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# How Large are Productivity Differences between Islamic and Conventional Banks?

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**Abstract**

Despite the enormous growth in Islamic banking over the last thirty years, most studies, using DEA/stochastic frontier analysis, have found Islamic banks are either as productive or less productive than conventional banks. We take advantage of recent improvements in the direct estimation of production functions by Olley-Pakes and Ackerberg-Caves-Frazer (ACF) to develop fresh evidence on this question. Production functions are estimated and productivity calculated for conventional and Islamic banks in Bahrain and Malaysia between 1990 and 2011. We find that although in many respects the different techniques yield similar results, the ACF results are more plausible. Islamic banks in both countries tend to be around 50% as efficient as conventional banks though productivity growth is faster for Islamic banks. However, in Malaysia, a new set of banks, which we refer to as mixed banks, offering both conventional and Islamic banking, outperform conventional and Islamic banks in levels and growth. In Malaysia, at least, this new institution seems a promising way to meet the increasing demand for Islamic banking services.

# 1 Introduction

Over the last thirty years there has been enormous growth in Islamic banking. Originally, Islamic banks operated almost exclusively in Muslim countries to meet the need of Muslims for *Shari'ah* compliant financial products. Now there are Islamic banks operating in over 50 countries, including the major non-Muslim developed economies. And they now compete with non-Islamic banks for the business of non-Muslim customers. Because ethical principles restrict the operating methods and types of business an Islamic bank can engage in, simple economic theory suggests Islamic banks would tend to be less productive than conventional banks, which makes their rise puzzling and raises concerns about their sustainability. Furthermore, most previous empirical analyses of this question is consistent with this prediction. However, the relative productivity of Islamic banking remains an open question

for three reasons. First, there are two theoretical arguments that suggest this may not be the case. First, Islamic banks are producing a differentiated product valued by customers. Second, the restrictions under which Islamic banks operate may be an alternative solution to the asymmetric information problems, that the Global Financial Crisis reminds us, are endemic in even regulated conventional banking. The second main reason why the relative productivity of Islamic banking remains an open question is that most previous empirical work on this question uses the same tools of DEA\Stochastic frontier analysis. Furthermore many of these studies are based on either relatively old datasets or datasets constructed by pooling data across different markets and different regulatory environments. However, new approaches to the direct estimation of productivity \setvia production functions are being used extensively in industrial organization and international trade, but have not been applied to this question. Thirdly, in Malaysia, and to some extent elsewhere, Islamic banking services are increasingly delivered by mixed banks which provide both conventional and Islamic banking. These institutions have not been considered explicitly in the literature.

Hence, in this paper we provide new estimates of the productivity of conventional and Islamic banking for banks operating in two of the international hubs of Islamic banking: Bahrain and Malaysia. We use an unbalanced panel of 74 banks operating between 1990 and 2011 to estimate production functions using standard OLS and fixed effects estimators as well as the more recently developed Olley-Pakes and Ackerberg-Caves-Frazer (ACF) approaches. The latter approaches feature increasingly sophisticated techniques to overcome endogeneity of inputs as well as stronger identification of parameters. To determine the robustness of our findings, we estimate separate production functions by country and by type of bank as well as using a pooled sample. We calculate bank level productivity and compare both the levels and growth of Islamic, conventional and mixed banks in Bahrain and Malaysia. Averages at different levels from nations to individual banks are compared with a particular focus on developments around mixed banks. We find that the ACF estimator is preferred on both a priori grounds as well as in terms of the outcomes yielding more plausible estimates

of economies of scale and productivity. However, all four approaches yield broadly similar outcomes in that Islamic banks tend to have lower total factor productivity in terms of levels but have greater growth rates. Furthermore, in Malaysia, mixed banks tend to have a higher average total factor productivity and, once they begin offering Islamic banking services, tend to grow at a similar rate or faster than Islamic banks. Growth rates of conventional banks are almost identical across Malaysia and Bahrain.

These results are important for three reasons. First, in the first application of the OP approach to estimating the productivity of Islamic banking and the first application of the ACF approach to banking per se, we demonstrate these techniques can provide plausible and useful estimates. Second, using these new approaches nevertheless confirms the conclusions reached by using older techniques: Islamic banks tend to be less productive than conventional banks though we also show the gap is narrowing. In two markets that feature both substantial numbers of conventional and Islamic banks, the distribution of productivities for conventional banks looks quite similar. However, Islamic banks in Malaysia tend to be more productive than Islamic banks in Bahrain. Finally, we demonstrate how banks that provide both Islamic and conventional banking services tend to be more productive and, in Malaysia, have more rapid productivity growth than conventional banks or strictly Islamic banks. This seems a promising way to meet the increasing demand for Islamic banking services.

In the next section, we address the question as to why productivity might differ between Islamic and conventional banks and review the previous literature on comparing productivity across Islamic and conventional banks. In the third section, we review the Olley-Pakes and Ackerberg-Caves-Frazer approaches to directly estimating production functions, concluding with a brief review of the literature in which these and related techniques have been applied. Section four reviews the data, its descriptive statistics and outlines an estimation strategy. The fifth section reports the results for estimating production functions and analyses the implied estimates of productivity. Section six concludes.

# 2 Why might productivity differ between Islamic and conventional banks?

In this section we first summarise the nature of Islamic banks. This is followed by a comparision with conventional banks and the implications of the differences for outcomes when Islamic and conventional banks compete in the same market. In the final subsection we discuss previous research analysing the efficiency of Islamic banks compared with conventional banks

## 2.1 What are Islamic banks?

Islamic banks are banks that operate consistently with Islamic laws, often known as *Shari'ah* as derived from the Quran and *Sunnah* (Ahmed, 2011). The main objectives of Islamic laws are to protect wellbeing and avoid any harm. Thus moral values and ethical conduct is a must in Islamic banking operations. Islamic banks were established about four decades ago to meet the mandatory needs for Muslims in facilitating their financial activities. The early motivation for the creation of Islamic banks was to mainly capture the market of Muslims rather than compete with existing conventional banks. Despite this motivation, the development and massive growth of Islamic banking throughout the world has led to a more competitive market in banking. The initial intention in fulfilling the need of Muslims to have *Shari'ah* compliant products has been replaced with aiming to provide attractive and competitive products that suit both Muslims and Non-Muslims.

The primary application of *Shari'ah* to banking is the prohibition of unlawful conduct so to ensure fair and equitable treatment for all stakeholders. Thus it is very important in Islamic banking operation to ensure the total elimination of *riba*, *gharar* and *maisir*. *Riba* refers to unequal trade of values in exchange, which commonly includes interest. *Riba* or the involvement of interest in any Islamic banking transaction is strictly prohibited as it may become a burden to the less capable (financially) party. Therefore, to replace the use

of interest, Islamic banks apply the concept of Profit and Loss Sharing (PLS) to protect both banks and customers. At the same time, Islamic banks still earn a reasonable profit at an agreeable price. The specific arrangements are very much dependent on the type of contract between the two parties. For example, capital and the profit (or loss) proportion is predetermined in the contract such as a split of 70 and 30 percent between the two parties, such as the bank and the funds provider. *Gharar* refers to speculation that involves absolute or excessive uncertainty in business transactions. Deceit or fraudulent activities are examples of absolute uncertainty while a subprime mortgage is an example of excessive uncertainty. To achieve the Islamic objective in banking, of ensuring fair and equitable conduct, there should not be any uncertainty that could cause severe losses to one party and unjustified enrichment of the other party. Thus any transaction that comes with a *gharar* element is prohibited in Islamic banking. Other than the above mentioned prohibited activities, Islamic banks are forbidden to be involved with certain activities as specified in Quran. They include business transactions that involve unlawful and unethical activities such as bribery, prostitution, drug abuse, alcohol, pork and gambling (*maisir*). Islamic banks, though, still provide products and services similar to those of, both commercial and investment, conventional banks focussing on deposit taking and money lending. However, due to the different principles that govern Islamic banks, the terms of the contract used are unique so to achieve *Shari'ah* compliance.

In understanding *Shari'ah* in Islamic banking, it is necessary to be aware there are different interpretations of the Quran and *Sunnah* which has led to inconsistent conclusions on certain issues. To resolve this issue, there are four Islamic schools of thought (Islamic jurisprudence or *mazhab*).[1] These approaches are accepted among members of the same community (or in broader categories such as the state or country level) in resolving undecided issues. The use of *mazhab* should be consistent throughout time in ensuring it is not being abused by Muslims. Note that different *mazhab* may come out with different reso-

[1] *Hanafi*, *Shafii*, *Maliki* and *Hambali*.

lutions on certain disputes. Despite different *mazhab*, the core contents of Quran, mainly religious faith and belief (*Aqeedah*) are interpreted in a similar way by Muslims all over the world. In addition, there are authorised *Shari'ah* scholars in at least each state or country that sit together and discuss uncertain issues related to the Muslim community and *Shari'ah* laws. The decision from the discussion is referred as a *fatwa* and must be obeyed by the community. From a banking perspective, the government is responsible for setting up adequate regulatory agencies and appointing *Shari'ah* scholars, who are ideally equipped with business and banking skills, to resolve issues in Islamic banking.

## 2.2 Competition between Islamic banks, conventional banks and mixed banks

The simplest interpretation of the implications of section 2.1 is that Islamic banks are like conventional banks but subject to an additional set of constraints from *Shari'ah* law. This implies that Islamic banks will have lower productivity to the extent that *Shari'ah* law prevents them from undertaking more productive activities available to conventional banks.[2] There are, though, two qualifications to this view. First, the simple view implicitly assumes that Islamic banks are producing the same product as conventional banks which, in the eyes of their customers, is not the case. Muslim consumers of Islamic banking services undoubtedly get additional utility from banking provided in a way consistent with Islam.[3] If output is measured using deflated revenue, then this should offset the effect of other constraints that might otherwise lower total factor productivity. Second, as suggested by the extent of industry-specific regulation, banks are not like other firms being more acutely subject to potential market failures arising from asymmetric information or incomplete markets. Eliminating *riba* and *gharar* can also reduce potential losses from moral hazard or the absence of effective insurance markets for certain types of risks.[4] Hence, the productivity gap may not

[2]Basov and Bhatti (2014) argue Islamic banks may also attract managers with less human capital.
[3]See Berg and Kim (2014) for a signalling explanation of the demand for Islamic banking services.
[4]Abedifar et al (2013) discuss this at length as well as perform an empirical analysis.

be as large as the simple view suggests. Finally to the extent other activities exist with similar risk-return profiles to those industries prohibited as *maisir,* there is effectively no additional constraint on Islamic banks. Hence the size and even the existence of a productivity gap between Islamic and conventional banks remains an empirical question.

The question of the relative efficiency of Islamic banks is particularly acute in markets where both types of banks are in competition. This is the case in both Bahrain, the global centre of Islamic finance (Hassan & Lewis, 2007), and Malaysia, which is on the way to becoming an international Islamic financial hub. This is known as the dual-financial system in Malaysia and the "conventional plus" system in Bahrain (Yakcop, 2003). Regardless of their massive growth and success in developing Islamic products, the means to overcome inefficiency is limited relative to the conventional banks (Abdul-Majid et al., 2011a).

In addition, we identify a third type of banks, the mixed banks, which are conventional banks with Islamic subsidiaries. This is distinct from conventional banks offering some Islamic banking through what is known as an Islamic window. In 1993, ten years after the establishment of the first full-fledged Islamic banks in Malaysia, the government started to allow conventional banks to offer Islamic banking products through Islamic windows. These initially were very limited Islamic banking services. Malaysia then gave an option to conventional banks either to continue to offer Islamic windows, to set up new full-fledged Islamic banks/subsidiaries or to convert the existing conventional bank to an Islamic bank. The first conventional bank that established their Islamic subsidiary and became a mixed bank was in 2005.[5] It was later followed by other conventional banks. During the sample period Bahrain only had one mixed bank though more banks had Islamic windows.

Islamic banks established as subsidiaries of many large local and several foreign conventional banks have important advantages. The resources, networks and infrastructure are readily available from the parent bank to their Islamic subsidiaries. For instance, those Is-

[5]It is also worth noting that this was part of a new trend of conventional banks shifting their investment from the takeover of the deceased banks, following the restructuring, to Islamic banks resulting in the dual-banking system.

lamic banks categorised under mixed banks can only offer Islamic products in full-fledged Islamic branches. On the other hand, conventional banks categorised under mixed banks may offer both conventional and Islamic products through their conventional branches. Hence, for a start, there is little need for a mixed bank to establish many full-fledged Islamic branches and infrastructure such as automated teller machines (ATMs) throughout the whole country. In fact, some of the mixed banks only have full-fledged Islamic branches based in regional areas instead of in each state. For example in Malaysia, instead of having an Islamic branch for each state, some Islamic subsidiaries only have one Islamic branch to cater for the whole market for each region, i.e. the centre, the north, the south, and the eastern parts. Furthermore, it is much easier for full-fledged Islamic branches of mixed banks to gain new customers through readily available customers of the conventional branches. For instance, it is common for existing customers of mixed banks to apply for loan refinancing swapping from a conventional loan to an Islamic financing arrangement. With Shari'ah compliant products, some of the customers are willing to swap from conventional to Islamic products but at the same time can continue with the same bank. These advantages explain the dynamic expansion of new Islamic banks although most of them have been only recently established as compared to the long-lived purely Islamic banks in Malaysia and Bahrain.

## 2.3 Previous literature

There is a large literature analysing the bank productivity in general and a growing literature directly comparing the productivity of conventional and Islamic banks. As highlighted in a recent survey by Hughes and Mester (2010), there are three broad approaches to these problems. First, there is a large set of studies that apply Data Envelopment Analysis or Stochastic Frontier Analysis to estimate productivity and then use regression to analyse the determinants of the differences. Studies in this group which compare conventional and Islamic banks are comprehensively surveyed by Johnes et al. (2014). A second, much smaller group analyses differences in financial ratios rather than statistics directly matching

the economic concept of productivity. Beck et al. (2014) is a recent example. The third group analyses productivity based on directly estimating production functions or their duals. This approach was revitalised by advances in estimating production functions beginning with Olley and Pakes (1996) and continues to evolve rapidly. There are no papers using this third set of techniques analysing Islamic banks or comparing their productivity to conventional banks. Hence in this section, we draw directly on Johnes et al. (2014) and Beck et al. (2013) for the relevant lessons from these branches and provide additional details on a set of studies on Malaysia.

The picture that emerges from the earlier literature is mixed. Most of the studies Johnes et al. (2014) review find either no significant difference in efficiency or that Islamic banks are significantly less efficient. For example, in a recent study Bader, Mohamad, Ariff, and Hassan (2008) measure and compare the cost, revenue and profit efficiency of Islamic and conventional banks using Data Envelopment Analysis (DEA) in 21 Organisation of the Islamic Conference (OIC) member countries. They discover insignificant differences between the overall efficiency for the two groups of banks. Beck, Demirgüç-Kunt, and Merrouche (2013) compare Islamic and conventional banks in 22 countries and find Islamic banks obtain lower efficiency but have higher capitalisation and asset quality. The authors also document Islamic banks and conventional banks are not significantly different in terms of their business models irrespective of differences in theory and principles. Iqbal and Molyneux (2005) review the empirical evidence regarding efficiency in Islamic banks in various countries via a series of methods and approaches. They conclude that Islamic banks are at least as efficient as European or conventional banks, and in Qatar, GCC countries and some Middle East countries, Islamic banks are certainly more efficient.

Most previous studies analysing productivity differences between Islamic and conventional banks use data sets across multiple countries, either within a region, such as the Gulf Cooperation Council region, or across regions. A potential concern about these studies is what variation is driving the results? Is it cross bank-type variation or is it variation

across markets? Ideally, conditions for all banks in the sample should be identical except for whether the bank is conventional or Islamic but this is harder to justify when combining data for countries with different banking regulations and other characteristics. One way to overcome this problem is to study banks within one country or similar countries. There are several sets of studies analysing productivity in Malaysia. Abdul-Majid, Saal, and Battisti (2011a; 2011b) analyse Malaysian commercial banks by comparing the Islamic banks with the conventional banks in their cost efficiency and productivity change. They find Islamic banks have greater input requirements than conventional banks. Furthermore, conventional banks with an Islamic window, have greater input requirements than conventional banks without one. However, the findings also reveal that full-fledged Islamic banks have more rapid productivity growth. It is important to note though that their study uses data from 1996 to 2002. This is before the arrival of the mixed banks and also shortly after a set of mergers which they find also increased costs. More recently, Wasiuzzaman and Gunasegavan (2013) examine financial ratios and perform a basic regression analysis of returns finding conventional banks had a greater average return on assets but no significant difference in the regression analysis. There are no published studies specifically on the Bahrain banking system.

# 3 Estimating Productivity for Banking

In this section we present the two main approaches to estimating productivity that we use: the Olley-Pakes and Ackerberg-Caves-Frazer approaches. We introduce the Olley-Pakes approach first, followed by the Ackerberg-Caves-Frazer critique of its identification and their own estimation approach. The ACF approach is preferred on a priori grounds because of its stronger identification. It is interesting to see if the results from the two approaches differ though as, strictly speaking, successful estimation using the OP approach requires there to be mis-specification.

The Olley-Pakes method is motivated by three issues: the endogeneity of inputs, firm exit (selection) and unobserved productivity differences across firms. The Olley-Pakes approach is demonstrated with the Cobb-Douglas production function as in equation (1):

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \eta_{it} \tag{1}$$

where $y_{it}$ represents the output for firm $i$ at time $t$, $l$ and $k$ are the firm inputs of labour and capital respectively. Note that inputs and output are logged and there are two unobservable terms to the econometrician in the equation, $\omega_{it}$ and $\eta_{it}$. $\omega_{it}$ is the firms' productivity shock at time $t$ which is known by the firm when making its labour and investment decisions. $\eta_{it}$ is the error term which is not observed by the firm until after all inputs are chosen. The OP methodology assumes that the productivity term evolves exogenously following a first-order Markov process, as follows:

$$p\left(\omega_{it}|I_{it-1}\right) = p\left(\omega_{it}|\omega_{it-1}\right) \tag{2}$$

where $I_{it}$ is the information set for firm $i$ at time $t$. Hence productivity is modelled as follows:

$$\omega_{it} = E\left(\omega_{it}|\omega_{it-1}\right) + \zeta_{it} \tag{3}$$

OP assume that capital is a state variable which evolves following an investment process. With $d$ as the depreciation rate and $i_{it}$ as investment, capital at time t, is derived using equation (4):

$$k_{it} = (1-d)\, k_{it-1} + i_{it-1} \tag{4}$$

The assumption that capital stock is determined at period $t-1$, using the information set $I_{t-1}$, helps in solving an endogeneity problem for $k_{it}$. On the other hand, labour is not a state variable and it is assumed to be a non-dynamic input. The choice of labour does

not have an impact on the firm's future profits. Labour is chosen for each period without restriction from previous periods. $l_{it}$ is decided at $t$ and is correlated with $\omega_{it}$. Since $\omega_{it}$, the productivity shock, influences the management decision on labour, OLS estimation of equation (1) produces biased and inconsistent estimates. In order to counter the endogeneity issue, Olley-Pakes uses a proxy variable, investment, to control for the unobserved productivity shock and produce consistent estimates of the coefficients. Investment is modelled as a function of capital and productivity as shown in the following demand function:

$$i_{it} = f\left(k_{it}, \omega_{it}\right) \tag{5}$$

Note that prices are allowed to vary across time, but not across firms since they operate in the same input markets. Investment made by the firm is assumed monotonically increasing with its productivity. With this assumption of a strictly monotonic relationship between $i_{it}$ and $\omega_{it}$, the unobservable productivity variable, $\omega_{it}$ can be inverted and expressed as the function of the state variable, capital, and investment, as in equation (6):

$$\omega_{it} = \omega_t\left(k_{it}, i_{it}\right) \tag{6}$$

Substitution of equation (6) into equation (1) yields:

$$Y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega\left(k_{it}, i_{it}\right) + \eta_{it} \tag{7}$$

OP demonstrate consistent estimates of the production function and total factor productivity are obtained by applying a two stage semi-parametric estimation approach to equation (7). In the first stage output is regressed on labour and a non-parametric function of capital and investment yielding a consistent estimate of $\beta_l$. In the second stage, consistent estimates of the remaining parameters and total factor productivity are obtained using non-linear least squares.

ACF, though, demonstrate a fundamental identification problem with this approach and

suggest a modification to overcome it which we now present. The fundamental identification problem arises from the fact that under the above assumptions $l_{it}$ is also a function of $k_{it}$ and $\omega_{it}$ making it impossible to separately identify $\beta_l$ in the first stage. So successful estimation using the OP approach effectively requires some form of mis-specification. The ACF procedure introduces an alternative way to solve the collinearity issue by focusing on the timing assumption for labour. The main idea is to develop different information set for the variables of interest. Unlike for the OP model, ACF consider $l_{it}$ an imperfectly variable input chosen at some point in time between period $t-1$ and $t$, say period $t-b$, where $(0 < b < 1)$. With the assumption that productivity evolves between these sub-periods, a firm's observed labour input is not a function of $\omega_{it}$, but of $\omega_{it-b}$:

$$l_{it} = l_t\left(k_{it}, \omega_{it-b}\right) \tag{8}$$

Under this assumption $l_{it}$ is not collinear with the non-parametric term since $\omega_{it-b}$ cannot generally be written as a function of $k_{it}$ and $i_{it}$. Unlike investment, labour is determined by $\omega_{it-b}$ rather than $\omega_{it}$. The idea of two separate periods, $t$ and $t-b$ is meant to solve the collinearity issues between $l_{it}$ and the non-parametric function. In this situation, labour is chosen earlier without perfect information about productivity at time $t$ and without complete information on productivity, $l_{it}$ moves independently of the non-parametric function. The first implication of this alternative timing assumption is that equation (6) is rewritten as:

$$i_{it} = i_t\left(\omega_{it}, k_{it}, l_{it}\right) \tag{9}$$

This implies equation (7) is replaced with equation (10):

$$Y_{it} = \beta_l l_{it} + \beta_k k_{it} + \omega_t\left(i_{it}, k_{it}, l_{it}\right) + \eta_{it} \tag{10}$$

where the constant term is absorbed into $\omega_t\left(i_{it}, k_{it}, l_{it}\right)$. Estimation proceeds, as in OP, in two stages. In the first stage, $Y_{it}$ is regressed on a non parametric function of $i_{it}$,$k_{it}$ and $l_{it}$

yielding the following decomposition:

$$Y_{it} = \hat{\Phi}\left(i_{it}, k_{it}, l_{it}\right) + \hat{\eta}_{it} \tag{11}$$

GMM is used in the second stage to estimate $\beta_l, \beta_k$ and $\omega_{it}$. Two moment conditions are required:

$$E\left[\zeta_{it}\begin{pmatrix} k_{it} \\ l_{it-1} \end{pmatrix}\right] = 0 \tag{12}$$

which are operationalised in an iterative estimation routine using equations:

$$\hat{\omega}_{it} = \hat{\Phi}_{it} - \beta_l^* l_{it} - \beta_k^* k_{it} \tag{13}$$

$$\hat{\omega}_{it} = \sum_{n=0}^{3} \hat{\omega}_{it-1}^n + \hat{\zeta}_{it} \tag{14}$$

where $\beta_l^*$ and $\beta_k^*$ are estimates of the input coefficients in the iterative process, $\hat{\Phi}$ is obtained from equation (11) and equation (14) implements equation (3).

There is now a very large literature estimating productivity using either OP or the subsequent extension of Levinsohn and Petrin (2003) (LP) using materials instead of investment as the proxy variable (see Fernandes (2008), Hallward-Driemeier and Rijkers (2011), and Arnold, Javorcik, Lipscomb and Mattoo (2012) for examples). However, just a few studies have analysed productivity in banking using these techniques — almost all using the Levinsohn-Petrin approach. Nakane and Weintraub (2005) apply LP to estimate how productivity was affected by privatisation in Brazil. Sanyal and Shankar (2011), Martin-Oliver et al (2013) and Koetter and Noth (2013) are other examples. Buch et al (2014) applies both the LP and OP approaches. The present study is the first study to apply the ACF approach to banking.

# 4 Data and Estimation Strategy

We use an unbalanced panel data of 691 annual observations on 74 Malaysian and Bahrain banks over 22 years from 1990 to 2011. The dataset is more recent than many studies — particularly those on Malaysia — enabling an analysis of the mixed banks.

## 4.1 Definitions and Sources

The definitions of the variables required for estimation are summarised in Table 1. The primary data on inputs and outputs is obtained from the financial statements of individual banks contained in the International Bank Credit Analysis Bankscope database. Consolidated statements are used only if the unconsolidated statement is unavailable or data is insufficient. All data is inflation adjusted and in USD as reported by Bankscope. Information on bank ownership and specialisation are obtained and cross-checked from the central banks, Bank Negara Malaysia (BNM) and Central Bank of Bahrain (CBB). Finally, more detailed information and data such as bank establishment dates are obtained from the banks individual annual reports, all accessed from bank official websites.

Within the banking productivity literature, different choices have been made about how to measure output and which inputs should be included (see, for example the discussion in Berger and Humphrey (1997)). As is highlighted in the intermediation approach to modelling banks, the main output for banks arises from loans issued such as mortgage, retail and commercial loans. In the intermediation approach banks are considered as financial intermediaries that collect purchased funds and use labour and capital to transform these funds into loans and other assets. Hence we use total loans as a measure of output. For inputs we use labour and capital. The quantity of labour is measured as the value of personnel expenses. Total expenditure on employees for labour includes wages and salaries, bonuses, social security costs, pension costs and other staff costs such as stock options.

Capital is measured as the value of bank gross fixed assets. Reported fixed assets are

adjusted to include the value of leased assets, the leases of which are reported as off-balance sheet commitments. The inclusion of leased assets is essential in acquiring an adequate value of fixed assets in banking to match their output. Bankscope only reports fixed assets net of depreciation, $NFA$. Gross fixed assets are recovered from this by dividing by $(1-d)$ as below:

$$GFA_{it} = \frac{NFA_{it}}{0.83} \tag{15}$$

Calculation of the value of leased assets and the depreciation rate are discussed in more detail in the appendix. Investment is calculated as in equation (16):

$$i_t = GFA_t - GFA_{t-1} \tag{16}$$

A further issue to consider regarding fixed assets for calculating investments is the possibility of zero investment and disinvestment. Earlier studies drop zero observations because they are likely to violate the monotonicity assumption required for the inversion of the productivity estimates as in equation (8). Negative observations per se do not seem to violate the monotonicity requirement. In our initial sample of 698 observations, seven observations have zero investment and 257 observations feature negative investment. The study excludes all observations with zero investment from the analysis leaving 691 observations. As the first stages of the OP and ACF approaches require squared terms, we convert all negative values to positive values by adding a sufficiently large positive number to make all terms positive. Figures One and Two illustrate, using hypothetical data, how this works. As investment is just included in estimation as part of a control function, the scale does not matter as long as the ordering is preserved.

Finally, it is important to note that the observations on inputs and outputs for mixed banks aggregate those for the Islamic and conventional banking activities. It is typically not possible to construct separate data series for Islamic subsidiaries of the mixed banks because

of shared inputs with the conventional branches (particularly capital).

## 4.2 Estimation Strategy

As well as estimating production functions, and productivity, using the OP and ACF approaches, to better understand the nature of the data, we also estimate using OLS and a fixed effects estimator. In addition, we not only estimate using the full sample but also with two sets of sub-samples constructed by type of bank and by country. In particular, we estimate using separate samples for Malaysia and Bahrain and two separate samples of conventional banks and the combination of Islamic and mixed banks.

The reason for also estimating using these subsamples is because the theory suggests the full sample can only be used for estimating a common production function if all banks in the industry are charged the same price for inputs and all prices move concurrently over time. Malaysia and Bahrain are likely to have different prices for labour and capital given Bahrain is a developed economy while Malaysia is an emerging market. It is expected that the labour is less expensive in an emerging market relative to a developed market. Thus on average it is likely that banks in the less developed country use more labour per unit of capital than in the developed country. That being said, pooling data from Malaysia and Bahrain is probably less problematic than combining many other countries because both have relatively well developed Islamic banking sectors. We also divide the sample according to bank type because the two different types of banks may face different input prices because Islamic and conventional banks operate based on different frameworks and principles. For instance, purchasing of assets (capital) for Islamic banks must comply with Shari'ah principles which does not involve interest charges. Finally, Islamic banking is fairly new and may receive different input prices as compared to the conventional banks. Hence, we estimate using both the full sample and each of the subsamples.

## 4.3 Descriptive Statistics

We have annual data for an unbalanced panel of 74 Malaysian and Bahrain banks for 22 years from 1990 to 2011. Of the 698 observations, 467 are for the Malaysian banks and 231 are for the Bahrain banks. Alternatively the sample can be decomposed into 495 observations for the conventional banks and 203 observations for the Islamic plus mixed banks. To better demonstrate the variation in the data, we consider the descriptive statistics for the pooled sample and the subsamples of conventional, Islamic and mixed banks. In Table 2, the descriptive statistics for purely Islamic and mixed banks are also reported separately. It is important to note that although there is a relatively small number of observations for mixed banks, the mean and median assets for these banks are significantly higher than those for solely conventional banks and purely Islamic banks. This implies that banks which practice both conventional and Islamic operations are among the largest banks. Furthermore although the standard deviation for mixed banks total assets is double the standard deviation of assets in the full sample, the coefficient of variation for mixed banks total assets is the smallest as compared to the conventional and Islamic banks. This statistic demonstrates that mixed banks have less variability in their assets size. The statistics also reveal that mixed banks have distinctively large assets among banks. Both conventional and Islamic banks mean assets are lower than the mean assets for the total sample of 698 observations. Unsurprisingly, purely Islamic banks have the lowest mean assets which indicate Islamic banks are relatively new and smaller than conventional banks in Malaysia and Bahrain. Furthermore the assets size variation for Islamic banks is small as the coefficient of variation is smaller than that for the conventional banks.

The descriptive statistics for output loans shows a similar ranking as for banks total assets. The most loans are issued by mixed banks, followed by conventional and Islamic banks. The same scenario applies to the loans variability for mixed banks with a high standard deviation for loans, but the lowest coefficient of variation relative to conventional and Islamic banks. The large value of assets and loans by mixed banks may be due to the

sharing of conventional and Islamic products. These banks may use similar or even less inputs to obtain greater output of both products in their operation.

In terms of capital and labour, it is interesting to note the banking industry has very small values in relation to output. This is natural in a services industry, particularly in banking, as their development mainly depends on deposits and funds rather than physical assets and labour. The capital and labour inputs ranges between just 1 to 2 percent of total loans. In addition, investment is the measure of additional fixed assets or fixed assets disposal (disinvestment). The mean investment is very small relative to banks loans and total assets. However, Table 3 shows that investment is significantly correlated with bank loans and their growth. This suggests investment is reflecting the same underlying process that is driving growth in output.

# 5 Results

In the first sub-section we report the results from estimating the production function. In the second sub-section we calculate and analyse total factor productivity.

## 5.1 Productivity Estimation

Tables 4 and 5 report coefficients for estimating the production function using the four methods for all samples and sub-samples. The coefficient on labour is positive and statistically significant regardless of specification and estimation method for all samples and sub-samples. In most cases, it takes values between 0.6 and 0.9. There is greater variation in the estimated capital coefficient across samples and techniques. The results from OLS and ACF are broadly similar with higher values for the Malaysian and Islamic Bank samples and lower values for the Bahrain and Conventional Bank samples. For OP and Fixed effects, the capital coefficients are much smaller and often statistically insignificantly different from zero. This outcome for fixed effects is well known as the fixed effects absorb the primarily cross

firm variation of inputs that do not vary much over time (Mairesse, 1990). The different outcomes for the capital coefficient largely determine the different economies of scale implied by the two sets of specifications. OLS and ACF suggest there is increasing returns to scale where as FE and OP suggest there is decreasing returns to scale. The finding of decreasing returns to scale is not very plausible particularly as previous studies tend to find economies of scale in banking (Hughes and Mester, 2010). Hence, as well as being preferred on a priori grounds, the ACF estimation results seem more plausible. Also, within the Malaysian context, this different outcome is important as the Malaysian government has forced banks to merge (Sufian and Habibullah, 2014).

The estimates of the coefficients on the Islamic indicator variable are broadly similar across all of the specifications. Negative coefficients for the group dummy are returned by all methods except FE implying solely conventional banks produce more output with given inputs compared to Islamic plus mixed banks. For the pooled Malaysian-Bahrain sample, the coefficient is around -0.6 and statistically significant suggesting that the Islamic banks are about 45% less productive than conventional banks. When the sample is divided by country, then for the OLS and OP specifications, the coefficient for Malaysia is statistically insignificant for OP but, for both methods, the coefficient for Bahrain is larger and statistically significant. However, for the ACF specification, the coefficients are insignificant in both country samples. For the FE specification, the coefficients on the Islamic dummy for the pooled sample and Malaysian subsample are positive and stastistically significant. It is not possible to separately estimate this coefficient for the Bahrain subsample. The reason for all these results is that with bank specific fixed effects, the coefficient on the group dummy is identified off the banks which switch from being conventional to mixed. This occurs primarily in Malaysia. The descriptive statistics suggest that the switching banks tend to be larger — hence the positive coefficient on the group dummy. However, the average fixed effect for conventional banks is 0.08 whereas those for banks that are Islamic (including mixed banks) is -0.80. This suggests that the significant coefficient on the group dummy for the pooled

sample comes from variation across Malaysia and Bahrain. In Malaysia, there are more large mixed banks which tend to be more productive whereas in Bahrain there are almost no mixed banks.

For the bank-type subsamples, the results differ across the specifications. For OLS, the average productivity is higher for conventional banks whereas for the FE specification it is the other way around. We discuss the difference in productivity estimates in more detail in the next section.

## 5.2 Estimates of Total Factor Productivity

Descriptive statistics of the total factor productivity estimates are provided in Table 6. The main result is that regardless of the method used, Islamic banks have lower productivity than conventional banks. The gap is quite substantial — mostly between 50 and 65%. The differences across the samples tends to be greater than the differences across techniques within samples and seems mainly driven by Malaysia. In Bahrain, all four methods yield a productivity gap of between 63% and 70% whereas for the Malaysian sample the estimates range from 40-45% (FE and OP) to 50% (ACF and OLS). There is also about a 63% gap for the pooled sample but between ACF (59%) and FE (67%). Except for Bahrain (which has only one mixed bank), the comparison between mixed banks and conventional banks depends on the technique used. For OLS and ACF the averages are very close whereas for OP and FE, mixed banks are substantially more productive.

The results for the samples by bank-type are also of interest. In the sample of conventional banks the mean and standard deviations are almost identical for Malaysia and Bahrain for all four methods. Although Malaysian banks have a slightly higher average productivity than Bahrain conventional banks, the difference is extremely small. This is striking as the two countries are in many respects quite different. This result is consistent with technology diffusing fairly quickly in competitive markets across different countries. For the sample of Islamic and mixed banks, Malaysian banks are on average more productive for all four

methods. The fact that Islamic banks in Bahrain have greater variability in productivity than Islamic banks in Malaysia suggests this is not just because of there being more mixed banks in Malaysia.

Table 7 reports the median growth rates for TFP for six groups of banks; i) Malaysian solely conventional banks, ii) Malaysian purely Islamic banks, iii) Malaysian mixed banks before the establishment of Islamic branches, iv) Malaysian mixed banks after the establishment of Islamic branches, v) Bahrain solely conventional banks and vi) Bahrain purely Islamic banks. The median is used for analysis because there is large variation in yearly bank level productivity. Even though Islamic banks in Malaysia and Bahrain have lower TFP, in both countries, in most cases, Islamic banks, as a group, have higher median TFP growth than conventional banks. The productivity growth of the mixed banks in Malaysia before and after they became mixed is interesting. After becoming mixed banks, the median productivity growth is much higher than before. While median productivity growth was lower in the mixed banks than for Islamic banks before they became mixed banks, the pre-mixed banks median growth rate was higher than that for the conventional banks that remained conventional banks. After the banks became mixed banks, the median productivity growth is even higher than the Islamic banks.

Finally, in Table 8, we compare, using the OP and ACF estimates of total factor productivity, the level and growth before and after each solely conventional bank established a full-fledged Islamic subsidiary for the 12 mixed banks in Malaysia. Note that, there is only one mixed bank in Bahrain and due to insufficient data the growth comparison of this bank is not informative. The median growth between these two periods reveals that on average growth is higher after the solely conventional banks became mixed banks. For both OP and ACF productivity, except for CIMB Bank Berhad and EON Bank Berhad, banks have higher TFP growth after becoming mixed banks. In addition, Malayan Banking Berhad also shows a slight reduction of median TFP growth after the bank becomes mixed using ACF estimation. As for EON Bank Berhad, the reduction of median growth is possibly due

to their exiting, the bank being absorbed by the Hong Leong Bank Berhad in 2011. This result, suggests mixed banks are capable of increasing productivity with the establishment of Islamic branches in addition to their conventional operations.

Overall, we conclude mixed banks in Malaysia perform the best in terms of their productivity regardless of estimation method. They tend to have higher TFP and greater TFP growth after the banks become mixed by having both conventional and Islamic branches. Inspection of the levels and growth rates for individual banks demonstrate this result holds for most banks — not just a few outliers. The mixed banks increased their productivity and productivity growth by sharing their resources in producing a mixed output. By setting up the new full-fledged Islamic branches/subsidiaries, the mixed banks improved their productivity in their operations. Though the findings are also consistent with the more productive banks deciding to become mixed by setting up their own full-fledged Islamic banks. Recall that mixed banks are largest in size. In addition, we have also confirmed the findings of the earlier literature and most theoretical predictions that Islamic banks tend to have lower productivity than conventional banks and the difference is substantial. However, the difference is narrowing as Islamic bank productivity tends to grow more quickly than that for conventional banks. Finally, even though the four estimation approaches tended to yield broadly similar results, the ACF approach, which returns increasing returns to scale, is the preferred approach.

# 6 Conclusions

The present study analyses banks productivity comparing Islamic and conventional banks in Malaysia and Bahrain. The study uses financial data from both countries from 1990 to 2011 consisting of 691 observations. In estimating bank productivity, we use four approaches to estimating production functions: ordinary least squares, fixed effects, the Olley-Pakes and Ackerberg-Caves-Frazer approaches. In general, each approach yields initially plausible

estimates of production functions. For all approaches, labour is a statistically significant determinant of output. As for capital, the results differ across techniques and samples. In general, unlike the OP estimation, the ACF coefficients are not too disimilar from those yielded by OLS. The FE and OP approaches suggest banking features decreasing returns to scale whereas the OLS and ACF approaches suggest, more plausibly, that banks feature increasing returns to scale. The inclusion of a group dummy in the model implies that solely conventional banks have greater output with given inputs relative to Islamic plus mixed banks. A more detailed analysis of estimated total factor productivity from the four sets of results yields broadly similar results. Islamic banks have consistently lower productivity than conventional and mixed banks, although their productivity is growing more rapidly than the conventional banks. Notably most of the Islamic banks are relatively smaller and newer than the conventional and mixed banks. Conventional banks have similar productivity, on average, across Malaysia and Bahrain. Mixed banks are the most productive and their productivity has been continuing to grow rapidly. The creation of mixed banks in Malaysia was largely due to the government encouragement of the establishment of full-fledged Islamic subsidiaries for conventional banks. Consequently, Malaysian local banks that initially were solely conventional banks established full-fledged Islamic subsidiaries and increased their productivity. The new evidence provided in this study improves on previous work in three respects. First, it uses production function estimation rather than DEA/SFA used in most studies, taking advantage of recent developments — specifically the Olley-Pakes and Ackerberg-Caves-Frazer approaches are used. Second, it focuses on banks for two of the leading hubs of Islamic finance, Bahrain and Malaysia, reducing the likelihood that results are driven by cross-country rather than cross-type variation. Finally, it uses relatively recent data which enables analysis of a relatively new and distinctive way of delivering Islamic banking services — the mixed bank. In summary, the study reveals that bank productivity is associated with offering a range of products to generate more output. This is one advantage of mixed banks which is not accessible for purely Islamic banks that need to compete with

many other banks (solely conventional and mixed banks). It is not practical for purely Islamic banks to offer conventional products and conventional branches as it is against the concepts of Islamic finance and Shari'ah. The existence of mixed banks seems to have accelerated the growth of the Islamic banking industry, particularly in Malaysia.

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# Appendix

Ross, Westerfield, and Jordan (2003) provide a detailed explanation on operating lease capitalization. The present value of leased assets, $PVOL$, is calculated as follows:

$$PVOL = \sum (OL + LDepts)\,(1 - tax)\left(\frac{1 - (1 + r^{-n})}{r}\right) \tag{17}$$

where $OL$ is the annual operating lease payment and $LDepts$ is the lost depreciation tax shield. The tax rate, interest rate and lease life are denoted as $tax$, $r$ and $n$ respectively. The annual lost depreciation tax shield is an additional cost of leasing as banks lose this valuable tax shield with leasing instead of buying assets. We calculate this using an estimated depreciation rate of 17 percent. This rate is the weighted average depreciation rate, $d$, as calculated below:

$$d = \sum_{banks} \sum_{assets} d_{ia} w_{ia} \tag{18}$$

where $d_{ia}$is the implicit depreciation rate on asset class $a$ for bank $i$ and $w_{ia}$ is the share of assets of class $a$ held by bank $i$. This is calculated using data from the 16 Malaysian and Bahraini, Islamic and conventional banks which include sufficiently detailed depreciation data in their anmual reports. There is no obvious difference in depreciation rates across assets across different countries or banks.[6] Corporate tax data and information are obtained from KPMG (2002; 2007; 2011). Note, though, that there is no corporate tax applicable to banking in Bahrain. For an interest rate, the mortgage loan interest rate is used for Bahrain. As this rate is unavailable for Malaysia, we use the base lending rate as it is relevant for asset purchases. Both interest rates are gathered from the central bank of each country. For simplicity, we estimate the lease life to be 10 years.

[6]See Appendix 4.3 of Ahmad (2013) for more details.

Table 1 Data: Definitions

| Variables | Notation | Definition |
|---|---|---|
| *Dependant Variable:* | | |
| Output | $Y$ | Total loans, consisting of short-term and long-term loans |
| *Explanatory Variables:* | | |
| Labour | $l$ | Total expenditure on employees (personnel expenses) |
| Capital | $k$ | Fixed Assets (sum of physical capital and premises) |
| Investment | $i$ | Change in Gross Fixed Assets as calculated in equation (16) |
| Specialisation | SD | Dummy variable equals 1 if the bank is Islamic or mixed, 0 otherwise |

Sources: Values obtained from bank financial statements reported in Bankscope.

Specialisation, entry and exit dates obtained from bank websites.

Table 2 Descriptive Statistics

| Group | N | Mean | Min. | Median | Max. | Sd | CV | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|
| *Conventional* | | | | | | | | | |
| Loans | 495 | 3.33 | 0.01 | 1.2 | 41 | 5.22 | 1.6 | 3.2 | 16.6 |
| Capital | 495 | 0.05 | 0.0001 | 0.02 | 0.51 | 0.09 | 1.6 | 3 | 13.2 |
| Labour | 495 | 0.04 | 0.0001 | 0.02 | 0.51 | 0.06 | 1.5 | 3.2 | 17.1 |
| Investment | 452 | 0.004 | -0.06 | 0.0003 | 0.17 | 0.02 | 5.1 | 5.1 | 42.9 |
| Total Assets | 495 | 6.03 | 0.04 | 2.4 | 80 | 9.09 | 1.5 | 3.4 | 19.9 |
| *Islamic* | | | | | | | | | |
| Loans | 144 | 0.9 | 0.001 | 0.33 | 10 | 1.54 | 1.7 | 3.5 | 17.4 |
| Capital | 144 | 0.04 | 0.0001 | 0.01 | 0.3 | 0.06 | 1.5 | 2.4 | 9.3 |
| Labour | 144 | 0.02 | 0.0003 | 0.01 | 0.2 | 0.04 | 1.4 | 2.8 | 11.3 |
| Investment | 125 | 0.004 | -0.27 | 0.002 | 0.08 | 0.03 | 6.7 | -6 | 61.5 |
| Total Assets | 144 | 2.03 | 0.02 | 1 | 16 | 2.71 | 1.3 | 2.4 | 9.8 |
| *Mixed* | | | | | | | | | |
| Loans | 59 | 19.4 | 0.46 | 13 | 99 | 18.7 | 1.0 | 2.2 | 8.2 |
| Capital | 59 | 0.24 | 0.0001 | 0.16 | 1 | 0.21 | 0.8 | 1.5 | 5.0 |
| Labour | 59 | 0.23 | 0.001 | 0.14 | 1.2 | 0.22 | 1.0 | 2.3 | 8.9 |
| Investment | 58 | 0.02 | -0.04 | 0.004 | 0.35 | 0.06 | 2.9 | 4.1 | 23.6 |
| Total Assets | 59 | 31.1 | 0.61 | 22 | 130 | 26.7 | 0.9 | 1.8 | 6.0 |
| *Total* | | | | | | | | | |
| Loans | 698 | 4.19 | 0.001 | 1.2 | 99 | 8.45 | 2.0 | 5.1 | 40.9 |
| Capital | 698 | 0.07 | 0.0001 | 0.02 | 1.0 | 0.11 | 1.7 | 3.3 | 17.6 |
| Labour | 698 | 0.05 | 0.0001 | 0.02 | 1.2 | 0.1 | 1.9 | 5.3 | 44.8 |
| Investment | 635 | 0.01 | -0.27 | 0.001 | 0.35 | 0.03 | 5.1 | 3.5 | 71.8 |
| Total Assets | 698 | 7.32 | 0.02 | 2.4 | 130 | 13.2 | 1.8 | 4.2 | 27.4 |

Table 3: Correlation coefficients between Investment and Output

| Sample | Loans | Loans (t-1) | Loans Growth |
|---|---|---|---|
| Malaysia-Bahrain | 0.40 | 0.34 | 0.13 |
| Malaysia | 0.48 | 0.42 | 0.21 |
| Bahrain | 0.30 | 0.19 | 0.24 |
| Conventional Banks | 0.19 | 0.14 | 0.19 |
| Islamic Banks | 0.48 | 0.47 | 0.21 |

All correlation coefficients are significant at 1%. Two outliers were dropped from Malaysian and Bahrain sample for loans growth.

Table 4 Production Function Estimates: OLS and Fixed Effects

| | Variable | Malaysia-Bahrain | Malaysia | Bahrain | Conventional | Islamic |
|---|---|---|---|---|---|---|
| OLS | Capital | 0.29*** | 0.36*** | 0.13** | 0.18*** | 0.43*** |
| | | (6.45) | (7.47) | (1.70) | (4.11) | (4.46) |
| | Labour | 0.78*** | 0.72*** | 0.71*** | 0.87*** | 0.68*** |
| | | (14.74) | (12.93) | (7.30) | (16.08) | (6.25) |
| | Islamic | -0.66*** | -0.22** | -1.06*** | | |
| | | (-8.42) | (-2.40) | (-7.07) | | |
| | Constant | 3.57*** | 3.45*** | 5.60*** | 3.75*** | 2.37*** |
| | | (15.13) | (14.46) | (10.91) | (16.91) | (4.17) |
| | $R^2$ | 0.76 | 0.84 | 0.60 | 0.83 | 0.68 |
| Fixed Effects | Capital | 0.01 | 0.13*** | -0.06 | 0.08** | -0.09* |
| | | (0.18) | (2.62) | (-1.18) | (1.99) | (1.40) |
| | Labour | 0.76*** | 0.72*** | 0.79*** | 0.81*** | 0.82*** |
| | | (18.78) | (15.00) | (10.32) | (17.51) | (8.62) |
| | Islamic | 0.30*** | 0.23*** | n.a.# | | |
| | | (3.83) | (2.97) | | | |
| | Constant | 6.26*** | 5.68*** | 6.10*** | 5.31*** | 6.42*** |
| | | (21.78) | (13.31) | (13.15) | (16.67) | (9.8) |
| | $R^2$ | 0.57 | 0.60 | 0.54 | 0.63 | 0.44 |
| N | | 691 | 467 | 224 | 491 | 200 |

t-statistics in parentheses

Notes: 1% significance level:***; 5% significance level:**; 10% significance level:*

#: Unable to estimate a coefficient for group dummy because of insufficient variation.

Table 5 Production Function Estimates: Olley-Pakes and Ackerberg-Caves-Frazer

| | Variable | Malaysia-Bahrain | Malaysia | Bahrain | Conventional | Islamic |
|---|---|---|---|---|---|---|
| OP | Capital | 0.02 | 0.14 | -0.15 | 0.16 | -0.11 |
| | | (0.18) | (0.72) | (-1.21) | (1.38) | (-0.54) |
| | Labour | 0.68*** | 0.65*** | 0.68*** | 0.86*** | 0.50*** |
| | | (4.84) | (2.90) | (4.26) | (6.23) | (2.68) |
| | Islamic | -0.61*** | -0.25 | -0.89*** | | |
| | | (-5.69) | (-1.19) | (-4.59) | | |
| | Average Productivity | | | | 4.06 | 9.92 |
| | Standard Error | | | | (0.68) | (1.79) |
| ACF: | Capital | 0.35*** | 0.43*** | 0.14 | 0.15 | 0.52** |
| | | 2.61 | 2.81 | 0.86 | 1.05 | 2.29 |
| | Labour | 0.74*** | 0.62*** | 1.03*** | 0.93*** | 0.68*** |
| | | 4.20 | 3.59 | 3.30 | 6.88 | 2.54 |
| | Islamic | -0.55** | -0.01 | -1.04 | | |
| | | -2.39 | -0.04 | -0.74 | | |
| | Constant | 5.17** | -4.60 | 5.17 | 3.65 | 1.81 |
| | | 2.05 | -0.22 | 0.27 | 0.42 | 1.33 |
| N | | 628 | 432 | 196 | 448 | 180 |

t-statistics in parentheses

Notes: 1% significance level:***; 5% significance level:**; 10% significance level:*

Table 6: Descriptive Statistics: Total Factor Productivity

| | | | OLS | | FE | | OP | | ACF | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Malaysia and Bahrain | Conventional | 491 | 3.6 | 0.7 | 6.5 | 0.8 | 7.1 | 0.9 | 3.3 | 0.7 |
| | Islamic & Mixed | 200 | 2.9 | 1.4 | 6.0 | 1.5 | 6.8 | 1.5 | 2.7 | 1.2 |
| | Islamic | 141 | 2.6 | 1.4 | 5.4 | 1.4 | 6.1 | 1.3 | 2.4 | 1.3 |
| | Mixed | 59 | 3.8 | 0.6 | 7.4 | 0.6 | 8.1 | 0.5 | 3.4 | 0.5 |
| Malaysia | Conventional | 376 | 3.5 | 0.7 | 5.7 | 0.8 | 6.2 | 0.8 | 3.8 | 0.7 |
| | Islamic & Mixed | 91 | 3.2 | 0.9 | 5.8 | 1.0 | 6.5 | 1.0 | 3.6 | 0.9 |
| | Islamic | 38 | 2.8 | 1.0 | 5.1 | 1.1 | 5.7 | 1.1 | 3.1 | 1.1 |
| | Mixed | 53 | 3.6 | 0.5 | 6.4 | 0.5 | 7.0 | 0.5 | 4.0 | 0.4 |
| | All | 467 | 3.4 | 0.7 | 5.7 | 0.8 | 6.3 | 0.9 | 3.8 | 0.7 |
| Bahrain | Conventional | 115 | 5.6 | 0.6 | 6.6 | 0.6 | 8.5 | 0.8 | 2.5 | 0.6 |
| | Islamic & Mixed | 109 | 4.5 | 1.5 | 5.5 | 1.5 | 7.6 | 1.4 | 1.6 | 1.4 |
| | Islamic | 103 | 4.4 | 1.5 | 5.5 | 1.5 | 7.5 | 1.4 | 1.5 | 1.5 |
| | Mixed | 6 | 6.2 | 0.4 | 7.3 | 0.1 | 9.6 | 0.1 | 2.0 | 0.1 |
| | All | 224 | 5.1 | 1.2 | 6.1 | 1.3 | 8.1 | 1.2 | 2.1 | 1.2 |
| Conventional Banks | All | 491 | 3.7 | 0.7 | 5.3 | 0.7 | 4.1 | 0.7 | 3.4 | 0.7 |
| | Malaysia | 376 | 3.8 | 0.7 | 5.4 | 0.7 | 4.1 | 0.7 | 3.4 | 0.7 |
| | Bahrain | 115 | 3.7 | 0.6 | 5.2 | 0.6 | 4.0 | 0.6 | 3.4 | 0.6 |
| Islamic & Mixed Banks | All | 200 | 2.4 | 1.3 | 6.4 | 1.6 | 9.9 | 1.8 | 1.6 | 1.2 |
| | Malaysia | 91 | 2.8 | 0.8 | 7.4 | 1.1 | 11.0 | 1.4 | 1.9 | 0.8 |
| | Bahrain | 109 | 2.0 | 1.6 | 5.6 | 1.5 | 8.9 | 1.5 | 1.3 | 1.5 |

Table 7: Productivity Growth by Type of Bank

| | TFP | | TFP Growth (%) | |
|---|---|---|---|---|
| Type of Bank | OP | ACF | OP | ACF |
| Malaysian Conventional Banks | 6.32 | 3.88 | -0.13 | 0.06 |
| N | 218 | | 192 | |
| Malaysian Islamic Banks | 5.95 | 3.31 | 0.60 | 1.03 |
| N | 36 | | 31 | |
| Malaysian Mixed (Before) | 6.67 | 3.88 | 0.19 | -0.17 |
| N | 125 | | 113 | |
| Malaysian Mixed (After) | 6.87 | 3.89 | 0.87 | 1.30 |
| N | 53 | | | |
| Bahrain Conventional Banks | 8.46 | 2.31 | 0.69 | 0.38 |
| N | 105 | | 93 | |
| Bahrain Islamic Banks | 7.72 | 1.89 | 1.04 | -2.24 |
| N | 86 | | 69 | |

These results are from the Malaysian and Bahrain samples

Table 8: Malaysian Mixed Banks

| | | TFP | | | | TFP Growth | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | OP | | ACF | | OP | | ACF | |
| | | CB | Mix | CB | Mix | CB | Mix | CB | Mix |
| Affin Bank | Median | 6.54 | 6.64 | 3.65 | 3.81 | -0.51 | 1.25 | -2.64 | 2.40 |
| | N | 11 | 5 | 11 | 5 | 10 | 5 | 10 | 5 |
| Alliance Bank Malaysia | Median | 6.55 | 6.50 | 3.98 | 3.67 | -0.59 | 1.81 | -1.15 | 3.62 |
| | N | 13 | 4 | 13 | 4 | 12 | 4 | 12 | 4 |
| AmBank (M) | Median | 7.16 | 7.42 | 4.32 | 4.31 | -0.83 | -0.30 | -3.10 | -0.85 |
| | N | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 5 |
| CIMB Bank | Median | 6.89 | 6.87 | 4.13 | 3.60 | 0.64 | -0.08 | 0.44 | -0.38 |
| | N | 10 | 6 | 10 | 6 | 9 | 6 | 9 | 6 |
| EON Bank | Median | 6.56 | 6.89 | 4.03 | 4.10 | -0.22 | -0.45 | 0.07 | -0.88 |
| | N | 12 | 4 | 12 | 4 | 11 | 4 | 11 | 4 |
| HSBC Bank Malaysia | Median | 6.41 | 6.60 | 3.52 | 3.70 | 0.78 | 3.05 | 1.85 | 4.56 |
| | N | 13 | 3 | 13 | 3 | 12 | 3 | 12 | 3 |
| Hong Leong Bank | Median | 6.55 | 6.87 | 3.74 | 3.91 | -0.03 | 0.53 | -0.19 | 0.10 |
| | N | 9 | 6 | 9 | 6 | 8 | 6 | 8 | 6 |
| Malayan Banking | Median | 7.02 | 7.25 | 3.80 | 3.89 | 0.27 | 0.76 | 0.13 | -0.003 |
| | N | 11 | 4 | 11 | 4 | 10 | 4 | 10 | 4 |
| OCBC Bank (Malaysia) | Median | 6.89 | 7.05 | 4.14 | 4.22 | -0.42 | 0.83 | -0.44 | 0.54 |
| | N | 14 | 3 | 14 | 3 | 13 | 3 | 13 | 3 |

Continued over the page

Table 8 continued: Malaysian Mixed Banks

| | | TFP | | | | TFP Growth | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | OP | | ACF | | OP | | ACF | |
| | | CB | Mix | CB | Mix | CB | Mix | CB | Mix |
| Public Bank | Median | 6.42 | 7.32 | 3.12 | 4.06 | 0.49 | 1.19 | 0.86 | 2.26 |
| | N | 12 | 4 | 12 | 4 | 11 | 4 | 11 | 4 |
| RHB Bank | Median | 6.93 | 6.86 | 3.93 | 3.75 | -0.75 | 1.30 | -2.47 | 1.79 |
| | N | 9 | 6 | 9 | 6 | 8 | 6 | 8 | 6 |
| Standard Chartered Malaysia | Median | 6.74 | 6.84 | 4.02 | 4.13 | 0.68 | 2.58 | 1.38 | 4.38 |
| | N | 6 | 3 | 6 | 3 | 5 | 3 | 5 | 3 |
| Total | Median | 6.67 | 6.87 | 3.88 | 3.89 | 0.19 | 0.87 | -0.17 | 1.30 |
| | N | 125 | 53 | 125 | 53 | 113 | 53 | 113 | 53 |

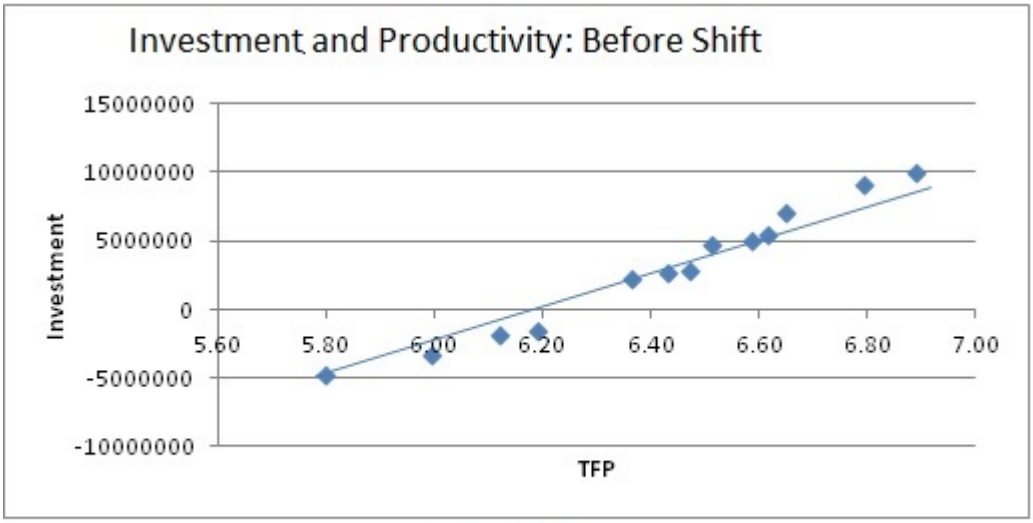


Figure One

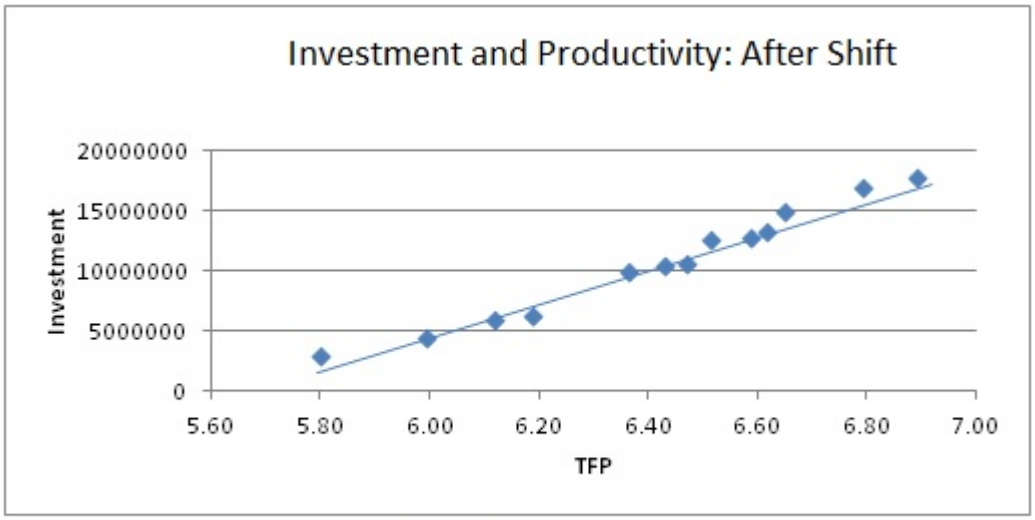
Investment and Productivity: After Shift
20000000
15000000
10000000
5000000
0
Investment
5.60
5.80
6.00
6.20
6.40
6.60
6.80
7.00
TFP

Figure Two