the internal operations of firms. The economic literature defines productivity as the ability of production factors (inputs) to generate a certain level of production (outputs). When there are variations in this ability, there are gains or losses in productivity. Burkart et al. (1999) stated that the productivity of a bank depends at least on three factors: (1) the characteristics of the production technology, (2) the efficiency of the production process, and (3) the ability to quickly adopt technical progress. Performance measures based on accounting ratios tackles these factors imperfectly and hardly measures their relative contributions. Moreover, the production function and its extension allows considering other measures of performance such as the productive efficiency and the Malmquist productivity index. For these reasons, the study of productive efficiency is indeed much more meaningful that accounting ratio analysis.

4.2 Productivity indices, technical progress and productive efficiency

The production activity is by nature a dynamic process. Thus it is crucial to observe the entities over several periods to assess changes in their performance. When time is introduced into the analysis of performance, a simple one-period detection of efficiency is not sufficient because changes in production over time and changes in technical progress must be taken into account.

The efficiency of an entity is measured by the distance that separates it from the maximum possible production, while technical progress corresponds to the increase in this optimum over time, with constant factor endowments. The result of these two phenomena can be interpreted in terms of changes in total factor productivity. In what follows, we present the construction of an index of total productivity for complex production technology (i.e. multi-outputs/multi-inputs) using the distance function defined by Shephard (1970).

4.2.1 Construction of the Malmquist productivity index

We consider here the production technology, defined for a period of time, as the set of feasible input and output vectors for each period *t* (*t = 1, ..., T*). In the general case of a bank that produces an output vector $Y_t (Y_t \in \Re_+^p)$ from an input vector $X_t (X_t \in \Re_+^m)$, we define:

$\mathbb{X}_t$ is the set of all input vectors such as $\mathbb{X}_t = \{X_t \mid X_t \geq 0\} = \Re_+^m$, and

$\mathbb{Y}_t$ is the set of all output vectors such as $\mathbb{Y}_t = \{Y_t \mid Y_t \geq 0\} = \Re_+^p$.

The production set $\Gamma^t(X_t, Y_t) = \Re_+^{p+m}$ and the subsets $L^t(Y_t)$, consisting of all input vectors that allow achieving a production level Y_t are defined respectively by:

$\Gamma^t(X_t, Y_t) = \{(X_t, Y_t) | X_t \in \mathbb{X}_t, Y_t \in \mathbb{Y}_t \; and \; Y_t \; can \; be \; produced \; through \; X_t\}$ and,

$L^t(Y_t) = \{X_t | (X_t, Y_t) \in \Gamma^t\}$

For each period *t* we can calculate $D_x^t(X_t, Y_t)$ that measures the distance between the input vector and the associated isoquant with the production level of the bank. Following Caves et al. (1982), we define a Malmquist productivity index as the ratio of two distance functions. By setting a reference technology, in period *t* for example, we can calculate the distance of production plan of period *t* on the defined isoquant $L(Y)$. Similarly, we can evaluate the production plan for the following period (*t+1*) compared to the reference technology in *t*. Having assessed an entity (a bank) over two periods relative to the same technology, the ratio of the two distances measures the change in total productivity. For the efficiency measures input-oriented, $D_x^t(X_t, Y_t)$ measures a distance function input-oriented for which the frontier of possibilities of reference inputs of period *t*:

$$D_x^t(X_t, Y_t) = \sup\{\lambda : (X_t / \lambda, Y_t) \in \Gamma^t\} = \left(\inf\{\lambda : (\lambda X_t, Y_t) \in \Gamma^t\}\right)^{-1}, \text{ and}$$

$$D_x^{t+1}(X_{t+1}, Y_{t+1}) = \sup\{\lambda : (X_{t+1} / \lambda, Y_{t+1}) \in \Gamma^{t+1}\} = \left(\inf\{\lambda : (\lambda X_{t+1}, Y_{t+1}) \in \Gamma^{t+1}\}\right)^{-1}$$

The input-oriented productivity index of Caves et al. (1982) taking the technology in the first reference period is determined by:

$$M_x^t = \frac{D_x^t(X_{t+1},Y_{t+1})}{D_x^t(X_t,Y_t)} \tag{1}$$

The input-oriented productivity index of Caves et al. (1982) taking the technology in the second reference period is determined by:

$$M_x^{t+1} = \frac{D_x^{t+1}(X_{t+1},Y_{t+1})}{D_x^{t+1}(X_t,Y_t)} \tag{2}$$

The construction of a productivity index is done somewhat arbitrary of the necessary choice of reference technology. Between two periods, the changes in efficiency and technology advances change the shape of the production frontier, and the Malmquist productivity indices calculated on different bases do not have the same values. Färe et al. (1992) suggest using the geometric mean of the two indices calculated on the basis of two reference technologies. Thus we can obtain a single measure defined by:

$$M_x = \left[\frac{D_x^t(X_{t+1},Y_{t+1})}{D_x^t(X_t,Y_t)} \times \frac{D_X^{t+1}(X_{t+1},Y_{t+1})}{D_X^{t+1}(X_t,Y_t)}\right]^{1/2} = \left(M_x^t \bullet M_x^{t+1}\right)^{1/2} \tag{3}$$

The problem of estimating the Malmquist productivity index is easily solved by restoring the relationship between the distance function of Shephard and the measurement of efficiency of Debreu-Farrell estimated by the data envelopment method (DEA). For two consecutive periods *t* and *t+1,* we can evaluate, using the DEA, the production plan of an entity (a bank) for times *t* and *t+1,* relative to the prevailing technology in *t*:

$$\begin{cases} D_x^t(X_t,Y_t) = Min\left\{h \middle| X_t / h \in L^t(Y_t)\right\} = DF_t(X_t,Y_t)^{-1} \\ D_x^t(X_{t+1},Y_{t+1}) = Min\left\{h \middle| X_{t+1} / h \in L^t(Y_{t+1})\right\} = DF_t(X_{t+1},Y_{t+1})^{-1} \end{cases} \tag{4}$$

Taking as reference period the time *t*, $DF_t(X_t,Y_t)^{-1}$ measures the efficiency of the production plan of an entity (a bank) in time *t* relative to the set of entities, and $DF_t(X_{t+1},Y_{t+1})^{-1}$ measures the performance the same entity would have been with its production plan in *t+1*. By relating these two distances, we compute a ratio that measures the gains or losses in productivity of an entity on two consecutive periods.

4.2.2 Decomposition of productivity gains: production efficiency and technical progress

Based on proportionally equivalent change of inputs that ensures the achievement of a certain level of production, the Malmquist productivity index can decompose productivity change into three components: (1) the change in productive efficiency, (2) the displacement of production frontier, and (3) a measure of the technological bias. The index proposed by Färe et al. (1992) can be specified as follows:

• The first is obtained by decomposing the first formulation of the productivity indices of Caves et al. (1982):

$$M_x^t = \frac{D_x^{t+1}(X_{t+1},Y_{t+1})}{D_x^t(X_t,Y_t)} = \frac{D_x^{t+1}(X_{t+1},Y_{t+1})}{D_x^t(X_t,Y_t)} \times \frac{D_x^t(X_{t+1},Y_{t+1})}{D_x^{t+1}(X_{t+1},Y_{t+1})} \tag{5}$$

The measure of technical progress is made by extracting for each observation of the second period, its distance from each of the two frontiers in *t* and *t+1*.

• The second is obtained by decomposing the second formulation of the productivity indices of Caves et al. (1982):

$$M_x^{t+1} = \frac{D_x^{t+1}(X_{t+1},Y_{t+1})}{D_x^{t+1}(X_t,Y_t)} = \frac{D_x^{t+1}(X_{t+1},Y_{t+1})}{D_x^{t+1}(X_t,Y_t)} \times \frac{D_x^{t+1}(X_t,Y_t)}{D_x^{t+1}(X_{t+1},Y_{t+1})} \tag{6}$$

• The last one is obtained by decomposing the productivity indices of Caves et al. (1982). In fact, the input-oriented productivity index of Färe et al. (1982) $\left(M_x^t \bullet M_x^{t+1}\right)^{1/2}$ can be rewritten as:

$$M_x = (X_t, X_{t+1}, Y_t, Y_{t+1}) = \frac{D_x^{t+1}(X_{t+1},Y_{t+1})}{D_x^t(X_t,Y_t)} \times \left[\left(\frac{D_x^t(X_{t+1},Y_{t+1})}{D_x^{t+1}(X_{t+1},Y_{t+1})}\right)\left(\frac{D_x^t(X_t,Y_t)}{D_x^{t+1}(X_t,Y_t)}\right)\right]^{1/2} \tag{7}$$

Equation 7 shows a first symptomatic component $\frac{D_x^{t+1}(X_{t+1},Y_{t+1})}{D_x^t(X_t,Y_t)}$ of technical progress in terms of efficiency reached between the two periods *t* and *t+1*, and a second symptomatic component of an average technical progress reached between the two periods. The technical progress appears here as an average because rather than choosing one of the two frontiers to carry out its measurement, we do this by reference to both technological frontiers.

So far, the Malmquist productivity index was calculated under the assumptions of constant returns-to-scale and a strong free disposal of inputs. Grifell-Tatje and Lovell (1995) discuss the relaxation of this assumption and show that in the case of constant returns-to-scale, Malmquist productivity indices are biased. In fact, in the presence of increasing returns-to-scale of production Malmquist indices underestimate the change in productivity, and it overstates this change in productivity if returns-to-scale are decreasing. To remedy this problem, Grifell-Tatje and Lovell (1995) presented productivity indices, calculated on the basis of Shephard distance functions, which allows studying situations under the assumption of non-constant returns-to-scale. We adjoin the suffix (C) for a calculation of distance carried out in the context of a constant returns-to-scale technology, and the suffix (V) when it is done in the context of a variable returns-to-scale technology. The efficiency related to the scale production is written as:

$$Ech_x^{t,t+1} = \frac{D_x^{t,t+1}\left(X_{t,t+1}, Y_{t,t+1} / V\right)}{D_x^{t,t+1}\left(X_{t,t+1}, Y_{t,t+1} / C\right)} \quad (8)$$

This measure identifies therefore the scale factor separating the value of efficiency of an entity in the sense of variable returns-to-scale technology and the value of the efficiency of the same entity with constant returns-to-scale. This measure of scale efficiency establishes the reduction in the volume of inputs necessary for operation of the firm at the optimum size in terms of constant returns-to-scale technology. Thus, the improvement component of efficiency $\frac{D_x^{t+1}(X_{t+1}, Y_{t+1})/C}{D_x^{t}(X_{t}, Y_{t})/C}$ can be broken down further:

$$\begin{aligned} \frac{D_x^{t+1}(X_{t+1}, Y_{t+1})/C}{D_x^{t}(X_{t}, Y_{t})/C} &= \frac{Ech_x^{t}}{Ech_x^{t+1}} \frac{D_x^{t+1}\left(X_{t+1}, Y_{t,t+1} / V\right)}{D_x^{t}\left(X_{t}, Y_{t} / V\right)} \\ &= \frac{D_x^{t}\left(X_{t}, Y_{t} / V\right)}{D_x^{t}\left(X_{t}, Y_{t} / C\right)} \frac{D_x^{t+1}\left(X_{t+1}, Y_{t,t+1} / C\right)}{D_x^{t+1}\left(X_{t+1}, Y_{t+1} / V\right)} \frac{D_x^{t+1}\left(X_{t+1}, Y_{t,t+1} / V\right)}{D_x^{t}\left(X_{t}, Y_{t} / V\right)} \end{aligned} \quad (9)$$

Similarly, the Malmquist productivity index can be decomposed according to the contribution of technical progress and efficiency, which can be decomposed into a scale efficiency component and a pure efficiency component (Färe et al, 1994):

$$M_x = \frac{D_x^{t+1}\left(X_{t+1},Y_{t+1}/C\right)}{D_x^t\left(X_t,Y_t/C\right)} \times \left[\left(\frac{D_x^t\left(X_{t+1},Y_{t+1}/C\right)}{D_x^{t+1}\left(X_{t+1},Y_{t+1}/C\right)}\right)\left(\frac{D_x^t\left(X_t,Y_t/C\right)}{D_x^{t+1}\left(X_t,Y_t/C\right)}\right)\right]^{1/2}$$
$$= \frac{D_x^{t+1}\left(X_{t+1},Y_{t+1}/V\right)}{D_x^t\left(X_t,Y_t/V\right)} \times \frac{Ech_x^t}{Ech_x^{t+1}} \times Tech = \Delta Eff \times \Delta Ech \times Tech \quad (10)$$

To construct the Malmquist productivity index, we must establish the production frontier that envelops the observations so that, for the efficient units are above, and the inefficient units are below this efficient production frontier. Since the distance function oriented towards maximizing the outputs and the distance function oriented towards minimizing the inputs, used to construct the different Malmquist productivity indices, are reciprocal of the efficiency measures defined by Farrell, this technique is directly related to the DEA. In practice, the calculation of the Malmquist productivity index requires solving four linear programming problems. We are interested only in the dual approach (cost function) which allows, unlike the original approach, to consider the multi-output and multi-input activity of a decision making unit. In the case of variable returns-to-scale the dual linear programs necessary for the evaluation of productivity can be written as follows:

$$Min\ h = D_x^t(X_t, Y_t)^{-1}$$

under the constraints

$$hX_{io}^t - \sum_{j=1}^{n} \mu_j X_{ij}^t$$

$$\sum_{j=1}^{n} \mu_j Y_{rj}^t \geq Y_{ro}^t \quad \forall r$$

And,

$$Min\ h = D_x^{t+1}(X_{t+1}, Y_{t+1})^{-1}$$

under the constraints

$$hX_{io}^{t+1} - \sum_{j=1}^{n} \mu_j X_{ij}^{t+1}$$

$$\sum_{j-1}^{n} \mu_j Y_{rj}^{t+1} \geq Y_{ro}^t \quad \forall\ r$$

Linear programs having as references the technology of the first period and of the second period are given by:

$$Min\ h = D_x^{t+1}(X_t, Y_t)^{-1}$$

under the constraints

$$hX_{io}^{t} - \sum_{j=1}^{n} \mu_j X_{ij}^{t+1}$$

$$\sum_{j=1}^{n} \mu_j Y_{rj}^{t+1} \geq Y_{ro}^{t} \quad \forall\, r$$

And,

$$Min\ h = D_x^{t}(X_{t+1}, Y_{t+1})^{-1}$$

under the constraints

$$hX_{io}^{t+1} - \sum_{j=1}^{n} \mu_j X_{ij}^{t+1}$$

$$\sum_{j=1}^{n} \mu_j Y_{rj}^{t+1} \geq Y_{ro}^{t+1} \quad \forall\, r$$

The introduction of the constraint $\sum_{j=1}^{n} \mu_j = 1$ in the above presented models allows calculating total technical efficiency and pure technical efficiency. Dividing the first by the second, we obtain the scale efficiency. In addition, this approach allows calculating the total factor productivity and the index of technological change.

Finally, we note that to study the efficiency and productivity of the Arab banks, we will use the data envelopment analysis and the Malmquist productivity index. The choice is mainly due to the limited number of banks in some countries and due to the multi-outputs/multi-inputs nature of banking activity.

5. Data and descriptive statistics

Our analysis of banking production technology, leads us to consider three outputs: (1) total earning assets, (2) bank deposits, and (3) off-balance sheet activities. These activities are generated using three inputs: (1) personnel expenses, (2) general expenses, and (3) financial expenses. These factors represent the majority of bank expenses and have the advantage of being measurable quantities (borrowed amounts, number of employees, and the amount of capital or number of branches), which allow calculating factors' unit price. We consider the three following prices of production factors: (1) the price of labour capital measured by the average salary per bank, (2) the price of physical capital measured by the ratio of capital expenditures to fixed assets, and (3) the price of financial resources measured by finance expenses-to-creditor accounts.

Our study about the impact of financial liberalisation on the efficiency and productivity of Arab banks is performed on 11 Arab banking systems: Lebanon (with a sample of 38 banks), Qatar (4 banks), Oman (5 banks), Morocco (7 banks), Kuwait (6 banks), Saudi Arabia (9 banks), Egypt (20 banks), Jordan (8 banks), United Arab Emirates (14 banks), Tunisia (8 banks), and Bahrain (6 banks). Bank data are extracted from the international banking database Bankscope, which provides individual time series (i.e. per bank) of annual financial statements (balance sheet and income statement). The study covers the period 2000-2010 (i.e. 11 years). Tables 2 and 3 present the descriptive statistics for the values of outputs and the prices of inputs.

We use the data envelopment model under the assumption of variable returns-to-scale. In the methodological framework of DEA, it restricts the set of possible combinations to construct "virtual producers". If we exploit less homogeneous samples (e.g. banks with significantly different sizes), then the assumption of constant returns-to-scale might be more appropriate. It is recognised that, in this case, the assumption of variable returns-to-scale creates a bias in favour of large banks. It is also recognised that the assumption of constant returns biased generally the results in favour of medium-sized banks. Either way, we avoid this dilemma because we have carefully constructed our sample, as homogeneous as possible.

Table 2: Descriptive statistics of banking inputs and outputs for the GCC countries ($ millions)

		Earning Assets		Deposits		Off Balance Sheet		Operating Cost		Interest Expenses		Staff Expenses	
		2000	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**
UAE	Max	7,177.0	14,727.1	5,796.6	12,574.3	5,788.9	12,604.0	67.3	75.5	279.2	257.8	67.3	94.3
	Min	107.2	623.3	74.6	487.2	55.7	319.6	0.9	3.6	2.9	5.9	1.3	7.2
	Mean	1,845.2	4,785.6	1,405.7	3,940.6	1,176.6	2,409.4	21.7	27.5	54.3	62.8	18.7	36.9
	SD	2,297.8	4,858.1	1,855.9	4,093.4	1,860.1	3,244.4	23.7	26.8	79.5	75.4	20.6	32.0
KUW	Max	12,797.5	18,117.7	7,384.7	11,080.4	2,920.5	5,296.9	57.0	130.6	514.5	258.6	68.0	116.7
	Min	2,633.6	5,635.6	1,666.3	3,270.8	451.8	582.3	6.3	42.1	114.0	93.7	13.4	24.4
	Mean	4,899.0	8,114.6	3,094.1	5,032.5	938.1	1,977.4	26.0	64.9	204.5	140.7	26.1	46.5
	SD	3,928.6	4,957.3	2,148.7	3,002.3	977.1	1,671.0	20.3	33.7	153.3	60.6	20.9	34.8
QAT	Max	4,165.7	10,003.4	2,102.6	8,727.3	6,577.6	7,858.5	12.5	52.1	198.5	138.7	37.6	50.6
	Min	343.5	1,132.5	314.4	910.4	131.1	588.1	3.2	3.2	13.6	11.3	4.0	8.2
	Mean	1,466.9	4,346.3	890.3	3,662.2	1,797.1	2,751.1	7.2	29.4	66.6	53.2	14.9	27.0
	SD	1,807.7	3,891.9	821.1	3,459.5	3,188.5	3,428.4	4.4	20.1	88.3	57.8	15.4	17.6
BAH	Max	18,238.0	18,735.9	16,100.0	15,198.2	26,040.0	4,480.0	96.0	54.0	864.0	360.0	231.0	121.0
	Min	305.6	338.3	239.9	248.1	254.5	65.6	2.1	3.2	9.0	4.0	2.1	3.7
	Mean	8,037.8	8,027.8	7,171.0	6,371.2	9,565.5	1,555.5	36.8	27.8	361.8	143.9	87.5	54.2
	SD	8,256.8	7,088.0	7,268.8	5,547.9	12,798.9	1,645.6	46.0	19.2	399.9	146.3	111.4	42.9
OMA	Max	758.4	4,636.9	706.6	3,474.9	386.2	1,123.3	20.5	84.8	24.4	76.7	15.6	67.1
	Min	254.6	1,029.4	206.8	780.5	154.5	20.8	1.3	17.9	8.3	9.4	7.3	16.6
	Mean	545.0	2,113.4	490.1	1,663.4	276.0	633.9	11.1	43.4	16.1	34.6	10.7	31.5
	SD	210.0	1,442.4	218.4	1,048.7	91.2	481.9	8.7	27.0	6.2	27.9	3.5	20.8
SAU	Max	16,518.8	32,343.5	16,037.7	30,100.5	26,208.1	6,667.9	171.0	427.9	584.1	503.4	216.6	287.1
	Min	903.5	2,637.9	898.2	2,397.5	68.7	285.4	8.9	77.3	16.5	34.6	13.7	32.7
	Mean	7,977.2	16,616.2	7,534.7	15,273.3	8,823.6	3,415.2	69.2	190.0	302.9	195.3	91.7	153.8
	SD	4,816.0	8,504.2	4,571.1	7,855.5	8,835.9	2,149.0	48.7	126.2	175.7	136.1	59.3	77.0

Notes: UAE: United Arab Emirates, KUW: Kuwait, QAT: Qatar, BAH: Bahrain, OMA: Oman, and SAU: Saudi Arabia.

Table 3: Descriptive statistics of banking inputs and outputs for the non-GCC Arab countries ($ millions)

		Earning Assets		Deposits		Off Balance Sheet		Operating Cost		Interest Expenses		Staff Expenses	
		2000	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**
EGY	Max	11,840.1	20,317.2	10,327.7	18,531.1	7,309.7	14,095.7	705.0	78.6	862.1	1,011.3	490.0	274.8
	Min	191.3	316.7	133.2	285.1	32.0	30.3	1.1	3.7	9.0	16.3	2.5	4.6
	Mean	2,296.5	3,345.6	2,060.0	3,282.3	721.2	1,056.8	46.4	19.9	146.3	162.4	55.4	57.5
	SD	3,467.4	4,756.4	3,137.5	4,735.1	1,605.7	3,089.8	155.8	21.3	253.6	261.7	111.0	81.1
TUN	Max	2,449.8	3,274.2	1,557.9	1,724.4	1,843.2	2,364.8	127.6	106.8	30.2	65.2	30.9	36.3
	Min	498.2	872.9	0.2	63.6	433.4	672.4	23.0	5.8	10.2	2.3	3.9	1.1
	Mean	1,027.4	2,077.9	582.9	852.6	864.4	1,608.7	49.0	52.9	17.4	29.3	18.1	18.7
	SD	654.6	907.2	516.2	528.0	511.4	669.8	35.3	32.1	8.5	20.4	8.9	11.5
MOR	Max	4,833.4	10,840.2	4,626.1	11,287.2	2,643.2	3,384.0	125.1	392.0	190.5	324.7	76.7	162.6
	Min	926.0	2,099.4	823.0	2,360.6	300.3	371.1	24.9	69.1	36.8	32.4	21.4	44.0
	Mean	2,252.3	6,176.4	2,177.5	6,454.1	828.3	1,217.7	49.5	151.4	87.4	149.1	35.4	86.4
	SD	1,531.1	3,623.0	1,573.4	3,729.1	818.7	994.1	35.3	115.7	57.4	124.2	20.8	49.3
JOR	Max	6,146.0	26,600.9	1,180.5	21,237.6	7,917.6	9,189.7	92.4	244.5	475.3	505.1	107.1	269.9
	Min	0.8	139.0	20.3	138.7	59.5	40.0	0.1	7.3	7.8	7.1	1.3	4.6
	Mean	840.2	4,526.6	180.7	3,665.0	1,150.8	1,549.0	14.8	50.5	88.9	79.5	18.1	49.2
	SD	2,144.5	8,972.6	404.3	7,148.0	2,735.5	3,121.0	31.4	80.0	158.4	172.3	36.1	89.7
LEB	Max	138.2	230.3	125.9	196.4	24.4	44.2	0.9	1.3	10.3	10.2	1.3	1.4
	Min	0.6	2.8	0.3	0.5	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	31.0	49.5	27.5	43.4	3.9	6.8	0.3	0.3	2.0	1.9	0.4	0.4
	SD	38.0	50.7	34.4	45.2	5.6	10.0	0.3	0.3	2.6	2.2	0.4	0.4

Notes: EGY: Egypt, TUN: Tunisia, MOR: Morocco, JOR: Jordan, and LEB: Lebanon.

6. Empirical results

Table 4 presents the efficiency and productivity scores of GCC banks, and Table 5 presents those of the non-GCC Arab banks. The last four rows of each table present the averages of the two groups of banks.

Table 4: Evolution of efficiency and productivity of GCC banks

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
UAE	TEF	0.85	0.83	0.85	0.81	0.84	0.85	0.87	0.86	0.85	0.89	0.93
	TECHCH	-	1.02	1.07	0.95	1.06	0.98	1.03	0.97	1.00	1.02	0.92
	SECH	-	0.98	0.97	1.01	1.03	1.02	1.01	1.01	1.00	0.99	1.00
	TFP	-	1.00	1.03	0.97	1.09	1.01	1.04	0.98	0.98	0.99	0.96
KUW	TEF	0.94	0.95	0.92	0.93	0.92	0.93	0.92	0.96	0.98	0.98	1.00
	TECHCH	-	1.31	1.04	0.95	1.05	1.03	1.09	0.91	1.03	0.89	0.94
	SECH	-	0.97	0.96	1.03	1.01	1.01	0.97	1.05	1.00	0.98	1.02
	TFP	-	1.27	1.00	0.98	1.06	1.04	1.06	0.95	1.03	0.87	0.96
QAT	TEF	0.96	0.92	0.94	0.94	0.94	0.89	0.93	0.95	1.00	0.99	1.00
	TECHCH	-	0.97	1.03	1.00	0.90	0.96	0.86	1.03	1.11	0.96	1.11
	SECH	-	1.01	0.98	1.03	0.98	1.02	0.99	1.01	1.00	1.00	0.97
	TFP	-	0.98	1.01	1.02	0.88	0.99	0.86	1.05	1.11	0.96	1.08
BAH	TEF	0.87	0.89	0.89	0.88	0.89	0.87	0.90	0.91	0.94	0.98	0.99
	TECHCH	-	1.04	1.03	1.14	1.02	1.08	0.88	1.29	1.29	1.24	0.83
	SECH	-	1.04	1.01	1.00	0.98	1.01	1.02	0.98	1.00	0.99	1.04
	TFP	-	1.08	1.05	1.15	1.00	1.09	0.90	1.26	1.29	1.21	0.86
OMA	TEF	0.88	0.90	0.92	0.87	0.91	0.94	0.93	0.89	0.92	0.94	0.98
	TECHCH	-	1.22	1.13	0.96	0.96	0.98	1.00	0.86	1.15	1.26	0.95
	SECH	-	1.00	1.01	0.98	1.02	1.01	1.00	0.99	1.00	1.01	1.01
	TFP	-	1.22	1.14	0.94	0.98	0.99	0.98	0.86	1.13	1.27	0.96
SAU	TEF	0.96	0.95	0.96	0.96	0.96	0.95	0.95	0.97	0.98	0.97	0.99
	TECHCH	-	1.03	0.97	1.04	0.95	0.95	1.32	0.87	0.95	0.95	1.12
	SECH	-	1.00	1.00	1.00	1.00	0.99	0.99	1.01	1.00	1.01	1.00
	TFP	-	1.01	0.97	1.04	0.96	0.95	1.31	0.88	0.95	0.96	1.11
Average GCC	**TEF**	**0.91**	**0.91**	**0.91**	**0.90**	**0.91**	**0.91**	**0.92**	**0.92**	**0.95**	**0.96**	**0.98**
	TECHCH	**-**	**1.10**	**1.05**	**1.01**	**0.99**	**1.00**	**1.03**	**0.99**	**1.09**	**1.05**	**0.98**
	SECH	**-**	**1.00**	**0.99**	**1.01**	**1.00**	**1.01**	**1.00**	**1.01**	**1.00**	**1.00**	**1.01**
	TFP	**-**	**1.09**	**1.03**	**1.02**	**1.00**	**1.01**	**1.03**	**1.00**	**1.08**	**1.04**	**0.99**

Notes: UAE: United Arab Emirates, KUW: Kuwait, QAT: Qatar, BAH: Bahrain, OMA: Oman, SAU: Saudi Arabia. TEF: technical efficiency; TECHCH: technological change; SECH: scale efficiency change; TFP: total factor productivity (Malmquist productivity index).

The technical efficiency scores show that the all Arab banks have improved their efficiency (e.g. organisational and managerial efficiency) and in using production factors (inputs) to produce their outputs. The results show that UAE banks have rationalised their production factors over the study period, and lowered their inputs by 9.4% to generate the same level of outputs. Similar results were recorded by Kuwaiti banks (a decrease in inputs by 6.4%), Qatari banks (a decrease in inputs by 4.2%), Bahraini banks (a decrease in inputs by 13.8%), Omani banks (a decrease in inputs by 11.4%), and the Saudi banks (a decrease in inputs by 3.1%). The overall rationalisation of inputs for the GCC banking sectors was 7.7% between 2000 and 2010. These figures show that on average, GCC banks have developed their technical efficiency, which resulted in better exploitation of production factors.

Table 5: Evolution of efficiency and productivity of non-GCC Arab banks

		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
EGY	TEF	0.88	0.87	0.82	0.83	0.84	0.86	0.88	0.88	0.90	0.88	0.95
	TECHCH	-	1.02	0.95	1.09	0.97	1.00	1.08	1.05	1.11	0.93	1.17
	SECH	-	1.03	1.00	1.00	1.02	0.99	0.96	0.99	0.97	1.02	0.92
	TFP	-	1.05	0.95	1.04	1.00	0.99	1.04	1.05	1.06	0.93	1.10
TUN	TEF	0.83	0.81	0.83	0.82	0.75	0.76	0.81	0.84	0.88	0.91	0.92
	TECHCH	-	1.31	1.37	0.52	0.79	1.03	1.09	1.04	0.92	1.57	1.00
	SECH	-	1.05	0.96	1.08	1.03	0.99	1.00	1.01	1.00	1.00	0.99
	TFP	-	1.37	1.43	0.55	0.89	1.03	1.09	1.02	0.90	1.48	1.01
MOR	TEF	0.95	0.95	0.96	0.96	0.99	0.97	0.94	0.99	0.97	0.98	0.99
	TECHCH	-	1.11	1.17	1.09	1.07	0.98	0.94	1.04	0.96	0.96	0.96
	SECH	-	1.00	1.00	1.00	1.00	0.99	1.01	1.00	1.00	1.00	1.00
	TFP	-	1.11	1.18	1.08	1.08	0.98	0.94	1.05	0.95	0.97	0.95
JOR	TEF	0.87	0.94	0.89	0.89	0.91	0.88	0.91	0.90	0.88	0.91	0.97
	TECHCH	-	1.33	1.12	1.02	0.95	1.05	1.00	0.97	0.99	1.16	1.12
	SECH	-	1.00	1.00	1.00	1.01	0.98	1.02	0.99	1.00	0.98	0.97
	TFP	-	1.39	1.04	1.08	0.96	1.00	1.03	0.98	0.99	1.10	1.08
LEB	TEF	0.90	0.89	0.88	0.91	0.92	0.90	0.92	0.92	0.90	0.93	0.93
	TECHCH	-	1.04	1.70	1.00	1.10	1.11	1.26	0.54	0.96	0.99	1.09
	SECH	-	1.06	0.78	1.08	0.97	0.91	0.79	1.61	1.03	1.01	0.91
	TFP	-	1.08	1.31	1.12	1.09	0.99	1.01	0.87	0.97	1.03	0.98
Average non-GCC	**TEF**	**0.89**	**0.89**	**0.88**	**0.88**	**0.88**	**0.87**	**0.89**	**0.91**	**0.91**	**0.92**	**0.95**
	TECHCH	**-**	**1.16**	**1.26**	**0.95**	**0.98**	**1.04**	**1.07**	**0.93**	**0.99**	**1.12**	**1.07**
	SECH	**-**	**1.03**	**0.95**	**1.03**	**1.01**	**0.97**	**0.96**	**1.12**	**1.00**	**1.00**	**0.96**
	TFP	**-**	**1.20**	**1.18**	**0.98**	**1.01**	**1.00**	**1.02**	**1.00**	**0.97**	**1.10**	**1.02**

Notes: EGY: Egypt, TUN: Tunisia, MOR: Morocco, JOR: Jordan, LEB: Lebanon. TEF: technical efficiency; TECHCH: technological change; SECH: scale efficiency change; TFP: total factor productivity (Malmquist productivity index).

The sample of non-GCC banking sectors has also witnessed an increase in technical efficiency. The Egyptian banking sector recorded an improvement by 8%, the Tunisian banking sector recorded an improvement by 10.8%, the Moroccan banking sector by 4.2%, the Jordanian banking sector by 11.5%, and the Lebanese banking sector 3.3%. The figures resulted in an average improvement by 7.4% for the entire sample. Despite these developments, we notice that there is still a room for improvement for the majority of Arab banks. For instance, UAE banks can further enhance their efficiency by 7%, Bahraini banks by 1%, Omani banks by 2%, Saudi banks by 1%, Egyptian banks by 5%, Tunisian banks by 8%, Moroccan banks by 1%, Jordanian banks by 3%, and Lebanese banks by 7%.

Moving to productivity indicators we observe the following. The first indicator TECHCH shows the efficiency of banks in using technological progress, i.e., investment in technology. The empirical results show that UAE banks recorded deterioration in TECHCH scores by 9.8% between 2001 and 2010, which may suggest an over-investment in technology, or banks have been unable to economically exploit the technology they use (which is among the most advanced technologies worldwide). Worst score has been recorded by Kuwaiti banks (-22.2%), Bahraini banks (-20.2%), and Omani banks (-22.1%). Conversely, Qatari banks recorded an improvement by 14.4%, and Saudi banks by 8.7%. All the above figures have resulted in an overall decrease in technological progress by 10.9% for the sample of GCC banks. Regarding the sample of non-GCC banking sectors, the Egyptian banks recorded on average improvement by 14.7% and the Lebanese banks an improvement by 3.3%. Conversely, the Tunisian banks recorded deterioration by 23.5%, the Moroccan banks by 13.5% and the Jordanian banks by 15.8%. The above figures resulted in an overall deterioration by 8.1% for the overall sample of non-GCC Arab banks.

The scale efficiency indicator (SECH) shows if banks operate at the "appropriate" size. Table 4 shows an improvement in SECH by 2% recorded by UAE banks, 5.2% improvement recorded by Kuwaiti banks, and 1% recorded by Omani banks. On the other hand, Bahraini and Saudi banks recorded the same scores in 2001 and 2010. Conversely, Qatari banks witnessed deterioration by 4%. These figures resulted in an average improvement by 1% for the sample of GCC banks. On the other hand, the sample of non-GCC banks recorded on average, either a deterioration (Egypt by 10.7%, Tunisia by 5.6%, Jordan by 3%, and Lebanon by 14.2%), or no change as in the case of Moroccan banks. These results implied an overall deterioration by 6.8% in scale efficiency change score. It is therefore possible that Arab banks are actually in a situation of increasing returns-to-scale (i.e. with insufficient size), which does not allow them to exploit the full economies of scale, or diminishing returns (i.e. excessive size). In other words, a part of their inefficiency is the result of an inadequate size.

The bottom line of our study is obtaining total factor productivity scores (Malmquist productivity index) for Arab banks after a decade of deregulation and liberalization. A productivity index higher (lower) than 1 indicates an improvement (deterioration) in the productivity of banks during the study period. Looking first at the sample of GCC banks, we obtain the following results. Our empirical results show a considerable deterioration in TFP scores for UAE banks (by 4%), Kuwaiti banks (by 24.4%), Bahraini banks (by 20.4%), and by Omani banks (by 21.3%). These negative results are the consequences of the deterioration in TECHCH scores presented previously (-9.8% for UAE banks, -28.2% for Kuwaiti banks, -20.2% for Qatari banks, and -22.1% for Omani banks). This shows the impact of technological inefficiency on total factor productivity. One possible explanation for this low productivity growth in these countries is that the introduction of technical progress has resulted in (due to a learning phenomenon) a reduction in productivity rather than an increase (Dietsch et al., 1998). Therefore, we conclude that technological proficiency of a bank have been reflected in an increased level of outputs, but this production may be considered inefficient if too much is needed to achieve this production level (i.e. waste of resources).

Conversely, banking sectors that record an improvement in TECHCH, witnessed an improvement in TFP scores: Qatari banks by 10.2% (with an improvement in TECHCH by 14.4%) and Saudi banks by 9.9% (with an improvement in TECHCH by 8.7%). On the other hand, Egyptian banks recorded an improvement in TFP by 4.8% between 2001 and 2010, whereas the other four non-GCC banking sectors recorded deterioration in this indicator: Tunisia by 26.7%, Morocco by 14.4%, Jordan by 22.3%, and Lebanon by 9.3%. These results have been consistent with the scores of TECHCH. A final remark in this regard is that the deterioration in TFP scores for non-GCC banking sectors has been higher than that of GCC banking sectors. Thus, the empirical results show that the banking sectors in the Arab countries can increase productivity either by improving scale efficiency or through technological proficiency.

7. Conclusion

This study examined the effect of deregulation and liberalisation on the performance of eleven Arab banking sectors between 2000 and 2010. It employed a non-parametric DEA efficiency frontiers and Malmquist indices of total factor productivity change. The latter are further broken down into technological change, technical efficiency, and scale efficiency. The results of this paper show that deregulation and financial liberalisation had beneficial effects on the technical efficiency of all Arab Banking sectors under study, which suggests that banks operating in those countries have benefited from the changing economic and financial environment to improve this type of efficiency. However, the results show that there is still a room for further improvement.

Conversely, the technological change scores show significant deterioration in technological proficiency for the majority of Arab banking sectors (seven out of eleven), which may be evidence of excess investment on technology not accompanied with identical increase in productivity. Moreover, several Arab banks have recorded a decrease in scale efficiency scores (five out of eleven), which may suggests that those banks are operating at inadequate size.

Finally, the Malmquist total factor productivity index results show an improvement in productivity only in three out the eleven banking sectors under study. We have noticed that all banking sectors with deterioration in technological progress efficiency, witnessed a parallel deterioration in productivity. This shows the significant negative impact of over-investment in technology on productivity if this investment is not translated in an analogous increase in production.

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