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# Total Factor Productivity Change in the Middle East Banking: The Case of Jordanian Banks at the Turn of the Millennium

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## Abstract

*This paper analyzes the total factor productivity developments in the Middle East banking, by drawing on the experience of Jordanian banks at the start of the new millennium. In order to control for the effects of different specifications of banking technology on the results, this study estimates the productivity and efficiency growth scores under two alternative approaches, production and intermediation models. On average, under the former model, we found 79% technical efficiency and 3.2% productivity growth, while under the later model we found 92% technical efficiency and 3.3% productivity growth for the sector. One implication is that the Jordanian banks can obtain considerable resource savings if they can catch up with the best practice banks. Among the organizational forms operating in this emerging market, we found that commercial banks generally outperform both investment and Islamic banks in terms of efficiency and total factor productivity growth.*

***Keywords:*** *Jordan; Middle East; Efficiency; Productivity; DEA; Malmquist index*

***JEL classification****: D61; G21; G34*

## Introduction

Like other financial intermediaries, banks facilitate the flow of funds from surplus spending units (savers) to deficit spending units (borrowers). In essence, banks are financial institutions that accept deposits and make loans. Both theoretical and empirical literature suggests that how efficiently they perform this function is critical for a genuine and sustained economic growth in a country (Gurley and Shaw, 1960; Levine and Zervos, 1998; and Darrat and Haj, 2002). By channeling funds, they improve the economic welfare of everyone in the society, as they move funds from people with no productive investment opportunities to those with such opportunities, thereby contributing to increased efficiency in the economy. The degree, to which financial institutions transform scarce resources of a nation (investible funds) into their most productive uses (loans/investments) with no or minimal waste, has been the focus of many parties in an economy, such as bank customers, policy–makers, managers and researchers, especially in a rapidly changing and complicated new environment. If these institutions are run efficiently, improvements in resource allocation can lead to increased profitability, greater amounts of funds intermediated, better prices and service quality for consumers, and greater safety and soundness in the financial system (Isik et al., 2016 a, b).

Throughout the past two decades, many countries all around the world have deregulated their financial services industries in order to boost the productivity and efficiency levels of financial institutions. However, as geographic and product deregulation took place, the borders which defined the scope of the business for financial institutions and segment their markets have been blurred. Deregulation has made it easier to enter and exit a market, leading to an environment where traditional banks have began to face for the first time a head-on competition from all fronts, not only from firms within and outside of banking industry but also from firms within and outside of country. The resulting increase in competition puts financial institutions around the globe in a situation where their success depends on their ability to adapt and operate (convert inputs to outputs) efficiently. Also, mounting competition and more opportunities to assume risky ventures in the new liberal environment made banks more susceptible to financial disruptions (Isik and Hassan, 2003a,b; Al-Amarneh, 2014). Therefore, investigation of bank efficiency and productivity has become a critical inquiry for bank regulators and managers alike because the studies on bank and thrift failures showed that there seems to be a positive relationship between operating inefficiency and failure rates (e.g., Berger and Humphrey, 1992a; Cebenoyan, Cooperman, and Register, 1993; Hermalin and Wallace, 1994; Wheelock and Wilson, 1995; Isik et al., 2015). In fact, in perfectly competitive and contestable markets, inefficient firms will face hardship to survive and ultimately will be weeded out by efficient ones, as will anything that reduces the costs for customers result in switching to low-cost firms or more efficient structures (Isik and Hassan, 2002a; Hassan et al; 2010).

In this framework, the purpose of this study is to analyze the level and developments of efficiency and productivity scores of banking firms operating in the Middle East, by drawing on the Jordanian experience. This study is important because first and foremost, to the best of our knowledge, there is no empirical study that addresses the productivity growth, technical progress and efficiency change issues of Jordanian banks. Thus, this paper will complement and extend the international banking efficiency literature, which is substantially skewed towards the banks of developed countries (Berger and Humphrey, 1997; Berger et al., 1998; Isik et al; 2016a, b). Second, like in many emerging markets, banks in Jordan are the dominant financial institution, as they control most of the financial flows and possess most of the financial assets in the economy. Moreover, many non-bank financial institutions in Jordan, like in other emerging economies, are also affiliates of banks. As the competition in banking market is somewhat constrained, inefficient usage of resources in these institutions may result in higher operating costs and thus more expensive bank services and higher loan prices, eventually raising cost of funding for all economic units and making many public and private projects unfeasible ventures (by making their IRR fall below the hurdle rate). Thus, the study of how efficiently those banks are operating is also important for the government and industrial firms, as banks are in effect the only external source of funds for public and private funding in the country. Third, one of the cardinal missions of bank regulators is to ensure the efficient functioning of the banking system along with its safety and soundness. The first step in this endeavor is to determine the level of efficiency and productivity of the banking system. Hence, this study may also help regulators in Jordan in their efforts

to improve the overall performance of the banking sector and determine the causes of non-optimal behavior observed among their banks. By the revelation of the most efficient and productive banks, this study provides a "model" to follow for the managers of poorly performing banks. By the same token, policy-makers may foster overall managerial performance of banks by first identifying "best practices" and "worst practices" associated with the most and least efficient banks and then encouraging the former practices while discouraging the latter (Berger and Humphrey, 1997; Isik, 2008). Furthermore, this paper has also some important research implications. Studies from different regulatory environments and market structures may help us conceive the impact of these differences on bank performance. For instance, the Jordanian banking market is highly concentrated as compared to those of advanced economies. For instance, the three-bank concentration ratio is 91% for Jordan, whereas it is 19% for the US, 22% for Japan, 41% for France, 45% for Germany and 0.56% for the UK. The Jordan's concentration ratio is also higher when compared to those of other emerging markets, such as 59% for Tunisia, 64% for Bangladesh, 65% for Egypt, 0.69 for Peru, 0.74 for Pakistan and 0.87 for Uruguay (Demirguc-Kunt and Levine, 1999). In some cases, the recent finance literature reports that there is a negative association between market concentration and bank performance (Berger and Mester, 1997; Berger et al., 1998). It is possible that banks of concentrated markets become less motivated to operate efficiently and productively, as they do not face strong competition from new banks and non-bank financial institutions. Moreover, the lack of developed money and capital markets also provides comfort for banks of emerging countries, as "disintermediation" from depositors and borrowers has not threatened their business yet to the extent that it did in developed markets. Therefore, ceteris paribus, comparisons of banking productivity and efficiency growth in Jordan vis-à-vis in less concentrated markets may let us understand further the dynamics between market concentration and bank performance.

In this study, we aimed to measure the productivity performance of banking firms under relatively stable and normal conditions to draw "healthy" conclusions about the Middle East banking. Hence, in order to avoid the possible adverse impact of the economic and political crises on the results, particularly emanating from the Gulf Wars in 1991 and 2003, Global Financial Recession in the late 2000s and the most recent skirmishes in the whole region due to the Arab Spring, we purposefully concentrated on the period 1996-2001 for this analysis. This period also allows us to document how the Middle East Banking, as represented here by the Jordanian experience, greeted the new millennium in terms of productivity and efficiency developments.

## Literature Review

### Banking Efficiency and Productivity

Separating banks by their performances has been the focus of many studies, both theoretical and empirical. Frontier efficiency is one sophisticated way employed in the finance literature to "benchmark" the relative performance of banks. *X-efficiency* is a measure of how close an observed bank is to an estimated "best-practice" frontier. The frontier X-efficiency concerns a bank's use of *inputs* and refers to whether a bank is using its inputs, like labor and capital, in a cost-effective manner relative to the firms on the efficient frontier (Isik et al., 2016a). Put differently, for a given level and mix of outputs, is a bank producing its outputs in the least cost way possible? If not, the bank is wasting some of the inputs it has employed (technical inefficiency). There is a virtual consensus in the literature that differences in X-efficiency among financial institutions exceed inefficiencies attributable to incorrect scale or scope of output. The evidence to date suggests that X-inefficiencies account for on the order of 20% or more of total banking costs, and about 50% of the industry's potential profits, while scale and scope inefficiencies are usually found to account for less than 5% of costs (Berger and Humphrey, 1991). It seems that banks operate relatively efficiently with respect to the optimal combination and scale of outputs, yet they are very inefficient in transforming their inputs into outputs.

In the literature, researchers utilize two competing methods, *parametric frontier approach* (Aigner et al., 1977; Berger, 1993; Habolth, 2003; Isik and Hassan, 2002b) or *nonparametric frontier approach* (Fare et al., 1994; Leightner and Lovell, 1998; Wheelock and Wilson, 1999; Isik and Hassan, 2003a, b; Isik, Topuz and Agcayazi-Yilmaz; 2015), to measure growth and efficiencies of financial institutions. Both of these

sophisticated techniques, as mentioned, attempt to "benchmark" the relative performance of production units but differ from each other mainly due to their underlying assumptions. Unlike the parametric approach, the non-parametric approach puts relatively little structure on the specification of the banking technology (frontier) and thus it is relatively immune from the specification errors. In addition, unlike the former, the latter approach does not make any assumption regarding the structures and distributions of inefficiency and error terms because the latter approach deems all deviations from the frontier as inefficiency, while the former assumes that part of the deviations is due to pure luck or data problems and part of the deviations is due to managerial errors. Furthermore, non-parametric frontiers are estimated using a mathematical linear programming, thus they work well with small samples. Whereas, parametric frontiers are estimated using econometric techniques, thus they require large sample size to estimate unbiased coefficients of inputs, outputs, environmental factors and inefficiency and error terms (Aly et al., 1990; Evanoff and Isralievich, 1991; Avkiran, 1999; Sathye, 2002; Darrat et al., 2002; Isik and Hassan, 2002a).

The literature on the efficiency and productivity of financial institutions, especially for industrialized countries, is voluminous and well documented in some studies.[1] Because the intent of this study is to examine the performance of banks in an emerging market, it is useful to focus on some relevant studies that provide insights on the efficiency and productivity of banks operating in developing economies. After surveying 69 applications of nonparametric methods and 60 applications of parametric methods for various financial institutions from 21 countries, developed and developing, Berger and Humphrey (1997) emphasize that of those only about 5% investigate the banking sectors of emerging economies. In other words, they note that the great majority of these studies are concerning the institutions of advanced countries (95%) in general and the U.S. in particular (75%). Most of the literature on bank efficiency in emerging markets dwells on the efficiency variations among banks with different ownership structures and size. As known, banking markets in these economies are still in their infancy and characterized with state dominance, newly structured privatization programs, relaxation of entry barriers for domestic and foreign banks. The policy questions examined in these studies are related to the impacts of privatization of public banks, lifting of entry restrictions for domestic and foreign banks and consolidation of financial institutions on the efficiency of the sector.

Earlier research has provided mixed results about the effect of ownership on bank efficiency and productivity. In the banking markets of developed world, domestic banks were found to be more efficient than foreign banks (Hasan and Hunter, 1996; Mahajan et al.; 1996; Chang et al.; 1998; DeYoung and Nolle, 1996 and Berger et al., 2000; Sathye, 2002). The proposed reason in these papers is that foreign banks had to finance their rapid market expansion relying predominantly on *purchased funds*, which are relatively costlier and unstable, rather than *core funds*, which require broader branching network, but at the same time, relatively less expensive and more stable. Peek et al. (1999), on the other hand, explain this observation with another conjecture. Foreign banks enter the U.S. market basically acquiring domestic banks. Thus, the relatively low efficiency of foreign banks can be attributed to the lower efficiency and performance of the acquired domestic banks. On the contrary, in emerging markets, foreign banks were found to be more efficient than either public or private domestic banks. For instance, Bhattacharya et al. (1997), Srivastava et al. (1999) for Indian banks, Hasan and Marton (2000) for Hungarian banks and Isik and Hassan (2002a, b) for Turkish banks report that foreign banks are more cost efficient than their domestic peers. Likewise, studying Turkish and Hungarian case, respectively, Ozkan-Gunay (1998) and Hasan and Marton (2000) find that foreign-owned banks are also more profit efficient than publicly- or privately-owned domestic banks. Claessens et al. (2001) and Isik and Hassan (2002b) state that foreign banks are also more profitable than their domestic counterparts. In this line, Leigthner and Lovell (1998) and Laeven (1999) also indicate that as compared to domestic banks, foreign banks demonstrate greater efficiency in the banking system of Thailand.

[1] For example, see Berger et al. (1993) and Berger and Humphrey (1997) for overall efficiency issues and see Berger and Mester (1997) and Isik and Hassan (forthcoming) for correlates of efficiency in the US and Turkish markets, respectively. While constructing this summary, in addition to the above studies, this section also partly benefits from Yildirim and Philappatos (2002).

As for size, Hasan and Marton (2000) found that larger banks are more cost and profit efficient than smaller banks in Hungary. Likewise, Srivastava (1999) reports that there exist significant economies of scale in the Indian banking market. Levaen (1999) reports that small Thai banks underachieve both medium and large banks in terms of efficiency. By contrast, Isik and Hassan (2002a) and Darrat et al. (2002) find a negative association between bank size and efficiency for the Turkish and Kuwaiti banks, respectively. Furthermore, Leightener and Lovell (1998) and Isik, Topuz and Agcayazi (2015) find that productivity of banks and REITs in the US, respectively, is also negatively correlated with size.

A large proportion of the studies in the existing literature agree on the positive relationship between the financial deregulations and bank productivity growth. For instance, by using a DEA type efficiency and Malmquist TFP indexes for Turkish banks, Isik and Hassan (2003a), Isik et al. (2004), Isik and Uysal (2006), Isik and Akcaoglu (2006) and Isik (2007) examined this relationship in Turkey and suggested that financial liberalization has a positive impact, although at varying degrees, on the productivity and efficiency of banking firms with different organizational forms, e.g.; state, privately, foreign-owned banks, traditional and newly established banks, small, medium and large banks. Kumbhakar and Lozano-Vivas (2005) investigated the contribution of deregulations in Spain and also found that TFP growth for savings and commercial banks are positively affected. In the case of India, Sanyal and Shanker (2011), suggests that private banks performed better than public and foreign banks in terms of productivity after 1991 reforms in India.

As regards to the Middle East and North Africa (MENA) region, efficiency and productivity literature contains a scant number of empirical studies that exclusively focus on the banking systems of the region. For example, Al-Faraj et al. (1993), utilizing a non-parametric approach, DEA, study the operational efficiency of *branch offices* of a Saudi bank and report 87% overall efficiency for those branches. Employing a parametric approach, SFA, both Chaffai (1993) and Chaffai (1997) examine the productive efficiency of banks operating in Tunisia. These studies find that Tunisian banks exhibit a cost efficiency score ranging from 61% to 65%. While the former Tunisian study is basically related to general level of efficiency in the banking system, the latter is primarily involved in methodological issues. A frontier study by Darrat et al. (2002), using a DEA methodology and a sample of eight banks, examine the banking efficiency and productivity in the Kuwaiti banking sector. They report that on average Kuwaiti banks demonstrate 68% cost efficiency, and 28% productivity growth over the period 1994-1997. They suggest that input waste could be reduced by 47%, were Kuwaiti banks operating on the efficient frontier. Finally, in a recent non-frontier study, Al-Amarneh (2014), studies the effect of ownership structure and corporate governance on bank performance. Using publicly available data of thirteen Jordanian banks between 2000 and 2012, this study suggests that ownership concentration and foreign ownership positively affect bank profitability. Also, as board size increases the bank performance also increases, suggesting that good governance standards are important for every bank along with investors and shareholders.

# Research and Methodology

## Non-Parametric Malmquist Total Factor Productivity Change Index

According to Evanoff and Israilevich (1991), Leightner and Lovell (1998), Isik et al. (2015), the DEA works well with small samples. Although our sample contains the *universe* of banking firms in Jordan, our population size is relatively small. We have 18 banks per year over the study period (90 raw observations overall). Also, we would like to focus on the input usage skills of banks to see whether the Jordanian banks are rationing their inputs given the hard economic conditions the country has been facing amid the recent political instabilities in the region. Therefore, we opt to use a non-parametric frontier approach, *input-orientated* DEA technique, to measure the efficiency and productivity scores of the Jordanian banks. One sort of X-efficiency index is the technical efficiency measure that relies on the *amounts* of inputs and outputs and does not necessitate the problematic and detailed price information.

*Technical efficiency (TE)* measure indicates whether a bank employs minimum amount of inputs to produce a given amount outputs, or whether a bank produces maximum level of outputs given a fixed amount of inputs, as compared to a bank operating on the efficient frontier. *"Pure" technical efficiency (PTE)* is simply

technical efficiency devoid of scale effects, which indicates a proportional reduction in input usage if inputs are not wasted given the current production level that may be scale inefficient. *Scale efficiency (SE)* refers to a proportional reduction in input usage if the bank can attain the optimum production level where there are constant returns to scale. For the least and the most efficient units in the sample, the efficiency measures take values between 0% and 100%, respectively. We expect that construction of different efficiency indexes will allow us to trace the sources of technical inefficiency better.[2] Pure technical inefficiency (PTE), which is technical inefficiency (TE) devoid of scale effects, is entirely under the control of and results directly from management errors. Hence, it is also called *managerial inefficiency* in the finance literature. It arises when more of each input is used than should be required to produce a given level of output. It is generally attributed to lack of strong competitive pressures, which allow firms to survive with less than optimal performance. A scale efficient (SE) firm will produce where there are constant returns to scale (CRS). Thus, when there are increasing returns to scale (IRS), then efficiency gains could be obtained by expanding production levels. In case decreasing returns to scale (DRS) exist, efficiency gains could be achieved by reducing production levels. As it involves the choice of an inefficient level, scale inefficiency is also considered a form of technical inefficiency. Thus, *technical in-efficiency* includes both PTE and SE; that is, in-efficient level of both inputs and outputs. Because our focus in this study is more on the dynamic total factor productivity change [TFPCH] indexes rather than the static efficiency indexes of the Middle Eastern banks, we will discuss the measurement of tfpch indexes in detail here and refer the interested readers in the computation of efficiency indexes [TE, PTE, SE] to other papers, such as Isik et al. (2016a, b). A direct comparison of efficiency measures across periods may not be an indicator of absolute improvement or deterioration of efficiency, as it would only show changes in relative efficiency vis-à-vis other banks. The frontier could shift from one period to another because of innovation, financial shock or increased competition in the market. Moreover, there could be substantial bank entries and exits over time, resulting in different samples of banks and thus frontiers across periods. For this reason, and due to its superiority, in a changing environment, the Malmquist TFPC index is commonly used to calculate absolute improvement or deterioration in bank efficiency and productivity (Wheelock and Wilson, 1999; Isik and Hassan, 2003a, b; Isik, 2007; Isik, 2008).

We utilize Farrel (1957)'s distance functions and employ the Fare *et al.* (1994)'s specification of productivity, in order define the Malmquist total factor productivity change (*tfpch*) index. Accordingly, the Malmquist index (*tfpch*) is simply 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 (*tecch*), which is how much the benchmark production frontier shifts at each bank's observed input mix (*technical innovation* or *shock*). Total factor productivity change index *(tfpch)* 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*) technical efficiency change into scale efficiency and pure technical efficiency components (*effch* = *pefch* × *sech*). This requires the calculation of distance functions under variable returns to scale (*VRS*) (rather than *CRS*) technology.

$$TFPCH(t,t+1)=\overbrace{\underbrace{\frac{D^{VRS}_{t+1}(x_{t+1},y_{t+1})}{D^{VRS}_{t}(x_{t},y_{t})}}_{PEFCH}\times\underbrace{\left[\frac{D^{CRS}_{t+1}(x_{t+1},y_{t+1})/D^{VRS}_{t+1}(x_{t+1},y_{t+1})}{D^{CRS}_{t}(x_{t},y_{t})/D^{VRS}_{t}(x_{t},y_{t})}\right]}_{SECH}}^{EFFCH}\times\underbrace{\left[\frac{D^{CRS}_{t}(x_{t+1},y_{t+1})}{D^{CRS}_{t+1}(x_{t+1},y_{t+1})}\times\frac{D^{CRS}_{t}(x_{t},y_{t})}{D^{CRS}_{t+1}(x_{t},y_{t})}\right]^{1/2}}_{TECHCH} \quad (1)$$

[2]Since the DEA is standard by now, we refer the interested readers in further discussion to more technical studies on the efficiency techniques and their applications. For complete discussion on DEA and other frontier techniques, please see Bauer et al. (1998).

Consider the example in Figure 1 to see this decomposition, where the firm located at point *C* moves to point *D* from year *t* to year *t+1*, but the estimated $CRS_t$ and $VRS_t$ frontiers remain the same. From equation (1), $effch = (X_3D/X_3F)/(X_3C/X_3F) > 1$ and $tecch = [((X_3D/X_3F)/(X_3D/X_3F))\times((X_3C/X_3F)/(X_3C/X_3F))]^{1/2} = 1$, thus, *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 (*effch*>1) is driven by increases both in pure technical efficiency ($pefch = (X_3D/X_3E)/(X_3C/X_3E) > 1$) and scale efficiency ($sech = ((X_3D/X_3F)/(X_3D/X_3E))/((X_3C/X_3F)/(X_3C/X_3E)) > 1$). Notice that productivity growth does not always indicate an efficiency increase. For instance, reconsider the bank located at point *C*. By moving to point *D*, we saw that the bank became more productive. If *tfpch* were 1.1, the firm would be able to produce 10% 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 20% more output from the same amount of input ($X_3$). Despite the increased productivity, the bank still elicits technical inefficiency (measured as proximity to the frontier) by 10%.

In order to measure the productivity change, we obtain *tfpch* index utilizing again the same linear programming (LP) technique, DEA. We first assume that the CRS technology exists: all banks are scale efficient, however, later we will relax this assumption to decompose *effch* index in addressing scale efficiency issues. To get *tfpch* index, we need the four component distance functions, which involves four linear programming (LP) problems for each bank in the sample. First, $d_t(x_t, y_t)$ is obtained solving the following CRS output-orientated LP:

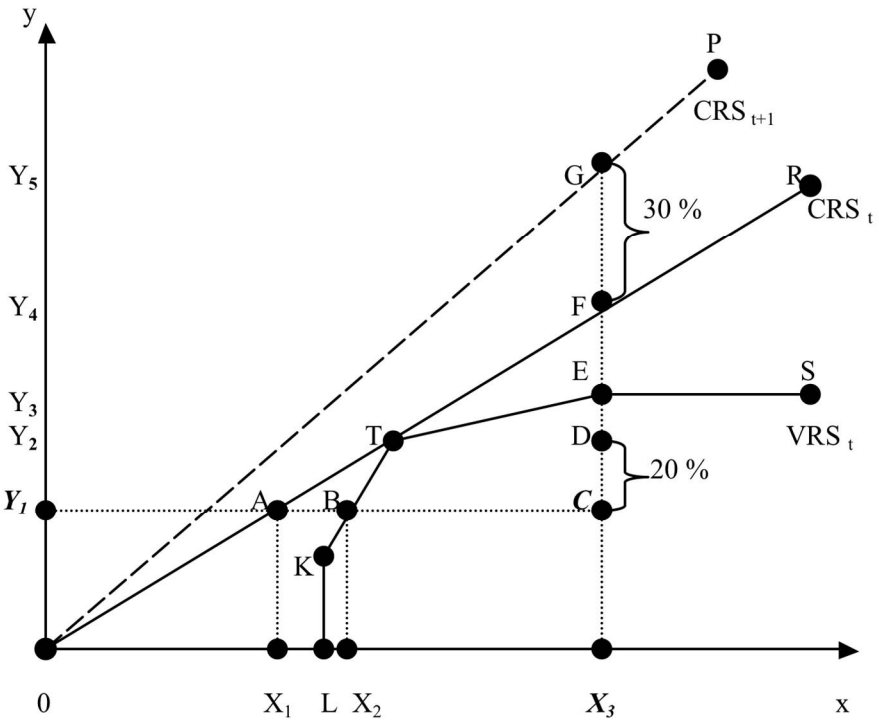


***Figure 1:*** *Total Factor Productivity Change Measures*

$$
\begin{aligned}
&[d_t(x_t, y_t)]^{-1} = \max_{\phi,\lambda} \phi, \\
&st. \\
&-\phi yy_{it} + Y_t\lambda \geq 0, \\
&x_{it} - X_t\lambda \geq 0, \\
&\lambda \geq 0,
\end{aligned} \tag{2}
$$

The remaining three LP problems, (3), (4), and (5), are simple the variants of (2):

$$
\begin{aligned}
&[d_{t+1}(x_{t+1}, y_{t+1})]^{-1} = \max_{\phi,\lambda} \phi, \\
&st. \\
&-\phi yy_{i,t+1} + Y_{t+1}\lambda \geq 0, \\
&x_{i,t+1} - X_{t+1}\lambda \geq 0, \\
&\lambda \geq 0,
\end{aligned} \tag{3}
$$

$$
\begin{aligned}
&[d_t(x_{t+1}, y_{t+1})]^{-1} = \max_{\phi,\lambda} \phi, \\
&st. \\
&-\phi yy_{i,t+1} + Y_t\lambda \geq 0, \\
&x_{i,t+1} - X_t\lambda \geq 0, \\
&\lambda \geq 0,
\end{aligned} \tag{4}
$$

$$
\begin{aligned}
&[d_{t+1}(x_t, y_t)]^{-1} = \max_{\phi,\lambda} \phi, \\
&st. \\
&-\phi yy_{it} + Y_{t+1}\lambda \geq 0, \\
&x_{it} - X_{t+1}\lambda \geq 0, \\
&\lambda \geq 0,
\end{aligned} \tag{5}
$$

where $\lambda$'s represent intensity variables showing at what intensity a particular activity may be used in production. Also, $1 \leq \phi < \infty$ and $\phi$ -1 is the proportional increase in outputs that could be realized by the *i*'th DMU, with input quantities held constant. The $\phi$ and $\lambda$'s are likely to take different values in the above four LP's. Finally, we can also decompose the (CRS) technical efficiency change into scale efficiency and pure technical efficiency change components (*effch* = *pefch* $\times$ *sech*). This requires the calculation of distance functions under variable returns to scale (VRS) (instead of a CRS) technology, enforcing us to solve two additional LP problems (when comparing two production points).

**Table 1:**The type of specialization for the Jordanian banks

| # | Name | Type |
|---|---|---|
| **1** | JORDAN GULF BANK | Commercial Bank |
| **2** | ARAB BANK | Commercial Bank |
| **3** | BANK OF JORDAN | Commercial Bank |
| **4** | PHILADELPHIA INVESTMENT BANK | Investment Bank |
| **5** | JORDAN INVESTMENT & FINANCE BANK | Investment Bank |
| **6** | MIDDLE EAST INVESTMENT BANK | Investment Bank |
| **7** | CAIRO AMMAN BANK | Commercial Bank |
| **8** | EXPORT & FINANCE BANK | Commercial Bank |
| **9** | INDUSTRIAL DEVELOPMENT BANK (Housing and Urban Dev. Bank) | Specialized Credit Institution (public ownership) |
| **10** | JORDAN KUWAIT BANK | Commercial Bank |
| **11** | ARAB BANKING CORPORATION / JORDAN | Commercial Bank |
| **12** | JORDAN ISLAMIC BANK FOR FINANCE & INVESTMENT | Islamic Bank |
| **13** | THE HOUSING BANK FOR TRADE AND FINANCE | Commercial Bank |
| **14** | ARAB JORDAN INVESTMENT BANK | Investment Bank |
| **15** | UNION BANK FOR SAVINGS & INVESTMENT | Investment Bank |
| **16** | JORDAN NATIONAL BANK | Commercial Bank |
| **17** | BEIT AL-MAL SAVING & INVESTMENT FOR HOUSING | Contractual Credit and Saving Companies (other financial institutions) |
| **18** | ISLAMIC INTERNATIONAL ARAB BANK | Islamic Bank |

## Data and Definition of Bank Production Variables

One reason for the lack of adequate number of empirical analyses on the banks of emerging markets in general and the MENA region in particular is the availability of data at the micro (firm) level. Most of the time, such data is considered confidential and typically proprietary. Therefore, even if made available, the emerging market data is usually aggregate; i.e., not detailed, inhibiting a comprehensive analysis of the institutions/sector under study. However, as the economies open up, money and capital markets develop and integration of financial markets constantly evolves across the globe, the demand for information disclosure by public and investment companies also increases. Because of public and diverse ownership structures of many banks, such data has been available for Jordan through some sources recently.[3]

The data used in this study comes from the Arab Monetary Fund (AMF), a joint organization between member Arab countries. The data covers the period 1996 to 2001 and encompasses rich information on the balance sheets, profit and loss statements, ownership and board structures as well as company shares of the Jordanian banks. We have 18 banks per year operating over the period under study, making up 90 raw observations overall.[4] Table 1 exhibits the identity and type of the Jordanian banks. As can be seen, of the 18 Jordanian banks that operated during the study period, 9 are commercial banks, 7 are investment banks and 2 are Islamic banks.

[3] For example, Global Vintage and Bank Scope databases provide some information on the Jordanian banks.
[4] Because one bank, namely Jordan Gulf Bank, had a negative worth over the period 1996-1999 and another bank, namely Islamic International Bank, was not existent between 1996 and 1997, the overall number of observation declines to net 84 observations.

In order to specify bank production variables, we should first decide on what factors of production (inputs) banks employ and what products and services (outputs) they generate. Prior researchers following the *asset*, *user cost* and *value-added* methods to assign financial goods to input and output vectors all agree that loans and other major earning assets of banks, such as investment securities, should count as bank outputs. However, they generally disagree on whether deposits should count as bank inputs or outputs. The source of disagreement is concerning the fact that deposits carry the typical features of both inputs and outputs. Deposits are like inputs because they are costly to collect (due to associated interest payments and overhead costs) and they are the major "raw material" that is transformed into earning assets in the financial production process. However, they are also like outputs because they provide a significant amount of liquidity, safekeeping and payments to depositors (Clark, 1988; Aly et al., 1990; Berger and Humphrey, 1997; Isik et al., 2016a).

As a matter of fact, the selection of inputs and outputs in practice is most of the time dependent upon the researcher's interest and view of banks and sometimes upon the availability of data. For example, macroeconomists and monetarists who are concerned with economy-wide issues tend to view banks as the producers of both deposits and loans, whereas others see banks as the producers of loans using deposits as raw materials (Benston et al., 1982). In fact, the former view is similar to the production approach, while the latter is similar to the intermediation approach, the two main approaches in the literature competing with each other in defining banking technology. The production approach considers deposits as *outputs* since it sees banks as firms producing services for customers such as performing transactions and processing loan applications. As such process requires only physical inputs such as labor and capital, input vector (and thus total costs) should be exclusive of deposits (and related expenses). However, the intermediation approach considers deposits as *inputs* since it views banks as the conduit of funds between depositors and borrowers. Banks employ labor, capital and deposits in the intermediation. Thus, the input vector (and total costs) should include deposits (and related expenses in addition to operation costs).

Because the classification of deposits in efficiency models may affect the efficiency estimates, in this study, we first treat deposits as an input and then as an output. We call the first treatment as *production model* and the second treatment as *intermediation model*, as they are analogous to the production and intermediation approaches discussed above.[5] Under the *production model*, we specify banks as multi-product firms producing deposit and loan services by employing two major factors of production, labor and capital. Under the *intermediation model*, we define banks as financial intermediaries that convert deposits by means of labor and capital into primary and secondary financial assets (various loans and investment portfolios). Following this policy, we aim to control for the impact of different approaches of banking technology on the qualitative results. In other words, this procedure will serve as a robustness check that will show whether this aspect of model specification is of importance to the outcome.

[5] It should be noted that this analogy is less than perfect, particularly for the production approach, where inputs are measured by physical units and outputs are measured by the number and type of transactions or documents processed over a given time period (but in practice proprietary nature of such flow variables might necessitate the usage of stock variables for outputs instead: such as the number of deposit or loan accounts serviced).

**Table 2:** Descriptive statistics of the bank inputs and outputs for the Jordanian banks
(in 1,000 Jordanian Dinar)

| | **PANEL 1: PRODUCTION MODEL** | | | | **PANEL 2: INTERMEDIATION MODEL** | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std .Dev. | Min | Max | Mean | Std .Dev. | Min | Max |
| INPUTS | | | | | | | | |
| Labor | 936 | 1402 | 62 | 5978 | 936 | 1402 | 62 | 5978 |
| Capital | 8,605 | 19,368 | 1,814 | 1,009,000 | 8,605 | 19,367 | 1,814 | 1,009,000 |
| Deposits | -- | -- | -- | -- | 912,076 | 2,459,364 | 330 | 12,342,462 |
| OUTPUTS | | | | | | | | |
| Loans | 446,246 | 1,113,045 | 4,262 | 5,083,961 | 446,246 | 1,113,045 | 4,262 | 5,083,961 |
| Securities | 584,507 | 1,576,964 | 300 | 8,305,537 | 584,507 | 1,576,964 | 300 | 8,305,537 |
| Deposits | 912,076 | 2,459,364 | 330 | 12,342 | -- | -- | -- | -- |

In addition, it will allow us to compare our results with other international studies that had used the same procedure, such as Favero and Papi (1995) and Hunter and Timme (1995). For the production model, the input vector includes 1) labor and 2) capital, while the output vector includes 1) loans, 2) securities and 3) deposits. For the intermediation model, the input vector entails 1) labor, 2) capital and 3) deposits, whereas the output vector entails 1) loans and 2) securities. Labor input is measured by the number of full-time employees on the payroll. Capital input is approximated by the book value of financial capital. Deposits input (output) is measured by all types of loanable funds (the sum of demand and time deposits). Loans output includes both commercial/industrial credits and individual loans. Securities output contains other earning assets of banks such as marketable public and private securities. All bank variables are in annual terms expressed in the Jordanian Dinar, except for labor, which is measured by the number of workers. Our definition of intermediation model is compatible with that of Darrat et al. (2002).[6]

Table 2 displays the summary statistics for the inputs and outputs for the Jordanian bank sector. All variables are the five-year averages of bank inputs and outputs classified according to both production (Panel 1) and intermediation models (Panel 2). As can be seen, banks in our sample demonstrate a great deal of variation in terms of inputs and outputs, perhaps implying the wide discrepancies in scale, nature of business and operational strategies of sample banks.[7] In order to account for heterogeneous business operations among banks such as additional overhead costs that may result from operating large branch networks, we normalized all variables by the number of branch offices. This treatment is in accordance with Berger and Mester (1997) and Denizer et al. (2000). As the table indicates, the number of workers is 62, 936 and 5,978 for the smallest and the typical and the largest bank in the Jordanian banking sector, respectively. The typical branch office in Jordan (with 26 employees per branch) is less crowded than that in Kuwait (39 per branch) but more crowded than that in Turkey (22 per branch). Speculatively, this difference could be a product of variations in operational efficiency in banking or simply could be an artifact of geographical characteristics in these countries. Kuwait has less usable land than both Jordan and Turkey. Harsh terrain in rural areas may lead to high population density in main cities and thus more employees per branch to cater their financial needs.

[6] In some studies, bank capital is represented by the book value of fixed assets. However, following Mukherjee et al. (2001), we define it as the book value of bank equity because it lets us take into account the risk preferences of banks. For labor metric, which is invariant across years, we are not able to make distinction between administrative and non-administrative employees, as the available data does not allow such treatment. Investment securities contain all types of liquid financial assets other than very short-term loans.

[7] The sample in this study encompasses all types of banks operating in the Jordanian banking sector. Because of rather small sample size, we did not discriminate between different forms of banks in the sector. This procedure conforms to the sample structure in Altunbas et al. (1994), who study all types of banks operating in Turkish market, public, private and foreign development and investment banks and commercial banks. However, unlike them, we normalized the variables by the number of branch offices as it may be necessary to account for the differences in the underlying technologies for commercial, Islamic, and investment banks or commercial banks that are in reality investment banks in disguise.

Another interesting observation is that the sum of credits and investments in Jordan is almost equal to the total deposits. This implies that the major source of funding in Jordan is deposit collection, which is a typical characteristic of a traditional banking system. Thus, the lesser use of other means of funds may imply the underdevelopment of money and capital markets in the country. In addition, it appears that asset portfolios of Jordanian banks are markedly skewed towards liquid financial assets; i.e., investment securities. As Jordanian banks are facing risky business environment in recent years, they may be reluctant to engage heavily in loan markets, as business credits are costlier to maintain and more likely default than investment securities.

## Empirical Analysis of Technical Efficiency and Return to Scale Indexes

Rather than estimating a common frontier over time, we construct five separate annual frontiers, one for each year under study, to account for the changes in the macro economy over time.

Table 2 provides the descriptive statistics of the technical efficiency scores according to both production model (Panel 1) and intermediation model (Panel 2), and according to *separate frontiers* estimated for commercial banks and investment banks individually. Once again, technical efficiency (TE) is the product of pure technical efficiency (PTE) and scale efficiency (SE). TE refers to the frontier efficiency that is measured under the assumption of constant returns to scale (CRS), where banks are assumed to have no scale inefficiencies. It indicates the proportional reduction in input usage that could be achieved if the bank were operating on the production frontier rather than in its inefficient location.

Pure technical efficiency is the frontier efficiency that is measured under the variable returns to scale (VRS) assumption, where banks are allowed to have scale inefficiencies.

Unlike the former two scores that are input related, scale efficiency is output related and refers to the cost savings that could be attained if the banks were operating at the optimal scale, where there are neither increasing returns to scale (IRS) nor decreasing returns to scale (DRS).

Because the choice of input and output levels is to a great extent under management discretion, the underperformance of a firm with respect to the frontier businesses that are operating under similar conditions originates from "poor" management. Unlike Isik et al. (2016a), we constructed ***separate*** production frontiers for each sample (commercial banks and other banks)[8]. The three efficiency measures, TE, PTE and SE, are then estimated for each separate group.[9]

[8] The reason for combining investment banks and Islamic banks into one sample is twofold. First, the number of Islamic banks is too small to calculate a specific frontier for this group. Second, because Islamic banks usually become partners in the firms they finance and they manage large portfolios of common stock, they look more like investment banks than commercial banks.

[9] Technical efficiencies are calculated with respect to the separate frontiers constructed for commercial banks and other banks groups. The frontier for the latter group includes investment and Islamic banks due to their more similar banking technology.

**Table 3:** Mean technical efficiency of Jordanian banks according to *separate frontiers*

| Models | | **PRODUCTION MODEL** | | | **INTERMEDIATION MODEL** | | |
|---|---|---|---|---|---|---|---|
| **All Banks** | **#** | **TE** | **PTE** | **SE** | **TE** | **PTE** | **SE** |
| 1996 | 16 | 76.44 | 94.07 | 80.74 | 91.16 | 99.76 | 91.39 |
| 1997 | 16 | 72.86 | 92.94 | 79.05 | 93.19 | 98.88 | 94.15 |
| 1998 | 17 | 77.29 | 94.94 | 81.75 | 90.84 | 98.01 | 92.56 |
| 1999 | 17 | 78.80 | 94.60 | 82.89 | 91.41 | 97.96 | 93.30 |
| 2000 | 18 | 81.50 | 95.68 | 84.81 | 91.99 | 98.08 | 93.71 |
| 2001 | 17 | 83.51 | 99.44 | 83.86 | 93.06 | 99.79 | 93.27 |
| Overall | 101 | 78.71 | 95.37 | 82.43 | 92.02 | 98.75 | 93.14 |
| **Commercial Banks** | | | | | | | |
| 1996 | 8 | 76.63 | 90.20 | 83.31 | 98.01 | 100.00 | 98.01 |
| 1997 | 8 | 71.36 | 94.31 | 76.43 | 98.66 | 100.00 | 98.66 |
| 1998 | 8 | 80.69 | 97.81 | 82.79 | 96.46 | 100.00 | 96.46 |
| 1999 | 8 | 84.99 | 99.98 | 85.00 | 98.99 | 100.00 | 98.99 |
| 2000 | 9 | 87.16 | 99.19 | 87.70 | 97.12 | 99.78 | 97.34 |
| 2001 | 9 | 85.30 | 99.24 | 85.90 | 97.89 | 99.61 | 98.28 |
| Overall | 50 | 81.45 | 97.04 | 83.75 | 97.80 | 99.89 | 97.91 |
| **Other Banks (Investment + Islamic)** | | | | | | | |
| 1996 | 8 | 76.25 | 97.94 | 78.18 | 84.30 | 99.51 | 84.76 |
| 1997 | 8 | 74.35 | 91.58 | 81.68 | 87.73 | 97.76 | 89.64 |
| 1998 | 9 | 74.27 | 92.39 | 80.83 | 85.84 | 96.23 | 89.09 |
| 1999 | 9 | 75.66 | 90.42 | 82.92 | 85.63 | 96.37 | 88.99 |
| 2000 | 9 | 75.84 | 92.17 | 81.92 | 86.86 | 96.39 | 90.07 |
| 2001 | 8 | 81.50 | 99.66 | 81.56 | 87.64 | 100.00 | 87.64 |
| Overall | 61 | 76.14 | 93.80 | 81.18 | 86.58 | 97.68 | 88.65 |
| **Investment Banks** | | | | | | | |
| 1996 | 7 | 72.86 | 97.64 | 75.06 | 82.06 | 99.44 | 82.59 |
| 1997 | 7 | 70.69 | 90.37 | 79.06 | 85.97 | 97.44 | 88.16 |
| 1998 | 7 | 72.04 | 92.97 | 78.30 | 86.86 | 98.36 | 88.37 |
| 1999 | 7 | 78.77 | 93.10 | 85.54 | 85.97 | 98.61 | 87.34 |
| 2000 | 7 | 78.00 | 94.66 | 83.23 | 88.37 | 99.30 | 89.07 |
| 2001 | 6 | 77.20 | 99.55 | 77.28 | 84.25 | 100.00 | 84.25 |
| Overall | 41 | 75.46 | 94.34 | 80.60 | 86.48 | 98.83 | 87.56 |
| **Islamic Banks** | | | | | | | |
| 1996 | 1 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 1997 | 1 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 1998 | 2 | 82.05 | 90.35 | 89.70 | 82.30 | 88.80 | 91.60 |
| 1999 | 2 | 64.75 | 81.05 | 73.75 | 84.45 | 88.50 | 94.75 |
| 2000 | 2 | 68.30 | 83.45 | 77.35 | 81.55 | 86.20 | 93.55 |
| 2001 | 2 | 94.40 | 100.00 | 94.40 | 97.80 | 100.00 | 97.80 |
| Overall | 10 | 78.67 | 91.79 | 83.35 | 86.96 | 93.36 | 92.71 |

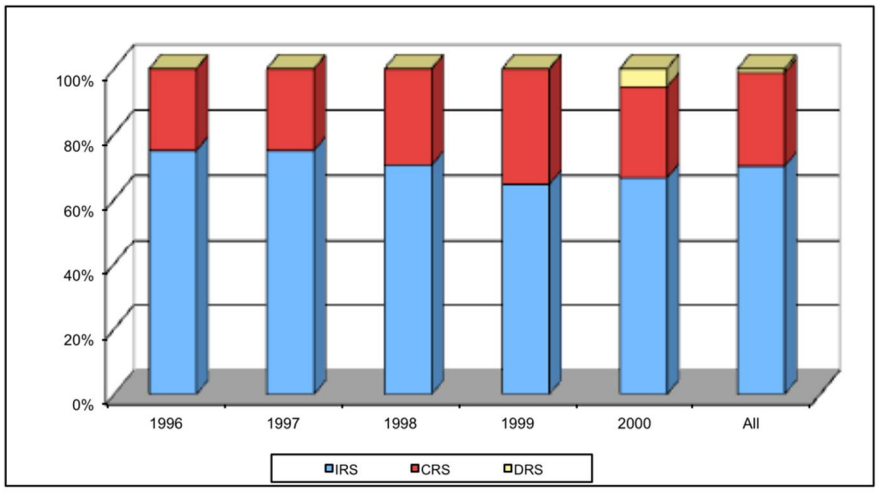


***Figure 2:*** *RTS in Jordan Banking Industry- Production Model*

The results for the mean values of efficiency scores calculated relative to the different frontiers are summarized in Table 3. In the production model, overall technical, pure technical and scale efficiency scores are about 81%, 97%, and 84% for commercial banks, 76%, 94%, and 81% for investment banks, 79%, 92%, and 83% for Islamic banks, respectively. While, under the intermediation model, overall TE, PTE and SE scores are about 98%, 100%, and 98% for commercial banks, 86%, 99%, and 88% for investment banks, 87%, 93%, and 92% for Islamic banks, respectively. Commercial banks lead other banks (both investment and Islamic) concerning technical and scale efficiency.

The efficiencies of commercial banks tend to rise over time. Also, for all forms of banks, scale inefficiency remains the primary source of technical inefficiency. In the Jordanian banks, as our results indicate that scale inefficiency causes the biggest problem of stimulating overall managerial inefficiency, we will next focus on their returns to scale.[10] Constant returns to scale occurs in cases where banks double their outputs by replicating their current technology (original production process). IRS take place in cases where increased output enables banks to increase the division of labor and equipment or to use of more specialized labor and capital. In these circumstances, bank employees specialize in a small number of tasks at which they become highly proficient. DRS happen in all production and service technologies at some output rate, particularly in large ones. The larger output and service levels of banks, the more complex is their management and organizational structure. Too large banking organizations have a greater number of layers of the management, and they face substantial costs in monitoring and controlling of large operations and marketing processes.

Since a bank's cost curves are determined by its technology, whether a bank faces IRS, CRS or DRS influences its long run costs. Economies of scale are present when, as output increases, long-term average cost decreases. Whereas, diseconomies of scale are present, as output increases, long run average cost increases. Both IRS and DRS represent non-optimal output levels, thus scale inefficiencies. As discussed, TE = PTE * SE, where TE refers to the frontier efficiency that is measured by the constant returns to scale (CRS) assumption, where banks are assumed to have no scale inefficiencies. Accordingly, TE indicates a proportional reduction in input usage that could be achieved if banks were operating on the production frontier rather than at their inefficient locations. PTE is the frontier efficiency that is measured by the variable returns to scale (VRS) assumption, where banks are allowed to have scale inefficiencies. Unlike

[10] The law of diminishing returns indicates what happens to output when a bank changes only one input, say labor or capital, and holds all other input constants. Whereas, returns to scale (RTS) tell us what happens to a bank's output if it changes all inputs. Thus, we define RTS as the increases in output that result from increasing all inputs by the same percentage. Increasing returns to scale (IRS) occurs when 1% increase in inputs produces more than 1% increase in outputs; while constant returns to scale (CRS) happens when 1% increase in inputs results in exactly 1% increase in outputs. Finally, decreasing returns to scale (DRS) happen when 1% increase in inputs leads to less than 1% increase in outputs.

PTE that is input related, scale efficiency (SE) is output related and refers to input savings that could be attained if the banks were operating at the optimal scale (CRS), where there are neither increasing returns to scale (IRS) nor decreasing returns to scale (DRS). Thus, the difference between the TE and PTE scores refers to the cost of operating at an incorrect scale, either at the DRS or IRS portion of the long-run average cost curve.

Figure 2 reports trends in the returns to scale of the Jordanian banks according to production (intermediation) model. Also, the scale trends for individual banks are presented more details in Table 4. As Figure 2 and 3 set forth, the majority of banks of Jordan undergo increasing returns to scale (IRS) in their operations. The Jordanian banks show 70% IRS, 29% CRS and 1% DRS in Figure 2 under production model. On the other hand, these banks show 52% IRS, 43% CRS and 5% DRS in their intermediation model from 1996 to 2001. However, between 1996-99 in the production and 1998-99 and 2001 in the intermediation model, no banks experienced decreasing returns to scale, suggesting that these banks are still small in size.

The results in Table 4 present that commercial, investment, and Islamic banks show mostly IRS in their operations under the both panels. However, commercial banks are the banks that have more scale efficient operations since it always exhibits constants returns to scale (CRS). More specifically, Beit Al-Mal Saving and Investment for Housing demonstrate increasing returns to scale (IRS) every year according to both production and intermediation models. This firm is suffering excessively from underproduction and could reap substantial economies of scale if it could grow.

According to Cummins et al. (1999), these types of firms are ideal for mergers and acquisitions, as the combined firm with increased size could benefit from economies of scale opportunities present in the incumbent. Supporting the findings in Figure 2 and 3, almost none of the Islamic or investment banks show DRS throughout our sample period. Due to increasing returns to scale, it appears that most of the banks are experiencing considerable scale issues, which occur when the output increases by a larger proportion than the increase in inputs during the production process, meaning the banks' possession of cost advantage. These banks are expected to absorb the weak ones in a competitive environment

In consequence, banks demonstrating IRS should either eliminate their scale inefficiency or be ready to become a prime target for acquiring banks, which can "create value" for underperforming banks by streamlining their operations and eliminating their redundancies and inefficiencies (Evanoff and Israilevich, 1991; Cummins et al., 1999; Isik et al., 2016a).

The results from Figure 2 and 3 indicate that scale inefficiency of the Jordanian banking sector persisted over an extended period. One of the reasons is the failure of the Jordan's financial market to eliminate inefficient behaviors. While preventing growth, weak regulations or market specific characteristics may hold back the operation of scale economies. Some are the strong tradition of family ownership, which avoids merging and corporate control and governance issues that prevent external growth (Isik et al., 2016a). Also, lacking effective competition leads to the existence of weak banks in the market persistently. Furthermore, other factors may be involved in the continuity of such inefficient banking behavior. The inadequate demand from the residents and companies for financial services may be obstructing the internal growth of these scale inefficient banks.

**Table 4:** Returns to scale (RTS) in the Jordanian banking sector in detail

| | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | All |
|---|---|---|---|---|---|---|---|
| **PANEL 1: PRODUCTION MODEL** | | | | | | | |
| **Commercial Banks (#)** | **8** | **8** | **8** | **8** | **9** | **9** | **Mostly** |
| Arab Bank | crs | crs | crs | crs | crs | crs | crs |
| Arab Banking Corporation / Jordan | irs | irs | irs | irs | irs | irs | irs |
| Bank of Jordan | irs | irs | irs | irs | irs | irs | irs |
| Cairo Amman Bank | crs | crs | crs | crs | crs | crs | crs |
| Export & Finance Bank | irs | irs | irs | crs | crs | crs | irs/crs |
| Jordan Gulf Bank | crs | crs | crs | crs | crs | crs | crs |
| Jordan Kuwait Bank | irs | irs | irs | irs | irs | irs | irs |
| Jordan National Bank | irs | irs | irs | crs | drs | crs | irs |
| The Housing Bank for Trade & Finance | irs | irs | irs | irs | irs | irs | irs |
| **Investment Banks (#)** | **7** | **7** | **7** | **7** | **7** | **6** | **Mostly** |
| Arab Jordan Investment Bank | irs | irs | irs | crs | irs | irs | irs |
| Beit Al-Mal Saving & Investment for Housing | irs | irs | irs | irs | irs | irs | irs |
| Industrial Development Bank | crs | crs | crs | irs | irs | irs | irs/crs |
| Jordan Investment & Finance Bank | irs | crs | crs | crs | crs | crs | crs |
| Middle East Investment Bank | irs | irs | irs | irs | irs | irs | irs |
| Philadelphia Investment Bank | irs | irs | irs | irs | irs | irs | irs |
| Union Bank for Savings & Investment | irs | irs | irs | irs | irs | irs | irs |
| **Islamic Banks (#)** | **1** | **1** | **2** | **2** | **2** | **2** | **Mostly** |
| Islamic International Bank | crs | crs | irs | irs | irs | irs | irs |
| Jordan Islamic Bank for Finance & Investment | crs | irs | crs | irs | irs | irs | irs |
| **PANEL 2: INTERMEDIATION MODEL** | | | | | | | |
| **Commercial Banks (#)** | **8** | **8** | **8** | **8** | **9** | **9** | **Mostly** |
| Arab Bank | crs | crs | crs | crs | crs | crs | crs |
| Arab Banking Corporation / Jordan | irs | irs | irs | irs | irs | irs | irs |
| Bank of Jordan | irs | irs | irs | crs | irs | irs | irs |
| Cairo Amman Bank | crs | crs | crs | crs | crs | crs | crs |
| Export & Finance Bank | drs | drs | crs | crs | crs | crs | crs |
| Jordan Gulf Bank | crs | crs | crs | crs | crs | crs | crs |
| Jordan Kuwait Bank | irs | irs | irs | irs | crs | irs | irs |
| Jordan National Bank | irs | irs | crs | crs | drs | crs | crs |
| The Housing Bank for Trade & Finance | irs | irs | irs | irs | irs | irs | irs |
| **Investment Banks (#)** | **7** | **7** | **7** | **7** | **7** | **6** | **Mostly** |
| Arab Jordan Investment Bank | crs | crs | crs | crs | drs | crs | crs |
| Beit Al-Mal Saving & Investment for Housing | irs | irs | irs | irs | irs | irs | irs |
| Industrial Development Bank | crs | crs | crs | crs | crs | crs | crs |
| Jordan Investment & Finance Bank | irs | crs | crs | crs | crs | crs | crs |
| Middle East Investment Bank | irs | irs | irs | irs | crs | irs | irs |
| Philadelphia Investment Bank | irs | irs | irs | irs | irs | irs | irs |
| Union Bank for Savings & Investment | irs | irs | irs | irs | drs | irs | irs |
| **Islamic Banks (#)** | **1** | **1** | **2** | **2** | **2** | **2** | **Mostly** |
| Islamic International Bank | crs | crs | irs | irs | irs | irs | irs |
| Jordan Islamic Bank for Finance & Investment | crs | crs | crs | crs | irs | irs | crs |

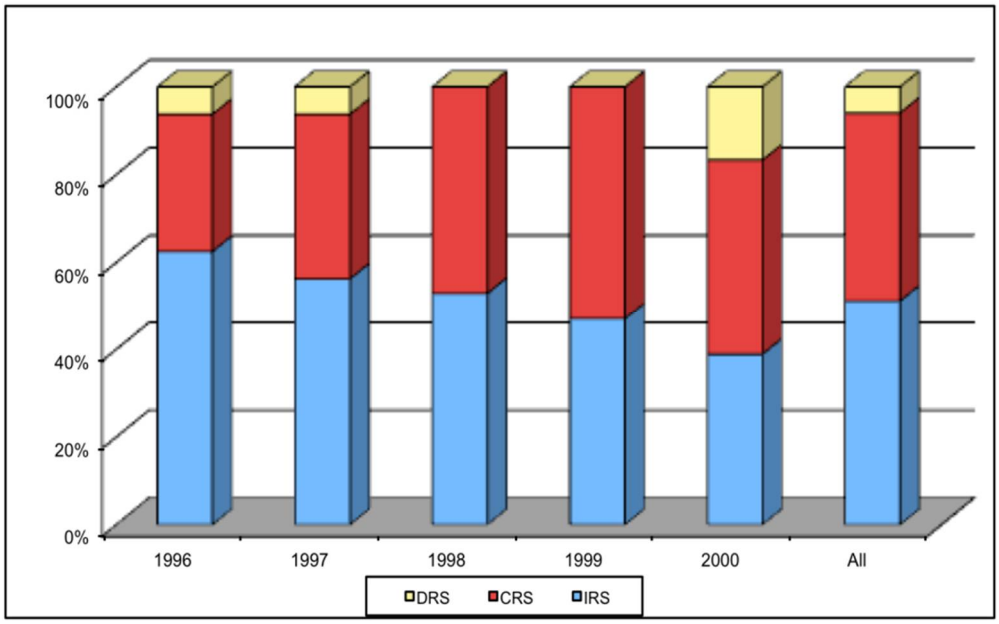


***Figure 3:*** *RTS in Jordan Banking Industry- Intermediation Model*

As Eltony (2003) suggests, the long-run mobilization ratio, M1/M2, which designates the magnitude of long-term banking, is relatively small in Jordan (about 30%) concerning the other Arab countries (74% in Morocco, 66% in Syria and 43% in Tunisia). These low ratios are the sign of limited access to financial institutions and limited concentration of banking transactions. Cash is still the dominant instrument of payment services rather bank deposits in Jordan; that may be due to the unfamiliarity of the public with the public financial institutions and services. This limited demand for financial services industry may be somewhat related to stagnant economy of Jordan. Hence, while internal or external growth would create cost savings and higher efficiencies for the Jordanian banks, exploiting such opportunities may be challenging due to the characteristics of the local financial market.

## Empirical Analysis of Total Factor Productivity Change Indexes

Table 5 and 6 exhibit the summary statistics of the total factor productivity change measures of the Jordanian banks over the period 1996-2001.[11] Table 5 reports the relevant TFPCH index and its sub-component indexes based on the production approach, whereas Table 5 reports them based on the intermediation approach. Under the production model, the overall averages of efficiency change (EFFCH), technology change (TECCH), and total factor productivity change (TFPCH) over the study period are 2.9%, 0.3%, and 3.2%, respectively.

As mentioned earlier, TFPCH is the product of EFFCH and TECCH. The results show that the efficiency change mainly triggers the growth of total factor productivity. Because EFFCH measure is a composite of both PECH and SECH, the relative sizes of these indexes provide evidence as to the source of overall efficiency. The results indicate that pure efficiency change (PECH), scale efficiency change (SECH) indexes show 0.9% and 2.0% growth, respectively. The components of EFFCH designate that efficiency growth is mainly due to output related scale efficiency changes (movement of the banks towards the optimum scale where there are constant returns to scale) rather than input related pure efficiency changes (movement of the banks to the efficient frontier due to improvements in managerial performance).

[11] The results are based on a common frontier that is estimated including all types of domestic banking firms in Jordan.

**Table 5:** Summary statistics of the TFPCH for the Jordanian banks – *Production Model*

| Indices/Years | **1997** | **1998** | **1999** | **2000** | **Overall** |
|---|---|---|---|---|---|
| **Efficiency Change (effch)** | | | | | |
| Mean | **1.079** | **1.086** | **0.965** | **0.989** | **1.029** |
| Std Dev | 0.788 | 0.133 | 0.257 | 0.150 | 0.425 |
| Median | 1.000 | 1.029 | 1.025 | 1.000 | 1.000 |
| Minimum | 0.536 | 0.928 | 0.292 | 0.698 | 0.292 |
| Maximum | 3.787 | 1.373 | 1.388 | 1.290 | 3.787 |
| **Technology Change (tecch)** | | | | | |
| Mean | **0.953** | **0.983** | **1.033** | **1.047** | **1.003** |
| Std Dev | 0.070 | 0.044 | 0.073 | 0.122 | 0.090 |
| Median | 0.963 | 0.979 | 1.016 | 1.014 | 0.991 |
| Minimum | 0.843 | 0.898 | 0.961 | 0.926 | 0.843 |
| Maximum | 1.115 | 1.065 | 1.223 | 1.392 | 1.392 |
| **Pure Efficiency Change (pech)** | | | | | |
| Mean | **0.993** | **1.058** | **0.997** | **0.989** | **1.009** |
| Std Dev | 0.215 | 0.095 | 0.102 | 0.099 | 0.137 |
| Median | 0.990 | 1.011 | 1.000 | 1.000 | 1.000 |
| Minimum | 0.824 | 0.986 | 0.728 | 0.702 | 0.702 |
| Maximum | 1.780 | 1.287 | 1.262 | 1.163 | 1.780 |
| **Scale Efficiency Change (sech)** | | | | | |
| Mean | **1.087** | **1.026** | **0.968** | **1.001** | **1.020** |
| Std Dev | 0.715 | 0.060 | 0.219 | 0.100 | 0.378 |
| Median | 1.021 | 1.007 | 1.020 | 1.000 | 1.000 |
| Minimum | 0.591 | 0.941 | 0.292 | 0.754 | 0.292 |
| Maximum | 3.787 | 1.164 | 1.316 | 1.243 | 3.787 |
| **Total Factor Productivity Change (tfpch)** | | | | | |
| Mean | **1.028** | **1.067** | **0.998** | **1.036** | **1.032** |
| Std Dev | 0.772 | 0.142 | 0.290 | 0.178 | 0.420 |
| Median | 0.962 | 1.044 | 1.042 | 1.014 | 1.023 |
| Minimum | 0.523 | 0.898 | 0.286 | 0.742 | 0.286 |
| Maximum | 3.594 | 1.460 | 1.554 | 1.392 | 3.594 |

Under the intermediation model, as summarized in Table 6, the Jordanian banks showed 3.2% TFPCH, 1.4% EFFCH, and 1.9% TECCH on average over the study period. Total factor productivity growth is driven mainly by the technological change measure. It appears that technological progress is more impressive than efficiency growth in the Jordanian banks. Evidently, the results present that pure efficiency regress by 0.2% while scale efficiency grows by 1.6% implying that the deterioration in pure efficiency (PECH) held back the technical efficiency improvements (EFFCH) despite the improvements in the scale efficiency (SECH).

Since management has the responsibility for the selection of optimum production level, the underperformance of Jordanian banks concerning the frontier banks can be mainly attributed to poor internal management practices. Overall results suggest that across the production and intermediation models, total factor productivity growth (TFPCH) measures are the same (3.2%), while the factors that drive the productivity change. Under the production model, it was the efficiency change (EFFCH), while under the intermediation model technological progress (TECCH) influenced the total factor productivity growth.

**Table 6:** Summary statistics of the TFPCH for the Jordanian banks – *Intermediation Model*

| Statistics/Years | **1997** | **1998** | **1999** | **2000** | **Overall** |
|---|---|---|---|---|---|
| **Efficiency Change (effch)** | | | | | |
| Mean | **1.083** | **1.028** | **0.952** | **0.995** | **1.014** |
| Std Dev | 0.808 | 0.036 | 0.185 | 0.049 | 0.415 |
| Median | 1.000 | 1.013 | 1.000 | 1.000 | 1.000 |
| Minimum | 0.817 | 0.999 | 0.341 | 0.932 | 0.341 |
| Maximum | 4.210 | 1.104 | 1.193 | 1.134 | 4.210 |
| **Technology Change (tecch)** | | | | | |
| Mean | **0.987** | **1.011** | **0.957** | **1.127** | **1.019** |
| Std Dev | 0.316 | 0.079 | 0.153 | 0.514 | 0.317 |
| Median | 0.959 | 1.000 | 1.004 | 1.056 | 1.004 |
| Minimum | 0.731 | 0.904 | 0.418 | 0.942 | 0.418 |
| Maximum | 2.163 | 1.195 | 1.101 | 3.089 | 3.089 |
| **Pure Efficiency Change (pech)** | | | | | |
| Mean | **0.991** | **1.014** | **0.993** | **0.995** | **0.998** |
| Std Dev | 0.042 | 0.026 | 0.040 | 0.022 | 0.034 |
| Median | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Minimum | 0.908 | 0.996 | 0.848 | 0.946 | 0.848 |
| Maximum | 1.101 | 1.076 | 1.032 | 1.039 | 1.101 |
| **Scale Efficiency Change (sech)** | | | | | |
| Mean | **1.093** | **1.014** | **0.959** | **1.001** | **1.016** |
| Std Dev | 0.804 | 0.018 | 0.180 | 0.044 | 0.412 |
| Median | 1.005 | 1.003 | 1.000 | 1.000 | 1.000 |
| Minimum | 0.858 | 1.000 | 0.341 | 0.925 | 0.341 |
| Maximum | 4.210 | 1.053 | 1.193 | 1.134 | 4.210 |
| **Total Factor Productivity Change (tfpch)** | | | | | |
| Mean | **1.069** | **1.039** | **0.910** | **1.122** | **1.032** |
| Std Dev | 0.724 | 0.085 | 0.241 | 0.517 | 0.462 |
| Median | 0.989 | 1.037 | 1.031 | 1.027 | 1.027 |
| Minimum | 0.711 | 0.904 | 0.325 | 0.944 | 0.325 |
| Maximum | 3.608 | 1.195 | 1.188 | 3.089 | 3.608 |

Table 7 provides the descriptive statistics of TFPCH and its subcomponents for Jordanian banks by organizational types.[12] The results indicate that under the production (intermediation) model in Panel A (Panel B), the commercial banks recorded, on average, 6.5% (1%) EFFCH, 0% (0.7%) TECCH, 4.4% (0.4%) PECH, 1.7% (0.6%) SECH, and 7.4% (1.8%) TFPCH. On the other hand, while the investment banks registered, on average, 1.8% (2.8%) EFFCH, 1.8% (4.3%) TECCH, -1.2% (-1.2%) PECH, 3% (3%) SECH, and 3.5% (7.1%) TFPCH, the Islamic banks displayed, on average, -9% (-5%) EFFCH, -4.7% (-2.7%) TECCH, -7.5% (-4.9%) PECH, -1.6 (-0.2%) SECH, and -13.2% (-7.6%) TFPCH.

[12] Due to missing data, our Islamic bank group entails only one bank, namely Jordan Islamic Bank For Finance & Investment. Thus, our results based on one bank should be taken with a grain of salt.

**Table 7:** Total factor productivity change of Jordanian banks by organizational form

| | | effch | tecch | pech | sech | tfpch |
|---|---|---|---|---|---|---|
| **Panel A - PRODUCTION MODEL** | | | | | | |
| **Commercial Banks** | Mean | 1.065 | 1.000 | 1.044 | 1.017 | 1.074 |
| | Std. Dev | 0.163 | 0.073 | 0.109 | 0.059 | 0.250 |
| | Median | 1.038 | 0.973 | 1.010 | 1.023 | 1.005 |
| | Minimum | 0.851 | 0.952 | 0.953 | 0.893 | 0.848 |
| | Maximum | 1.421 | 1.172 | 1.304 | 1.090 | 1.666 |
| **Investment Banks** | Mean | 1.018 | 1.018 | 0.988 | 1.030 | 1.035 |
| | Std. Dev | 0.059 | 0.059 | 0.038 | 0.024 | 0.059 |
| | Median | 1.043 | 1.014 | 1.000 | 1.034 | 1.021 |
| | Minimum | 0.889 | 0.958 | 0.905 | 0.982 | 0.982 |
| | Maximum | 1.060 | 1.104 | 1.017 | 1.055 | 1.154 |
| **Islamic Banks** | Mean | 0.910 | 0.953 | 0.925 | 0.984 | 0.868 |
| **Panel B - INTERMEDIATION MODEL** | | | | | | |
| **Commercial Banks** | Mean | 1.010 | 1.007 | 1.004 | 1.006 | 1.018 |
| | Std. Dev | 0.022 | 0.046 | 0.014 | 0.011 | 0.063 |
| | Median | 1.007 | 0.999 | 1.005 | 1.000 | 1.010 |
| | Minimum | 0.970 | 0.962 | 0.974 | 0.995 | 0.947 |
| | Maximum | 1.038 | 1.113 | 1.024 | 1.023 | 1.155 |
| **Investment Banks** | Mean | 1.028 | 1.043 | 0.998 | 1.030 | 1.071 |
| | Std. Dev | 0.045 | 0.103 | 0.014 | 0.040 | 0.089 |
| | Median | 1.018 | 1.028 | 1.000 | 1.014 | 1.038 |
| | Minimum | 0.976 | 0.947 | 0.972 | 0.999 | 1.003 |
| | Maximum | 1.096 | 1.260 | 1.018 | 1.096 | 1.260 |
| **Islamic Banks** | Mean | 0.950 | 0.973 | 0.951 | 0.998 | 0.924 |

Under the production model, commercial banks outclass both investment and Islamic banks in terms of TFPCH and EFFCH, whereas, under the intermediation model, investment banks dominate both commercial and Islamic banks. Albeit weak, Islamic bank group, represented by Jordan Islamic Bank For Finance & Investment in our sample, seems to be the poorest form of organizational forms. The results surprisingly imply that the treatment of deposits as bank inputs mostly benefits the investment banks.

Table 8 categorizes the best and worst practice banks according to the six-year averages of their TFPCH measures.13 The rank columns present the orders of banks within the entire banking industry with respect to the relevant index. According to the ***production model***, Table 8, Panel 1, the bank with the highest (second highest) EFFCH is Export and Finance Bank (Jordan National Bank); the bank with the highest (second highest) TECCH is Export and Finance Bank (Industrial Development Bank); the bank with the highest (second highest) PECH is Export and Finance Bank (Jordan National Bank); the bank with the highest (second highest) SECH is Export and Finance Bank (Jordan National Bank); the bank with the highest (second highest) TFPCH is Export and Finance Bank (Jordan Investment and Finance Bank). Export and Finance Bank is clearly the best practice bank in the industry, with competence both in minimizing the input usage per output and in choosing the optimum production scale in terms of cost

[13] All efficiency and productivity measures and ranks for the banks are based on 6-year grand averages (1996-2001), except for three banks, which had some missing variables or were inexistent in the relevant period. The efficiency scores of Islamic International Bank are based on the period 1997-2001. The efficiency scores of Jordanian Gulf Bank are based on the period 2000-2001. This bank had negative net worth during the 1996-1999 period, which impedes the calculation of the efficiency scores for the bank

control. Under the production model, the bank with the lowest (second lowest) EFFCH is The Housing Bank for Trade & Finance (Industrial Development Bank); the bank with the lowest (second lowest) TECCH is Cairo Amman Bank (Jordan Islamic Bank for Finance & Investment); the bank with the lowest (second lowest) PECH is Industrial Development Bank (Jordan Islamic Bank for Finance & Investment); the bank with the lowest (second lowest) SECH is The Housing Bank for Trade & Finance (Industrial Development Bank); the bank with the lowest (second lowest) TFPCH is The Housing Bank for Trade & Finance (Jordan Islamic Bank for Finance & Investment). The Housing Bank for Trade & Finance seems to be the worst practice bank in the industry in terms of productivity and efficiency growth.

With respect to the alternative ***intermediation model***, Table 8, Panel 2, the bank with the highest (second highest) EFFCH is Beit Al-Mal Saving & Investment F. H. (Middle East Investment Bank); the bank with the highest (second highest) TECCH is Industrial Development Bank (Export & Finance Bank); the bank with the highest (second highest) PECH is Export and Finance Bank (Philadelphia Investment Bank); the bank with the highest (second highest) SECH is Beit Al-Mal Saving & Investment F. H (Middle East Investment Bank); the bank with the highest (second highest) TFPCH is Industrial Development Bank (Export & Finance Bank). Apparently, under the alternative model, there is more than one dominant financial institution. Export and Finance Bank and Beit Al-Mal Saving & Investment F. H seem to fare generally better than other banks in terms of productivity and efficiency change. On the contrary, with respect to the alternative intermediation model, the bank with the lowest (second lowest) EFFCH is Jordan Islamic Bank for Finance & Investment (The Housing Bank for Trade & Finance); the bank with the lowest (second lowest) TECCH is Beit Al-Mal Saving & Investment F. H. (Cairo Amman Bank); the bank with the lowest (second lowest) PECH is Jordan Islamic Bank for Finance & Investment (Union Bank for Savings & Investment); the bank with the lowest (second lowest) SECH is The Housing Bank for Trade & Finance (Bank of Jordan); the bank with the lowest (second lowest) TFPCH is Jordan Islamic Bank for Finance & Investment (The Housing Bank for Trade & Finance).

**Table 8:** The overall ranks of the Jordanian banks in terms of TFCH

| **PANEL 1: PRODUCTION MODEL** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Name of banks** | **effch** | **rank** | **tecch** | **rank** | **pech** | **rank** | **sech** | **rank** | **tfpch** | **rank** |
| Arab Bank | 1.000 | 12 | 1.016 | 5 | 1.000 | 9 | 1.000 | 11 | 1.016 | 7 |
| Arab Banking Corporation / Jordan | 1.037 | 9 | 0.963 | 11 | 1.015 | 4 | 1.022 | 10 | 0.999 | 9 |
| Arab Jordan Investment Bank | 1.012 | 11 | 1.019 | 4 | 0.980 | 10 | 1.034 | 6 | 1.032 | 5 |
| Bank of Jordan | 1.038 | 8 | 0.956 | 13 | 1.014 | 5 | 1.024 | 9 | 0.992 | 10 |
| Beit Al-Mal Saving & Investment F. H | 1.050 | 4 | 0.963 | 11 | 1.000 | 9 | 1.050 | 4 | 1.011 | 8 |
| Cairo Amman Bank | 1.000 | 12 | 0.952 | **15** | 1.000 | 9 | 1.000 | 11 | 0.952 | 13 |
| Export & Finance Bank | 1.421 | **1** | 1.172 | **1** | 1.304 | **1** | 1.090 | **1** | 1.666 | **1** |
| Industrial Development Bank | 0.889 | **14** | 1.104 | **2** | 0.905 | **13** | 0.982 | **13** | 0.982 | 12 |
| Islamic International Bank | - | - | - | - | - | - | - | - | - | - |
| Jordan Gulf Bank | - | - | - | - | - | - | - | - | - | - |
| Jordan Investment & Finance Bank | 1.060 | 3 | 1.089 | 3 | 1.004 | 8 | 1.055 | 3 | 1.154 | **2** |
| Jordan Islamic Bank for Finance & Inv | 0.910 | 13 | 0.953 | **14** | 0.925 | **12** | 0.984 | 12 | 0.868 | **14** |
| Jordan Kuwait Bank | 1.045 | 6 | 0.967 | 10 | 1.006 | 7 | 1.039 | 5 | 1.011 | 8 |
| Jordan National Bank | 1.128 | **2** | 0.978 | 9 | 1.059 | **2** | 1.065 | **2** | 1.104 | 3 |
| Middle East Investment Bank | 1.027 | 10 | 0.958 | 12 | 1.000 | 9 | 1.027 | 8 | 0.984 | 11 |
| Philadelphia Investment Bank | 1.047 | 5 | 1.014 | 6 | 1.017 | 3 | 1.030 | 7 | 1.061 | 4 |
| The Housing Bank for Trade & Fin | 0.851 | **15** | 0.997 | 7 | 0.953 | 11 | 0.893 | **14** | 0.848 | **15** |
| Union Bank for Savings & Investment | 1.043 | 7 | 0.979 | 8 | 1.009 | 6 | 1.034 | 6 | 1.021 | 6 |

| **Table 8 Cont'd** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **PANEL 2: INTERMEDIATION MODEL** | | | | | | | | | | |
| **Name of banks** | **effch** | **rank** | **tecch** | **rank** | **pech** | **rank** | **sech** | **rank** | **tfpch** | **Rank** |
| Arab Bank | 1.000 | 10 | 1.013 | 6 | 1.000 | 7 | 1.000 | 9 | 1.013 | 9 |
| Arab Banking Corporation / Jordan | 1.013 | 8 | 0.993 | 10 | 1.015 | 3 | 0.998 | 11 | 1.006 | 10 |
| Arab Jordan Investment Bank | 0.994 | 11 | 1.030 | 4 | 0.995 | 8 | 0.999 | 10 | 1.024 | 7 |
| Bank of Jordan | 1.001 | 9 | 1.005 | 7 | 1.005 | 5 | 0.996 | **12** | 1.006 | 10 |
| Beit Al-Mal Saving & Investment F. H | 1.096 | **1** | 0.947 | **15** | 1.000 | 7 | 1.096 | **1** | 1.038 | 5 |
| Cairo Amman Bank | 1.000 | 10 | 0.962 | **14** | 1.000 | 7 | 1.000 | 9 | 0.962 | 12 |
| Export & Finance Bank | 1.038 | 3 | 1.113 | **2** | 1.024 | **1** | 1.013 | 7 | 1.155 | **2** |
| Industrial Development Bank | 1.000 | 10 | 1.260 | **1** | 1.000 | 7 | 1.000 | 9 | 1.260 | **1** |
| Islamic International Bank | - | - | - | - | - | - | - | - | - | - |
| Jordan Gulf Bank | - | - | - | - | - | - | - | - | - | - |
| Jordan Investment & Finance Bank | 1.018 | 7 | 1.067 | 3 | 1.004 | 6 | 1.014 | 6 | 1.087 | 3 |
| Jordan Islamic Bank for Finance & Inv | 0.950 | **14** | 0.973 | 13 | 0.951 | **11** | 0.998 | 11 | 0.924 | **14** |
| Jordan Kuwait Bank | 1.032 | 5 | 0.998 | 9 | 1.008 | 4 | 1.023 | 3 | 1.029 | 6 |
| Jordan National Bank | 1.025 | 6 | 0.999 | 8 | 1.004 | 6 | 1.021 | 4 | 1.024 | 7 |
| Middle East Investment Bank | 1.078 | **2** | 0.993 | 10 | 1.000 | 7 | 1.078 | **2** | 1.070 | 4 |
| Philadelphia Investment Bank | 1.037 | 4 | 0.978 | 11 | 1.018 | **2** | 1.019 | 5 | 1.014 | 8 |
| The Housing Bank for Trade & Fin | 0.970 | **13** | 0.976 | 12 | 0.974 | 9 | 0.995 | **13** | 0.947 | **13** |
| Union Bank for Savings & Investment | 0.976 | 12 | 1.028 | 5 | 0.972 | **10** | 1.004 | 8 | 1.003 | 11 |

The poorest performers in terms of efficiency and productivity change under the intermediation model seem to be Jordan Islamic Bank for Finance & Investment and the Housing Bank for Trade & Finance. Under the both models, the vast majority of increases in managerial inefficiency in the worst practice banks stems from the increases in scale inefficiency. The least inefficient banks in each model suffer mostly from scale related problems rather than technical difficulties, highlighting the importance of scale inefficiency in Jordan. The very similar performance orders for the worst and best practice banks under both models support the robustness of our efficiency growth measures against different representations of banking technology in Jordan. Figures 4 and 5, which are presenting the (overall and annual) percentage of banks (out of 18 Jordanian banks) with gain, loss or stability in the productivity measures under production and intermediation models, attest to our major observations. Under both models, we see that the percentage of Jordanian banks with improvement in TE (EFFCH), technology/frontier (TECCH), PTE (PECH), SE (SECH) and productivity (TFPCH) is higher than the percentage of the Jordanian banks with worsening in these measures.

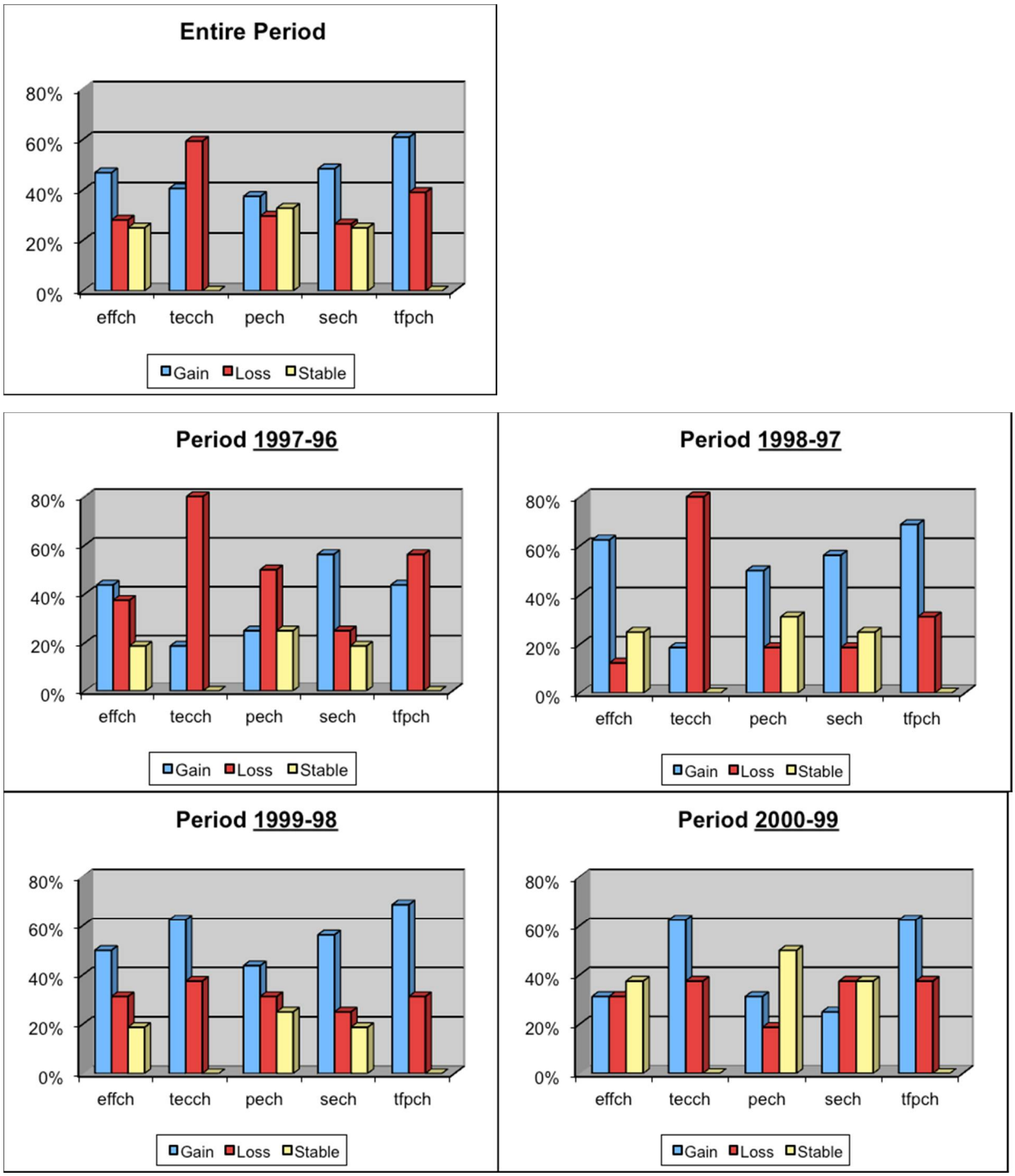


***Figure 4:*** *Percentage of banks with gain, loss or no change in TFPCH: Production Model*

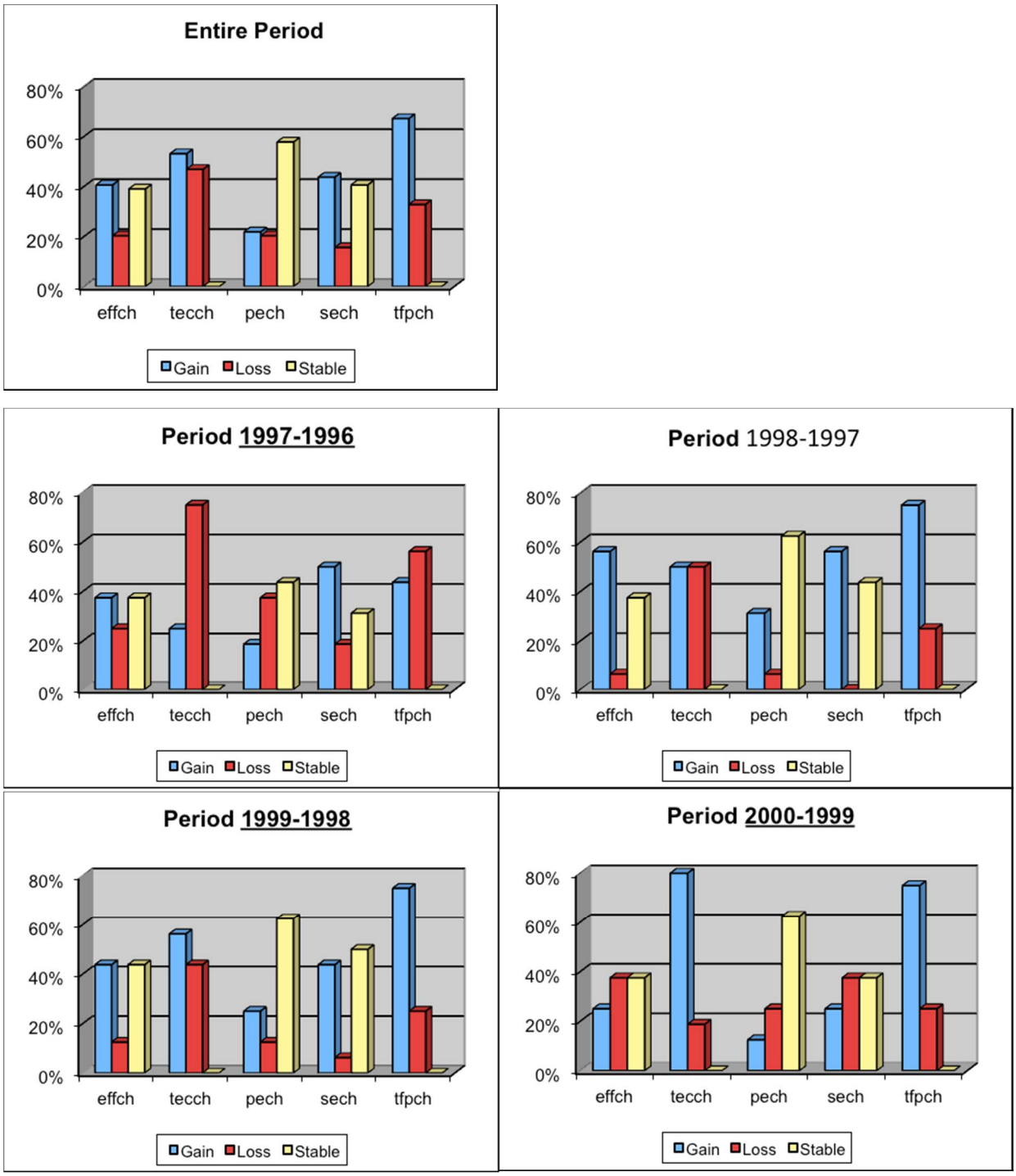


***Figure 5:*** *Percentage of banks with gain, loss or no change in TFPCH: Intermediation Model*

The results also show that productivity gains are greater under the intermediation model, especially due to technological gains with this specification. The year 1997 seems to be a problematic year for the Jordanian banks; under both models, the most of the Jordanian banks experienced productivity loss, mainly due to technological regress. We also observe that efficiency gains are predominantly triggered by scale efficiency growth, implying movement of the banks towards the optimum scale where there are constant returns to scale.

## Conclusions

Utilizing a DEA-type non-parametric Malmquist total factor productivity change (TFPCH) approach, we examined the productivity and efficiency change in the Middle East banking, by drawing on the performance of the Jordanian commercial, investment, and Islamic banks at the turn of the millennium. To the best of our knowledge, this is the first work of investigation that focuses specifically on the TFPCH of the Jordanian banking sector. We adopted two alternative methodologies to represent the banking technology (frontier) in Jordan, namely production model, which treats deposits as bank outputs, and intermediation model, which considers deposits as bank inputs. Doing so, for robustness check, we wish to see the impact of different specification of banking production process on the TFPCH index and its subcomponents.

The mean values of efficiency scores calculated relative to the separate frontiers under the both models, regardless of the bank's organizational form, indicate that scale inefficiency causes the biggest problem of stimulating overall managerial inefficiency in the Jordanian banks. Under the production model, overall technical, pure technical and scale efficiency scores are about 81%, 92%, and 84% for commercial banks, 76%, 94%, and 81% for investment banks, 79%, 92%, and 83% for Islamic banks, respectively. While, under the intermediation model, overall TE, PTE and SE scores are about 98%, 100%, and 98% for commercial banks, 86%, 99%, and 88% for investment banks, 87%, 93%, and 92% for Islamic banks, respectively. Commercial banks tend to dominate other banks (both investment and Islamic) concerning technical and scale efficiency measures. Moreover, the efficiencies of commercial banks tend to rise over time. Because for all forms of banks, scale inefficiency remains the primary source of technical inefficiency, we also examined the returns to scale developments in Jordanian banks. The results present that majorities of these banks are experiencing increasing returns to scale. This finding suggests that the Jordanian banks could obtain significant efficiency gains and input savings by increasing production of outputs. Moreover, the poor managerial performance of Jordanian banks may be stemming from lack of necessary skills or agency problems. These findings imply that the Jordanian banks could obtain significant efficiency gains and input savings by increasing managerial skills.

According to the production (intermediation) approach, the overall averages of efficiency change, technology change, and total factor productivity change scores over the study period are 2.9%, (1.4%,), 0.3%, (1.9%), and 3.2%, (3.2%), respectively. On the other hand, the pure technical efficiency change and scale efficiency change scores under the production (intermediation) approach are -0.7% (-0.9%) and 8.7% (9.3%), respectively. Even though the components vary by model, the total factor productivity change index remains the same. Under the production approach, efficiency change measures drive the productivity through scale efficiency growth, implying that there are managerial issues in Jordanian banks that cause the pure efficiency to be low. Also under the intermediation model, pure inefficiency is again the problem of efficiency measures. As for subgroups, total factor productivity change under the production (intermediation) model is 7.4% (1.8%) for commercial banks, 3.5% (7.1%) for investment banks and -13.2% (-7.6%) for Islamic banks. Technological progress (regress) under the production (intermediation) model is 0% (0.7%) for commercial banks, 1.8% (4.3%) for investment banks and -4.7% (-2.7%) for Islamic banks. On the other hand, overall technical efficiency change under the production (intermediation) model is 6.5% (1%) for commercial banks, 1.8% (2.8%) for investment banks and -9% (-5%) for Islamic banks. The results indicate that commercial banks dominate other banks in terms of productivity growth and efficiency change in general. However, further decomposition of other group of banks into investment and Islamic banks indicates that the latter lags behind the performance of other forms of banks. Interestingly, the classification of bank deposits as inputs benefits the investment banks mostly.

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