Financial Development in Arab Countries

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Contents

Forward

Financial sector constitutes a large and growing sector in all economies whereby all branches of economic activity today are fundamentally dependant on access to financial services. Accordingly, the Islamic Research and Training Institute (IRTI) have pursued an active research agenda in this field. In collaboration with other research and policy-oriented institutions in Muslim countries, IRTI has organized several conferences, seminars and orientation courses in the area of Islamic finance.

This book includes selected papers presented at the International conference on Financial Development in Arab Countries, held in Abu Dhabi, during 31 March – 2 April 2003, in collaboration with the College of Business and Economics, University of United Arab Emirates. The book provides fruitful policy recommendations on various financial development issues in the Arab world such as operational efficiency and service quality in banking. It also examines different aspects related to stock markets development such as efficiency, volatility, hedging, and returns. The book should be useful for policy-makers and research students alike.

The opinions expressed in the book reflect the views of the authors which do not necessarily reflect the opinion and view of IRTI and IDB.

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Part One

Banking Sector Performance in Arab Countries

CHAPTER ONE

Introduction

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Financial services are the backbone of modern economies. Financial services constitute a large and growing sector in all economies, developed or developing, alike. All branches of economic activity today are fundamentally dependant on access to financial services. Financial sector fulfils essential functions in intermediating between savers and investors, financing private sector trade and investment, and helping to ensure that the economy's financial resources are allocated effectively.

The relationship between finance and economic growth has received considerable attention in recent theoretical and empirical literature.[1] McKinnon (1973) and Shaw (1973) argue that financial development is a pre-requisite for economic growth. They also point out that financial development can affect growth rate positively through its influence on saving and investment. The endogenous growth models, for example Bencivenga and Smith 1991, Greenwood and Jovanovic 1991, and King and Levine 1993, provide additional theoretical support to the relationship between financial development and economic performance. These models assume that financial intermediaries provide the economy with various sorts of services, such as reducing investment risks (liquidity and productivity risks), collecting information to evaluate alternative investments, and offering better share diversification. Such financial services improve the efficiency of investment and its volume. Endogenous growth models assume that the level of investment and productivity growth are the channels of transmission from financial intermediation to economic growth. A healthy and stable financial system, underpinned by sound macroeconomic management and prudential regulations, is essential for sustained growth.

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[1] A comprehensive survey on the relationship between financial development and economic growth can be found in Levine (1997).

Numerous empirical studies deal with different aspects of the relationship between finance and economic growth and found a strong evidence to support the causal relationship between financial development and growth (see for example, King and Levine, 1993; Demetriades and Hussein, 1996; Khan and Senhadji, 2000).

1. Financial Development in Arab Countries

Prior to financial reform in Arab countries, the degree of monetisation differed significantly among these countries. Financial sector was market oriented in Morocco and Lebanon, while it was heavily regulated and repressed in many other Arab countries. Financial repression was mainly in the form of interest rate ceilings, credit allocation by the government and setting high reserve requirements. With the exception of Lebanon and the GCC countries, interest rates were controlled by the monetary authority in most of the Arab countries in the 1980s and early 1990s (Elhag et al, 2000). Interest rate was kept negative in real terms which caused financial disintermediation and small savers used to direct their surplus outside the formal financial sector. Prior to the implementation of the financial liberalisation policies, banks were obliged to make loans to state enterprises in many Arab countries such as Algeria, Egypt, Jordan, and Tunisia (Nigel et al, 1996). Furthermore, in most Arab countries banking sectors were generally not competitive and the range of financial services available to customers were narrow whereby the maturity and yield structure was not related to risk and liquidity (Elhag et al, 2000).

The extent of financial reform has varied among Arab countries in speed and depth. The GCC made significant progress in building a modern financial infrastructure during the 1970s and 1980s. The sharp increase in oil revenues was intermediated by GCC financial institutions and till early 1990s the GCC nations were net providers of savings to the rest of the world. GCC financial institutions were mainly dealing with short-term lending to trade, and construction sectors (Jbili et al, 1997). It was till 1990s when the process of rapid financial development and integration with international financial markets started to take place. After the first Gulf war, banks increased their capital, strengthened deposit base, and improved productivity by implementing new technology. Furthermore, monetary authorities have strengthened prudential regulations and bank supervision in all GCC countries.

The GCC countries have already completed most of the crucial stages of financial development (Jbili et al, 1997). On the other hand, competition remains relatively limited in many GCC countries, with restrictions applying to bank licensing and foreign participation. On the other hand, a key challenge facing the financial sector in GCC countries is to respond to the new demand arising from the greater role of the private sector where private enterprises are expected to be the main engine of growth. Large investment projects have to be carried out with private sector participation and financing. Therefore, there will be strong incentives to mobilise resources from domestic market and to encourage foreign direct investment. Domestic financial intermediation is under pressure to compete for this large business.

Over the 1990s, several Arab countries (such as Algeria, Djibouti, Egypt, Jordan, Morocco, Sudan, Tunisia, and Yemen) made substantial progress in financial reform as part of extensive economic reform and structural adjustment programmes. The reform aimed at transforming the economy into a market-driven economy dominated by the private sector, improve the capacity of financial institutions to mobilise domestic savings, improve the effectiveness of monetary policy, and strengthen financial soundness.

The design, sequence and speed of financial reforms varied across Arab countries. Many Arab countries adopted indirect (market-based) monetary policies such as open markets operations. In 1999, Libya and Syria are the only Arab countries that entirely rely on direct instruments to conduct monetary policy. Most of the other Arab countries waived preferential interest rates and credit ceilings (Elhag et al, 2000).

In many Arab countries, such as Algeria, Egypt, Libya, Sudan, Syria, and Tunisia, public banks continue to dominate the financial sector whereby domestic credit is not allocated in terms of the expected productivity of the potential investment, thus a large ratio of nonperforming loans is accumulated (Elhag et al, 2000).

In a recent study by Creane et al (2003) of the IMF where a comprehensive index of 36 financial indicators was established, Arab countries has been divided into three groups according to the level of financial development they have achieved so far. The GCC countries, Lebanon and Jordan have been classified in the high level of financial development category. Algeria, Djibouti, Egypt, Mauritania and Morocco have been placed in the medium level of financial development category. The low financial development group includes Libya, Sudan, Syria, and Yemen.

Bashir and Hassan (2003) argue that the outcome differed across countries due to different commitments to implementations of reforms. In addition, when financial reforms began, the pre-requisites (i.e. low inflation, stable exchange rate, and effective monetary policy) for successful reform were not available in all Arab countries. While the process of financial reform is still under way, to date there has been no financial crisis in any of the Arab countries .

During the past three decades, Islamic banking has grown rapidly in the region especially in Sudan and Bahrain. Since 1992 the financial sector in Sudan is built entirely on Islamic principles and any financial transaction that is not compatible to *Shariah* is not allowed. Bahrain is the host of the largest concentration of Islamic banks in the region. Since 1979, Islamic financial institutions have grown considerably in Bahrain, the consolidated balance sheet of Islamic banks has shown total assets of $8.4 bn in December 2001. Islamic banks complement the activities and operations of other traditional financial institutions, they provide a variety of financial products ranging from traditional Islamic modes of finance such as mudaraba, murabaha, leasing and musharaka to Islamic syndicated finance and collective investment funds.

In the early 1990s, many GCC commercial banks started Islamic banking operations. A number of new Islamic investment funds have been launched to manage wide-ranging portfolio of shares in companies whose activities are compatible with Islamic principles.

Islamic financial institutions have not yet sufficiently benefited from their potential in assets creation, especially in the area of Islamic financial instruments. The modes of Islamic finance are sufficiently rich to be used as a basis for financial innovation in the areas of fund raising and investment. Furthermore, Islamic banks need to pay more attention to their asset and liability composition, acquire the necessary expertise in financial engineering, and cooperate in establishing settlement mechanisms and rating agencies. Islamic financial institutions should also make more use of information technology in its financial operations. They must reorient their size and operations for higher efficiency in order to face more local competitors. Governments can assist through providing the proper investment climate, regulatory and supervisory environment.

2. Where do Arab Financial sectors stand?

While there are sharp differences in the level of financial development between the Arab countries, the financial sector still plays a smaller role in the Arab economies compared to their counterparts in emerging market economies. Furthermore, the Arab financial sectors are mainly dominated by banks whereby much of the financial progress was in the banking sector while stock markets remain underdeveloped (World Bank, 2003).

2.1 Banking and Non-Banking Financial Institutions

Although Arab banks have recently shown significant growth, the size of the whole Arab banks remains quite small in comparison to those in Europe and the United States. According to end of December 2002 figures published by *the Middle East* in October 2003, only six Arab banks[2] have assets exceeding $20 billion, which compares poorly to the leading banks in the world. Furthermore, the total capital of the top 100 Arab banks stand at $50.25 billion which is less than the capital of Citigroup ($92.9).

[2] The five Arab banks are National Commercial Bank in Saudi Arabia, Arab Banking Corporation in Bahrain, Saudi American Bank in Saudi Arabia, Arab Bank in Jordan, the National Bank of Egypt, and Commercial Bank of Syria. [see Table 5 for more details]

Table (1): Geographical distribution of capital and assets of Arab banks at beginning of 2001

	Assets	**%**	**Capital**	**%**
Bahrain	57,953	10.33	5,939	12.48
Kuwait	60,956	10.86	6,170	12.97
Oman	8,238	1.47	910	1.91
Qatar	10,785	1.92	1,465	3.08
Saudi Arabia	121,549	21.66	12,144	25.52
UAE	50,318	8.97	6,820	14.33
GCC	**309,799**	**55.21**	**33,448**	**70.29**
Algeria	17,889	3.19	760	1.60
Egypt	78,289	13.95	4,560	9.58
Jordan	26,476	4.72	2,207	4.64
Lebanon	27,416	4.89	1,720	3.61
Libya	16,870	3.01	1,241	2.61
Morocco	20,249	3.61	2,005	4.21
Syria	55,668	9.92	738	1.55
Tunisia	8,440	1.50	907	1.91
Non-GCC	**251,297**	**44.79**	**14,138**	**29.71**

Source: Arab Banking & Finance, 2002-2003

Note:
Assets and capital are in $ million.
The Arab Banking and Finance only includes data for fourteen Arab countries as listed in Table 1.

There is a misallocation of financial resources among the Arab banking institutions. Arab Banking & Finance report (2002-2003) shows that the GCC-based banks hold 70% of total capitalisation and 55% of assets in the Arab world. On the other hand, non-GCC Arab banks have 30% of total capitalisation and 45% of total assets. These figures contrast with the population composition where the GCC and the other non-GCC count for 11% and 89%, respectively. Saudi Arabia has the largest banking sector in the region, accounting for almost a quarter of the Arab banking market in terms of total capital and assets. In Egypt, UAE, Bahrain and Kuwait, the size of the banking sector accounts for around one-tenth of the total Arab banking sector. The Tunisian and Omani banking sectors are the smallest in the region, accounting for less than 2% of total capitalisation and total assets.

Table (2): The Top Arab Banks, 31-12- 2002

	Capital	Assets	CAR%	Profits	ROE%	ROA %
1.National Commercial Bank (KSA)	2,381	28,480	8.3	650	27.3	2.3
2. Saudi American Bank	2,339	20,390	11.4	496	21.2	2.4
3. Arab Banking Corporation (Bahrain)	2,195	29,313	7.5	16	0.7	0.05
4. Riyad Bank	2,164	17,946	12.0	378	17.4	2.1
5. Arab Bank (Jordan)	2,096	22,793	9.2	294	14	1.3
6. Al Rajhi Banking & Invest. Corp (KSA)	1,826	15,785	11.5	377	20.6	2.4
7. National Bank of Kuwait	1,470	17,605	8.3	376	25.5	2.1
8. Qatar National Bank	1,368	8,532	16.0	159	11.6	1.8
9. Gulf International Bank (Bahrain)	1,270	16,236	7.8	86	6.7	0.5
10. Banque Saudi Fransi	1,269	11,939	10.6	271	21.3	2.6
11. Gulf Investment Corporation (Kuwait)	1,178	5,805	20.3	90	7.6	1.5
12. Emirates Bank International	1,177	7,411	15.9	166	14.1	2.2
13. National Bank of Dubai	1,174	9,575	12.2	155	13.2	1.6
14.Saudi British Bank	1,142	12,344	9.2	260	22.7	2.1
15. Abu Dhabi Commercial Bank	1,112	7,538	14.7	160	14.4	2.1
16. Investcorp Bank (Bahrain)	1.040	4,112	25.3	-8	-0.8	-0.2
17. National Bank of Abu Dhabi	980	10,632	9.2	180	18.3	1.7
18. Arab National Bank (KSA)	952	11,829	8.0	156	16.3	1.3
19. National Bank of Egypt	948	24,694	3.8	90	9.5	0.3
20. Mashreqbank	862	6,449	13.3	145	16.8	2.2

Source: The Middle East, October 2003

Notes:
NCB = National Commercial Bank
ARBIC = Al Rajhi Banking & Investment Corporation
CAR = Capital adequacy ratio (%)
ROE = Returns on equity (capital); ROA = Return on assets
1 = Bank for International Settlements capital ratio
2 = NPLs (Non-performing loans)
Profits = Net of tax, and before dividend distribution, or allocation to reserves

The list of the top 100 Arab banks is dominated by the six GCC countries where 58 GCC banks are included. The 58 GCC banks account for 70% of the capital and 55% of the combined assets in the top 100 banks list. Furthermore, Saudi Arabian banks dominate the top 100 Arab banks, accounting for 25.5% of the total capital, followed by Kuwait and UAE with 14% each, then Bahrain with 12.5%.

On the top 100 banks, 76 banks have met the minimum capital adequacy ratio (CAR) of 8% set by the Bank of International Settlements (BIS). Eight banks have placed with CAR exceeding 20%. Siddiqi (2002) points out that due to the fact that most GCC banks rely on short-term deposits to finance their loans, they exceed the BIS 8% capital adequacy ratio. For instance, the average CAR is 18% in Bahrain, 11% in Kuwait, 19.3% in UAE and 10.4% in Saudi Arabia. Return on assets varied across the top 100 Arab banks, ranging from -5.3% in Bahrain International Bank to 3.9% in the National Bank of Umm Al-Qaiwain (UAE).

The performance of the Arab banks has recently been affected by the slowdown in economic activities caused by the decline in oil prices in 1998 and the first quarter of 1999. Arab banks have also been affected by the global exposure of the Asian financial crisis. From mid-1999, the higher oil prices together with the banks' structural adjustment programmes led to healthy returns. For example, the net income of the top 100 Arab banks has risen by 10.2%. The cost to income ratio, which is an indicator of efficiency, shows that the Middle East banks have a lower cost/income ratio of 48.17%, compared to 81.5% in Japan and 60.2% in the US. The total profits of Arab banks rose by 12% to $9.3 bn in 2000. The total assets of banking sector in the region grew faster than the average GDP growth. For example, assets increased by 4.2 and 9% (to $574 bn) in 1999 and 2000, while the average growth rate stood at 3% (Jordan Times, 2001a).

The banking sector's concentration ratios are relatively high. For example, in Egypt the four largest public banks control 50% of total financial assets. The Saudi American Bank and the National Commercial Bank in Saudi Arabia hold about 50% of the banking assets. In Jordan, the top 5 banks have 80% of the financial assets. Both the National Bank of Bahrain and the National Bank of Kuwait control 30% of the financial assets in their respective countries (MECG, Sept/Oct 2000).

The GCC banking sector has recently experienced a sharp increase in consumers' credit. In some countries, the share of personal credit has reached 30 percent of total credit (Jbili et al, 1997). The major problem that affects GCC banking performance is the changes in oil prices. GCC banking performance is highly related with oil prices. An increase in government expenditure, due to rise in oil prices, leads to greater economic activities and therefore more financial transactions in the Gulf region.

GCC banks are well ahead of their North African counterparts. In North Africa, banking performance is hindered by the oligopolistic structure of the banking sector. There is a small number of banks characterised by segmentation of activities. Egypt has uncompetitive banking system where the state-owned banks still control 70% of bank assets. As for the private banks, they prefer short-term commercial lending to large and medium private enterprises. However, the majority of small and medium business enterprises do not have access to banking finance because of the oligopolistic structure of the Egyptian banking sector. Egypt has implemented a wide scale of financial reforms in the 1990s.[3] The financial reforms have been successful till the last two years when the Egyptian financial institutions were hit by economic slowdown and liquidity crisis. The profitability of the largest four (state-owned) banks is undermined by high levels of bad debts and provision charges. Currently, the privately owned Commercial International Bank is the most efficient and profitable bank in Egypt with a well-diversified portfolio (Siddiqi, 2002). Roe (1998) argues that the transformation of the Egyptian financial sector into a modern market-oriented system is still in its infancy.

Morocco, Tunisia and Algeria have made significant progression establishing a sound and market-based financial system. Since the mid-80's, wide-ranging measures have been taken to reform the banking sectors in the three countries. Like Egypt, the banking sectors in the three Maghreb countries are less competitive and some banks still require restructuring in order to foster their financial soundness. So Far, the banking sectors in all three countries are way behind emerging markets in

[3] In Egypt, controls on interest rates were lifted from early 1992, ceilings on bank lending were abolished in the same year, and privatisation of government's stake in the 23 joint-venture banks was gradually implemented.

terms of depth, efficiency and dynamism. Further strengthening of the banking system and development of financial instruments are still required. Jbili (1997) argues that in the Maghreb countries greater attention should be given to financing small and medium-sized enterprises where rural areas lag behind the urban areas in terms of access to bank financing.

Few Arab countries have introduced pension funds, mortgage institutions and insurance companies. The World Bank report on Middle East and North Africa financial sector development argues that the coverage of pension plans in terms of the portion of the working population is less than 20% in some Arab countries. Where pension systems exist in the Arab region, they are "too generous". They replace about 80% of salaries, with yearly accrual rates approaching 2% per year of service. They also usually impose high payroll taxes on contributors, with a negative effect on labour market participation. Furthermore, the World Bank argues that demographic projections in most Arab countries are gloomy whereby present pension arrangement are financially unsustainable and will generate large and increasing deficits over the next few decades.

The World Bank reports that housing finance varies from less than 1% of GDP to 8% among Arab countries. In the past, state-owned housing banks have been the main provider of housing finance which have been constrained by limited resources and used to offer below market rate lending, therefore discouraging market-based financial institutions from entering the housing finance market. Currently Arab countries are reforming their housing finance policies and moving towards more market-based markets.

2.2 Stock Markets

Although the capitalization of the Arab Stock markets (ASM) has almost tripled between 1994 and 2002, Arab bourses are still quite small compared to their counterparts in emerging and developing markets. The total capitalization of the 12 Arab bourses[4] has reached $209 billion at the end of 2002 which means that the Arab

[4] The 12 ASM are listed in Table (3).

markets account for only 0.6% of the world's total stock market capitalization. Even by developing countries standards, Arab stock exchanges are thin. The total Arab stock markets capitalization accounts for 6.8% of the developing countries' markets. Non of the Arab bourses is located on the emerging markets map except the Egyptian bourse.[5] Table (1) shows that even individual emerging markets such as Brazil, Taiwan and South Africa are larger than all Arab bourses together. The market capitalization of the Mexican stock market is almost equal to total market capitalization of all Arab bourses.

Table (3): Market Capitalisation

(in Million Dollars)

	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Arab Markets	72.5	84.6	107.8	145.2	123	149.4	148.2	152.2
Mexico	130.2	90.7	106.5	156.6	91.7	154	125.2	126.6
Malaysia	199.3	222.7	307.2	93.6	98.6	145.4	116.9	118.9
South Africa	225.7	280.5	241.6	232.1	170.3	262.5	205	88.4
Taiwan	247.3	187.2	273.6	287.8	260	375.9	---	---
Brazil	189.3	147.6	216.9	255.5	160.9	227.9	226.2	186.2
China	43.5	42.1	113.8	206.4	231.3	330.7	581	523.9

Sources: (1) Arab Financial Markets Database, Arab Monetary Fund.
(2) World Development Indicators, World Bank, 2003.

The structure of the Arab stock markets is different from the emerging ones. While banking, insurance and real estate companies account for 24% of the market capitalisation in the emerging economies, they stood at 60% of the total capitalisation of the Arab stock markets. Less than 15% of the market capitalisation is in manufacturing, compared to 36% in the emerging markets. Governments are still

[5] The Egyptian market has been included in Morgan Stanley Emerging Markets Index in 2001.

major shareholders in the Arab bourses with an estimated 40% share of total capitalization (Azzam, 2000).

Table (4) shows that between 1994 and 2002, the total number of registered companies in the largest 12 Arab bourses has increased by 68%, the value of shares traded has remarkably grown by 522%, and the number of shares traded has peaked by 1363%. These healthy figures are the results of a series of technical and legal upgrades that Arab stock exchanges have introduced in the 1990s.

If the Egyptian stock market, which has 1150 registered companies, is excluded, Arab bourses have an average of 41 companies, compared to 900 and 519 in Western bourses and emerging markets, respectively (see Bakheet, 2002). Two factors may explain the small number of registered companies in the Arab stock markets: First, many of the Arab economies are still dominated by the public sector. Second, some Arab economies are dominated by family enterprises which are not open to the public.

Table (4) also shows that the turnover ratio, as the ratio of value of shares traded as percentage of market capitalization, has increased from 14.5% to 43.9% between 1994 and 1997 before declining to 29% in 1998 and reached 31% by end of 2002. The turnover ratio of the Arab bourses is quite low compared to emerging markets where the turnover ratio stands at 88%. The low turnover ratio reflects a serious illiquidity problem in the Arab bourses. Al-Sharrah (2000) argues that the low turnover ratio in the Gulf stock markets is due to the fact that a great part of financial transactions takes place in the informal markets especially in UAE and Qatar. He also points out that, in the Gulf region, the performance of the stock markets is highly related to the oil prices.

Table (4): Arab Stock Markets between 1994-2002

(million US$)

	1994	1995	1996	1997	1998	1999	2000	2001	2002
Market capitalisation	72,523.66	84,564.83	107,766.47	145,186.91	122,971.53	149,400.43	148,158.37	152,230.05	208,858.11
Value of shares traded	10,513.17	14,988.24	30,529.62	63,894.75	35,536.37	35,594.16	36,538.93	42,687.85	65,400.09
Number of shares traded	3,150,05	9,590.30	26,621.45	35,856.03	15,837.26	11,865.52	9,073.07	23,522.53	46,086.29
Number of companies	1,089	1,081	1, 100	1,184	1,446	1,634	1,678	1,687	1,826
Turnover ratio	14.49	17.71	28.28	43.9	28.92	23.86	24.66	28.04	31.31
AMF index	100	108.3	119.93	138.45	104.12	114.3	102.21	100.11	100.71

Source: Arab Financial Markets Database, Arab Monetary Fund.

Table (5) shows the capital concentration ratio in the Arab region. Half of the capital is concentrated in Saudi Arabia and Kuwait. The Saudi stock market is the largest in the region in terms of capitalisation, accounting for one-third of the total capital. With the exception of Bahrain, Jordan and Kuwait, the stock market capitalisation as percentage of the GDP in the Arab countries is low. It has an average of 46%, compared to an average of 60% in the emerging markets. This means that there is potential for future growth in the Arab markets.

The recent performance of the Arab stock markets shows a great degree of volatility. This phenomenon is apparent in the performance of the largest three Arab stock markets (Saudi Arabia, Egypt and Kuwait). The Saudi stock market index increased by 28% in 1997, followed by a drop of 28% in 1998 and then a rise of 43.6% in 1999. The Egyptian stock market index dropped by 24.7% in 1998 and increased by 43.8% in 1999. The same picture can be observed in Kuwait where the stock market index witnessed a rise of 40% in 1997, and a drop of 41% and 9% in 1998 and 1999, respectively.

Table (5): Arab Stock Markets in 2002

Stock Market	Market Capitalization	Market Capitalization %	Turnover %
Abu Dhabi	20,375	---	1.78
Amman	7,087	87	18.83
Bahrain	7,716	100	2.67
Saudi Arabia	74,851	40	41.38
Kuwait	35,098	98	63.03
Casablanca	8,564	26	16.82
Tunis	2,125	9	11.60
Dubai	9,469	---	7.26
Muscat	5,268	26	11.04
Doha	10,567	61	8.36
Beirut	1,395	---	8.24
Egypt	26,338	31	24.46

Source: Arab Monetary Fund : http://www.amf.org.ae/.
The on-line International Financial Statistics is the source for GDP data.

Notes:
1. Market capitalization is in $ million.
2. Turnover % is the ratio of value of shares traded as percentage of market capitalization.
3. Market capitalization % is the market capitalization as a percentage of GDP.

Despite the common factors among the Arab bourses, their recent performances show mixed results. The Saudi stock market was found in 1985 and, like other Gulf markets, is largely affected by the changes in crude oil prices. The best performance of the Saudi market took place in 1991 with 83% rise in the market index. Over the last five and ten years the Saudi market index has increased by 36% and 59%, respectively (Bakheet, 2002). The capitalisation of the Saudi stock market almost doubled over the last 7 years, increasing from $38.69 bn in 1994 to $68 bn in 2001. Over the same period, the number of registered companies increased by 13 companies (from 62 to 75 companies). It is worth noting that the market regulations do not allow foreign investment except in investment funds.

The Egyptian (Cairo & Alexandria) stock market –CASE- is the largest and most international stock market among the 12 Arab markets. The market is mainly driven by the telecommunication sector. CASE has achieved impressive performance in the 1990s, especially in 1996 and 1999 where the market index was up 39% and 42%, respectively. The trading value increased by 18-fold between 1992 and 1996, while market capitalisation rose by 443% over the same period. Furthermore, market capitalisation as a percentage of GDP increased from less than 6% in 1991 to 31% in 1996 (Shams El-Din, 1998). Recently, CASE has been hit by a liquidity and currency crisis, where between April 2000 and 2001 the market has reached the lowest point in seven years and lost 50 % of its value.

The stock market in Kuwait is the oldest in the Gulf region and it is quite open to foreign investors without restrictions except in the banking sector where foreign investors are not allowed to hold more than 49% shares of a bank (Bakheet, 2002). The Kuwaiti stock market witnessed an increase in market capitalisation from $11bn in 1994 to $22 bn in 2001. In addition, the number of registered companies went up from 48 in 1994 to 86 companies in 2001. The Kuwaiti market index has risen by 68% over the last ten years, before falling by 12% over the last five years. In 2000, despite the recovery of oil prices, the stock market index has risen by 7.2% due to the failure to implement expected economic reform (Barnett, 2001).

The stock market in Bahrain did not change much since 1994 where market capitalisation slightly increased from $5.1 bn to $6.2 bn in 2001. The number of registered companies increased by 23% since 1994 (from 32 to 41 companies). The Bahrain stock exchange is open to foreign investment with no restrictions, and has the highest market capitalisation as percentage of the GDP among the Arab markets. On the other hand, the Bahrain stock exchange is the most illiquid market where the turnover ratio was 6.2% by end of 1999. Barnett (2001) argues that although Bahrain is a strong financial centre in the Middle East region and enjoys an efficient central bank, it suffers from its small market size. Since end of 1996, the stock exchange index has increased by 14%, compared to an average increase of 33% in the GCC countries over the same period. The same picture is revealed when data for the last ten years are considered where the Bahrain stock exchange has risen by 23%, compared to average of 55% in the GCC index. Azzam (2000) argues that the recent performance of Bahrain stock market is linked to the developments in Kuwait where some of the shares are cross-listed.

Muscat stock market (MSM) was quite volatile over the last 7 years where market capitalisation jumped from $1.65 bn in 1994 to $7.31 bn in 1997 due to speculative transactions that caused a huge (unjustified) increase in shares' prices. During the same period the number of registered companies increased by 101%. In 1998, MSM witnessed a sharp drop in market capitalisation to reach $4.54 bn. Currently, MSM is stable at a market capitalisation of $5.1 bn. Between end of 1996 and 2001, MSM has lost 22% of its value. MSM achieved the best performance in the world in 1997 with a rise of 141% in its value, before dropping by 54% in 1998 and losing fifth of its value in 2000. Barnett (2001) argues that MSM is the best run and most open market in the Middle East where the market is well regulated by an independent body.

The book is divided into two parts: Part one focuses on banking sector in nine Arab countries. The four papers on banking tackle issues related to operational efficiency, service quality and risk. Part two is devoted to stock markets in Arab countries where authors discuss and examine a variety of issues related to efficiency, volatility, hedging, and returns. The included papers are essentially technical and use the most up-to-date statistical and econometrics analysis.

In their paper “Cost efficiency, scale elasticity and scale economies in Arabian banking” Al-Jarrah and Molyneux estimate the efficiency levels in various Arab banking sectors by applying various statistical analyses to a data set on Jordan, Egypt, Saudi Arabia and Bahrain. Their study employs cost efficiency concept using a number of different measurement methods. Cost efficiency averaged around 95% over the 1992-2000 period. Islamic banks are found to be the most cost efficient, while investment banks are the least. Based on bank asset size, large banks seem to be relatively more cost efficient. Geographically, Bahrain is the most cost efficient while Jordan is the least. It should be noted that these results, in general, are similar to those found in other US and European banking studies. They also report scale elasticity and scale efficiency measures for the banks under study. The cost scale elasticity estimates reveals diseconomies of around five percent and the cost scale inefficiency estimates also suggest that banks are 65% scale efficient. Islamic and commercial banks are again found to be the most cost scale efficient. Large banks are also generally found to be more efficient than smaller institutions. In addition, geographically, Saudi Arabian and Egyptian banks seem to be the most cost scale efficient. A major finding of their study is that there is little evidence to suggest that the major economic and financial reforms undertaken in Jordan, Egypt, Saudi Arabia and Bahrain over the last decade have had a noticeable impact on improvement in banking sector efficiency.

“Are GCC banks efficient?” by Shams and Molyneux raised the same issues discussed by Al-Jarrah and Molyneux. The paper analyses the cost and profit efficiencies of the GCC banking sector over the period 1995-2000. Efficiencies are estimated using the most recent frontier technique, the Fourier Flexible form. The paper also uses a logistic regression model to estimate the determinants of GCC bank efficiency. The findings show that the level of inefficiencies in the GCC banking industry ranges between 8 and 10% for costs and 30 and 32% for profits. There are no major differences in banks inefficiency levels among GCC countries. Moreover, inefficiencies show almost stable trends over 1995-2000. The paper main result is that the strengthening of financial capital is a central element in explaining bank efficiency in the GCC region. However, the erosion in loan quality reduces banking sector efficiency. The authors suggest that regulations need to focus on building a safe and sound banking system with adequate and prudential rules. This should ultimately feed into improved banking sector efficiency levels.

It is generally agreed that service quality in banking is a significant issue facing this industry. In their paper “Analysing service quality in the UAE Islamic Banks” Al-Tamimi and Al-Amiri analyze service quality in the UAE Islamic Banks. They compare service quality between Dubai Islamic Bank and Abu Dhabi Islamic Bank. Linear regression results indicate that there is a positive and statistically significant relationship between overall service quality and the SERVQUAL (service quality questionnaire model) dimensions in the UAE Islamic Banks. ANOVA results showed that there is no significant difference between level of overall service quality in the Dubai Islamic Banks and Abu Dhabi Islamic Banks. ANOVA results also indicate that there is no significant difference in the level of service quality in the UAE Islamic Banks based on customers’ gender, nationality. However, the results indicate that there is a significant difference in the level of service quality in the UAE Islamic Banks based on customers’ age, customers’ education and customers’ number of years with the bank.

The one-factor CAPM (Capital Asset Pricing Model) has been widely accepted and used in the valuation of financial assets. More recently, Fama and French [1993] proposed the three-Factor Pricing Model (TFPM) that encompasses the one factor CAPM variable, namely the stock’s beta. Alongside beta, average stock returns could be explained by some size and book-to-market supplementary effects. In their paper “Using CAPM and TPFM to estimate Tunisian bank cost of equity” Naceur and Ghazouani estimate of cost of equity is carried out for the Tunisian banking sector. To account for inter-individual heterogeneity, estimation of the coefficients is conducted according to random-coefficient specifications within the context of panel data analysis. The obtained results show that Tunisian banks are less exposed to market risk than the average companies in the TSE (Tunisian Stock Market). The authors argue that investing in the banking securities seems to be a no risk alternative. This is because most of the banks operating in Tunisia are big in size.

In his paper "Testing stock market efficiency in Oman" Al-Shanfari examines the stock market efficiency hypotheses in Oman. His results indicate that oil prices and interest variables do not have significant power of prediction since they are not co-integrated. The results indicate that oil prices and interest variables do not form a long-run statistical equilibrium relationship with listed share prices in Muscat stock exchange. As a result, it is possible to state that the local stock market in Oman during the period from January 1992 to December 1999 was efficient in at least the weak form.

In their paper "An analysis of day of the-week-effects in the Egyptian stock market", Hassan, Mehdian, and Perry examine the stock market efficiency as in the paper by Al-Shanfari. However, the place and the technique are different. Aly, Mehdian, and Perry investigate daily stock market anomalies in the Egyptian stock market using its major stock index, the Capital Market Authority Index (CMA). They try to shed some light on the degree of market efficiency in an emerging capital market with a four-day trading week. The results of the paper indicate that Monday returns in the Egyptian stock market are positive and significant, but are not significantly different from returns of the rest of the week. Monday returns are significantly more volatile than returns from Tuesday to Thursday. Hence, the significantly positive returns on Monday are associated with returns that are more risky. The authors conclude that stock market returns in Egypt are consistent with the weak form efficiency.

Value at Risk (VaR) measures risk exposure at a given probability level and is very important for risk management. In their paper "Forecasting value at risk in emerging Arab stock markets" Guermat, Hadri and Kucukozmen compare between VaR forecast accuracy using measures which are adapted to the objectives of VaR. The comparison was based on the out of sample prediction of VaR. These measures were applied to three emerging Arab stock markets and one developed stock market (U.S.A). The results indicate comparable proportions of failures, but the total and average costs were generally lower in the Arab stock markets. At the same time, the average and total coverage costs were also lower in the Arab stock markets. Guermat, Hadri and Kucukozmen measure of forecast accuracy shows that VaR forecast accuracy depends on two main factors. First, forecast accuracy may be different at different levels of confidence. In their study, for example, US forecasts were more accurate than Morocco forecasts at the 95% level, while the opposite was found at the 99.9% level. The second factor is the weight that should be given to both failure cost and coverage cost. Overall, the various forecast accuracy measures employed in their paper indicate that forecasts produced for the three Arab stock markets are more accurate than those produced for the US stock market, especially at the extreme tail. However, Guermat, Hadri and Kucukozmen highlight the fact that cross-country risk cannot be assessed unless the VaR for exchange rates between Arab currencies and the US $ is incorporated into the model. Guermat, Hadri and Kucukozmen left the possibility of combining the VaR for stock market returns and the VaR for exchange rate for future research. Hopefully, other Arab researchers reading this text could start from where Guermat, Hadri and Kucukozmen had stopped.

The issue of the bid-ask determinants has very important implications for fund managers as well as individual and institutional investors. Commonly quoted variables that can explain the cross sectional spread include security prices, trading frequency, firm size, and risk. In their paper "The microstructure of the Jordanian capital market: electronic trading and liquidity cost" Omet and Mashharawe examine the factors determining the bid-ask spread in the Amman stock market. The empirical results show that transaction cost in the Jordanian market is high. Security prices, trading frequency, and price volatility are found to consistently affect the bid-ask spread. Omet and Mashharawe conclude that large transaction costs may induce corporations to cross-list their stocks in more liquid and developed markets, and thereby hinder Jordanian market development.

Multifactor models such as the widely used BARRA E3 have gained wide acceptance in the fund management industry. They can measure the portfolio exposures to different risk factors. Accordingly, fund manager can adjust the portfolio holdings to increase its exposure to the factors that are expected to do exceptionally well in the future, and vice versa. They have also proved very useful in performance evaluation against a relevant benchmark. They can measure the fund manager's style and possible deviations from the fund investment policy. In his paper "Multivariate statistical analysis of risk factors in the Egyptian stock market" Omran applies the multivariate technique of the principal component analysis to identify the major risk factors in the Egyptian stock market. Three principal components are identified. The first is a representative of the total performance of the market. It is heavily loaded with telecommunications, media and construction. The second represents the housing and development. The third represents consumer staples, specially the mills. The results make economic sense since Egypt has witnessed a massive growth in telecommunications sector especially mobile phones. Also the construction and housing sectors are very active due to the rapid growth in population and growing needs for infrastructure and housing projects. The mills are very important given that bread and bakeries are among the most important food items in Egypt. The three components explain 90% of the variation in the returns on the general market index.

The relationship between financial ratios and stock returns has been a popular issue in empirical capital market research. The relationship is particularly important in research focusing on stock fundamental analysis and the semi-strong form market efficiency. In his paper "Linear versus non-linear relationships between financial ratios and stock returns: empirical evidence from Egyptian firms" Ragab models the relationship between common financial ratios and stock returns for a sample of 46 Egyptian firms from 1996 to 2000, using linear and non-linear forms. The empirical findings suggest that non-linear relationships exist and are more descriptive of the behaviour of stock returns. Investors in Egyptian firms, consider the ROE ratio as the most important factor when making investment decisions.

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CHAPTER TWO

Cost Efficiency, Scale Elasticity and Scale Economies in Arabian Banking

Idries Al-Jarrah and Philip Molyneux[a]

1. Introduction

Several approaches have been developed in the banking literature for measuring bank (firm) level efficiency, ranging from simple financial ratios to complex econometric models. Forsund et al. (1980) sums up that efficiency studies can be classified according to the way in which the frontier is specified and estimated. First, the frontier may be specified as a parametric function of inputs, or it may not. Second, an explicit statistical model of the relationship between the observed output and the frontier may be specified, or it may not. Finally, the frontier itself may be specified as deterministic or random. Several permutations of these possibilities have been considered.

In general, there have been two major types of frontier approaches utilized in most prior efficiency studies; deterministic and stochastic. The deterministic approach assumes that all firms share a common technology and therefore face common production and cost frontiers and all variation in firm performance is attributed to variation in firm efficiencies relative to these common frontiers. However, the notion of a deterministic frontier shared by all firms ignores the possibility that a firm's performance may be affected by factors outside its control as well as by factors under its control (inefficiency). The stochastic approach, on the other hand, assumes that firms may deviate from the minimum attainable cost levels for purely exogenous reasons as well as through inefficiency effects (see for instance, Forsund et al., 1980 and Cummins and Weiss, 1998).

Berger and Humphrey (1997) note that efficiency estimation techniques can be broadly categorized into parametric and non-parametric methods. However, no

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consensus exists as to the preferred method for determining the best-practice frontier against which relative efficiencies are measured. The most commonly used non-parametric methods are known as Data Envelopment Analysis (DEA) and the Free Disposable Hull (FDH). On the other hand, the most commonly used parametric methods are the Stochastic Frontier Approach (SFA), the Thick Frontier Approach (TFA) and the Distribution Free Approach (DFA). These approaches differ primarily in the assumptions imposed on the data in terms of the functional form of the best-practice frontier.

Why use frontier methodology to estimate efficiency in banking?

According to Berger and Humphrey (1997), frontier approaches are superior, for most regulatory purposes, to standard financial ratio analysis because they use programming or statistical techniques that remove the effects of differences in input prices and other exogenous market factors affecting the standard performance of firms. This, they argue, provides more accurate estimates of the underlying performance of firms and their managers. Therefore, frontier efficiency has been used extensively in regulatory analysis to measure the effects of mergers and acquisitions, capital regulation, deregulation of deposit rates, removal of geographic restrictions on branching and holding company acquisitions, and on financial institution performance in general (Bauer et al., 1997).

In addition, frontier efficiency models are preferred by researchers over other performance indicators primarily because these models result in an objectively determined quantified measure of relative performance that removes many exogenous factors (Barr et al., 1999). This permits the researcher to focus on quantified measures of costs, inputs, outputs, revenues, profits, etc. to impute efficiency relative to the best practice institutions in the population. Previous studies have examined efficiency and associated effects on financial institution performance from several different perspectives. These include the effects of mergers and acquisitions, institutional failure, and deregulation on banking sector efficiency.

Siems and Barr (1998) state that the use of frontier efficiency techniques yields useful comparative and benchmarking information that can provide impetus for significant improvements and can alert institutions to new practices and new paradigms. Simple ratio-based analysis that is used for benchmarking can provide important insights but, they argue, are limited in scope because they take a one-dimensional view of a service, product, or process and ignore any interactions, substitutions, or trade-offs between key variables. Thus, a more inclusive multiple-input, multiple-output framework for evaluating productive efficiency, that provides benchmarking information on how to become a well-managed bank, seems essential to improve decision making processes (especially at poorly managed banks).

In addition, frontier methodologies can also provide helpful guidance to regulators and policy makers in various areas. For instance, frontier analysis may help regulators to understand more about efficiency effects of financial deregulation and disruption; efficiency issues relating to institutional failure, risk-taking, problem lending and management quality; efficiency issues associated with market structure and concentration; and the efficiency effects of mergers and acquisitions (Cummins and Weiss, 1998; Berger and Humphrey, 1997). Frontier methodologies can also be applied to help inform management about the effects of policies, procedures, strategies, and technologies adopted by the firm. Furthermore, frontier analysis can be used to track the evolution of a firm's productivity and efficiency over time and to compare the performance of different sections within the firm.

From an academic perspective, frontier efficiency methods are useful for testing various economic hypotheses. For example, both agency theory and transactions cost economies generate predictions about the likely success of firms with different characteristics in attaining objectives such as cost minimisation or profit maximisation under various economic conditions. In general, greater knowledge of productive efficiency also allows one to address various important research areas (Intarachote, 2001). For example, current methodological areas of research focus on how efficiency varies with different frontier approaches, output definitions and overtime in order to demonstrate the consistency of different types of efficiency estimates. Furthermore, measuring bank efficiency may be useful to evaluate whether bank management maximize shareholder value (SWM). Greater bank-level efficiency, in turn, is expected to improve financial products and services, increase the volume of intermediated funds and should lead to a more responsive financial system with improved risk taking capabilities (if efficiency gains are channelled to enhance capital adequacy positions).

2. Methodology: Measures of Efficiency and Productivity

The stochastic frontier, with the Fourier-flexible functional form, is the main methodology to be employed to derive efficiency measures in the countries under study. While the translog functional form has been probably the most widely utilised to derive efficiency estimates, the Fourier-flexible has received more focus in the recent efficiency literature. This section presents the main features of the Fourier-functional form and shows how to derive scale economies and scale inefficiencies estimates using this functional form.

2.1 The Stochastic Frontier Approach (SFA)

This section presents a theoretical framework of the SFA as this approach will be utilised later to examine the efficiency levels in the banking systems of Jordan, Egypt, Saudi Arabia and Bahrain. The stochastic frontier production function was independently proposed by Aigner et al. (1977), and Meeusen and Van den Broeck (1977), and it has been widely used in the banking efficiency literature. The SFA postulates that firms face various technical inefficiencies in producing a particular level of output. For a given combination of input levels, it is assumed that the realized production of a firm is bounded by the sum of a parametric function of known inputs, involving unknown parameters, and a random error, associated with measurement error of the level of production or other factors. The greater the amount the realized production falls below the production frontier, the greater the level of technical inefficiency.

The frontier approach labels a bank as inefficient if its costs (profits) are higher (lower) than those predicted for an efficient bank producing the same input/output combination and the difference cannot be explained by statistical noise. The cost frontier is obtained by estimating a cost function with a composite error term, the sum of a two-sided error term representing random fluctuations in cost and a one-sided positive error term representing inefficiency. The single-equation stochastic cost function model can be given as:

$$\mathrm{TC} = \mathrm{TC}(y_i, w_i) + \varepsilon_i$$

where *TC* is observed total cost, y_i is a vector of output, and w_i is an input-price vector. Following Aigner et al. (1977), the error of the cost function is:

$$\varepsilon = u + v$$

where *u* and *v* are independently distributed; u is assumed to be distributed as half-normal; $u = N(0,\sigma_u^2)$, that is, a positive disturbance capturing the effects of inefficiency, and *v* is assumed to be distributed as two-sided normal with zero mean and variance, σ_v^2, capturing the effects of the statistical noise.

Observation-specific estimates of the inefficiencies, *u*, can be estimated by using the conditional mean of the inefficiency term, given the composed error term, as proposed by Jondrow et al. (1982). The mean of this conditional distribution for the half-normal model is shown as:

$$E(u_i / \varepsilon_i) = \frac{\sigma\lambda}{1+\lambda^2}\left[\frac{f(\varepsilon_i\lambda/\sigma)}{1-F(\varepsilon_i\lambda/\sigma)} + \left(\frac{\varepsilon_i\lambda}{\sigma}\right)\right]$$

where $\lambda = \sigma_u / \sigma_v$ and total variance, $\sigma^2 = \sigma_u^2 + \sigma_v^2$; F(.) and *f*(.) are the standard normal distribution and the standard normal density function, respectively. (u_i / ε_i) is an unbiased but inconsistent estimator of u_i since regardless of the number of observations, *N*, and the variance of the estimator remains nonzero (see Greene, 1991,p. 80-82). Jondrow et al. (1982) have shown that the ratio of the variability (standard deviation, σ) for *u* and *v* can be used to measure a bank's relative inefficiency, where $\lambda = \sigma_u / \sigma_v$, is a measure of the amount of variation stemming from inefficiency relative to noise for the sample. Estimates of this model can be computed utilising the maximum likelihood procedure directly (see Olson et al., 1980).

Bauer et al. (1997) refers to Greene's (1990) argument that alternative distributions for inefficiency may be more appropriate than the half-normal, and the application of different distributions sometimes 'do matter' to the average efficiencies for financial institutions. If panel data are available, however, some distributional assumptions can be relaxed, and the distribution-free approach (DFA) may be used. The distribution-free method assumes that there is a core efficiency or average efficiency for each firm over time. The core inefficiency is distinguished from random error (and any temporary fluctuations in efficiency) by assuming core inefficiency as persistent over time, while random errors tend to average out over time. In particular, a cost or profit function is estimated for each period of a panel data set. The residual in each separate regression is composed of both inefficiency (ln u) and random error (ln v) but the random component is assumed to average out over time. Furthermore, an adjustment (called truncation) is assigned to the average of a bank's residuals from all of the regressions (ln $\hat{u}$). This is done so as to assign less extreme values of $\ln \hat{u}$ to these banks, since extreme values may indicate that random error has not been completely purged by averaging. The resulting ln $\hat{u}$ for each bank is used to compute its core efficiency.

The distributional assumptions of the stochastic frontier approach are rather arbitrary. Two prior studies (Bauer and Hancock, 1993; Berger, 1993) found that when the inefficiencies were unconstrained, they behave much more like symmetric normal distributions than half-normal, which would invalidate the identification of the inefficiencies. Carbo et al. (2000) summarize the specification of previous studies that modelled bank inefficiencies. Allen and Rai (1996) and Kaparakis et al. (1994), and Mester (1996) all use the half-normal specification to test for inefficiency differences between financial institutions. Cebenoyan et al. (1993) uses the truncated normal model. Mester (1993) in common with many studies uses the half-normal distribution. Stevenson (1980) and Greene (1990) have used the normal and gamma model, respectively. Altunbas and Molyneux (1994b) note that efficiency estimates are relatively insensitive to different distributional assumptions when testing the half normal, truncated normal, exponential and gamma efficiency distributions, as all distributions yield similar inefficiency levels for the German banking market. Vennet (1998) uses both the half-normal and exponential distributions to derive efficiencies in European banking, but notes that there was little difference between the two and so reports only the half-normal estimates.

The Advantage of the Fourier-Flexible (FF) versus the Translog Functional Form

The most widely used functional form in the bank efficiency literature is the translog; however, it is subject to certain limitations, namely it does not necessarily fit well the data that are far from the mean in terms of output size or mix. In addition, McAllister and McManus (1993), and Mitchell and Onvural (1996) show that some of the differences in results of scale economies across studies may be due to the ill fit of the translog function across a wide range of bank sizes, some of which may be underrepresented in the data. The translog functional form for a cost function represents a second-order Taylor series approximation of any arbitrary, twice-differentiable cost function at a given (local) point. This restrictive property of the translog form is part of White's (1980) appraisal, which led Gallant (1981) to propose the Fourier flexible functional form (FF) as a preferred alternative.

This methodology was first proposed by Gallant (1981, 1982), discussed later by Elbadawi, Gallant and Souza (1983), Chalfant and Gallant (1985), Eastwood and Gallant (1991), Gallant and Souza (1991) and applied to the analysis of bank cost efficiency by Spong et al. (1995), Mitchell and Onvural (1996) and Berger et al. (1997). It has been shown (Tolstov, 1962), that a linear combination of the sine and cosine function, namely the Fourier series, can fit exactly any well-behaved multivariate function.

The Fourier-flexible functional form is preferred over the translog because its better approximates the underlying cost function across broad range of outputs as suggested by Spong et al. (1995), Mitchell and Onvural (1996). The semi-nonparametric Fourier functional form has desirable mathematical and statistical properties because an infinite Fourier series is capable of representing any function exactly and even truncated Fourier series can approximate a function reasonably well throughout its entire range. When using the Fourier functional form, one avoids holding any maintained hypothesis by allowing the data to reveal the true cost function through a large value of fitted parameters.

Besides, Berger and Mester (1997) note that the local approximations of the translog may distort scale economy measurements since it imposes a symmetric U-shaped average cost curve. This aspect of the translog might not fit very well data that are far from the mean in terms of output size or mix. The FF alleviates this problem since it can approximate any continuous function and any of its derivatives (up to a fixed order). Any inferences that are drawn from estimates of the FF are unaffected by specification errors (Ivaldi et al., 1996). Carbo et al. (2000) indicate that since the FF is a combination of polynomial and trigonometric expansions, the order of approximation can increase with the size of the sample size. This is due to the mathematical behaviour of the sine and cosine functions which are mutually orthogonal over the [0, 2π] interval and function space-spanning.

Finally, the FF has several appealing properties in terms of modelling bank cost structures as pointed out by Williams and Gardener (2000). Unlike other commonly used functional forms such as the translog, the FF form is unaffected by specification errors. Furthermore, it has been widely accepted that the global property is important in banking where scale, product mix and other inefficiencies are often heterogeneous, therefore, local approximations (such as those generated by the translog function) may be relatively poor approximation to the underlying true cost (or profit) function. Specifically, the Fourier-flexible functional form augments the translog by including Fourier trigonometric terms.

2.2 The Fourier-flexible Functional Form

The stochastic cost model for a sample of N firms can be written as:

$$\ln TC_i = \ln TC(y_i, w_i, z_i; B) + u_i + v_{i,}, \quad i = 1, ..., N,$$

where TC_i is observed cost of bank i, y_i is the vector of output levels and w_i is the vector of input prices for bank i. z_i represents a vector of control variables which in the case of our estimates includes the quality of bank's output (q_i), the level of its financial capital (k_i) and the time trend (T_i). B is a vector of parameters, v_i is a two-sided error term representing the statistical noise (assumed to be independently and identically distributed and have a normal distribution with mean 0 and variance σ_v^2).

u_i are non-negative random variables that account for technical inefficiency. In case of Battese and Coelli (1995) model, u_i are assumed to be independently distributed as truncations at zero of the $N(m_i, \sigma_u^2)$ distribution; where $m_i = \delta_i d$, where δ_i is a set of environmental variables (defined in the previous section) which are employed to control for firm's specific factors that may contribute to explain the differences in the efficiency estimates, and d is a vector of parameters to be estimated. In case of Battese and Coelli (1992) model, u_i are assumed to be iid as truncations at zero of the $N(\mu, \sigma_u^2)$ distribution. The translog functional form for the cost frontier is specified as:

$$\begin{aligned}\ln(C/w_3) = {} & \alpha + \sum_{i=1}^{2} B_i \ln(w_i/w_3) + \sum_{k=1}^{3} \gamma_k \ln y_k + \sum_{r=1}^{3} \psi_r \ln z_r \\ & + \frac{1}{2}\left[\sum_{i=1}^{2}\sum_{j=1}^{2} B_{ij} \ln(w_i/w_3)\ln(w_j/w_3)\right] + \frac{1}{2}\left[\sum_{k=1}^{3}\sum_{m=1}^{3} \gamma_{km} \ln y_k \ln y_m\right] \\ & + \frac{1}{2}\left[\sum_{r=1}^{3}\sum_{s=1}^{3} \psi_{rs} \ln z_r \ln z_s\right] + \sum_{i=1}^{2}\sum_{k=1}^{3} \eta_{ik} \ln(w_i/w_3)\ln(y_k) \\ & + \sum_{i=1}^{2}\sum_{r=1}^{3} \rho_{ir} \ln(w_i/w_3)\ln(z_r) + \sum_{k=1}^{3}\sum_{r=1}^{3} \tau_{kr} \ln y_k \ln z_r + u_{it} + v_{it}\end{aligned}$$

By augmenting the previous translog form by Fourier trigonometric terms, we get the Fourier-flexible functional form written as:

$$\begin{aligned}\ln(C/w_3) = {} & \alpha + \sum_{i=1}^{2} B_i \ln(w_i/w_3) + \sum_{k=1}^{3} \gamma_k \ln y_k + \sum_{r=1}^{3} \psi_r \ln z_r \\ & + \frac{1}{2}\left[\sum_{i=1}^{2}\sum_{j=1}^{2} B_{ij} \ln(w_i/w_3)\ln(w_j/w_3)\right] + \frac{1}{2}\left[\sum_{k=1}^{3}\sum_{m=1}^{3} \gamma_{km} \ln y_k \ln y_m\right] \\ & + \frac{1}{2}\left[\sum_{r=1}^{3}\sum_{s=1}^{3} \psi_{rs} \ln z_r \ln z_s\right] + \sum_{i=1}^{2}\sum_{k=1}^{3} \eta_{ik} \ln(w_i/w_3)\ln(y_k) \\ & + \sum_{i=1}^{2}\sum_{r=1}^{3} \rho_{ir} \ln(w_i/w_3)\ln(z_r) + \sum_{k=1}^{3}\sum_{r=1}^{3} \tau_{kr} \ln y_k \ln z_r \\ & + \sum_{n=1}^{8} \left[\phi_n \cos(x_n) + w_n \sin(x_n)\right] + \\ & \sum_{n=1}^{8}\sum_{q=n}^{8} \left[\phi_{nq} \cos(x_n + x_q) + w_{nq} \sin(x_n + x_q)\right] \\ & + \sum_{n=1}^{8} \left[\phi_{nnn} \cos(x_n + x_n + x_n) + w_{nnn} \sin(x_n + x_n + x_n)\right] + u_{it} + v_{it}\end{aligned}$$

where *lnC* is the natural logarithm of total costs (operating and financial); $ln\ y_i$ is the natural logarithm of bank outputs (i.e. loans, securities, off-balance sheet items); $ln\, w_i$ is the natural logarithm of *i*th input prices (i.e. wage rate, interest rate and physical capital price); the x_n terms, n=1,...,8 are rescaled values of the ln(w_i / w_3), i=1,2, ln(y_k), k=1,2,3, and ln(z_r), r=1,2,3, such that each of the x_n span the interval [0,

2π], and π refers to the number of radians here (not profits), and $\alpha, \beta, \gamma, \psi, \rho, \tau, \eta, d, \omega, \phi$ and *t* are coefficients to be estimated.

Since the duality theorem requires that the cost function be linearly homogeneous in input prices and continuity requires that the second order parameters are symmetric, the following restrictions apply to the parameters of the cost function in the equation above: $\sum_{i=1}^{3} \beta_j = 1$; $\sum_{i=1}^{3} B_{ij} = 0$; $\sum_{i=1}^{3} \eta_{ij} = 0$; $\sum_{i=1}^{n} \rho_{ij} = 0$ for all *j*. Moreover, the second order parameters of the cost function must be symmetric, that is, $B_{ij} = B_{ji}$ and $\eta_{ik} = \eta_{ki}$, for all *i, k*. The scaled log-output quantities; x_i are calculated as in Berger and Mester (1997) by cutting 10% off each end of the [0, 2π] interval so that the z_i span [0.1 x 2π, .9x 2π] to reduce approximation problems near endpoints. The formula for z_i is [0.2π - μ x a + μ x variable], where [a, b] is the range of the variable being transformed, and $\mu \equiv$ (0.9 x 2π – 0.1 x 2π/ (9b-a)). This study applies Fourier terms only for the outputs, leaving the input price effects to be defined entirely by the translog terms, following Berger and Mester (1997). The primary aim is to maintain the limited number of Fourier terms for describing the scale and inefficiency measures associated with differences in bank size. Moreover, the usual input price homogeneity restrictions can be imposed on logarithmic price terms, whereas they cannot be easily imposed on the trigonometric terms.

The maximum-likelihood estimates for the parameters in the Fourier-flexible stochastic frontier for Cost, Standard and Alternative profit efficiency functions; that includes efficiency correlates, are estimated using the computer program FRONTIER Version 4.0 (see Coelli 1996). This computer program uses three steps to obtain the maximum likelihood estimates. The first step involves obtaining ordinary least squares (OLS) estimates of the equation. These estimates are unbiased because of the non-zero expectation of u_{it}. The second step involves evaluating the log-likelihood function for a number of values of γ between zero and one. During this procedure, d_i are set to zero and the values of B_0 and σ^2 are adjusted according to the corrected ordinary least squares formulae for the half-normal model. The estimates corresponding to the largest log-likelihood value in this second step are used as starting values in the iterative maximisation procedure in the third and final part of the estimation procedure.

2.3 Calculation of within-sample Scale Elasticities

This study also estimates scale elasticities for the banks under study. Scale elasticity for the cost function (i.e., scale economies) refer to the proportional increase in cost resulting from a small proportional increase in the level of output (the elasticity of total cost with respect to output). Within the sample scale elasticities are calculated as in Mester (1996) and Altunbas et al. (1998) and are evaluated at the mean output, input price, asset quality and financial capital levels for the respective size quartiles. The degree of scale elasticities is given by the sum of individual cost elasticities. For the case of FF cost function, the measure of overall economies of scale (SE) is given by the following cost elasticity by differentiating the cost function in the above equation with respect to output;

This gives us: $\text{SE} = \sum_{i=1}^{3} \frac{\partial \ln TC}{\partial \ln y_i}$

$$
= \sum_{k=1}^{3} \gamma_k + \sum_{k=1}^{3}\sum_{m=1}^{3} \gamma_{km} \ln y_m + \sum_{i=1}^{2}\sum_{k=1}^{3} \eta_{ik} \ln(w_i / w_3) + \sum_{k=1}^{3}\sum_{r=1}^{3} \tau_{kr} \ln z_r +
$$
$$
\sum_{n=1}^{8}\left[-\phi_n \sin(x_n) + \omega_n \cos(x_n)\right] + \sum_{n=1}^{8}\sum_{q=n}^{8}\left[-\phi_{nq} \sin(x_n + x_q) + \omega_{nq} \cos(x_n + x_q)\right]
$$
$$
+ \sum_{n=1}^{8}\left[-\phi_{nnn} \sin(x_n + x_n + x_n) + \omega_{nnn} \cos(x_n + x_n + x_n)\right]
$$

If the calculated SE is less than 1 then increasing returns to scale, implying economies of scale. On the other hand, if SE = 1 then constant returns to scale and if SE < 1 then decreasing returns to scale, implying diseconomies of scale.

2.4 Calculation of Scale Inefficiency

Recently Evanoff and Israilevich (1995) have noted that comparing scale economies (scale elasticities) with x-inefficiencies are misleading as the former is an elasticity and the latter is a relative efficiency measure. While many authors compare scale economies and x-inefficiencies, Evanoff and Israilevich suggest one should calculate scale inefficiencies for accurate comparisons.

The scale elasticity measure, $\varepsilon = \partial \ln C / \partial \ln Y$, is an elasticity associated with a particular output level and indicates the relative change in cost associated with an increment change from this output level. Scale inefficiency (I), on other hand, can be measured as the aggregate cost of N inefficient firms ($\varepsilon \neq 1.0$) relative to the cost of a single efficient firm ($\varepsilon = 1.0$); that is $I = [N * C_I / C_E]-1.0$, where C_I and C_E are the cost of production at the inefficient and efficient firms, respectively.

Therefore, the two concepts differ because elasticity is related to incremental changes in output, and inefficiency related to the change in output required to produce at the minimum efficient scale. The inefficiency measure is typically associated with significantly larger output changes as it measures the difference in total or average cost at distinct output levels. Furthermore, the cost savings realised by an incremental increase in output by a scale inefficient firm is irrelevant for measuring inefficiency since this is not the savings realised by producing at the efficient scale.

Given the following simple representation for the cost function:

$$\ln C = a + b (\ln Y) + .5\, c (\ln Y)^2,$$

then the scale elasticity for inefficient firms $= \varepsilon_I = \partial \ln C_I / \partial \ln Y_I = b$, on the other hand the scale elasticity for the efficient firms = 1.0; by definition.

The scale inefficiency (see Evanoff and Israilevich, 1995) then can be written as:

$$I = e^{(.5/c)(1-\varepsilon_I)^2} -1.0,$$

that is scale inefficiency is a function of the first and second derivatives of the function (cost function as well as other functional forms) with respect to output (the second derivation aims to reach c which is the key for inefficiency calculation).

Furthermore, if the estimated scale elasticity value is insignificantly different from unity, this does not imply scale inefficiency is insignificantly different from zero because the statistical difference of the elasticity measure from a value of unity depends entirely on the standard error of the estimated coefficient b.

For completeness, this study estimates x-inefficiencies, scale inefficiencies and scale economies for our sample of Arabic banks.

2.5 Specification of Bank's Inputs, Outputs and Costs

A financial firm is an entity engaged in the intermediation of services between borrowers and lenders. These services are related directly or indirectly to the financial assets and liabilities held by this firm such as loans and deposits. In addition, financial institutions such as banks are naturally multi-product firms, many of their services are jointly produced and so certain kinds of costs are jointly related to production of a variety of services. Furthermore, financial firms provide services rather than readily identifiable physical products, and there is no consensus as to the precise definition of what banks produce and how service output can be measured.

Intermediation theories do not provide a clear-cut view regarding bank's output and input and therefore do not present precise indication as to how to define bank's costs. Allen and Santomero (1998) argue that many current theories of intermediation are too narrow and focus on functions of institutions that are no longer crucial in many developed financial systems. Bhattacharya and Thakor (1993) provides a review of the relevant literature where such theories are often unable to account for those activities that have become more central to many institutions such as risk management and cost-reduction oriented activities (see Casu and Molyneux, 2001).

Casu and Molyneux (2001) note that the earliest cost studies in banking applied a variety of different banking output indicators. Some early studies proxied bank services by a single index that combined all services into a uni-dimensional measure; others measured each bank service separately. In addition, some researchers chose to measure output in terms of bank assets and liabilities by focussing either on only one side of the balance sheet, or on both sides at the same time. Others have used bank revenues to measure bank output. Greenbaum (1967), for example, used the dollar market value of services rendered to measure output in an attempt to estimate the real social value of banking services.

While the multi-product nature of the banking firm is recognised, there is still no agreement as to the definition and measurement of bank inputs and outputs. The banking literature is divided concerning the issue of bank cost and there is no agreement concerning the variables that provide good proxy for bank costs. Benston, Hanweck, and Humphrey (1982) have summarized the issue into three viewpoints: economists tend to view bank's output as dollars of deposits or loans, monetary economists see banks as producers of money-demand deposits, while others see banks as producing loans, with demand and time deposits being analogous to raw materials. In general, researchers take one of two approaches labelled the 'intermediation approach' and the 'production approach'.

2.5.1 The Intermediation Approach

The intermediation approach views bank as an intermediator of financial services. This approach was suggested by Sealey and Lindley (1977) and assumes that bank collect sources of funds (deposits and purchased funds with the assistance of labour and capital) and transform these into loans and other assets. The deposits are treated as inputs along with capital and labour and the volumes of earning assets are defined as measures of output. Consistent with this approach, costs are defined to include both interest expense and total costs of production. Some authors support the exclusion of interest expense from total costs, reasoning that interest costs are purely financial and not pertinent in measuring efficiency. Others have argued that excluding interest costs disregards the process of financial technology by which deposits are transformed into loans (for these viewpoints, see for instance, Miller and Noulas, 1996, Aly. et al., 1990 and Clark, 1988).

Intarachote (2001) summarises the advantages of the intermediation over other approaches. This approach treats deposits as inputs which are more convincing since banks use deposits as well as other funds to make loans and investment. This view is in accord with Mehdian and Elyasiani (1990) who support the idea that banks buy rather than sell deposits. Furthermore, the unit of bank inputs and outputs, under the intermediation approach, are measured in terms of monetary values that can determine the market share of individual banks. In addition, some services cannot be measured in terms of number of accounts such as investment in securities. Moreover, the intermediation approach includes interest expenses on deposits and other purchased funds which comprise the bulk of bank costs. Finally, the intermediation approach has been the most widely used in the empirical bank efficiency literature.

Berger, Leusner and Mingo (1997b) indicate that the intermediation approach has the advantages of being more inclusive and captures the role of banking institution. It emphasizes the overall costs of banking and is appropriate for addressing questions related to the cost minimization of banks (Ferrier and Lovell, 1990). Studies using this approach include Elyasiani and Mehdian (1990 a&b), Miller and Noulas (1996), Mester (1996), Altunbas and Molyneux (1997) and DeYoung (1998).

2.5.2 The Production Approach

The production approach views banks as producers of loan and deposit services using capital and labour. The number of accounts of each type is the appropriate definition of outputs. The total costs under this approach are exclusive of interest expense and outputs are measured by the number of accounts serviced as opposed to dollar values, thus considering only operating but not interest costs (Clark, 1988, Miller and Noulas, 1996, Aly. et al., 1990). Studies that have used this approach include Sherman and Gold (1985), Ferrier and Lovell (1990) and Berger and DeYoung (1997).

3. Data

Our data comprises a representative sample of the banks operating in Jordan, Egypt, Saudi Arabia and Bahrain and consists of 82 banks over the 1992-2000 period. This sample represents around 78%, 88%, 63% and 55% of the financial systems of these countries (excluding the assets of foreign branches and central banks) (Table 1 below shows the details).

Table 1: Size of the study sample relative to the banking sectors of Jordan, Egypt, Saudi Arabia and Bahrain over 1992-2000 (US$ million, figures rounded to nearest 2 digits)

	Bahrain			Egypt			Jordan			Saudi Arabia		
Country Year	/Sample Assets	Total. Banking Assets	%	Sample Assets	Total Banking Assets	%	Sample Assets	Total Banking Assets	%	Sample Assets	Total Banking Assets	%
1992	34,200	77,500	44	52,200	62,500	84	6,900	9,100	75	77,600	129,600	60
1993	34,300	68,400	50	54,300	60,900	89	7,100	9,600	74	82,700	142,800	58
1994	37,000	73,700	50	57,200	62,300	92	8,000	10,700	75	85,400	146,300	58
1995	40,000	73,700	54	63,900	69,800	92	9,100	11,900	77	89,600	150,100	60
1996	42,500	76,600	55	67,600	77,100	88	9,800	12,500	79	93,900	156,400	60
1997	44,900	83,500	54	77,200	89,100	87	11,100	13,700	81	105,000	163,900	64
1998	48,700	99,400	49	82,600	97,300	85	12,000	14,800	81	111,500	171,400	65
1999	55,200	102,100	54	88,700	103,300	86	13,000	16,300	80	121,700	172,200	71
2000	57,400	106,400	54	93,800	103,600	90	14,500	18,900	77	131,900	181,300	73
Average	43,800	84,600	52	70,800	80,600	88	10,200	13,100	78	99,900	157,100	63

Source: The total assets were extracted from the annual financial reports of the monetary agencies in the countries under study (the consolidated financial statements of the banks) while the sample was drawn from the London Bankscope database (January, 2000 & 2002).

Our sample represents the major financial institutions that have consistently published their financial statements over the last ten years in the countries under study. The relative size of Bahrain's banks sample looks small and the reason is that the financial system in this country has been dominated by offshore banking units which are excluded from the sample as these belong to large international financial institutions and their data are unavailable. In Saudi Arabia, the specialised government institutions, while important, do not publish detailed financial statements and so these are not included in the sample.

Table 2 shows the specialisation of the banks included in the sample. The number of commercial banks comprises around 66% of the total sample. The percent of commercial banks operating in each country varies; ranging from 42% in Bahrain to 77% in Saudi Arabia.

Table 2: Specialisation of banks under study, 1992-2000

% of total	Bahrain	Egypt	Jordan	Saudi Arabia	All
Commercial	44	76	57	77	66
Investment	28	8	29	8	16
Islamic	17	5	7	0	7
Other	11	11	7	15	11
Total Number	18	37	14	13	82

Source: Bankscope (Jan. 2000 & 2002)

Table 3 shows that the size of total assets of all the banks included in the present study increased from about US$ 180 billion in 1992 to about US$ 310 billion in 2000 and averaged about US$ 235 billion over the whole period. Dividing these financial institutions into nine size categories, the share of the largest banks (with assets size greater than US$ 5 billion) constituted around 70 percent of the total assets of all the banks over the period 1992-2000.

Table 3: Distribution of banks' assets in Jordan, Egypt, Saudi Arabia and Bahrain, 1992-2000

	1992	1993	1994	1995	1996	1997	1998	1999	2000	Avg.
	%	%	%	%	%	%	%	%	%	US$, mil.
1-99.9	0.11	0.08	0.14	0.16	0.14	0.10	0.06	0.02	0.02	202
100-199.9	1.16	1.05	0.78	0.35	0.31	0.18	0.21	0.29	0.27	1,073
200-299.9	1.76	1.35	1.10	1.78	1.04	0.80	0.67	0.36	0.32	2,173
300-499.9	3.78	4.08	3.47	2.79	2.92	2.75	2.49	2.04	1.58	6,422
500-999.9	2.56	2.73	4.64	4.57	4.51	3.53	3.67	3.47	3.29	8,569
1,000-2,499.9	11.87	11.50	9.89	13.09	10.02	11.31	11.84	10.51	10.15	25,911
2,500-4,999.9	8.29	8.56	4.68	4.94	7.12	6.65	6.50	7.66	8.26	16,470
5,000-9,999	18.22	19.28	24.51	26.23	24.40	26.82	14.88	19.13	9.28	46,196
10,000+	52.26	51.37	50.78	54.22	49.54	47.85	59.67	56.53	66.83	129,190
T. Assets (US$, mil., nominal values)	179,033	186,975	197,046	213,044	225,426	250,325	267,943	292,855	313,209	

Source: Bankscope (Jan. 2000 & 2002)

This study employs the intermediation approach for defining bank inputs and outputs. Following Aly et al. (1990), the inputs used in the calculation of the various efficiency measures are deposits (w_1), labour (w_2) and physical capital (w_3). The deposits include time and savings deposits, notes and debentures, and other borrowed funds. The price of loanable funds was derived by taking the sum of interest expenses of the time deposits and other loanable funds divided by loanable funds. Labour is measured by personnel expenses as a percent of total assets*. Bank physical capital is measured by the book value of premises and fixed assets (including capitalised leases). The price of capital was derived by taking total expenditures on premises and fixed assets divided by total assets. The three outputs used in the study includes total customer loans (y_1), all other earning assets (y_2), and off-balance sheet items (y_3), measured in millions of US dollars.

The off-balance sheet items (measured in nominal terms) were included as a third output. Although the latter are technically not earning assets, these constitute an increasing source of income for banks and therefore should be included when modelling the banks' cost characteristics; otherwise, total banks' output would tend to be understated (Jagtiani and Khanthavit, 1996). Furthermore, these items are included in the model because they are often effective substitutes for directly issued loans, requiring similar information-gathering costs of origination and ongoing monitoring and control of the counterparts, and presumably similar revenues as these items are competitive substitutes for direct loans.

The definitions, means, standards of deviation of the input and output variables used in the stochastic frontier estimations are reported in table 4. The table shows that the average bank had US$ 1.26 billion in loans, US$ 1.39 billion other earning assets and US$ 1.32 billion of balance sheet items over 1992-2000. The cost of input variables averaged about 7.0 percent for purchased funds, 2.0 percent for labour and 1.0 percent for physical capital over the period 1992-2000. On the other hand, the prices of banks output averaged about 15.0 percent for loans*; 5.0 percent for other earning assets and 1.0 percent for off-balance sheet items over the same period.

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* As staff numbers were not available for the banks in the sample, we used this measure instead. This measure for staff costs has been used in various previous studies including Altunbas et al. (1996) and (1999).

* This may be an overstatement as interest earned on bonds is also included in this figure.

Table 4: Descriptive statistics of the banks' inputs and outputs for Jordan, Egypt, Saudi Arabia and Bahrain over 1992-2000

Variables	Description	Mean	St. Dev	Min.	Max.
TC	Total cost (includes Interest expense, Personnel expense, Commission expense, Fee expense, Trading expense, other operating expense) (US$ millions).	170	300	0	1,720
W1	Price of funds (%) (total interest expense/ total customer deposits (demand, saving and time deposits)).	0.07	0.09	0.00	1.98
W2	Price of labour (%) (total personnel expense/total assets).	0.02	0.01	0.00	0.21
W3	Price of physical capital (Non-interest expense/Average assets).	0.01	0.01	0.00	0.21
Y1	The US $ value of total aggregate loans (all types of loans) (US$ millions).	1,260	2,280	1	15,060
Y2	The US $ value of total aggregate other earning assets (short-term investment, equity and other investment and public sector securities (US$ millions)).	1,390	2,470	1	13,600
Y3	The US $ value of the off-balance sheet activities (nominal values, US$ millions).	1,320	3,510	1	26,740
p1	Price of loans (%) (total earned interest/ Total loans).	0.15	0.07	0.01	0.87
p2	Price of other earning assets (%) (Trading income and other operating income excluding commission and fees income/Other earning assets).	0.05	0.04	0.01	0.33
P3	Price of off-balance sheet items (%) (Commission and fees income/ off-balance sheet items).	0.01	0.02	0.00	0.20

Source: Bankscope (Jan. 2000 & 2002)

In addition to the above input and output variables, the present study employs a variety of control and environmental variables[*] to rule out the effect of other factors that might explain differences among efficiency estimates for the banks under study. The three control variables included in our model include the size of loan loss reserves as a percent of bank's credit portfolio, the capital adequacy ratio, and a time trend (see table 5 below for details). The loan loss reserves as a proportion of gross loans ranged between 0.01 and 19.68 percent, the latter figure suggests that some banks faced substantial credit quality problems. The total banks' capital as a percentage of total assets averaged around 14.0 percent with a standard deviation of

[*] The control variables enter into the stochastic frontier model in the same way as the input variables (as betas) and these variables are fully interactive with other parameters of the model; On the other hand, the environmental variables are not interactive with other model parameters and added to the model as delta (as will be shown later).

12.0 percent, this reflects sizeable differences in the capital adequacy of the banks under study.

The size of loan loss reserves as a proportion of gross loans is added to the model to control for the bank's risk structure. It is also used as a measure of bank's asset quality and as a measure of the bank's management efficiency in monitoring the credit portfolio. A lack of diversity in a bank's asset portfolio may be associated with increases in problem loans without sufficient provisioning, exposing bank's capital to risk and potential bankruptcy that might be closely related to the quality of bank management. Banks facing financial distress have been found to carry large proportions of nonperforming loans (Whalen, 1991). Furthermore, studies on bank failures suggest a positive relationship between operating inefficiency and failure rates (see for example, Cebenoyan, Cooperman, and Register, 1993; Hermalin and Wallace, 1994; Wheelock and Wilson, 1995). Barr, Seiford and Siems (1994) found that this positive relationship between inefficiency and failure is evident a number of years ahead of eventual failure. Kwan and Eisenbeis (1994) report that problem loans are negatively related to efficiency even in non-failing banks. Berger and DeYoung (1997) found a link between management quality and problem loans by reporting that an increase in management quality reduces the bank's problem loans.

Hughes et al. (1996a, b) and Mester (1996) included the volume of nonperforming loans as a control for loan quality in studies of US banks, and Berg et al. (1992) included loan losses as an indicator of loan quality evaluations in a DEA study of Norwegian bank productivity. Whether it is appropriate to include nonperforming loans and loan losses in bank's cost, standard and alternative profit functions depends on the extent to which these variables are exogenous. Such variables would be exogenous if caused by negative economic shocks "bad luck", but they could be endogenous, either because management is inefficient in managing its portfolio "bad management" or because it has made a conscious decision to reduce short-run expenses by cutting back on loan origination and monitoring resources "skimping". Berger and DeYoung (1997) tested the bad luck, bad management, and skimping hypotheses and found mixed evidence on the exogeneity of nonperforming loans.

Another important aspect of efficiency measurement is the treatment of financial capital. A bank's insolvency risk depends on the financial capital available to absorb portfolio losses, as well as on the portfolio risk themselves. Even apart from risk, a bank's capital level directly affects costs by providing an alternative to deposits as a funding source for loans. On the other hand, raising equity typically involves higher costs than raising deposits. If the first effect dominates, measured costs will be higher for banks using a higher proportion of debt financing; if the second effect dominates, measured costs will be lower for these banks. Large banks depend more on debt financing to finance their portfolios than small banks do, so failure to control for equity could yield a scale bias. The specification of capital in the cost and profit functions also goes part of the way toward accounting for different risk preferences on the parts of banks. Therefore, if some banks are more risk averse than others, they may hold a higher level of financial capital than maximising profits or minimising costs. If financial capital is ignored, the efficiency of these banks would be mismeasured, even though they behave optimally given their risk preferences. Hughes et al. (1996a, b, 1997) and Hughes and Moon (1995) tested and rejected the assumption of risk neutrality for banks. Clark (1996) included capital in a model of economic cost and found that it eliminated measured scale diseconomies in production costs alone. The cost studies of Hughes and Mester (1993) and the Hughes et al. (1996a, 1997) profit studies incorporated financial capital and found increasing returns to scale at large-asset-size banks. A possible reason is that large size confers diversification benefits that allow large banks to have lower capital ratios than smaller banks. Akhavein et al. (1997a) controlled for equity capital and found that profit efficiency increases as a result of mergers of large banks. Bank's capital is also included in the model of Berger and Mester (1997) who find that well-capitalised firms are more efficient. This positive relationship between capital and efficiency may indicate that inefficient banks with lower capital have less to lose in taking more risky projects than an efficient bank. This is consistent with moral hazard and agency conflict between mangers and shareholders where less monitored mangers with lower equity have incentives to expense preference.

The environmental variables (or efficiency correlates) were also added to the model to investigate the reason for the differences in efficiency scores across banks under study. These include variables that control for market structure and organisational characteristics, geographical segmentation and bank liquidity. We identify variables to account for bank specialisation, bank size and concentration in the respective banking industries. Financial institutions in each country are divided into four categories; commercial, investment, Islamic and other financial institutions (that perform various bank functions). Furthermore, we employ the 3-firm asset concentration ratio which is widely used to test for monopoly characteristics. Furthermore, we include a dummy variable to control for bank geographical (countries) location (Table 5 shows descriptive statistics of the control and environmental variables).

Table 5: Descriptive statistics of the banks' control and environmental variables for Jordan, Egypt, Saudi Arabia and Bahrain over 1992-2000

Variables	Description	Mean	St. Dev	Min	Max
The control Variables					
K	Capital Adequacy (%) (Total Equity/ Total Assets)	0.14	0.12	0.01	0.72
S	Asset Quality (Loan Loss Reserve / Gross Loans)	0.22	0.81	0.01	19.68
T	Time Trend	5.00	2.58	1.00	9.00
The Environmental Variables					
TA	Total Assets (US$ millions)	2,881	4,966	35	26,70
B	Dummy variable for Bahrain	0.22	0.41	0.00	1.00
J	Dummy variable for Jordan	0.17	0.38	0.00	1.00
E	Dummy variable for Egypt	0.45	0.50	0.00	1.00
Com.	Dummy variable for commercial banks	0.66	0.47	0.00	1.00
Inv.	Dummy variable for investment/ securities banks	0.16	0.37	0.00	1.00
Isl.	Dummy variable for Islamic banks	0.07	0.26	0.00	1.00
L	Liquidity ratio (%) (Total liquid assets/ Total Assets)	0.14	0.16	0.00	0.71
3-FCR	Three firm concentration ratio (%) (the largest 3 banks total assets of /Total assets of all banks in the bank country for the respective years)	0.62	0.14	0.48	0.81
MS	Bank assets market share (%) for each year	0.05	0.10	0.00	0.68

Source: Bankscope (Jan., 2000, 2002)

The total assets variable is used to control for bank size where bank size should be strongly associated with efficiency as size may be required to utilise scale and (maybe) scope economies (if large banks are more diversified). Furthermore, larger banks may have more professional management teams and/or might be more cost conscious due to greater pressure from owners concerning the bottom-line profits (Evanoff and Israilevich, 1991). Berger et al. (1993) found that most of the efficiency differences among large banks was on the output side as larger banks might be better able to reach their optimal mix and scale of outputs. On the other hand, Hermalin and Wallace (1994), Kaparakis et al. (1994), DeYoung and Nolle (1996) found significant negative relationships. Other studies, however, report no significant relationship between bank size and efficiency, such as Aly et al. (1992), Cebenoyan et al. (1993), Mester (1993), Pi and Timme (1993), Mester (1996), Berger and Hannan (1995), Berger and Mester (1997), and Chang et al. (1998).

The 3-firm concentration ratio and market share variables were included to control for oligopoly behaviour along the lines of the traditional structure-conduct-performance paradigm (see Molyneux et al., 1996) and as an indicator of the characteristics of the respective banking industry structures. The Cournot model of oligopolistic behaviour suggests that there is a positive relationship between concentration and profitability. Consistent with this model, some studies have found a positive relationship between market concentration and profitability (Berger and Hannan, 1997; Berger and Mester, 1997). The market power that prevails in the less competitive markets enables some banks to charge higher prices for their services and make supernormal profits. Banks may exert their own market power through size as noted by Berger (1995) and so we include a market share variable to control for what Berger refers to as ‘relative market power’.

Dummy variables for bank specialisation are also included in the model so as to control for the product diversity as efficiency might associated with firm’s strength in carefully targeting its market niches. The cost of producing various products might be lower when specialised banks produce them rather than when a single bank produces all the products due to diseconomies of scope. There are number of studies that have examined the impact of product diversity on efficiency. Aly et al. (1990) found a negative relationship between product diversity and cost efficiency. Ferrier, Grosskopf, Hayes and Yaisawarng (1993) found that banks with greater product diversity tend to have lower cost efficiency. Chaffai and Dietsch (1995) compared the efficiency of universal versus non-universal (more specialised) banks in Europe and found the former to be less cost efficient.

Finally, the liquidity ratio is included to account for bank's liquidity risk. Banks that hold more liquidity may be expected to have lower liquidity risk but may be less profit efficient as liquid assets tend to yield lower returns. In contrast, as liquid assets are controlled in outputs, one would expect banks with higher liquid assets (all other things being equal) to be more cost efficient.

4. Results: Efficiencies and Productivity Changes

This section presents the steps undertaken for our preferred cost model. This includes employing different models utilised in the banking efficiency literature based on different assumptions concerning the distribution of efficiency terms. In addition, various hypotheses are tested, given different combination of control and environmental variables, to arrive at the preferred models based on maximum likelihood estimation*. Based on the preferred model, we present cost efficiency, scale elasticity and scale efficiency measures for the banks under study.

4.1 Estimating the Preferred Model

There are three stages undertaken to arrive at the preferred model for our cost function estimates. The first stage involves utilising Battese and Coelli's (1995)

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* The Maximum Likelihood (ML) and Log-likelihood (LL) functions are the basis for deriving parameters estimates, given certain data. While the shapes of these two functions are different, they have their maximum point at the same value. Both seek to estimate the value of p (the unknown parameter in the model) that maximises the ML or LL function given the data z. The MLE have many statistical appealing features especially when the sample size is large. First, consistency: as the sample size increases, the MLEs converge to the true parameters values. Second, asymptotic normality and efficiency (i.e., as the sample size increases, the sampling distribution of the MLE converges to normality with least possible variance (Hence, estimates obtained typically have the smallest confidence intervals)). The MLE of unknown parameter, $\hat{p}$ is the value of p that corresponds to the maximum of L(p/z) that is most likely to have produced from data z. Since it is easier to deal with addition rather than multiplication, the problem is generally tackled in the log form. This is called the log likelihood function that truly maximises the sum of the log likelihoods by choosing the parameters that give identical results to maximising the untransformed likelihood. The log likelihood takes the following form:

$$\log(L) = -(n/2)\log(2\pi) - (n/2)\log(\sigma_u^2) - (1/2)\sigma_u^2 \sum_i (Y_i - a - bX_i)^2$$

approach that allows us to include the efficiency correlates directly in the model estimation. The second stage involves utilising Battese and Coelli's (1992) time-varying efficiency approach that gives flexibility to examine different assumptions concerning the distribution of efficiency terms, comparing time-variant versus time-invariant models but it does not allow for the inclusion of efficiency correlates in the model. Finally, stage 3 compares the best specified models in stage 1 and stage 2 to arrive at a single preferred model from the two stages and provides the basis for the model choice.

Stage 1: Estimating the Cost Frontier Models that include Efficiency Correlates

This stage estimates the stochastic frontier for the cost function, given the Fourier-flexible functional form that includes efficiency correlates. This stage follows Dietsch and Lozano-Vivas (2000) who emphasise the importance of including country and other specific information in common frontier estimations of bank efficiency. This stage is conducted using the approach suggested by Battese and Coelli's (1995) technical inefficiency effects model that allows us to include firm-specific (and country-specific variables) directly into the model as these might explain some of the efficiency differences between banks as well as the variation in bank inefficiency overtime.

Battese and Coelli's (1995) model defines the inefficiency term u_{it} as non-negative variables that account for technical inefficiency and are assumed to be independently and identically distributed (iid) as truncations at zero of the $N(\delta_{it}d, \sigma^2_{u_{it}})$ distribution. This methodology follows Kumbhakar, Ghosh and McGukin (1991) and Reifschneider and Stevenson (1991) and Battese and Coelli (1991) who propose a stochastic model in which u_i are stated as an explicit function of a vector of firm-specific variables and random error. According to Coelli (1996), this specification proves to be better than that of Pitt and Lee (1981) who have estimated stochastic frontiers and predicted firm-level efficiencies using these estimated functions, and then regressed the predicted efficiencies upon firm-specific variables (such as managerial experience, ownership characteristics, etc.) in an attempt to identify some of the reasons for differences in predicted efficiencies between firms. Furthermore, the two-stage procedure utilised by Pitt and Lee (1981) has been recognised as one which is inconsistent in its assumptions regarding the independence of the inefficiency effects in the two estimation stages.

In order to derive the bank efficiency model that includes firm-specific variables, we employ the control and environmental variables detailed earlier. The control variables include the loan loss reserves as a percent of loans, capital strength and a time trend. The loan loss reserve as a percent of gross loans is included to control for asset quality. Capital strength is measured by the ratio of equity to total asset ratio. A time trend variable is included in the model (table 5 shows descriptive statistics of these variables). Environmental variables are employed, as a set of explanatory variables, to control for organisational characteristics, geographical location. Organisational characteristics refer to the structure of the financial systems in the countries under study. We identify three ratios to test these characteristics; dummy variables for bank specialisation, bank market share and concentration in the pertinent banking systems. The banks in each country are divided into four categories; commercial, investment, Islamic and other financial institutions. Furthermore, we employ the 3-firm concentration ratio which is widely used to test for monopoly characteristics in the pertinent market. Furthermore, we include dummy variables to control for bank geographical (country) location.

To reach the best-specified model in this stage, we have examined many hypotheses which can be summarised in the following steps:

Step 1: Estimating the Fourier-Truncated with different Combination of Control Variables (see table 6 for details)

1.1. The unrestricted Fourier-flexible model is estimated assuming inefficiency to be truncated. This model includes all the control variables (bank's capital, bank's asset quality and the time trend) and all the efficiency correlates (the environmental variables). This general model will be compared later with some other models to decide upon (based on maximum-likelihood ratio tests) preferred model specifications utilising different combinations of control variables.

1.2. The Fourier-truncated model that includes the efficiency correlates is estimated but without the time parameters. This is done to examine whether there has been any technical change over the sample period. This involves restricting all the coefficients associated with the time trend equal to zero. Next, we estimate the model but without the capital parameters. Then, we estimated the model without the risk (bank's asset quality) parameters.

At this point, there are three null hypotheses to be examined. The first null hypothesis is that the specification of the truncated model without time parameters is better than that of the unrestricted model in (**1.1**). The second null hypothesis states that the specification of the truncated model without the risk parameters is better than that of the unrestricted model. The third null hypothesis states that specification of the truncated model without capital parameters is better than that of the unrestricted model. The alternative hypothesis (Ha) against these hypotheses is that the full model (**1.1**) is better specified than these restricted models.

As table 6 shows, based on the log-likelihood one-sided ratio[*], only the null hypothesis that the model without time-parameters is better specified model is accepted at the critical value of 5% while the other null hypotheses are rejected. In other words, the value of the generalised likelihood-ratio statistics compared with those of the upper five per cent point for χ-square (for the appropriate degree of freedom) were not in favour of accepting these null hypotheses. This means that the model without time parameters are better specified than the unrestricted model (**1.1** above).

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[*] The Maximum likelihood (ML) provides a convenient way to test the hypotheses in the form of the Log-likelihood ratio (LR) that examines whether a reduced model provides the same fit as a full model. This ratio allows us to test whether the likelihood estimates for parameters are significantly different from other fixed values. It permits to compare the likelihood of the data under one hypothesis against the likelihood of the data under another (more restricted) hypothesis. The LR shows whether the data are significantly less likely to have arisen if the null hypothesis is true than if the alternate hypothesis is true?. The difference between the likelihoods is multiplied by a factor of 2 for technical reasons, so that this quantity will be distributed as the familiar χ^2 statistic. The LR test statistic is given by $LR = -2[L(\hat{\Theta}_r / z) - L(\hat{\Theta} / z)]$ where $L(\hat{\Theta} / z)$ is the likelihood function evaluated at the MLE where $L(\hat{\Theta}_r / z)$ is the maximum if the likelihood function, subject to the restriction that r unconstrained parameters in the full likelihood analysis are assigned fixed values. For sufficiently large sample size, the LR test statistic is χ_r^2 -distributed, a χ^2 with r degrees of freedom (Wald, 1943). The degrees of freedom equal the difference in the number of parameters being estimated under the alternate and null models.

1.3. The Fourier-truncated model that includes the efficiency correlates is estimated without time and capital parameters simultaneously. Next, the model is estimated without time and risk parameters. Then, the model is estimated without risk and capital parameters.

Again here, we have three null hypotheses that need to be examined. The first null hypothesis states that the Fourier-truncated that includes the efficiency correlates but without time and capital parameters is specified better than the models in **1.1** and **1.2** above. The second null hypothesis states that the truncated model without time and risk parameters is better specified than those in **1.1** and **1.2**. Finally, the third null hypothesis states that the truncated model without risk and capital parameters is better specified than those in **1.1** and **1.2**. Based on the log-likelihood ratio, all the null hypotheses are rejected (table 6 shows the details).

1.4. The Fourier-truncated that includes the efficiency correlates is estimated but without any of the control variables (capital, risk and time) in the model. In this case, the null hypothesis states that Fourier-truncated model excluding the control variables is specified better than the models specified in **1.1, 1.2** and **1.3** above. Based on the maximum likelihood ratio, this model is not rejected at critical level of 5%. Therefore, the best specified model up to this step is the Fourier-truncated that excludes all the control variables.

Step 2: Comparing Fourier Specification with Translog Specification

In this step, we will compare the best Fourier specifications concluded from **step 1** with identical translog specifications. The null hypothesis in this step states that translog specifications are more appropriate than the Fourier specifications for estimating efficiency. The alternative hypothesis states that translog specification is not better than that of the Fourier. Based on the log-likelihood ratio, the null hypothesis is rejected at the 5% significance level. This means that the data is better specified utilising the Fourier than the translog form.

Step 3: Examining the Impact of Efficiency Correlates (the Environmental Variables) on the Model Specification

The best specified model up to **step 1** and **2** above is the Fourier-truncated that includes the efficiency correlates (environmental variables) but does not include any of the control variables. In the following, we estimate the Fourier-truncated without including the efficiency correlates. In this case, the null hypothesis states that the specified truncated model without efficiency correlates is better than the model that includes them. The alternative hypothesis, on the other hand, states that the model that excludes the efficiency correlates is not specified better than the model that includes them. Based on the log-likelihood ratio, the null hypothesis is rejected in favour of the alternative hypothesis that necessitates the existence of such variables in the model (see table 6 for details).

Step 4: Examining the Impact of Inefficiency-Terms on the Model Specification

In this step, the best specified model selected until **step 3** will be compared with the model that excludes the inefficiency term from the model. The null hypothesis here states that the inefficiency effects in the cost function are not present, and so the banks are fully technically efficient. If this is the case, the technical inefficiency error term, U_{it}, would be removed from equation, and the resulting model would be appropriately estimated using OLS. This hypothesis is rejected and so, the model which accounts for technical inefficiency is warranted in these instances (see table 6 for details).

Based on the results of the steps above, the best specified model from **stage 1** is the Fourier-truncated model that excludes the control variables (time trend, capital adequacy and asset quality) but includes the efficiency correlates (table 6 shows the details).

Stage 2: Estimating the Cost Frontier Models that exclude Efficiency Correlates

This stage estimates the stochastic frontier, given the Fourier-flexible functional form that excludes efficiency correlates. The models in this stage are estimated utilising Battese and Coelli's (1992) time-varying approach. This approach gives some flexibility concerning the distribution of inefficiency term in the stochastic frontier; truncated or half normal. Furthermore, it allows us to examine the time-varying efficiency model against the time-invariant model. Therefore, one of the advantages of the time-varying inefficiency model is that the technical inefficiency changes overtime can be distinguished from technical change, provided the latter is specified in the model parameters, in the frontier function. This discrimination is only possible given that the technical inefficiency effects are stochastic and have the specified distributions. However, this approach does not allow us to add the efficiency correlates directly into the model.

The inefficiency term u_{it} s in this model is assumed to be an exponential function of time, involving only one unknown parameter. The technical inefficiency effects are assumed to be defined by

$$u_{it} = \{exp[-\eta(t-T)]\}u_i \ , \quad i = 1,2,...,N; \ t = 1,2,...,T;$$

where u_{it} s are assumed to be independently and identically distributed (i.i.d.) as the generalised truncated-normal random variable and η is an unknown scalar parameter to be estimated. The major disadvantages of this time-varying model is that the technical inefficiency effects of different firms at any given time period, t, are equal to the identical exponential function ($exp[-\eta(t-T)] \equiv exp[\eta(T-t)]$) of the corresponding firm-specific inefficiency effects at the last period of the panel (the u_{it} s). This implies that the ordering of the firms according to the magnitude of the technical inefficiency effects is the same at all time periods. Thus, the time-varying model of the equation does not account for situations in which some firms may be relatively inefficient initially but become relatively more efficient in subsequent periods.

In our search for the best model specification utilising this model, we follow studies that assume no restriction to be imposed on the distributional features of the inefficiency term. These studies include Cebenoyan et al. (1993) who use the truncated normal model, Stevenson (1980) and Greene (1990) who use the normal and gamma distribution respectively. Then, we restricted Mu (μ) to be zero to obtain Pitt and Lee's (1981) half-normal model. The studies that use the half-normal specification to model inefficiency in banking include Allen and Rai (1996), Kaparakis et al. (1994) and Mester (1996). Next, we restrict both Mu (μ) and Eta (η) to be zero to get the time-invariant model as outlined in Battese, Coelli and Colby (1989). All the above models assume that the inefficiency term to be independently and identically as truncations at zero of the N(μ, σ_u^2) distribution. This definition of the inefficiency term conforms to the original definition of the stochastic frontier, which was proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and Van de Broeck (1977).

The following steps summarise the procedures followed to arrive at the most appropriate model specifications in this stage using Battese and Coelli's (1992) approach:

Step 1: Comparing the Fourier-Truncated Time-Variant with Time-Invariant Model

The specification of the estimated truncated time-variant model is compared with the truncated time-invariant model and the better specified model is chosen based on the log-likelihood ratio test. The null hypothesis in this step states that the specification of Fourier-truncated time-invariant model is better than the time-variant model. The null hypothesis in this step is rejected, as the time-invariant model cannot be specified using the stochastic frontier methodology (see table 7 for details).

Step 2: Fourier Truncated Time-Variant versus Fourier Half-Normal Time Variant Model

The specification of the truncated time-variant model chosen from step 1 is compared with the half-normal time-variant model. Here, the null hypothesis states that the half-normal time-variant model specification is better than the specification of the truncated time-variant model. Utilising the log-likelihood ratio, the null hypothesis is rejected given the appropriate degree of freedom.

Step 3: Fourier-Truncated with Different Combinations of Control Variables

The Fourier-truncated time-variant model is estimated with different combinations of control variables to see if we can accept simpler model specification for our data. In this step, there are seven hypotheses examined. The first one states that the specification of the Fourier-truncated time-variant model without time parameters is better than the model specified in **step 1** and **2** above. The second hypothesis examines the model without risk parameters and the third examines the model without the capital parameters. The fourth hypothesis examines the model without time and risk parameters at the same time. The fifth hypothesis examines the model without time and capital parameters. The sixth hypothesis examines the model without capital and risk parameters. Finally, the seventh hypothesis examines the model specification without any of the control variables (capital, risk and time trend). Comparing the estimated models in this step and based on the log-likelihood ratio, the most appropriate model is the Fourier-truncated time-variant model without the control variables (see table 7 for details).

Step 4: Comparing the Fourier-Specification with Translog Specification

In this step, we compare the Fourier-truncated model specifications selected in **step 3** above with the translog form given an identical specification. At this point, the null hypothesis states that the translog specification is more appropriate than the Fourier specification. The null hypothesis is not rejected and so, the best specified model in this stage is the translog-truncated without the control variables.

Stage 3: Comparing the Models from Stage 1 and Stage 2

It should be noted that we cannot formally compare directly the results of **stage 1** and **stage 2** above because we utilise Battese and Coelli's (1995) approach in the first stage and Battese and Coelli's (1992) approach in the second stage. The first approach does not have the second approach as a special case, and neither does the converse apply. Thus, these two model specifications are non-tested and hence no set of restrictions can be defined to permit a test of one specification versus the other.

However, the second approach suffers from a main weakness as indicated earlier; that is the technical inefficiency effects of different firms at any given time period, t, are equal to the same exponential function ($exp[-\eta(t-T)] \equiv exp[\eta(T-t)]$) of the corresponding firm-specific inefficiency effects at the last period of the panel (the u_{it} s). This implies that the ordering of the firms according to the magnitude of the technical inefficiency effects is the same at all time periods. Thus, the time-varying model of equation does not account for situations in which some firms may be relatively inefficient initially but become relatively more efficient in subsequent periods. (Furthermore, as Battese and Coelli (1995) indicated, a small error was detected in the first partial derivative with respect to η in the 1992 model of the program. This error would have only affected results when η was assumed to be non-zero).

Therefore, if the above two stages lead more or less to the same model specifications, we will take the efficiency estimates of the first stage which utilises the 1995 approach. However, if the two stages lead to different preferred model specifications, we will report the results of two stages and then compare the efficiency estimates result from each stage.

In the case of the cost function, the first stage leads us to select the Fourier-truncated without control variables but with efficiency correlates. The second stage leads us to select the translog-truncated without control variables as well. As such, it is plausible to assume that the inclusion of efficiency correlates in the first stage is the reason for the selection of the Fourier over translog in the first stage. Furthermore, as the second stage is estimated utilising Battese and Coelli's (1992) approach which does not allow us to include directly the efficiency correlates in the model and since there is no major differences between the specifications of the two stages, we will choose the result of **stage 1** as the cost preferred model; the Fourier-truncated model excluding control variables (capital, risk and time trend) but including all the efficiency correlates(the parameter estimates of the preferred model are shown in Table 8).

Table 8: Maximum Likelihood Estimates of the Preferred Cost Function Model

	The variables (all are logged)	coefficient	standard-error	t-ratio
□		115.71	0.97	118.76
□1	lny1	0.54	0.54	1.00
□□	lny2	0.78	0.90	0.87
□□	lny3	0.17	0.38	0.44
□1	Lnw1/w3	-14.15	0.65	-21.92
□□	lnw2/w3	28.76	0.45	63.58
□11	lny1lny1	0.08	0.08	1.05
□1□	lny1lny2	-0.15	0.08	-1.77
□1□	lny1lny3	-0.05	0.08	-0.65
□11	lny1lnw1/w3	0.07	0.19	0.38
□1□	lny1lnw2/w3	0.18	0.27	0.65
□□□	lny2lny2	0.01	0.13	0.09
□□□	lny2lny3	0.07	0.07	0.97
□□1	lny2lnw1/w3	0.02	0.24	0.08
□□□	lny2lnw2/w3	0.03	0.05	0.57
□□□	lny3lny3	-0.02	0.03	-0.59
□□1	lny3lnw1/w3	-0.01	0.14	-0.09
□□□	lny3lnw2/w3	-0.08	0.30	-0.27

	The variables (all are logged)	coefficient	standard-error	t-ratio
□11	lnw1/3lnw1/w3	3.16	0.40	7.97
□1□	lnw1/w3lnw2/w3	-1.69	0.36	-4.65
□□□	lnw2/w3lnw2/w3	-16.62	0.38	-43.26
□1	Cos(y1)	-0.19	0.27	-0.70
□1	Sin(y1)	0.03	0.38	0.08
□□	Cos(y2)	0.02	0.28	0.08
□□	Sin(y2)	0.03	0.22	0.13
□□	Cos(y3)	0.03	0.30	0.10
□□	Sin(y3)	0.00	0.17	0.00
□□	Cos(w1/w3)	-4.00	0.56	-7.10
□□	Sin(w1/w3)	3.87	0.51	7.56
□□	Cos(w2/w3)	-15.04	0.78	-19.18
□□	Sin(w2/w3)	-14.05	0.76	-18.46
□11	Cos(y1+y1)	0.00	0.02	-0.13
□11	Sin(y1+y1)	-0.03	0.04	-0.68
□1□	Cos(y1+y2)	0.04	0.08	0.55
□1□	Sin(y1+y2)	-0.05	0.09	-0.54
□1□	Cos(y1+y3)	0.00	0.06	0.02
□1□	Sin(y1+y3)	0.00	0.04	0.11
□1□	Cos(y1+w1/w3)	-0.03	0.26	-0.12
□1□	Sin(y1+w1/w3)	0.08	0.12	0.63
□1□	Cos(y1+w2/w3)	0.05	0.21	0.24
□1□	Sin(y1+w2/w3)	-0.03	0.27	-0.10
□□□	Cos(y2+y2)	-0.01	0.07	-0.13
□□□	Sin(y2+y2)	0.04	0.01	5.96
□□□	Cos(y2+y3)	0.00	0.03	0.03
□□□	Sin(y2+y3)	0.00	0.04	-0.07
□□□	Cos(y2+w1/w3)	-0.01	0.20	-0.03
□□□	Sin(y2+w1/w3)	-0.10	0.16	-0.61
□□□	Cos(y2+w2/w3)	0.03	0.09	0.36
□□□	Sin(y2+w2/w3)	0.03	0.34	0.10
□□□	Cos(y3+y3)	0.01	0.00	1.67
□□□	Sin(y3+y3)	0.00	0.04	-0.02
□□□	Cos(y3+w1/w3)	-0.01	0.10	-0.13
□□□	Sin(y3+w1/w3)	0.01	0.33	0.03
□□□	Cos(y3+w2/w3)	-0.02	0.20	-0.08
□□□	Sin(y3+w2/w3)	-0.02	0.14	-0.17
□□□	Cos(w1/w3+w1/w3)	0.09	0.33	0.29
□□□	Sin(w1/w3+w1/w3)	1.14	0.42	2.70
□□□	Cos(w1/w3+w2/w3)	0.96	0.51	1.89
□□□	Sin(w1/w3+w2/w3)	0.14	0.24	0.57
□□□	Cos(w2/w3+w2/w3)	0.24	0.50	0.49
□□□	Sin(w2/w3+w2/w3)	3.81	0.42	9.05
□111	Cos(y1+y1+y1)	-0.01	0.05	-0.25
□111	Sin(y1+y1+y1)	0.02	0.02	0.65
□□□□	Cos(y2+y2+y2)	0.00	0.02	-0.21
□□□□	Sin(y2+y2+y2)	0.00	0.03	-0.10
□□□□	Cos(y3+y3+y3)	0.01	0.02	0.36
□□□□	Sin(y3+y3+y3)	0.00	0.03	-0.06
□□□□	Cos(w1/w3+w1/w3+w1/w3)	0.33	0.17	1.90
□□□□	Sin(w1/w3+w1/w3+w1/w3)	0.23	0.22	1.01
□□□□	Cos(w2/w3+w2/w3+w2/w3)	0.32	0.28	1.11
□□□□	Sin(w2/w3+w2/w3+w2/w3)	-0.58	0.19	-2.99
□̃		-0.05	0.57	-0.08
□1	L	0.13	0.56	0.23
□□	TA	0.00	0.00	0.34
□□	B	-0.09	0.23	-0.40

	The variables (all are logged)	coefficient	standard-error	t-ratio
□□	J	0.13	0.69	0.18
□□	E	0.11	0.25	0.43
□□	Com	0.01	0.61	0.01
□□	Inv.	0.05	0.47	0.10
□□	Isl.	-0.06	0.39	-0.16
□□	3-FCR	-0.02	0.16	-0.12
□1	MS	-0.17	1.26	-0.14
sigma-squared (S)		0.08	0.01	9.42
Gamma		0.008	0.006	1.263
Sigma-squared		0.001		
Sigma-squared (v)		0.082		
Lambda		0.089		
The relative contribution of the inefficiency effect to the total variance term		0.003		
Log likelihood function		69.06		
LR test of the one-sided error		90.72		
[note that this statistic has a mixed chi-squared distribution]				

Source: Author's own estimation

4.2 Estimated Levels of Cost Efficiency

Efficiency estimates for the cost efficiency, derived from the preferred model, are summarised in tables 10 below.

Given the preferred cost function, efficiency estimates for banks in the countries under study averaged 95% and these estimates have slightly varied over time from 95% in 1992 to 94% in 2000. This suggests that the same level of output could be produced with approximately 95% of current inputs if banks under study were operating on the most efficient frontier. This level of efficiency is somewhat less than the range of 10-15% for the 130 studies surveyed by Berger and Humphrey (1997)* and Berger and DeYoung (1997). These results are also less than the level of inefficiency found in European studies including Carbo et al.'s (2000) whose findings for a sample of banks, from twelve countries, show mean cost inefficiency of around 22 % for the period 1989 to 1996.

Referring to table 8, the average efficiency based on bank specialisation ranged from 93% for investment banks to 98% for Islamic banks. The efficiency scores based on geographical location, ranged from 89% in Jordan to 99% in Bahrain. Finally, based on asset size, the differences among technical efficiency scores are not significant where optimal bank size is between US$ 2.5-5.0 billion and the largest banks seems to be somehow more efficient. These results are noticeably different

* Of these, 60 parametric studies found that the mean technical inefficiency is smaller than 15%.

from Carbo et al.'s (2000) findings on European savings banks who find that the least X-efficient banks were the largest in asset size.

Table 8: Cost Efficiency in Jordan, Egypt, Saudi Arabia and Bahrain banking over 1992-2000

	1992	1993	1994	1995	1996	1997	1998	1999	2000	All
Bahrain	100	100	100	100	100	99	99	99	99	99
Egypt	94	94	94	94	94	93	93	93	93	94
Jordan	90	89	89	89	89	89	89	88	88	89
Saudi Arabia	97	97	97	97	97	97	97	97	96	97
Commercial	95	95	95	95	94	94	94	94	94	94
Investment	93	93	93	93	93	93	93	93	93	93
Islamic	98	98	98	98	99	99	98	98	98	98
Other	97	96	96	96	96	96	96	96	96	96
All	95	95	95	95	95	94	94	94	94	95

Asset Size (US$ million)

	1-199	200-299	300-499	500-999	1,000-2,499	2,500-4,999	5,000-9,900	10000+		All
Bahrain	100	99	100	99	99	99	99	99		99
Egypt	95	94	94	94	94	93	92	90		94
Jordan	88	87	88	91	90			91		89
Saudi Arabia				98	98	98	98	95		97
All	95	93	94	95	95	96	96	94		95

Asset Size (US$ million)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	All
1-199.9	94	94	95	95	96	96	95	96	95	95
200-299	93	94	92	93	92	92	95	95	95	93
300-499	95	95	95	95	94	94	92	92	91	94
500-999	96	94	94	94	94	95	96	95	96	95
1,000-2,499	96	96	95	96	96	94	94	94	94	95
2,500-4,999	95	96	99	96	96	96	96	96	96	96
5,000-9,999	98	98	97	96	96	96	95	96	95	96
10000+	95	95	94	94	94	93	94	93	94	94
All	95	95	95	95	95	94	94	94	94	95

Source: Author's own estimation

To summarise the main findings, cost efficiency levels averaged around 95 percent over the period 1992-2000 without noticeable change over the 1992-99 period but have experienced a fall in 2000. Islamic banks are found to be the most cost efficient while investment banks are the least efficient. This result may partially explain the motives behind the increase in Islamic banking activities over the past few years; as the cost of funds for Islamic banks is relatively cheaper than the cost of funds for other financial institutions. On the other hand, intense competition between investment and commercial banks might explain the competitive disadvantages of the investment banks in terms of their market share and expose the motives for increased mergers and consolidation activity between such banks.

Based on assets size, large banks seem to be relatively more cost efficient, in general. This result suggests that large banks enjoy several advantages compared to small banks. These include the ability of large banks to utilise more efficient technology with less cost, the ability of these banks to set up more specialised staff for the most profitable activities and the ability of these banks to provide better quality output and therefore charge higher prices. Geographically, Bahrain is the most cost and profit efficient banking systems while Jordan is the least cost and profit efficient.

Finally, while the countries under study have implemented many economic and financial reforms over the last twenty years or so as indicated earlier, these reforms do not appear to have had much impact on banking sector efficiency. Given our findings, it seems that more reform may be needed to improve their efficiency. Perhaps the move to create a single GCC market may help to facilitate these developments as the creation of a similar European single market appears to have had a positive impact on European bank efficiency (see European Commission (1997)).

4.3 Estimated levels of Scale Elasticities

Productive efficiency requires optimising behaviour with respect to outputs as well as inputs as indicated earlier. Regarding outputs, optimal behaviour relates to producing the level of outputs that correspond to the lowest cost per unit. For the cost function, the optimal output level is possible if economies and diseconomies exist at different output levels; that is at some point, there will be constant returns defining the optimal level of production. Economies of scale exist if, over a given range of output, per unit costs decline as output increases. Increases in per unit cost correspond to decreasing returns to scale. A scale efficient firm will produce where there are constant returns to scale; that is, changes in output result in proportional changes in costs (Evanoff and Israilevich, 1991).

Given the cost function specification, the scale economy measure is a cost elasticity; the percent change in cost with respect to a percent change in output. On this basis, the results suggest existence of scale diseconomies across the banks under study and the scale diseconomies for these banks ranged from around 3% in 1992 to

6% in 2000 and averaged 5% over the 1992-2000 period (table 9 shows the details*). Thus, a 100 percent increase in the level of outputs would lead to about 105% percent increase in total costs. The magnitude of these scale diseconomies estimates is not different from other banking literature that finds evidence of diseconomies in the US banking market. For example, see Berger et al. (1993), Hughes et al. (1995) and McAllister and McManus (1993).

Based on the size of banks' assets, the optimal bank size are those in the ranges of US$ 5-10 billion where banks in this category experience increasing returns to scale. In addition, scale economies increase with size, and optimal bank size is inexhaustible which supports an argument for further consolidation. Based on geographical location, Saudi Arabian and (to a lesser extent) Egyptian banks seem to have the largest unrealised scale economies (see table 6.12 for details).

To summarise, (cost) scale elasticity estimates for the banking systems under study is around 105% and this did not noticeably change over 1992-2000. This implies that increasing the size of operations by 100 percent results in an increase in cost by 105 percent. In other words, scale diseconomies predominate. Nevertheless, we do not find evidence of significant scale economies for the largest banks in the sample. Overall, it appears that scale elasticities are most prevalent for commercial banks and for the largest banks in general.

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* See table 9's footnote to observe if these values are statistically significant from unity.

Table 9: Scale Elasticities in the Banking Sectors of Jordan, Egypt, Saudi Arabia and Bahrain over 1992-2000

	1992	1993	1994	1995	1996	1997	1998	1999	2000	***All***
Bahrain	1.23	1.25	1.22	1.24	1.27	1.22	1.22	1.21	1.26	***1.23***
Egypt	0.92	0.97	0.92	0.90	0.96	1.00	1.02	1.03	1.00	***0.97***
Jordan	1.14	1.09	1.16	1.23	1.21	1.20	1.17	1.15	1.07	***1.16***
Saudi Arabia	0.94	0.90	0.88	0.92	0.89	0.92	0.90	0.93	0.97	***0.92***
Commercial	0.94	0.95	0.92	0.92	0.94	0.95	0.95	0.95	0.94	***0.94***
Investment	1.15	1.15	1.16	1.24	1.22	1.27	1.31	1.28	1.30	***1.23***
Islamic	1.19	1.30	1.34	1.40	1.49	1.42	1.39	1.31	1.29	***1.35***
Other	1.26	1.29	1.25	1.17	1.25	1.27	1.24	1.32	1.29	***1.26***
All	1.03	1.04	1.02	1.03	1.06	1.07	1.07	1.07	1.06	***1.05***

Asset Size (US$ million)

	1-199	200-299	300-499	500-999	1,000-2,499	2,500-4,999	5,000-9,900	10000+	***All***
Bahrain	1.33	1.15	1.25	1.38	1.42	1.23	1.15	0.46	***1.23***
Egypt	0.79	0.88	0.92	0.97	1.17	1.15	0.97	0.67	***0.97***
Jordan	1.06	1.15	1.15	1.25	1.29			0.90	***1.16***
Saudi Arabia				0.83	1.03	1.15	0.95	0.69	***0.92***
All	1.05	1.01	1.06	1.13	1.19	1.16	0.98	0.67	***1.05***

Asset Size (US$ million)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	***All***
1-199.9	1.01	1.11	1.10	1.03	1.09	0.98	0.94	1.06	1.03	***1.05***
200-299	1.01	1.08	0.92	1.05	1.02	1.07	1.07	0.93	0.81	***1.01***
300-499	1.07	1.04	1.06	1.09	1.08	1.10	1.01	1.02	1.02	***1.06***
500-999	1.09	1.02	1.00	1.09	1.16	1.07	1.24	1.19	1.18	***1.13***
1,000-2,499	1.05	1.10	1.19	1.14	1.19	1.29	1.26	1.23	1.23	***1.19***
2,500-4,999	1.13	1.05	0.94	1.10	1.05	1.06	1.20	1.33	1.33	***1.16***
5,000-9,999	0.99	0.96	0.99	0.84	0.97	0.99	1.06	1.01	1.04	***0.98***
10000+	0.90	0.81	0.73	0.69	0.66	0.57	0.62	0.55	0.62	***0.67***
All	1.03	1.04	1.02	1.03	1.06	1.07	1.07	1.07	1.06	***1.05***

Note: The scores that fall within the ranges [0.983-1.016] and [0.966-1.033] are not statistically different from one at 5 percent and 1 percent level respectively for two-tailed test.
Source: Author’s own estimation.

4.4 Estimated Levels of Scale Efficiency

The scale elasticity measure, as indicated earlier, is an elasticity associated with a particular output level and indicates the relative change in cost associated with an increment change from this output level. Scale inefficiency (I), on other hand, can be measured as the aggregate cost of F inefficient firms ($\varepsilon \neq 1.0$) relative to the cost of a single efficient firm ($\varepsilon = 1.0$).

Given the following representation for the cost function: $\ln C = a + b (\ln Y) + .5\, c (\ln Y)^2$, then the scale elasticity for inefficient firms $= \varepsilon_I = \partial \ln C_I / \partial \ln Y_I$ = b. On this basis, scale inefficiency can be written as: $I = e^{(.5/c)(1-\varepsilon_I)^2}$ -1.0, that is scale inefficiency is a function of the first and second derivatives of the function with respect to output (the second derivation helps to reach c which is the key for calculation of inefficiency). Note, if the estimated scale elasticity is insignificantly different from unity, this does not imply scale inefficiency is insignificantly different from zero because the statistical difference of the elasticity measure from a value of unity depends entirely on the standard error of the estimated coefficient b.

Given the cost function specification of the stochastic frontier, scale efficiency averaged around 65% for banks under study over 1992 to 2000. Furthermore, there is a significant drop in scale efficiency over time when it decreased from around 72% in 1992 to reach 60% percent in 2000. According to geographical location, the efficiency scores ranged from 72% for Jordan and Saudi Arabian banks to 51% for Bahrain banks. Furthermore, commercial banks are the most efficient with cost efficiencies around 70% while the least efficient are the Islamic banks (table 10). Furthermore, the results generally show that some categories of small and large banks are scale efficient while other ranges do have similar efficiency levels.

Table10: Cost scale inefficiency for the banking sectors of Jordan, Egypt, Saudi Arabia and Bahrain over 1992-2000

	1992	1993	1994	1995	1996	1997	1998	1999	2000	All
Bahrain	47	49	44	51	53	53	49	46	52	49
Egypt	24	24	31	33	32	35	36	41	40	33
Jordan	21	26	25	34	31	34	30	27	25	28
Saudi Arabia	20	21	27	27	23	29	30	36	40	28
Commercial	24	25	30	34	29	31	30	33	33	30
Investment	32	30	30	42	39	44	45	40	42	38
Islamic	34	47	50	59	74	77	71	65	55	59
Other	38	43	31	25	38	46	46	57	70	44
All	28	29	32	36	35	38	37	39	40	35

Asset Size (US$ million)

	1-199	200-299	300-499	500-999	1,000-2,499	2,500-4,999	5,000-9,900	10000+		All
Bahrain	44	27	41	54	75	54	17	79		49
Egypt	44	26	17	28	51	23	28	50		33
Jordan	21	20	21	39	47			20		28
Saudi Arabia				25	26	27	16	43		28
All	38	24	24	37	49	31	19	48		35

Asset Size (US$ million)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	All
1-199.9	30	32	39	37	40	46	46	46	51	38
200-299	20	33	19	28	25	24	24	16	26	24
300-499	25	19	19	29	33	35	21	20	14	24
500-999	30	35	33	40	37	35	44	35	37	37
1,000-2,499	42	47	49	47	53	55	50	51	47	49
2,500-4,999	25	16	54	24	3	13	28	48	49	31
5,000-9,999	10	10	19	37	20	22	12	14	23	19
10000+	30	29	40	43	46	52	50	69	56	48
All	28	29	32	36	35	38	37	39	40	35

Source: Author's own estimation

5. CONCLUSION

A major aim of this study is to estimate efficiency levels in various Arab banking sectors by applying various statistical analyses to a data set on Jordan, Egypt, Saudi Arabia and Bahrain. This study employs cost efficiency concept using a number of different measurement methods (including the stochastic frontier approach, specification of the Fourier-flexible functional form versus the translog form, and inclusion of bank's asset quality and financial capital in a number of different ways) to a single data set.

In choosing the 'preferred' cost model, we follow the recent efficiency methodologies that proceed by testing various model specifications to arrive at the preferred model. Based on the preferred models, cost efficiency measures are reported for the banks in the countries under study. Given cost efficiency, the preferred model is the Fourier-truncated form that excludes the control variables (capital adequacy, asset quality and the time trend) but includes all the environmental variables.

Based on the chosen preferred model, cost efficiency averaged around 95% over the 1992-2000 period. Islamic banks are found to be the most cost efficient, while investment banks are the least. Based on bank asset size, large banks seem to be relatively more cost efficient. Geographically, Bahrain is the most cost efficient while Jordan is the least. It should be noted that these results, in general, are similar to those found in other US and European banking studies.

Based on the estimated preferred model, we also report scale elasticity and scale efficiency measures for the banks under study. The cost scale elasticity estimates reveals diseconomies of around five percent and the cost scale inefficiency estimates also suggest that banks are 65% scale efficient. Islamic and commercial banks are again found to be the most cost scale efficient. Large banks are also generally found to be more efficient than smaller institutions. In addition, geographically, Saudi Arabian and Egyptian banks seem to be the most cost scale efficient.

A major finding of this study is that there is little evidence to suggest that the major economic and financial reforms undertaken in Jordan, Egypt, Saudi Arabia and Bahrain over the last decade have had a noticeable impact on improvement in banking sector efficiency. The main policy recommendation from this study, therefore, is that these countries need to continue the reform process in order to enhance financial sector performance.

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Table 6: Hypotheses Testing of the Cost Function (stage 1)

Model Description	Restrictions	Log likelihood	LR test of 1-sided error	DF	Critical value for α =5%	Decision
Stage 1: Models estimation including environmental variables						
- Fourier-truncated without restrictions		108.02				
- Fourier-truncated without time parameters	$\psi_3=\psi_{r3}=\psi_{3S}=\rho_{i3}=\tau_{k3}=\phi_8=\omega_8=\phi_{n8}=\phi_{8q}=\omega_{8q}=\omega_{n8}=\phi_{888}=\omega_{888}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	193.42	-170.8	29	42.56	Accept Ho
- Fourier-truncated without capital parameters	$\psi_1=\psi_{r1}=\psi_{1S}=\rho_{i1}=\tau_{k1}=\phi_6=\omega_6=\phi_{n6}=\phi_{6q}=\omega_{6q}=\omega_{n6}=\phi_{666}=\omega_{666}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	13.29	189.46	29	42.56	Reject Ho
- Fourier-truncated without risk parameters	$\psi_2=\psi_{r2}=\psi_{2S}=\rho_{i2}=\tau_{k2}=\phi_7=\omega_7=\phi_{n7}=\phi_{7q}=\omega_{7q}=\omega_{n7}=\phi_{777}=\omega_{777}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	69.07	77.9	29	42.56	Reject Ho
- Fourier-truncated without time and capital parameters	$\psi_1=\psi_3=\psi_{r1}=\psi_{r3}=\psi_{1S}=\psi_{3S}=\rho_{i1}=\rho_{i3}=\tau_{k1}=\tau_{k3}=\phi_6=\phi_8=\omega_6=\omega_8=\phi_{n6}=\omega_{n8}=\phi_{n8}=\phi_{6q}=\phi_{8q}=\omega_{6q}=\omega_{8q}=\omega_{n6}=\omega_{n8}=\phi_{666}=\phi_{888}=\omega_{666}=\omega_{888}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	-80.17	547.18	26	38.88	Reject Ho
- Fourier-truncated without time and risk parameters	$\psi_2=\psi_3=\psi_{r2}=\psi_{r3}=\psi_{2S}=\psi_{2S}=\rho_{i2}=\rho_{i3}=\tau_{k2}=\tau_{k3}=\phi_7=\phi_8=\omega_7=\omega_8=\phi_{n7}=\omega_{n8}=\phi_{n8}=\phi_{7q}=\phi_{8q}=\omega_{7q}=\omega_{8q}=\omega_{n7}=\omega_{n8}=\phi_{777}=\phi_{888}=\omega_{777}=\omega_{888}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	161.26	64.32	26	38.88	Reject Ho
- Fourier-truncated without capital and risk parameters	$\psi_1=\psi_3=\psi_{r1}=\psi_{r2}=\psi_{1S}=\psi_{2S}=\rho_{i1}=\rho_{i2}=\tau_{k1}=\tau_{k2}=\phi_6=\phi_7=\omega_6=\omega_7=\phi_{n6}=\omega_{n7}=\phi_{n7}=\phi_{6q}=\phi_{7q}=\omega_{6q}=\omega_{7q}=\omega_{n6}=\omega_{n7}=\phi_{666}=\phi_{777}=\omega_{666}=\omega_{777}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	ols				Reject Ho
- Fourier-truncated without time, capital and risk parameters*	$\psi_r=\psi_{rS}=\rho_{ir}=\tau_{kr}=\phi_6=\phi_7=\phi_8=\omega_6=\omega_7=\omega_8=\phi_{n6}=\phi_{n7}=\phi_{n8}=\phi_{6q}=\phi_{7q}=\phi_{8q}=\omega_{6q}=\omega_{7q}=\omega_{8q}=\omega_{n6}=\omega_{n7}=\omega_{n8}=\phi_{666}=\phi_{777}=\phi_{888}=\omega_{666}=\omega_{777}=\omega_{888}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	213.44	40.04	49	73.11	Accept Ho
Step 2: Fourier-truncated versus translog-truncated						

Model Description	Restrictions	Log likelihood	LR test of 1-sided error	DF	Critical value for α =5%	Decision
- Translog-truncated without time, capital and risk parameters	$\psi_r = \psi_{rS} = \rho_{ir} = \tau_{kr} = \phi_n = \omega_n = \phi_{nq} = \omega_{nq} = \phi_{nnn} = \phi_{qqq}$ =0, n=q= 1, 2,...,8.	128.89	169.1	75	128.80	Reject Ho
Step 3: Fourier truncated without environmental and control variables	$\psi_r = \psi_{rS} = \rho_{ir} = \tau_{kr} = \phi_n = \omega_n = \phi_{nq} = \omega_{nq} = \phi_{nnn} = \phi_{qqq} = \delta_i$ =0, n=q= 1, 2,...,8.	-81.26	589.4		180.57	Reject Ho
Step 4: Fourier –truncated without efficiency term	$\psi_r = \psi_{rS} = \rho_{ir} = \tau_{kr} = \phi_n = \omega_n = \phi_{nq} = \omega_{nq} = \phi_{nnn} = \phi_{qqq} = \delta_i = \lambda$ =0, n=q= 1, 2,...,8.	ols				Reject Ho

Source: Author's own estimation. *The grey shade indicates the best model in this stage

Table 7: Hypotheses testing of the cost function (stage 2)

Model Description	Restrictions	Log likelihood	LR test of 1-sided error	DF	Critical value for α =5%	Decision
Stage 2: Models estimation excluding environmental variables						
Step 1: Time-variant versus time-invariant models						
- Truncated time-variant model that includes all the control variables		114.42				
- Truncated time-invariant model that includes all the control variables	$\eta = 0$	ols				Reject Ho
Step 2: Truncated versus half-normal models						
-Half-normal time-variant model that includes all the control variables	$\mu = 0$	111.19	7.45	1	3.841	Reject Ho
Step 3: Truncated time-variant model with different combination of the control variables						
- Fourier-truncated without time parameters	$\psi_3 = \psi_{r3} = \psi_{3S} = \rho_{i3} = \tau_{k3} = \phi_8 = \omega_8 = \phi_{n8} = \phi_{8q} = \omega_{8q} = \omega_{n8} = \phi_{888} = \omega_{888} = 0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	-6.70	235.78	29	42.56	Reject Ho
- Fourier-truncated without capital parameters	$\psi_1 = \psi_{r1} = \psi_{1S} = \rho_{i1} = \tau_{k1} = \phi_6 = \omega_6 = \phi_{n6} = \phi_{6q} = \omega_{6q} = \omega_{n6} = \phi_{666} = \omega_{666} = 0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	29.10	170.64	29	42.56	Reject Ho
- Fourier-truncated without risk parameters	$\psi_2 = \psi_{r2} = \psi_{2S} = \rho_{i2} = \tau_{k2} = \phi_7 = \omega_7 = \phi_{n7} = \phi_{7q} = \omega_{7q} = \omega_{n7} = \phi_{777} = \omega_{777} = 0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	8.45	211.94	29	42.56	Reject Ho

Model Description	Restrictions	Log likelihood	LR test of 1-sided error	DF	Critical value for α =5%	Decision
- Fourier-truncated without time and capital parameters	$\psi_1=\psi_3=\psi_{r1}=\psi_{r3}=\psi_{1S}=\psi_{3S}=\rho_{i1}=\rho_{i3}=\tau_{k1}=\tau_{k3}=\phi_6=\phi_8=\omega_6=\omega_8=\phi_{n6}=\omega_{n8}=\phi_{n8}=\phi_{6q}=\phi_{8q}=\omega_{6q}=\omega_{8q}=\omega_{n6}=\omega_{n8}=\phi_{666}=\phi_{888}=\omega_{666}=\omega_{888}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	-83.88	396.6	55	73.11	Reject Ho
- Fourier-truncated without time and risk parameters	$\psi_2=\psi_3=\psi_{r2}=\psi_{r3}=\psi_{2S}=\psi_{2S}=\rho_{i2}=\rho_{i3}=\tau_{k2}=\tau_{k3}=\phi_7=\phi_8=\omega_7=\omega_8=\phi_{n7}=\omega_{n8}=\phi_{n8}=\phi_{7q}=\phi_{8q}=\omega_{7q}=\omega_{8q}=\omega_{n7}=\omega_{n8}=\phi_{777}=\phi_{888}=\omega_{777}=\omega_{888}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	-17.11	263.06	55	73.11	Reject Ho
- Fourier-truncated without capital and risk parameters	$\psi_1=\psi_3=\psi_{r1}=\psi_{r2}=\psi_{1S}=\psi_{2S}=\rho_{i1}=\rho_{i2}=\tau_{k1}=\tau_{k2}=\phi_6=\phi_7=\omega_6=\omega_7=\phi_{n6}=\omega_{n7}=\phi_{n7}=\phi_{6q}=\phi_{7q}=\omega_{6q}=\omega_{7q}=\omega_{n6}=\omega_{n7}=\phi_{666}=\phi_{777}=\omega_{666}=\omega_{777}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	3.44	221.96	55	73.11	Reject Ho
- Fourier-truncated without time, capital and risk parameters	$\psi_r=\psi_{rS}=\rho_{ir}=\tau_{kr}=\phi_6=\phi_7=\phi_8=\omega_6=\omega_7=\omega_8=\phi_{n6}=\phi_{n7}=\phi_{n8}=\phi_{6q}=\phi_{7q}=\phi_{8q}=\omega_{6q}=\omega_{7q}=\omega_{8q}=\omega_{n6}=\omega_{n7}=\omega_{n8}=\phi_{666}=\phi_{777}=\phi_{888}=\omega_{666}=\omega_{777}=\omega_{888}=0$, r=S=k= 1, 2,3; i=1,2; n=q= 1, 2,...,8.	69.06	90.72	78	99.62	Do not reject Ho
Step 3: Fourier-truncated versus translog						
- Translog-truncated without time, capital and risk parameters	$\psi_r=\psi_{rS}=\rho_{ir}=\tau_{kr}=\phi_n=\omega_n=\phi_{nq}=\omega_{nq}=\phi_{nnn}=\phi_{qqq}=0$, n=q= 1, 2,...,8.	68.15	92.54	104	128.80	Accept Ho

Source: Author's own estimation.

CHAPTER THREE

Are GCC Banks Efficient?

Khalid Shams [a] and Philip Molyneux[b]

1. Introduction

This paper examines the efficiency of GCC banking system between 1995-2000. Generally, the interest in measuring X-inefficiency in banking has increased over the last decade as commentators have sort to examine the impact of increased competition on banking sector costs. While an extensive literature has developed to examine banking sector efficiency in the US and Europe (see Berger and Humphrey, 1997; Goddard et al. 2001) there is only limited literature on developing countries (e.g. Bhattacharyya, Lovell, and Shay, 1997; Isik and Hassan, 2002; Al-Jarrah, 2002).

The aim of this paper is to extend the established literature by examining the efficiency features of Gulf banking. Over the last decade, GCC banking systems have experienced many regulatory changes. The most important of these has been the gradual removal of interest rate ceilings on loans and deposits, which commenced from the mid-90's onwards. The aim of these regulatory changes was to bring about a more competitive environment and to foster improved efficiency in the banking system. GCC banking systems will also be exposed to even more competition by the time they become more integrated within the recently announced GCC economic and monetary union or when the GATT's agreement (which all GCC countries have joined except Saudi Arabia) will come into effect. Given the ongoing deregulation process, it is important therefore to have an indication of the efficiency features of

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GCC banks in order to evaluate the influence of financial reforms that aim to improve the soundness and enhance competitiveness of the GCC financial systems overall.

In this paper, banking inefficiencies are examined by estimating both cost and profit functions, where these inefficiencies are depicted as the deviation of actual cost and profit of each bank from the optimal banking industry's cost and profit functions. This deviation is known as X-inefficiency, an important feature of operational inefficiency. The measurement of this deviation enables us to know the status of GCC banking inefficiency and how it is compared to banking sector inefficiency in other studies. In addition, this paper also takes into consideration the influence both risk and asset quality factors have on the levels of measured inefficiency in GCC banking markets. Generally, there is evidence that both risk and asset quality factors can influence both cost and profit efficiencies (Mester, 1996; Berger and Mester, 1997; Altunbas et al., 2000). These factors are typically closely monitored by regulatory authorities so as to ensure that banks keep adequate levels of capital and have acceptable quality of loan portfolios. The links between efficiency, risk, and asset quality may therefore be important from a policy maker's perspective. Especially, for instance if we find that efficient banks have high asset quality and are less risky. The paper also investigates the extent to which GCC banks exploit economies of scale in conducting banking operations. Knowledge of optimal bank size provides more information about the competitive status of GCC banking. Finally, we investigate the main determinant of efficiency in Gulf banking.

The paper is organised as follows. Section 2 discusses efficiency concepts and their functions. Section 3 describes the methodology of inefficiency calculation, the functional forms, and the data and variables used in the efficiency estimation. Section 4 introduces the logistic regression model, an approach used to evaluate inefficiency determinants in the GCC banking industry. Section 5 discusses the empirical results, and section 6 is the conclusions.

2. The X-Efficiency Concepts

In a first step to measure efficiency in this paper, it is vital to identify the sort of efficiency upon which a banking industry is assessed. Here, our focus is to measure X-inefficiency, where X-inefficiency refers to the deviation from the frontier that gives the maximum attainable outcome, given the employed resources. In following Berger and Mester (1997), we estimate X-inefficiency in the GCC banking industry on the basis of three efficiency concepts: cost inefficiency, standard profit inefficiency, and alternative profit inefficiency. Cost efficiency is the widely used measure of bank efficiency from the input side (for example, Altunbas et al., 2000; Lang and Welzel, 1996; Kwan and Eisenbeis, Berger and Mester, 1997) and profit efficiency measures focus on the output side (incorporating both costs and revenues).

Measurement of profit efficiency is vital because it is believed that firms may not only err on the input side by choosing non-optimal input mix, but also err on the output side by producing output mixes that make them deviate from the optimal obtainable profit in the industry. Moreover, profit efficiency is '… based on [the] more accepted economic goal of profit maximization, which requires that the same amount of managerial attention be paid to raising a marginal dollar of revenue as to reducing a marginal dollar of cost' (Berger and Mester, 1997, p. 900). Therefore, it is important to examine both cost and profit inefficiencies as they provide a collective analysis of X-efficiency that helps explore more factors that may enhance or diminish banking efficiency from both the input and output sides of the production process.[1]

2.1 Cost Inefficiency

Under the same market conditions and for the same output bundle produced, the cost inefficiency concept views inefficiency as the distance at which the estimated cost function of a financial firm is located away from the least cost function that belongs to the best practice firm in an underlying industry. Thus if the measured cost inefficiency for a banking industry is 15 per cent, this means that banks should use their inputs as efficiently as possible in order to gain a reduction of 15 per cent in their

[1] For example, ceilings on deposit and loan prices could affect both cost and profit functions of the banking industry.

costs in order to make their cost functions reach the minimum cost function of the best practice bank.

Cost inefficiency is derived from the cost function.[2] Basically, the cost function describes a relationship between a cost variable and a set of explanatory variables plus the random and inefficiency factors. The cost function can be written in a natural logarithm form as

$$\ln TC = f(Q, P, Z) + \ln u_c + \ln v_c \tag{1}$$

where ln TC is the total cost variable, f stands for some functional form, Q is the vector of outputs, P is the vector of prices of input variables, Z is the set of other likely important exogenous variables, ln u_c is the inefficiency factor that reflects X-inefficiency and raises cost above the industry's optimal cost, and ln v_c is the random error incorporated to capture luck and measurement error, which may temporarily increase or decrease a bank's costs.

2.2 Standard Profit Inefficiency

Standard profit inefficiency focuses on how a bank's profits are compared to the profits of the best practice firm operating in a market where banks use the same inputs, produce the same output bundles, and face the same (market) conditions. In fact, standard profit inefficiency shows the percentage by which a bank needs to increase profits so that it moves to the profits of the best practice bank. Thus, if a standard profit efficiency average score is 60 per cent, this implies that bank i is losing 40 per cent of its profits, probably because of its excessive use of inputs and other deficiencies in generating revenues.

Calculation of standard profit inefficiency is derived from some specified profit function that can be written in a basic form with logs as

[2] The formal calculation of the inefficiency is illustrated in the next section.

$$\ln(\pi,\theta) = f(PQ,P,Z) + \ln u_{\pi} + \ln v_{\pi} \quad (2)$$

where PQ is the vector of prices of output variables. Note that the standard profit function regresses profits on the same set of the explanatory variables that appear in the cost function, except that it takes output prices as given rather than output levels. This also makes it necessary to calculate the standard profit inefficiency on the basis of how banks choose output levels for the given output prices, a matter that allows for standard profits to capture inefficiency stemming from the non-optimal choice of outputs when responding to these prices.

2.3 Alternative Profit Inefficiency

Alternative profit inefficiency (as developed by Berger and Mester, 1997) reflects how far a firm's profit function is away from the maximum profit function earned by the best practice firm, given the same inputs used and outputs produced within the same prevailing market conditions. Generally, alternative profit efficiency is identical to standard profit efficiency, except that the concept of alternative profit efficiency is introduced to account for the effects of output prices on profit efficiency. That is, because output quantities are held constant in the alternative profit function, the level of inefficiency in the alternative profit model differs in response to the prices of output, which are set free to vary.

The calculation of alternative profit inefficiency is based on the profit function written in the log form as

$$\ln(\pi,\theta) = f(Q,P,Z) + \ln u_{\pi} + \ln v_{\pi} \quad (3)$$

where the explanatory variables in Eq. 3 are the same as for the standard profit function (of Eq. 2), except that the output quantities, Q, replaces prices of outputs, PQ.

The usefulness of the alternative profit inefficiency concept stems from several factors. Alternative profit inefficiency alleviates the problem of scale bias and avoids the problem of output price inaccuracy, which are problems related to the standard profit method. The problem of scale bias usually emerges from differences in bank sizes and outputs levels because the standard profit method does not control output levels. With alternative profit inefficiency measures, this problem is less severe because comparisons are made between a bank's ability to generate profits for a given level of outputs.

With regard to output price information, proxy measures are usually used for the output prices. Since it is often difficult to obtain prices for the outputs, the standard profit inefficiency measures may have an inherent price inaccuracy problem that affects the reliability of the inefficiency estimates. For the same reason, taking output levels instead of output prices allows the alternative profit efficiency measures to avoid this problem of price inaccuracy.

The alternative profit function could be a more appropriate measure of inefficiency when banks have market power that enables them to set higher prices for given output levels. On the other hand, in a more competitive market, the standard profit function seems also plausible since banks tend to be price takers, regardless of the output level they produce. In both cases, it is advisable to estimate both the standard and alternative profit functions together as they provide insights into the level of profit inefficiency given the prevailing condition of market competitiveness.

It should, however, be noted that profit inefficiency is expected to be greater than cost inefficiency since profit inefficiency accounts for inefficiencies on both the input and output sides of financial production. Moreover, alternative profit inefficiency is expected to be greater than standard profit inefficiency because the former captures a wider source of inefficiencies such as those related to output qualities and market power.

Having explained the efficiency concepts to be used in the empirical part of this paper, the following outlines the methodology used to estimate these efficiency concepts.

3. Methodological Approach to Estimating Efficiency

In this section we discuss the methodology used to estimate inefficiency in the GCC banking industry. There are two main approaches to estimate inefficiency: parametric and non-parametric approaches (see also the review by Berger and Humphrey, 1997). Each of these also includes various modelling techniques: for example, the stochastic frontier, distribution-free, and thick frontier are parametric techniques used to derive efficiencies; data envelopment analysis and the disposal hull technique are the main non-parametric approaches. Our choice in estimating GCC banking sector efficiency is the parametric approach. In our opinion, the parametric approach adds more statistical sense to the efficiency estimation because the stochastic nature (or randomness), representing deviation from the true population path, is always present when a random sample is tested to obtain a general inference about a population.

Regarding the choice of techniques among the parametric approaches, we use the stochastic frontier technique because it has the advantage of considering the distribution on both error term composites. Non-consideration of distributional assumptions may lead to an inexact separation of the inefficiency and the random error terms, which may in turn produce an overestimation of inefficiency, especially when the random error term is not cancelled out over time. This problem is present also, to some extent, in the distribution-free technique (see Allen and Rai, 1996). Moreover, the thick frontier technique may encounter bias when ordering banks to construct the quartiles according to input prices. Because these prices are not the same across banks, inefficiency measures might be overestimated as well (Kaparakis et al., 1994).

Therefore, to estimate X-inefficiency in the GCC banking industry, we use the stochastic frontier technique, the methodology of which we discuss below in more detail.

A stochastic frontier, as typically explained for the cost function (i.e. stochastic cost frontier) can be constructed to estimate a theoretical least cost function for the industry, which will be attributed as the efficient cost function that belongs to the best practice firm. Accordingly, the estimated best practice firm is said to employ the minimum amount of inputs to produce the given level of outputs.

In a formal way, the single equation stochastic cost function can be given in a logarithmic form for N firms as[3]

$$\ln TC_i = f(Q_i, P_i) + \ln \varepsilon_i, \qquad i = 1,...., N, \tag{4}$$

where $\ln TC_i$ is the observed total cost of bank i, Q_i is the vector of its output levels, and P_i is the vector of input prices the bank i pays. The cost function $\ln TC_i = f(Q_i, P_i)$ gives an indirect representation of the feasible technology; it relates the firm's cost to output levels and input prices, and shows the minimum cost of producing the output vector Q, given the price vector P (Varian, 1992). So, the minimum predicted cost for the industry is explained by $f(Q_i, P_i)$, which is the cost frontier portion in Eq. (4) and is considered to be the industry's benchmark of the most efficient firm. The deviation of banks' costs from the cost frontier is explained by the error term ε_i, which consists in a logarithmic form of

$$\varepsilon_i = v_i + u_i, \tag{5}$$

where v_i is the statistical noise that represents random fluctuations due to measurement error and luck factors and u_i is the inefficiency term which is presumed to result from mistakes in the choices of input mix that are specific to the firm's practice.

It should be noted that the inefficiency factor, *u*, is the X-inefficiency measure representing both technical inefficiency, which occurs when employing excessive inputs beyond the level needed to produce the given output level, $Q_{i;}$; and allocative

[3] While the analysis here describes the methodology used to calculate the efficiency measure for some frontier function given in Eq.4, the functional form for the frontier function specification used to estimate efficiencies will be discussed in the following subsection.

inefficiency, which occurs when failing to react optimally to relative prices of inputs, P_i.[4]

In order to obtain the measurement of inefficiency estimates, u_i, for the cost function mentioned above, [5] it is essential to determine how both error term components, v_i and u_i, are assumed to be distributed. Following Aigner, Lovell, and Schmidt (1977), we assume the distribution of the error term v_i has an identical two-sided normal distribution representing statistical noise which is believed to be independently distributed with zero mean and σ_v^2 variance, that is, $v_i \sim IIN(0, \sigma_v^2)$. The rationale behind this type of distribution is to allow for a pure randomness of the v component upon which this component can either take positive or negative values according to the nature of luck and factors out of management control that can affect bank performance.

On the other hand, we adopt the half-normal distribution for the inefficiency part for which we consider u_i to be a non-negative or one-sided error term representing inefficiency and assumed to be distributed independently of the v_i term.

Formally,

$$f(u) = \left(\frac{2}{\pi}\right)^2 \exp\left[-\tfrac{1}{2}(u/\sigma_u)^2\right], \tag{6}$$

$$E[u] = \left(\frac{\sigma_u \phi(0)}{\Phi(0)}\right) = \left(\frac{2}{\pi}\right)^2 \sigma_u, \tag{7}$$

$$Var[u] = \left[1 - \frac{2}{\pi}\right]\sigma_u^2, \tag{8}$$

[4] The studies of Berger and Humphrey (1997), Altunbas et al., (2000), as well as others have considered the inefficiency term as reflecting both technical and allocative inefficiencies without disentangling them from each other.
[5] The functional form from which the inefficiency, u, will be derived is the Fourier Flexible form explained in the following subsection.

where N is the number of banks, $f(.)$ is the distribution function, $E[.]$ is the mean, $Var[.]$ is the variance, $\sigma = \left(\sigma_u^2 + \sigma_v^2\right)^{1/2}$, and ϕ and Φ are the standard normal distribution and the standard normal density functions respectively.

The rationale behind using the half normal distribution lies in the perception that the deviation from the frontier should take one side off the cost frontier, and that the cost frontier would have no mean if there should exist observations that fall anywhere under the cost frontier.

It should be noted that the approach of Aigner, Lovell, and Schmidt (1977) does not, however, estimate the *u* term directly. Accordingly, Jondrow et al. (1982) developed Aigner et al.'s model by providing an explicit formula, which shows that the ratio of variability, σ, for both v and u can be used to calculate the firm's relative inefficiency. This ratio is utilized for the error term portion of the estimated cost function in a way that calculates the inefficiency term given the estimate of the whole error term for each firm in each observation. That is, the level of inefficiency for each bank is calculated by the mean of the conditional distribution of u_i given ε_i. The mean of this conditional distribution for the half-normal model can be shown as

$$E(u \setminus \varepsilon) = \frac{\sigma\lambda}{1+\lambda^2}\left[\frac{\phi(\varepsilon_i\lambda/\sigma)}{1-\Phi(\varepsilon_i\lambda/\sigma)} + \left(\frac{\varepsilon_i\lambda}{\sigma}\right)\right], \qquad (9)$$

Greene (1993) claims that the mean of the conditional distribution $E(u \setminus \varepsilon)$ is unbiased. Nevertheless, this mean is an inconsistent estimator of u_i because, regardless of the number of observations, the variance of the estimator remains non-zero.

After defining the distributional assumption and the way inefficiency is calculated, we need to estimate the cost function (Eq. 4) in order to obtain the parameters that yield the frontier as well as the estimates of inefficiency explained above.

To estimate the cost function model (Eq. 4), we use the maximum likelihood estimation technique. In fact, this technique is widely implemented in efficiency parametric studies and is preferred over the ordinary least square method. Greene (1993) argues that the maximum likelihood technique is useful in treating the distributional models of the random noise and the inefficiency components. The log-likelihood function can be written as

$$\ln L = \frac{N}{2}\ln\frac{2}{\pi} - N\ln\sigma - \frac{1}{2\sigma^2}\sum_{i=1}^{N}\varepsilon_i^2 + \sum_{i=1}^{N}\ln\left[\Phi\left(\frac{\varepsilon_i\lambda}{\sigma}\right)\right], \quad (10)$$

where N is the number of banks, $\varepsilon_i = u_i + v_i$, $\sigma = \left(\sigma_u^2 + \sigma_v^2\right)^{1/2}$, $\lambda = \sigma_u / \sigma_v$, and ϕ and Φ are the standard normal distribution and the standard normal density functions respectively. The maximum likelihood estimation operates in a way that finds the minimum of the log likelihood function in order to obtain the estimates of the cost function (Eq. 4).

The cost function given in Eq. (4) is not our functional form from which to derive efficiency levels, however; it is only used here to simplify our explanation of the methodology used to derive efficiency estimates. The following discusses how to specify our functional form used to estimate the cost and profit frontiers from which cost and profit inefficiency measures are derived.

3.1 Functional Form Specification

As just stated, this subsection is devoted to showing how our stochastic cost and profit functional forms are constructed. Although most studies use the translog functional form to estimate inefficiency, this form is not applied here because of certain limitations. Instead, we use the Fourier Flexible model to specify the cost and profit functions and to obtain inefficiency measures. To arrive at this functional form some steps will also be explained.

A large number of banking studies have used the translog function expressed in a stochastic framework to estimate the cost frontier function (see, for example, Kwan and Eisenbeis, 1996; Altunbas et al., 2000). The translog model is a flexible functional form and is expanded by a second-order Taylor series (see Greene, 2000, p.

217). The flexibility of the translog model is demonstrated in its usefulness for approximating the second-order effect of an unknown functional form (Berndt and Christensen, 1973). This flexibility serves as an advantage for banking efficiency studies because it is difficult to identify exactly the functional form that fits the banking cost and production technology (Kaparakis et al., 1994). Moreover, the translog model allows homogeneity of degree one by simply imposing restrictions on the translog model parameter (McAllister and McManus, 1993).

However, since the translog form is said to be less global because of the bias that makes some observations follow the pattern of other dominant observations, the more recent semi-parametric functional form known as the Fourier Flexible form has been suggested to be the preferred approach that corrects for the translog model's ill fit on the true path of data (Gallant, 1981, 1982; Mitchell and Onvural, 1993). In essence, the Fourier Flexible functional form adds more global approximation and flexibility to the translog form by adding the trigonometric terms to the translog specification. This means that the frontier to be estimated will provide a greater flexibility 'by allowing for many inflection points and by including essentially orthogonal trigonometric terms that help the frontier fit the data wherever it is most needed' (Berger and Humphrey, 1997, p. 179).

On account of these advantages, the Fourier Flexible specification has recently become the more acceptable and increasingly applied parametric functional form in measuring banking inefficiency. Before we set the specification of the Fourier functional form, it should be noted that because the Fourier Flexible form is a translog form extended with trigonometric terms, it is appropriate to note certain features related to the translog form that also apply to the Fourier form as well.[6]

One thing to note regarding the translog function is that as the number of the inputs (also variables) increases, multicollinearity will likely be severe (Greene, 1980). Berndt and Christensen (1973) show how the use of factor demand equations may overcome this problem.[7] Moreover, some studies using the translog function drop the most likely interactive terms causing multicollinearity (see for examples Lang and Welzel, 1996). Doing this might not totally remove multicollinearity problems and its

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[6] However, Altunbas and Chakravarty (2001) note that although the Fourier Flexible form has a better fit than the translog, the former, they find, provides weaker predictive power.

[7] Econometricians generally suggest that one way of reducing the multicollinearity problem is to increase the number of observations.

continuing presence may induce an increase in standard errors, which may yield a number of nonsignificant coefficients.

Second, we should note that (as in a number of studies) factor share equations are used along with translog models (see e.g. Noulas et al., 1990). However, in our estimation, we exclude factor share equations from our model as they embody Shephard's Lemma or Hotelling's Lemma restrictions, which make unfavourable assumptions regarding the allocative efficiency (see Berger and Mester, 1997). Moreover, since inefficiency decomposition (into allocative and technical inefficiency) requires restrictive distributional assumptions, we prefer to keep inefficiency estimation non-decomposed and assume that the whole inefficiency residual component, as noted before, is the X-inefficiency measure (see Kaparakis et al., 1994).

As the Fourier Flexible functional specification is used in constructing our Fourier functional model that consists of the standard translog specification and the trigonometric terms, as well as the terms of X-inefficiency and the random error, we first show the core functions of our model along with the residuals, which include both inefficiency and the random error terms. Then we write the function in a translog form, which includes its interactive terms. We then add the trigonometric terms in order to reach the stochastic Fourier Flexible form.

To start building our Flexible functional form we recall the cost and profit functions explained in section 2. These functions are rewritten as

$\ln TC = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Q_i + \sum_{j=1}^{n} \beta_j \ln P_j + \varepsilon_i$ is the cost function,

$\ln(\pi + \theta) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln PQ_i + \sum_{j=1}^{n} \beta_j \ln P + \varepsilon_i$ is the standard profit function, and

$\ln(\pi + \theta) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Q_i + \sum_{j=1}^{n} \beta_j \ln P_j + \varepsilon_i$ is the alternative profit function,

where TC is the cost variable, π is the profit variable, θ is a constant added to the firm's profits so that its natural log is positive, Q is the vector of outputs, P is the vector of prices of input variables, PQ is the vector of prices of output variables, and ε_i is the stochastic error term where $\varepsilon_i = u_i + v_i$.

The basic functions given above are developed in a multi-product translog specification.

To save repetition, we typically continue showing the construction of our model using the cost function. The translog cost function is written as

$$\begin{aligned} \ln TC = \alpha_0 &+ \sum_{i=1}^{n} \alpha_i \ln Q_i + \sum_{j=1}^{n} \beta_j \ln P_j \\ &+ \frac{1}{2}\left[\sum_{i=1}^{n}\sum_{j=1}^{n} \delta_{ij} \ln Q_i \ln Q_j + \sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln P_i \ln P_j \right] \\ &+ \sum_{i=1}^{n}\sum_{j=1}^{n} \rho_{ij} \ln Q_i \ln P_j + \varepsilon_i \end{aligned} \qquad (11)$$

In order to reach our Fourier Flexible form, we transform output variables into the Fourier first and second order trigonometric terms, and, because input prices are attributed with little variations, they are left to be separately described in the translog portion.

As a result of this transformation, which adds the trigonometric terms to the translog form, the model becomes the Fourier Flexible form shown as

$$\begin{aligned} \ln TC = \alpha_0 &+ \sum_{i=1}^{n} \alpha_i \ln Q_i + \sum_{j=1}^{n} \beta_j \ln P_j \\ &+ \frac{1}{2}\left[\sum_{i=1}^{n}\sum_{j=1}^{n} \delta_{ij} \ln Q_i \ln Q_j + \sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln P_i \ln P_j \right] \\ &+ \sum_{i=1}^{n}\sum_{j=1}^{n} \rho_{ij} \ln Q_i \ln P_j + \sum_{i=1}^{n} [a_i \cos(z_i) + b_i \sin(z_i)] \\ &+ \sum_{i=1}^{n}\sum_{j=1}^{n} [a_{ij} \cos(z_i + z_j) + b_{ij} \sin(z_i + z_j)] + \varepsilon_i \end{aligned} \qquad (12)$$

where z_i is the adjusted value of the natural log of the output Q_i so that z_i span the interval $[0.1 * 2\pi, 0.9 * 2\pi]$.[8]

Eq. (12) is the standard model used to estimate the cost function and derive efficiency levels within the Fourier Flexible specification form. At this point, it should be noted that recent studies have added additional sets of variables in their standard Fourier form, mainly financial capital, asset quality, and time trend variables. These variables are included to account for risk, loan quality, and technical progress respectively when measuring inefficiency.[9]

Financial capital variable has recently been included in cost and profit efficiency studies[10] because it is believed that an adequate level of financial capital in banks can indicate their ability to absorb losses and work as a cushion against any insolvency risks, resulting in more efficient performance. Moreover, in order to lessen cost inefficiencies, financial capital could be an alternative source to finance a bank's portfolio instead of relying on debt finances, which incur interest payments.[11] Inclusion of financial capital can also take into account a bank's typical risk preferences (Berger and Mester, 1997). For example, banks' managements that obtain capital beyond their profit maximization schemes may be classified as risk averse banks. However, on the other hand, these banks may have more incentives to engage in riskier activities incurring volatile profits, which may result in inefficiency when negative profits dominate the outcomes of their operations.

Recent studies have shown the importance of considering asset quality in the efficiency measurement. Higher loan problems (proxied by nonperforming loans or loan provisions) may mean that there is an amount of loans extended to low-quality borrowers that face repayment difficulty. Moreover, high loan problems can cast doubts on the screening and monitoring methods of a bank. For these reasons, the loan

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[8] The ends of the $[0,2\pi]$ interval are cut off by 10% so that the z_n span $[0.1 * 2\pi, 0.9 * 2\pi]$ to reduce the approximation problems near endpoints (Gallant, 1981). The formula for z_n is $\{0.2\pi - \mu * a + \mu * \text{variable}\}$ where $[a,b]$ is the range of the variable being transformed, and $\mu \equiv (0.9 * 2\pi - 0.1 * 2\pi)/(b-a)$ (see Berger and Mester, 1997).

[9] In addition, environmental variables such as fixed assets and off-balance sheet variables have also been included in these studies (see e.g. Berger and Mester, 1997; Altunbas et al., 2000).

[10] Such as those of Altunbas et al., 2000; Berger and Mester, 1997; Mester, 1996.

[11] Banks treat paid interest on debt as cost, but paid dividends on capital are not considered as costs (Berger and Mester, 1997).

problems factor is expected to be a possible reason for distancing a bank from the efficient frontier.

A time trend variable has also been incorporated in various studies (such as those of Altunbas et al., 2000; and Lang and Welzel, 1996) to account for disembodied technical change. As the method of production changes over time, the time trend captures the factors of technological change, improvements in skills through learning by doing and training, as well as organizational and regulatory changes that may affect the efficient use of input resources (Altunbas, 2000; Baltagi and Griffin, 1988).

By considering the above-mentioned variables, we arrive at our preferred model, which can be written as[12]

$$\begin{aligned}\ln TC &= \alpha_0 + \sum_{i=1}^{2}\alpha_i \ln Q_i + \sum_{i=1}^{2}\beta_i \ln P_i \\ &+ \kappa_1 \ln E + \nu_1 \ln PROV + \tau_1 T \\ &+ \frac{1}{2}\left[\sum_{i=1}^{2}\sum_{j=1}^{2}\delta_{ij}\ln Q_i \ln Q_j + \sum_{i=1}^{2}\sum_{j=1}^{2}\gamma_{ij}\ln P_i \ln P_j + t_{11}T^2\right] \\ &+ \sum_{i=1}^{2}\sum_{j=1}^{2}\rho_{ij}\ln Q_i \ln P_j + \sum_{i=1}^{2}[a_i\cos(z_i) + b_i\sin(z_i)] \\ &+ \sum_{i=1}^{2}\sum_{j=1}^{2}[a_{ij}\cos(z_i + z_j) + b_{ij}\sin(z_i + z_j)] + \varepsilon_i,\end{aligned} \tag{13}$$

where E is equity capital, $PROV$ is total loan provisions, and T is time trend. Since both risk and asset quality have been the variables under focus to measure the health of the banking system, we estimate Eq. (13) by including and excluding risk and quality factors in order to see how far these factors have an effect on the inefficiency estimates for our sample of Gulf banks. We call the model that excludes risk and quality factors the traditional model (and the one that includes them is the preferred model).

[12] This preferred model is chosen from the feedback of our estimation experiment. In fact, the availability of data on the variables, how well the model behaves in the estimation process, and the validity of the model to pass the structural tests determined our model choice.

Note that, in Eq. (13), when estimating the profit functions, *TC* is replaced by profits (*PROF)* on the left-hand side for both the alternative and the standard profit functions. Moreover, the right-hand side of Eq. (13) is identical for both cost and alternative profit functions. However, for the standard profit function, we only replace the output quantities with output prices.[13]

Eq. (13) may be characterized by increasing, constant, or decreasing returns to scale, which means that because the degree of returns to scale is not known, the model might be nonhomogeneous. Thus, homogeneity restrictions are imposed on the translog portion of Eq. (13) to ensure that the cost function (as well as the profit functions) is linearly homogeneous in input prices. The homogeneity restrictions are shown as

$$\sum_{i=1}^{2} \beta_i = 1,$$

$$\sum_{i=1}^{2} \gamma_{ij} = 0 \text{ for all } j,$$

and $$\sum_{i=1}^{2} \rho_{ij} = 0 \text{ for all } j.$$

Moreover, Young's theorem requires symmetry of the second order parameters of the translog cost function, that is:

$$\delta_{ij} = \delta_{ji} \text{ for all } i,j,$$

and $$\gamma_{ij} = \gamma_{ji} \text{ fore all } i,j.$$

[13] For instance, the standard profit function is shown as

$$\begin{aligned} \ln PROF &= \alpha_0 + \sum_{i=1}^{2} \alpha_i \ln P_i Q_i + \sum_{i=1}^{2} \beta_i \ln P_i \\ &+ \kappa_1 \ln E + \nu_1 \ln PROV + \tau_1 T \\ &+ \frac{1}{2}\left[\sum_{i=1}^{2}\sum_{j=1}^{2} \delta_{ij} \ln Q_i \ln Q_j + \sum_{i=1}^{2}\sum_{j=1}^{2} \gamma_{ij} \ln P_i \ln P_j + t_{11} T^2 \right] \\ &+ \sum_{i=1}^{2}\sum_{j=1}^{2} \rho_{ij} \ln Q_i \ln P_j + \sum_{i=1}^{2} [a_i \cos(z_i) + b_i \sin(z_i)] \\ &+ \sum_{i=1}^{2}\sum_{j=1}^{2} [a_{ij} \cos(z_i + z_j) + b_{ij} \sin(z_i + z_j)] + \varepsilon_i, \end{aligned}$$

where ln *PROF* is ln (π+θ) given that π is the profit variable, θ is a constant added to the firm's profit so that the natural log of profits is positive, and *PQ* is the output price variable.

When solving for linear homogeneity restrictions, both the cost and the profit models are normalized by the price of labour (P_2) (see e.g. Greene, 1993; Berger and Mester, 1997; Altunbas et at., 2000). This can ensure that, on the efficient frontier, when input prices double, costs will exactly double by the same proportion as well, which would leave the input quantities unaffected.

Moreover, for the alternative profit function, homogeneity restrictions will serve to keep the relationship between input prices and profits in an equivalent fashion, although they need not to be imposed on the alternative profit function (Berger and Mester, 1997).

As explained, the Fourier functional form (Eq. 13) is the preferred model used to estimate cost, standard, and alternative profit functions. We obtain the parameters of these functions, as well as their inefficiency estimates, using Maximum Likelihood Estimation (MLE) regression. The next subsection explains the derivation of economies of scale, which is based on our preferred model (Eq. 13).

3.2 Economies of Scale

Economies of scale show by how much a proportional change in outputs level would lead to a change in total cost. In other words, economies of scale express the total cost elasticity with respect to output, which can be obtained by differentiating the cost function with respect to output variable. For the two outputs in our banking sample, economies of scale solved for Eq. (13) are given as

$$\begin{aligned} Scale\ economies = \sum_{i=1}^{2} \frac{\partial \ln TC}{\partial \ln Q_i} &= \sum_{i=1}^{2} \alpha_i + \sum_{i=1}^{2}\sum_{j=1}^{2} \delta_{ij} \ln Q_j + \sum_{i=1}^{2}\sum_{j=1}^{2} \rho_{ij} \ln P_i \\ &+ \mu_i \sum_{i=1}^{2} \left[-a_i \sin(Z_i) + b_i \cos(Z_i) \right] \\ &+ 2\mu_i \sum_{i=1}^{2}\sum_{j=1}^{2} \left[-a_{ij} \sin(Z_i + Z_j) + b_{ij} \cos(Z_i + Z_j) \right]. \end{aligned} \quad (14)$$

If $\sum_{i=1}^{n} \frac{\partial \ln TC}{\partial \ln Q_i} = 1$, this shows that a proportional change in outputs yields the same proportional change in total cost. This is known as constant returns to scale or constant economies of scale. When the measurement $\sum_{i=1}^{n} \frac{\partial \ln TC}{\partial \ln Q_i} < 1$, this means that a proportional change in outputs leads to a change in the total cost with a proportional change less than that of output. In this case the relationship between output and total cost is said to exhibit increasing returns to scale, implying economies of scale. If $\sum_{i=1}^{n} \frac{\partial \ln TC}{\partial \ln Q_i} > 1$, this means that a proportional change in outputs leads to a more than proportional change in total cost. This relationship is known as decreasing returns to scale, which implies diseconomies of scale.

Having specified our methodology, the following details various aspects of the data and the variables used in our analysis of GCC bank efficiency.

4. Data and Variables

4.1 Data

Our study contains a balanced time series cross-sectional dataset, which consists of 93 GCC banks covering the six-year period from 1995 to 2000. The source of our data is mainly the London-based IBCA bank credit rating agency's database (Bankscope, Jan., 2002), the Financial Position of Commercial Banks in the UAE (1995-2000), published by the Emirates Banks' Association, and the annual financial statements of banks operating in Qatar. The majority of data in our sample relates to commercial banks, [14] with the exception of seven specialized banks, that are included to enhance the total number of observations in order to reduce the impact of multicollenearity among variables.

Table 1 shows the percentage of the total bank assets for each country included in the sample relative to the total assets of the banking industry in each country in the year 2000. The table indicates that the sample constitutes at least 89 per

[14] According to the bank classification adopted in Qatar and by the UAE central bank authorities, Islamic banks are considered as commercial banks.

cent of the total banking industry's assets in Qatar, the UAE, Saudi Arabia, and Kuwait. However, the percentage of assets of Bahraini banks included in the sample is about half of the total bank assets of Bahrain's banking industry (as the rest belongs to the offshore banking units and other financial institutions for which data are unavailable). Moreover, the sample contains 64 per cent of the total Omani bank assets.

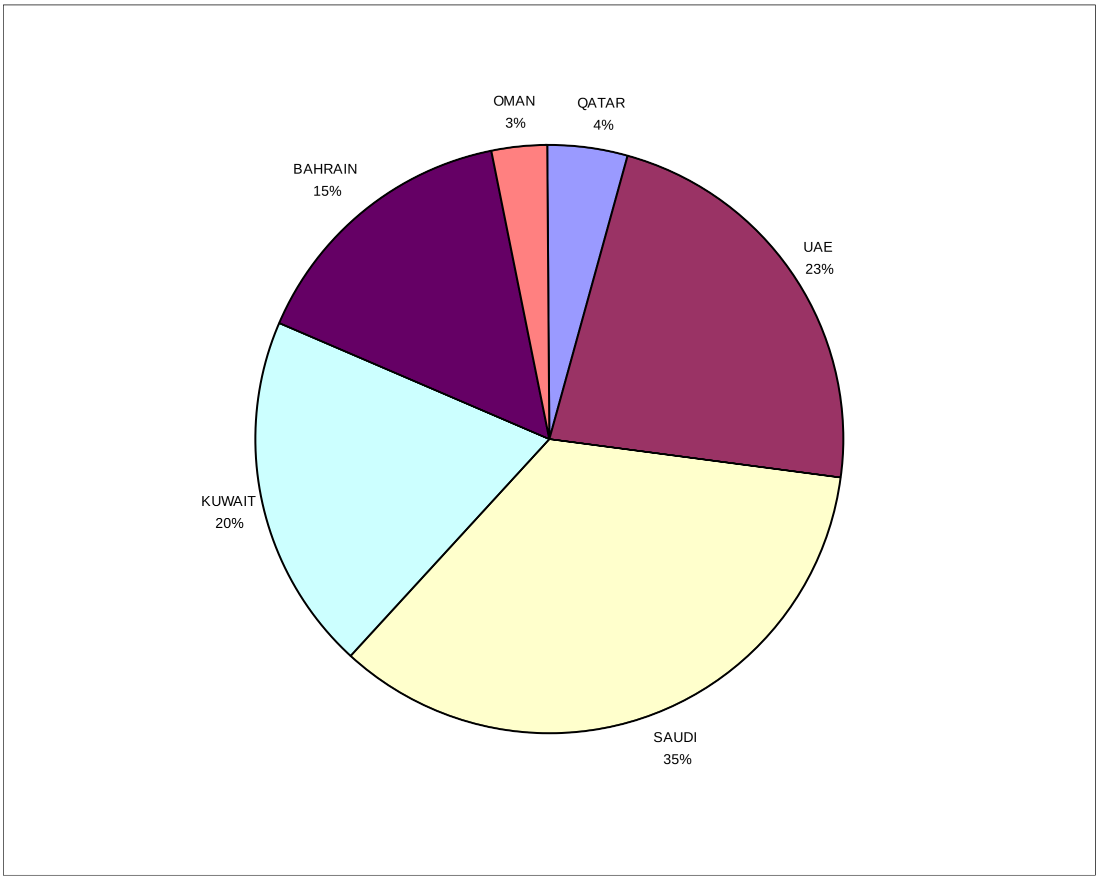
Table 1: Total assets of banks in each country in the sample relative to the total assets of the banking industry by country, 2000 - ('000 US dollars)

Country	Total assets of the sample	Total banking sector assets	%	No. of banks
QATAR	14,065,122	14,803,297	95%	14
UAE	71,967,905	75,504,087	95%	43
SAUDI ARABIA	108,197,277	121,195,722	89%	9
KUWAIT	62,552,718	70,413,140	89%	10
BAHRAIN	48,489,604	102,100,000	47%	11
OMAN	9,735,501	15,220,224	64%	6

Sources: Bankscope (Jan., 2002), financial reports of banks in the UAE and Qatar, and the annual reports published by the central banks in each country.

Figure 1 shows the share of the bank assets of each country included in the sample relative to the total bank assets of the whole sample in the year 2000. With only 9 Saudi banks, the figure indicates that the Saudi banks occupy the largest share of total assets of banks included in the sample. UAE banks occupy the second largest share in the sample, given that the number of UAE banks in the sample is 43, the highest among all GCC countries included in the sample.

Figure 1: Total assets of individual GCC country banks in the sample as a share in the total banking industry's assets for the underlying GCC country – Year 2000



Sources: Bankscope (Jan., 2002) and financial reports published by banks in the UAE and Qatar.

4.2 The Variables

Table 2 defines the variables used in the specification of cost and profit functions of Eq. (13).

Table 2: Descriptive statistics of the outputs, inputs, and control variables used in the Eq. (13)

Variable	Description	Mean	St. Dev.	Min.	Max.
Dependent variables					
TC	Total cost includes interest expenses and operating costs ('000 US dollars)	155,717.4	262,769.4	1,736.9	1,728,938.2
PROF	Profits include revenues from loans and other earning assets less total cost ('000 US dollars)	62,480.4	81,198.4	6,472.7	522,098.6
Prices of inputs					
P1	Price of deposits	0.0469	0.0100	0.0218	0.0728
P2	Price of labour	0.0182	0.0078	0.0047	0.0530
Output quantities					
Q1	Total loans ('000 US dollars)	1256245	2090826	2807	1728938
Q2	Other earning assets ('000 US dollars)	1397850	2488464	13456	14409000
Prices of Outputs					
PQ1	Price of loans	0.1413	0.0394	0.0509	0.2000
PQ2	Price of other earning assets	0.0402	0.0333	0.0018	0.2959
Control variables					
E	Total equity ('000 US dollars)	307,501.8	451,200.0	0.3	2,297,223.0
PROV	Total provisions ('000 US dollars)	12,688.1	42,650.2	0.3	882,099.1
T	Time trend			5.0	10.0

Sources: Bankscope (Jan., 2002), financial reports of banks in the UAE and Qatar, and annual reports published by the central banks of the GCC countries.

These variables are given along with their descriptive statistics including sample means and standard deviations. Both cost and alternative profit functions specify two outputs, two inputs, two input prices, and two output prices variables used in the standard profit functions, as well as risk, asset quality, and technical progress variables.

The specifications of outputs and inputs are viewed from the assets and liabilities sides respectively, which conforms with the intermediation approach to modelling banking production (Sealey and Lindley, 1977). The output variables are total loans, denoted by Q_1; and other earning assets, denoted by Q_2, which reflects investments or securities categories.

Two prices of inputs are considered: prices of borrowed funds, denoted by *P1*; and prices of labour, denoted by *P2*. These are calculated as follows. *P1* is obtained by the division of interest paid by the borrowed funds, where borrowed funds are the total of all interest bearing deposits. *P2* is a proxy of labour price computed as the ratio of staff costs to total assets.[15 & 16]

The dependent variable of the cost function, denoted by *TC*, is obtained from the sum of interest expenses and the staff costs, where both of these comprise the vast majority of the banking total cost. Variable profits, denoted by *PROF*, are calculated as the revenues from loans and other earning assets less total cost.

To control for bank risk, we use financial capital, denoted by *E*. The variable *PROV* is the loan loss provisions taken as a proxy for loan (or assets) quality.[17] The model also includes time trend, denoted *T,* which accounts for technical progress.

4.2.1 Inefficiency Determinants & Logistic Regression

After explaining the methodology measuring cost and profit inefficiency levels in the GCC banking sector, one may need to go a step further and investigate the

[15] Price of labour is usually computed by the division of staff cost by the number of staff. However, owing to the non-availability of data on staff numbers we follow Altunbas et al. (2000) to calculate the price of labour as a ratio of staff cost to the total assets.

[16] The majority of studies also include the price of fixed assets. However, for many banks considered in this paper (especially foreign banks in the UAE) there are no data on fixed assets expenses (for example, depreciations) to calculate the price of fixed assets. We are therefore forced to confine the number of inputs to borrowed funds and labour.

[17] Among categories of loan loss provisions, loan loss level and the non-performing loan data, only the loan loss provisions category is available for the entire sample.

sources or the possible determinants of inefficiency in the industry. In order to do this, we need to employ the most likely influential variables and the appropriate econometric technique. Table 3 presents the descriptive statistics of the variables that are examined as possible inefficiency determinants. Most of these variables have been used in studies such as those of Mester (1996), Altunbas et al. (2000), and Girardone et al. (2000).

The inefficiency variables (CN and SN) are the measured cost and profit inefficiencies derived from the traditional Fourier Flexible cost and profit functions that exclude risk and asset quality variables. We use inefficiency estimates derived from the traditional rather than the preferred model because we want to avoid double consideration of the risk and quality factors.

Basically, the authors of various studies (e.g. Mester, 1996; Altunbas et al., 2000) believe that factors of risk and quality are important variables determining inefficiency levels. Accordingly, our inefficiency determinant model mainly includes *EQUITY*(=financial capital) and *PROV*(=loan loss provisions); these variables are used again as proxies for risk and loan quality respectively.

Here, it is expected that the sign of *EQUITY* is negative, indicating that the more inefficient banks have more risk that may be attributed to inadequate capital maintained in their operations. In other words, efficient banks have lower risk and are more able to generate profits that help in accumulating more retained earnings added to the financial capital (this assumes that dividends are unchanged).

In relation to bank capital, risk, and bank returns, we also include the variable ROA(=rate of return on assets), which is used as a proxy for performance. ROA is expected to be inversely related to cost and profit inefficiency on the grounds that the more inefficient firms are believed to employ their inputs in non-productive outputs that earn low returns.

With regard to the loan quality variable, the sign of the loan quality (*PROV*) is expected to be positive, showing that the more inefficient firms have higher provisions, indicating that they face loan problems and, thus, regulations force them to increase their loan provisions in accordance with deteriorating loan quality.

Table 3: Descriptive statistics of the variables used in the logistic regression model

Variable	Description	Mean	St. Dev.	Min	Max
CN	Cost inefficiency half-normal	0.0839	0.0469	0.0144	0.4467
SN	Standard profit inefficiency half-normal	0.3312	0.1849	0.0361	.9897
EQUITY	Total equity ('000 US dollars)	307,501	451,200	0.3000	2,297,223
ROA	Rate of return on assets	0.0480	0.0404	0.0064	0.2841
PROV	The ratio of provisions to total loans	0.0170	0.0361	0.0000	0.3735
FOREIGN	Foreign banks – dummy variable	-	-	0	1
LTA	Ratio of loans to total assets	0.4966	0.1926	0.0105	0.9059
FIX	Fixed assets ('000 US dollars)	39,767	103,297	1	899,873
TA	Total assets ('000 US dollars)	2,832,011	4,704,465	31,616	26,699,785
TBGDP	Total bank assets as a ratio to GDP	1.7739	1.8609	0.1935	7.3626

Sources: Bankscope (Jan., 2002), financial reports of banks in the UAE and Qatar, and annual reports published by the central banks authorities in the GCC countries.

Moreover, because we wish to consider whether foreign banks are more efficient than their domestic competitors in the GCC, we include the dummy variable FOREIGN(=foreign banks), which consists of a value of one if the bank is foreign and zero otherwise. With regard to the GCC banking data of our sample, the foreign bank dummy variable and inefficiency variables are expected to be positively related since foreign banks operate under restrictions relating to bank size and branching limits, as well as tax impositions that may add to their costs.

Other independent variables are also considered in order to capture additional characteristics of bank and industry specifics. These are: L/TA(=net loans/total assets), FIX(=fixed assets), (TA=total assets), and TBGDP(=total banking assets/GDP). Variables L/TA, FIX, TA, and TBGDP respectively, control for balance sheet mix, bank size, and market size factors that may be influential in influencing banking sector inefficiency.

Overall, in order to investigate the determinants of GCC bank inefficiency we estimate the following model

$$INEFF = f \ (EQUITY, ROA, PROV, \ FOREIGN, \ LTA, FIX, TA, \ TBGDP) \quad (15)$$

As mentioned, this model will be estimated using the logistic functional form. The general form of the logistic model is written as

$$\hat{E}(u_i \backslash \varepsilon_i) = \frac{\exp(X_i^{'}\gamma)}{1+\exp(X_i^{'}\gamma)} + \xi_i \quad (16)$$

where X_i is a vector of independent variables for the ith firm, γ is the parameter vector, and ξ_i is a normally distributed error term.

Since the inefficiency variables are the dependent variables with values falling between zero and one, the logistic functional form is preferred here (compared with ordinary least squares methods) because the former is generally used to estimate models where the dependent variables are bounded between zero and one.

Following Mester (1996), the interpretation of the logistic function results only tells us about correlation relationships and do not tell us anything about causality.

Nevertheless, the logistic regression is also preferred over the simple correlation method because it is possible to take other variables into consideration when estimating inefficiency determinants.

5. The Empirical Results on GCC Banking Efficiency [18]

Following the methodology of Berger and Mester (1997), we evaluate three inefficiency concepts: cost inefficiency, profit inefficiency, and alternative profit inefficiency. The results are based on two specifications: the preferred model and the traditional model. For both the preferred and the traditional models we use the Fourier Flexible form; however, the preferred model differs from the traditional specification by including the equity and loan provisions variables, which are considered in this research as proxies for risk and loan quality factors respectively.

5.1 Structural Tests

Undertaking the estimation of the model (Eq. 13) using pooled time series cross-section data usually requires a test to check if it is permissible to pool both dimensions of the data, an issue that arises when one is using panel data (Baltagi, 2001). The checking of the data poolability is performed in order to detect whether or not the parameters of the model are the same (or stable) across time and bank observations, especially when data are pooled. This can be tested using the poolability test, which is an application of a generalized Chow's (1960) test. The residual sum squared of the restricted model, which is obtained from the OLS pooled model estimated for Eq. (13), and the total value of the unrestricted residual sum of squares, which is obtained from individual OLS regressions of 93 banks across each year of the study period, are calculated to carry out Chow's poolability test. As shown in Tables (5a to 5c), the test which is undertaken for the cost, standard profit, and alternative profit functions yields observed F-statistics of 1.05, 0.96, and 0.63 respectively, which are distributed as $F(120, 414)$. Under the null hypothesis: $H_0 : \beta_t = \beta$ for $t = 1, \ldots, T$, the test does not reject poolability at the 1 per cent level of significance. Therefore, our poolability test

[18] The estimation is carried out using *LIMDEP* econometric software version 7.0.

suggests that pooling our data in order to estimate Eq. (13) is valid, which also implies that the estimated model parameters are stable over time and bank observation.

As our data sample has a 'panel' dimension with a large cross-section (93 banks estimated over 6 years), the inclusion of banks of different sizes in the sample may give rise to concern of heteroskedasticity in the error term. We apply the Goldfeld-Quandt test (1965) to check whether or not the heteroskedasticity problem is present in the model. If not, then the test indicates that disturbance variances are homoskedastic, or, in other words, constant across observations. For the cost, standard profit, and alternative profit functions, Tables (5a to 5c) show that because the calculated test values are less than the critical value, the Goldfeld-Quandt test does not reject the null hypothesis of homoskedasticity at 1 per cent level of significance

As it is widely recommended to conduct more than one test for checking heteroskedasticity, the LM test for dependent-variable heteroskedasticity is another useful test to carry out here. [19 & 20] At the 1 per cent level of significance, Tables (5a to 5c) show that the LM test does not reject the null hypothesis of homoskedasticity in both standard and alternative profit functions; however, for the cost function the test is rejected. Assuming homoskedasticity in the disturbance term when heteroskedasticity is present would still produce consistent but not inefficient estimates (Baltagi, 2001).

Overall, the heteroskedasticity tests of these models tend to indicate that the estimation may be viewed as free from heteroskedasticity since both the Goldfeld-Quandt test and the LM test, if taken together, suggest that the error term is apparently not positively correlated with any of the explanatory variables. This implies that the various model specifications do not have serious heteroskedasticity problems.

Given that we are estimating models using panel data, it is also important to investigate whether fixed or random effects estimation must be undertaken. A number of studies that estimate translog and Fourier Flexible models suggest that it is not appropriate to work under the framework of the panel fixed effects model since this induces a substantial loss in the degree of freedom, especially when the number of cross-sections is large (see e.g. Lang and Walzel, 1996; Altunbas et al., 2000). However, before dismissing the fixed effects model, it is important to undertake the

[19] White's (1980) test of heteroskedasticity is not appropriate for our model since this test causes a loss in the degree of freedom if applied.
[20] See Thomas, 1997, Chapter 10.

random effects test since it can, at least, provide information as to whether individual effects are present or not. The test undertaken here to check the existence of random effects is the Lagrange Multiplier test, devised by Breusch and Pagan (1980). Tables (5a to 5c) show that the LM test rejects the hypothesis of no individual effects at the 1 per cent level of significance, for the cost, standard profit, and alternative profit functions. In this case, the LM test suggests that there is considerable heterogeneity across banks and that the random effects model is the method to be used to control for the effects of the differences across bank observations in our sample. Based on the LM test, we conclude that the random effects model is the appropriate panel estimation approach.

With regard to the choice of the functional form, the Fourier Flexible form is tested against the translog model. Using the F-test, Tables (5a to 5c) show that the hypothesis that the translog model is valid was rejected at the 1 per cent significance level for the cost, standard profit, and alternative profit functions. The results show the superiority of the Fourier Flexible form over the translog model since the presence of the Fourier trigonometric terms in the model is compelling.

Additional tests are also undertaken to check if the exclusion of the risk (E) and asset quality (PROV) variables, as well as the technical progress variables (T and TT), has no statistical significant effects on the model specification shown in Eq. (13). The F-test evaluated at the 1 per cent level of significance rejects the null hypothesis that these variables have a zero effect on the dependent variables in each efficiency concept function. In other words, the existence of these variables in the model are important for our inefficiency analysis.

Generally, as the structural tests imply, this section concludes that Eq. (13) for the cost, standard profit, and alternative profit functions (that have the Fourier Flexible functional form and incorporate banks' asset quality, risk, and time trend variables) are econometrically valid for our efficiency analysis. The inefficiency measures derived from estimating the aforementioned model are discussed in the following section.

Table 5 (a to c): Structural tests for model (13)

Table (5a) — **Structural tests of the cost function Eq. (13)**

Test Performed		Test Statistics	Degrees of Freedom		Critical value		H0 Hypothesis	Decision
Poolability	Chow's test	1.0592	((T-1)K)= ((N-K)T))=	120 414	F(.01,120,414)=	1.383	H0:Bt=B data is poolable or betas are stable	Not-rejected
Heteroskedasticity	Goldfeld-Quant test	0.8299	n1= n2=	253 253	F(a,N1-K,N2-K)=(.01,279-26,279-26)=	1.341	H0:Disturbances of the variances are constant	Not-rejected
Heteroskedasticity	LM test	18.391	k=	1	X2(0.01,1)=	6.635	H0:Disturbances of the variances are the constant	Rejected
Random effects	LM test	358.09	k=	1	X2(0.01,1)	6.635	H0:No individual effects	Rejected
Translog Form	F-test Chi-squared test	3.397 33.993	K=	10	F(.01,10,536) X2(10)=	2.354 23.209	H0:Translogn form is valid or Fourier terms =0	Rejected Rejected
DROP PROV,E,T,TT	F-test	13.327	k=	4	F(.01,4,532)=	3.355	H0:estimated model is better when these are dropped	Rejected
DROP PROV,E	F-test	25.059	k=	2	F(.01,2,532)=	4.645	H0:estimated model is better when these are dropped	Rejected
DROP PROV,T,TT	F-test	1.4102	k=	3	F(.01,3,532)=	3.819	H0:estimated model is better when these are dropped	Not-rejected
DROP E,T,TT	F-test	17.729	k=	3	F(.01,3,532)=	3.819	H0:estimated model is better when these are dropped	Rejected
DROP RPOV	F-test	0.1815	k=	1	F(.01,1,532)=	6.683	H0:estimated model is better when these are dropped	Not-rejected
DROP E	F-test	50.024	k=	1	F(.01,1,532)=	6.683	H0:estimated model is better when these are dropped	Rejected
DROP T,TT	F-test	1.9974	k=	2	F(.01,2,532)=	4.645	H0:estimated model is better when these are dropped	Not-rejected

Table (5b) — **Structural tests of the standard profit function Eq. (13)**

Test Performed		Test Statistics	Degrees of Freedom		Critical value		H0 Hypothesis	Decision
Poolability	Chow's test	0.9676	((T-1)K)= ((N-K)T))=	120 414	F(.01,120,414)=	1.383	H0:Bt=B data is poolable or betas are stable	Not-rejected
Heteroskedasticity	Goldfeld-Quant test	0.7705	n1= n2=	253 253	F(a,N1-K,N2-K)=(.01,279-26,279-26)=	1.341	H0:Disturbances of the variances are the constant	Not-rejected
Heteroskedasticity	LM test	6.4003	k=	1	X2(0.01,1)=	6.635	H0:Disturbances of the variances are the constant	Not-rejected
Random effects	LM test	400.64	k=	1	X2(0.01,1)	6.635	H0:No individual effects	Rejected
Translog Form	F-test Chi-squared test	661.00 6610.0	K=D101	10	F(.01,10,536) X2(10)=	2.354 23.209	H0:Translogn form is valid or Fourier terms =0	Rejected Rejected
DROP PROV,E,T,TT	F-test	19.025	k=	4	F(.01,4,532)=	3.355	H0:estimated model is better when these are dropped	Rejected
DROP PROV,E	F-test	35.174	k=	2	F(.01,2,532)=	4.645	H0:estimated model is better when these are dropped	Rejected
DROP PROV,T,TT	F-test	6.3979	k=	3	F(.01,3,532)=	3.819	H0:estimated model is better when these are dropped	Not-rejected
DROP E,T,TT	F-test	20.255	k=	3	F(.01,3,532)=	3.819	H0:estimated model is better when these are dropped	Rejected
DROP RPOV	F-test	14.096	k=	1	F(.01,1,532)=	6.683	H0:estimated model is better when these are dropped	Not-rejected
DROP E	F-test	56.348	k=	1	F(.01,1,532)=	6.683	H0:estimated model is better when these are dropped	Rejected
DROP T,TT	F-test	2.0251	k=	2	F(.01,2,532)=	4.645	H0:estimated model is better when these are dropped	Not-rejected

Table (5c) — **Structural tests of the alternative profit function Eq. (13)**

Test Performed		Test Statistics	Degrees of Freedom		Critical value		H0 Hypothesis	Decision
Poolability	Chow's test	0.6303	((T-1)K)= ((N-K)T))=	120 414	F(.01,120,414)=	1.383	H0:Bt=B data is poolable or betas are stable	Not-rejected
Heteroskedasticity	Goldfeld-Quant test	0.9854	n1= n2=	253 253	F(a,N1-K,N2-K)=(.01,279-26,279-26)=	1.341	H0:Disturbances of the variances are the constant	Not-rejected
Heteroskedasticity	LM test	2.8519	k=	1	X2(0.01,1)=	6.635	H0:Disturbances of the variances are the constant	Not-rejected
Random effects	LM test	375.520	k=	1	X2(1)	6.635	H0:No individual effects	Rejected
Translog Form	F-test Chi-squared test	6.9483 69.4850	K=	10	F(.01,10,532) X2(10)=	2.354 23.209	H0:Translogn form is valid or Fourier terms =0	Rejected Rejected
DROP PROV,E,T,TT	F-test	25.5201	k=	4	F(.01,4,532)=	3.355	H0:estimated model is better when these are dropped	Rejected
DROP PROV,E	F-test	50.1498	k=	2	F(.01,2,532)=	4.645	H0:estimated model is better when these are dropped	Rejected
DROP PROV,T,TT	F-test	12.7859	k=	3	F(.01,3,532)=	3.819	H0:estimated model is better when these are dropped	Not-rejected
DROP E,T,TT	F-test	20.5604	k=	3	F(.01,3,532)=	3.819	H0:estimated model is better when these are dropped	Rejected
DROP RPOV	F-test	36.8296	k=	1	F(.01,1,532)=	6.683	H0:estimated model is better when these are dropped	Not-rejected
DROP E	F-test	60.6521	k=	1	F(.01,1,532)=	6.683	H0:estimated model is better when these are dropped	Rejected
DROP T,TT	F-test	0.55111	k=	2	F(.01,2,532)=	4.645	H0:estimated model is better when these are dropped	Not-rejected

5.2 Parameter Estimation Analysis

The estimates in Tables (4a to 4c) show the maximum likelihood parameter estimation (MLE) of the Fourier Flexible cost, standard profit, and alternative profit functions, which are estimated for both the traditional and preferred model specifications (Eq. 13). The estimates of the model parameters are quite similar across model specifications (traditional and preferred model, as well as models excluding only risk variable [equity] or loan quality variable [provisions] from the preferred model).

The results in Tables (4a to 4c) also show that the functions' estimated coefficients mostly have consistent signs. To be specific, the input prices (P_1 and P_2) have positive effects on costs, implying that higher input prices lead to greater costs [see Table (3a)]. Moreover, in Table (3c), the positive relationship between the prices of inputs (P_1) and alternative profits may be explained by the fact that when the price of deposits increases, loan prices also increase, resulting in higher profits. Because output quantities are set as given in the alternative profit function and prices of output are left to move freely, changes in output prices induced by input price movements may bring the latter and profits into a close relationship. In addition, the negative coefficients on the price of loans (PQ_1) in relation to standard profits clearly indicate that an increase in the price of loans would decrease the level of profits [see Table (4b)]. At first glance, this result might look odd since profits may be expected to increase as prices rise. However, because the standard profit function takes the price of output as given and leaves the quantity of output to move freely, this means that at higher prices banks face a lower demand for output; hence, at this given higher price of output, banks' profits may decrease. Thus, this negative relationship between loan prices and profits could indicate that the quantity of loans demanded (rather than the price of loans) is more influential in driving GCC banking profits. An alternative explanation suggests that an increase in loan prices may result in a reduction in the quantity of loans demanded, reducing profits by a greater proportion than would be added by any loan price increases. The main finding is that an increase in prices results in lower levels of standard profits (all other factors remain the same).

Table 4 (a to c) Maximum likelihood parameter estimation for cost, standard, and alternative profit functions

Table 4 a

Maximum likelihood parameter estimation for the cost function using the half-normal model

		Traditional model			Preferred model Eq. (13)			No Equity			No Provisions		
Variable	Parameter	Coefficient	Std. Error	*T*-value	Coefficient	Std. Error	*T*-value	Coefficient	Std. Error	*T*-value	Coefficient	Std. Error	*T*-value
Constant	α_0	-5.6534	10.7210	-0.5270	-4.8803	15.6330	-0.3120	-5.7154	10.5360	-0.5420	-4.7678	15.1940	-0.3140
lnQ1	α_1	-0.8054	1.3327	-0.6040	-0.5292	2.3481	-0.2250	-0.7993	1.3166	-0.6070	-0.5465	2.2376	-0.2440
lnQ2	α_2	2.7250	1.2191	2.2350	2.4391	1.0588	2.3040	2.7296	1.2320	2.2160	2.4317	1.0610	2.2920
lnP1	β_1	0.5019	0.0428	11.7340	0.4970	0.0434	11.4650	0.5017	0.0435	11.5440	0.4989	0.0428	11.6620
lnE	κ	-	-	-	-0.0225	0.0025	-8.8460	-	-	-	-0.0228	0.0025	-9.0970
lnPROV	ν	-	-	-	0.0020	0.0028	0.7270	0.0019	0.0027	0.7110	-	-	-
T	τ	-0.0421	0.0443	-0.9500	-0.0458	0.0454	-1.0090	-0.0427	0.0442	-0.9680	-0.0454	0.0449	-1.0110
TT	τ^2	0.0055	0.0058	0.9510	0.0060	0.0060	1.0070	0.0056	0.0058	0.9660	0.0060	0.0059	1.0110
lnQ1 lnQ1	δ_{11}	0.2953	0.1067	2.7680	0.2824	0.1883	1.5000	0.2944	0.1055	2.7920	0.2847	0.1789	1.5910
lnQ1 lnQ2	δ_{12}	-0.1555	0.0130	-11.9200	-0.1704	0.0130	-13.1340	-0.1553	0.0133	-11.7000	-0.1706	0.0126	-13.5170
lnQ2 lnQ2	δ_{22}	-0.0456	0.0915	-0.4990	-0.0056	0.0791	-0.0710	-0.0460	0.0924	-0.4970	-0.0051	0.0792	-0.0640
lnP1 lnP1	γ_{11}	0.2491	0.0527	4.7240	0.2433	0.0502	4.8500	0.2513	0.0534	4.7040	0.2421	0.0490	4.9430
lnP1 lnP2	γ_{12}	-0.2115	0.0340	-6.2220	-0.2010	0.0343	-5.8670	-0.2123	0.0345	-6.1600	-0.2001	0.0339	-5.9030
lnP1 lnQ1	ρ_{11}	0.1004	0.0301	3.3320	0.0965	0.0291	3.3110	0.0990	0.0302	3.2740	0.0981	0.0294	3.3370
lnP1 lnQ2	ρ_{12}	-0.1043	0.0311	-3.3510	-0.0972	0.0303	-3.2090	-0.1024	0.0307	-3.3340	-0.0992	0.0310	-3.2030
lnP2 lnQ1	ρ_{21}	0.0154	0.0219	0.7050	0.0036	0.0205	0.1750	0.0163	0.0227	0.7180	0.0034	0.0204	0.1650
cos(z1)	a_1	-0.6970	0.5260	-1.3250	-0.5632	0.8861	-0.6360	-0.6931	0.5204	-1.3320	-0.5739	0.8453	-0.6790
sin(z1)	b_1	0.0153	0.1420	0.1080	-0.0244	0.2566	-0.0950	0.0130	0.1412	0.0920	-0.0178	0.2346	-0.0760
cos(z2)	a_2	0.7306	0.3138	2.3280	0.6695	0.2817	2.3770	0.7317	0.3159	2.3170	0.6661	0.2811	2.3700
sin(z2)	b_2	0.0744	0.0828	0.8980	-0.0358	0.0633	-0.5660	0.0757	0.0863	0.8770	-0.0304	0.0640	-0.4750
cos(z1+z1)	a_{11}	-0.1552	0.0681	-2.2790	-0.1374	0.1131	-1.2150	-0.1544	0.0678	-2.2790	-0.1393	0.1067	-1.3060
sin(z1+z1)	b_{11}	0.0668	0.0452	1.4790	0.0227	0.0739	0.3080	0.0656	0.0450	1.4580	0.0260	0.0685	0.3800
cos(z1+z2)	a_{12}	0.0059	0.0273	0.2180	0.0522	0.0342	1.5250	0.0057	0.0270	0.2120	0.0493	0.0331	1.4880
sin(z1+z2)	b_{12}	-0.0627	0.0346	-1.8120	-0.0269	0.0348	-0.7740	-0.0626	0.0347	-1.8030	-0.0269	0.0349	-0.7710
cos(z2+z2)	a_{22}	0.1444	0.0472	3.0600	0.0970	0.0453	2.1390	0.1453	0.0463	3.1380	0.0968	0.0458	2.1140
sin(z2+z2)	b_{22}	0.0414	0.0270	1.5330	0.0055	0.0234	0.2330	0.0422	0.0273	1.5460	0.0064	0.0237	0.2700
	λ	1.5721	0.3254	4.8320	1.5728	0.2800	5.6170	1.5601	0.3198	4.8780	1.5697	0.2860	5.4890
	σ	0.0061	0.0003	19.6390	0.0056	0.0003	21.7900	0.0060	0.0003	19.7230	0.0056	0.0003	22.2840
	θ	-	-	-	-	-	-	-	-	-	-	-	-
	σ_v	-	-	-	-	-	-	-	-	-	-	-	-
lnP2	β_2	0.4981			0.5030			0.4983			0.5011		
lnP2 lnP2	γ_{22}	0.2115			0.2010			0.2123			0.2001		
lnP2 lnQ2	ρ_{22}	-0.0154			-0.0036			-0.0163			-0.0034		
Variance components	$\sigma^2(v)$	0.00606			0.0056			0.00603			0.00565		
	$\sigma^2(u)$	0.00953			0.0089			0.00940			0.00886		
Log Likelihood function		527.3			542.4			527.9			541.2		
Function converged at iteration		11			20			12			19		
R^2		0.996			0.996			0.996			0.996		

Traditional Model = Fourier Flexible form with two outputs, two inputs, and time trend

Preferred Model = Traditional model with the addition of risk and asset quality variables. This model is given in Eq. (13)

Table 4 b

Maximum likelihood parameter estimation for the standard profit function using the half-normal model

		Traditional model			Preferred model Eq. (7.1)			No Equity			No Provisions		
Variable	Parameter	Coefficient	Std. Error	T-value	Coefficient	Std. Error	T-value	Coefficient	Std. Error	T-value	Coefficient	Std. Error	T-value
Constant	α_0	10.6471	0.8133	13.0910	9.4045	0.8779	10.7120	10.3903	0.8179	12.7040	9.7141	0.8797	11.0420
lnPQ1	α_1	-1.9503	0.6740	-2.8940	-2.1203	0.6741	-3.1460	-2.0625	0.6749	-3.0560	-1.9997	0.6812	-2.9350
lnPQ2	α_2	0.1650	0.3629	0.4550	0.0711	0.3802	0.1870	0.1249	0.3662	0.3410	0.1215	0.3757	0.3230
lnP1	β_1	1.3330	0.0903	14.7610	1.3433	0.0965	13.9220	1.3263	0.0888	14.9400	1.3511	0.0993	13.6070
lnE	κ	-	-	-	0.0601	0.0064	9.4450	-	-	-	0.0585	0.0059	9.9780
lnPROV	ν	-	-	-	0.0117	0.0044	2.6860	0.0108	0.0038	2.7960	-	-	-
T	τ	0.1243	0.0662	1.8770	0.1202	0.0646	1.8600	0.1173	0.0644	1.8210	0.1276	0.0659	1.9350
TT	τ^2	-0.0158	0.0089	-1.7800	-0.0157	0.0086	-1.8250	-0.0150	0.0086	-1.7440	-0.0164	0.0088	-1.8700
lnPQ1 lnPQ1	δ_{11}	-0.7008	0.3586	-1.9550	-0.7884	0.3827	-2.0600	-0.7193	0.3805	-1.8910	-0.7702	0.3771	-2.0430
lnPQ1 lnPQ2	δ_{12}	0.0102	0.0403	0.2530	0.0073	0.0421	0.1740	0.0064	0.0407	0.1570	0.0134	0.0414	0.3230
lnPQ2 lnPQ2	δ_{22}	0.0971	0.0366	2.6510	0.0849	0.0370	2.2980	0.0935	0.0367	2.5450	0.0891	0.0364	2.4470
lnP1 lnP1	γ_{11}	0.4361	0.1215	3.5900	0.4413	0.1249	3.5340	0.4492	0.1249	3.5970	0.4285	0.1230	3.4850
lnP1 lnP2	γ_{12}	0.1597	0.0859	1.8590	0.1714	0.0829	2.0680	0.1615	0.0832	1.9410	0.1685	0.0854	1.9730
lnP1 lnQ1	ρ_{11}	-0.2994	0.1375	-2.1780	-0.2887	0.1435	-2.0120	-0.3139	0.1414	-2.2200	-0.2736	0.1415	-1.9330
lnP1 lnQ2	ρ_{12}	-0.0139	0.0705	-0.1970	-0.0267	0.0724	-0.3690	-0.0201	0.0704	-0.2850	-0.0202	0.0720	-0.2810
lnP2 lnQ1	ρ_{21}	0.0983	0.0576	1.7080	0.0946	0.0591	1.6020	0.0961	0.0577	1.6660	0.0964	0.0586	1.6450
cos(z1)	a_1	0.6841	0.0682	10.0280	0.6418	0.0783	8.1940	0.6707	0.0755	8.8870	0.6560	0.0688	9.5370
sin(z1)	b_1	-0.6949	0.0675	-10.3010	-0.6397	0.0755	-8.4780	-0.6815	0.0685	-9.9550	-0.6553	0.0726	-9.0220
cos(z2)	a_2	-0.0275	0.0477	-0.5760	-0.0237	0.0552	-0.4290	-0.0186	0.0486	-0.3830	-0.0323	0.0537	-0.6010
sin(z2)	b_2	-0.8446	0.0641	-13.1750	-0.7735	0.0654	-11.8280	-0.8414	0.0647	-13.0080	-0.7761	0.0640	-12.1180
cos(z1+z1)	a_{11}	0.0566	0.0483	1.1710	0.0530	0.0506	1.0490	0.0557	0.0495	1.1240	0.0530	0.0485	1.0930
sin(z1+z1)	b_{11}	-0.1611	0.0360	-4.4740	-0.1513	0.0390	-3.8760	-0.1607	0.0375	-4.2810	-0.1525	0.0366	-4.1640
cos(z1+z2)	a_{12}	0.0117	0.0585	0.2000	0.0007	0.0621	0.0110	0.0072	0.0600	0.1200	0.0051	0.0598	0.0850
sin(z1+z2)	b_{12}	-0.2043	0.0674	-3.0310	-0.2071	0.0741	-2.7940	-0.2117	0.0690	-3.0670	-0.1998	0.0713	-2.8040
cos(z2+z2)	a_{22}	0.0314	0.0392	0.8010	0.0455	0.0399	1.1410	0.0429	0.0395	1.0850	0.0341	0.0397	0.8580
sin(z2+z2)	b_{22}	-0.1402	0.0375	-3.7440	-0.1201	0.0421	-2.8530	-0.1357	0.0388	-3.4950	-0.1251	0.0401	-3.1200
	λ	7.2100	2.2215	3.2460	5.9792	1.6861	3.5460	7.0114	2.1344	3.2850	6.2850	1.8185	3.4560
	σ	0.0223	0.0011	20.0310	0.0213	0.0011	19.3230	0.0220	0.0011	19.7520	0.0216	0.0011	19.4130
	θ	-	-	-	-	-	-	-	-	-	-	-	-
	σ_v	-	-	-	-	-	-	-	-	-	-	-	-
lnP2	β_2	-0.3330			-0.3433			-0.3263			-0.3511		
lnP2 lnP2	γ_{22}	-0.1597			-0.1714			-0.1615			-0.1685		
lnP2 lnPQ2	ρ_{22}	-0.0983			-0.0946			-0.0961			-0.0964		
Variance components	$\sigma^2(v)$	0.02227			0.02129			0.02196			0.02165		
	$\sigma^2(u)$	0.16058			0.12732			0.15398			0.13604		
Log Likelihood function		116.6			136.6			121.9			130.2		
Function converged at iteration		29			29			30			29		
R^2		0.959			0.963			0.960			0.962		

Table 4 c

Maximum likelihood parameter estimation for the alternative profit function using the half-normal model

		Traditional model			Preferred model Eq. (13)			No Equity			No Provisions		
Variable	Parameter	Coefficient	Std. Error	T-value	Coefficient	Std. Error	T-value	Coefficient	Std. Error	T-value	Coefficient	Std. Error	T-value
Constant	α_0	12.6909	37.4410	0.3390	16.5441	34.8460	0.4750	12.7897	38.0130	0.3360	16.3033	35.9250	0.4540
lnQ1	α_1	1.5433	3.7596	0.4100	1.3510	3.9883	0.3390	1.6818	4.5546	0.3690	1.2154	3.4139	0.3560
lnQ2	α_2	-1.9204	4.3169	-0.4450	-2.4241	3.5370	-0.6850	-2.0715	3.7442	-0.5530	-2.2559	4.1893	-0.5390
lnP1	β_1	1.0928	0.0896	12.1970	1.1120	0.0896	12.4100	1.0891	0.0892	12.2060	1.1151	0.0901	12.3740
lnE	κ	-	-	-	0.0656	0.0066	9.8890	-	-	-	0.0635	0.0071	8.9560
lnPROV	ν	-	-	-	0.0165	0.0038	4.3460	0.0158	0.0038	4.1330	-	-	-
T	τ	0.0997	0.0702	1.4190	0.0970	0.0692	1.4010	0.0923	0.0710	1.3000	0.1044	0.0688	1.5170
TT	τ^2	-0.0133	0.0094	-1.4100	-0.0134	0.0093	-1.4500	-0.0126	0.0095	-1.3280	-0.0141	0.0092	-1.5280
lnQ1 lnQ1	δ_{11}	-0.0810	0.3060	-0.2650	-0.0928	0.3205	-0.2900	-0.0931	0.3681	-0.2530	-0.0783	0.2776	-0.2820
lnQ1 lnQ2	δ_{12}	-0.0506	0.0313	-1.6190	-0.0273	0.0316	-0.8640	-0.0512	0.0325	-1.5730	-0.0285	0.0312	-0.9140
lnQ2 lnQ2	δ_{22}	0.2181	0.3352	0.6510	0.2313	0.2707	0.8550	0.2319	0.2872	0.8080	0.2178	0.3240	0.6720
lnP1 lnP1	γ_{11}	-0.2630	0.1665	-1.5800	-0.2534	0.1681	-1.5070	-0.2579	0.1685	-1.5300	-0.2555	0.1654	-1.5450
lnP1 lnP2	γ_{12}	0.1822	0.0746	2.4410	0.1861	0.0702	2.6500	0.1859	0.0707	2.6300	0.1827	0.0747	2.4470
lnP1 lnQ1	ρ_{11}	-0.0157	0.0692	-0.2270	-0.0364	0.0704	-0.5170	-0.0329	0.0700	-0.4700	-0.0169	0.0694	-0.2440
lnP1 lnQ2	ρ_{12}	-0.0711	0.0527	-1.3500	-0.0501	0.0550	-0.9110	-0.0514	0.0541	-0.9490	-0.0714	0.0533	-1.3380
lnP2 lnQ1	ρ_{21}	-0.0689	0.0427	-1.6110	-0.0530	0.0379	-1.3980	-0.0596	0.0376	-1.5840	-0.0623	0.0441	-1.4130
cos(z1)	a_1	1.0803	1.4067	0.7680	1.0522	1.4950	0.7040	1.1486	1.6888	0.6800	0.9759	1.2945	0.7540
sin(z1)	b_1	-0.2264	0.4882	-0.4640	-0.2525	0.4988	-0.5060	-0.1994	0.5814	-0.3430	-0.2772	0.4343	-0.6380
cos(z2)	a_2	-0.5098	1.0619	-0.4800	-0.6445	0.8681	-0.7420	-0.5554	0.9188	-0.6040	-0.5958	1.0187	-0.5850
sin(z2)	b_2	-0.0549	0.3099	-0.1770	-0.0741	0.2746	-0.2700	-0.0686	0.2795	-0.2450	-0.0583	0.3178	-0.1830
cos(z1+z1)	a_{11}	0.0891	0.1588	0.5610	0.0782	0.1781	0.4390	0.1018	0.1899	0.5360	0.0651	0.1549	0.4210
sin(z1+z1)	b_{11}	-0.0888	0.1106	-0.8030	-0.0805	0.1149	-0.7000	-0.0950	0.1295	-0.7330	-0.0742	0.1021	-0.7260
cos(z1+z2)	a_{12}	-0.0348	0.0679	-0.5130	-0.0259	0.0673	-0.3850	-0.0342	0.0669	-0.5110	-0.0294	0.0660	-0.4450
sin(z1+z2)	b_{12}	-0.0432	0.0913	-0.4730	-0.0993	0.0969	-1.0250	-0.0503	0.0987	-0.5100	-0.0914	0.0899	-1.0170
cos(z2+z2)	a_{22}	-0.0303	0.1303	-0.2330	-0.0279	0.1102	-0.2530	-0.0248	0.1150	-0.2150	-0.0325	0.1257	-0.2580
sin(z2+z2)	b_{22}	0.0346	0.0795	0.4350	0.0545	0.0674	0.8080	0.0369	0.0708	0.5210	0.0518	0.0805	0.6430
	λ	7.0035	2.0261	3.4570	5.7688	1.8094	3.1880	6.3914	2.0186	3.1660	6.3306	1.8600	3.4040
	σ	0.0276	0.0015	18.9990	0.0261	0.0014	18.5730	0.0270	0.0014	18.7780	0.0267	0.0014	18.6840
	θ	-	-	-	-	-	-	-	-	-	-	-	-
	σ_v	-	-	-	-	-	-	-	-	-	-	-	-
lnP2	β_2	-0.0928			-0.1120			-0.0891			-0.1151		
lnP2 lnP2	γ_{22}	-0.1822			-0.1861			-0.1859			-0.1827		
lnP2 lnQ2	ρ_{22}	0.0689			0.0530			0.0596			0.0623		
Variance components	$\sigma^2(v)$	0.02756			0.0261			0.0270			0.0267		
	$\sigma^2(u)$	0.19301			0.1505			0.1727			0.1690		
Log Likelihood function		58.4			81.6			67.7			71.1		
Function converged at iteration		46			43			42			39		
R^2		0.948			0.956			0.951			0.953		

The results also show that the risk variable (E) has consistent effects on both cost and profit functions. That is, since the estimated coefficient of equity is negative in the cost model, this might inform us that low levels of financial capital could contribute to increasing costs because of reliance on borrowed funds, while high levels of capital indicate the opposite.[21] Moreover, the positive coefficients of the (E) variable in the profit models indicate that as bank financial capital increases, banks secure greater profits as risk exposure lessens. Besides, the positive relationship between financial capital and profits may derive from the fact that profits add to financial capital in the form of retained profits, given that profits are not allocated as dividends. Thus, the stronger the financial capital base, the greater is banks' access to sources of internal finance, and therefore their opportunity of generating profits.

The coefficients reported in the tables also reveal some other interesting relationships. For example, Table (4a) shows that the loan quality proxy (PROV) has the expected relationship (though insignificant) with costs (indicating bad loans increase the cost burden of banks), and Tables (4b and 4c) indicate that PROV is positively related to profits. This is probably because more profitable banks have the ability to make greater provisions. (However, one could also argue that one may expect an inverse relationship as banks tend to be more profitable when provisions fall.)

It may also be noted from Tables (4a to 4c) that the cost, standard profit, and alternative profit functions fit the data reasonably well. The adjusted R^2 reported over the six years for all model specifications ranges from 94.8 to 99.6 per cent. This means that the explanatory variables explain most of the variation in the dependent variables.

Tables (4a to 4c) also present both inefficiency and random error variances, denoted as $\sigma^2(u)$ and $\sigma^2(\upsilon)$ respectively. Among all inefficiency concepts, the lowest inefficiency variance as a ratio in the total error term variance amounted to around 62 per cent (for the cost function estimated using the half-normal distribution). For the standard profit and alternative profit functions estimated using the half-normal distribution, the inefficiency term variance ratio accounted for around 86 per cent and 88 per cent of total variance respectively. These results suggest that the majority of

[21] High capital also means less risk exposure, which may place a low burden on the cost function compared to the case when capital is low and risk is high.

the total variances of the stochastic error term ε is accounted for by the variances in the inefficiency component u, rather than the variances in the random error υ. This suggests that the deviations from the best practice bank's cost and profit functions have much more to do with managerial factors (represented by X-inefficiency) than with luck and other factors that are incorporated in the random error term.

5.3 Inefficiency Estimates

The examination of how the mean inefficiency differs across model specifications gives us information on how the exclusion of the risk and quality variables from the preferred specification [Eq. (13)] would affect mean inefficiency estimations in the GCC banking industry.

As far as model specification is concerned, we notice from Table 6 that when estimating over each specification (traditional, preferred, preferred with no equity, and preferred with no provisions specifications), the inefficiency scores as well as the dispersions around inefficiency means tend to be similar. However, the elimination of equity and provisions variables from the preferred model resulted in a slight difference in the inefficiency means. For example, for the traditional model, Table 6 shows that the elimination of the E and PROV variables from the preferred model slightly increased the mean inefficiency for all efficiency concepts estimated using the half-normal distribution. Similarly, the individual elimination of E and PROV variables from the preferred model also resulted in a slight increase in the inefficiency levels across all efficiency concepts. This elimination process suggests that the control for risk and quality factors in the inefficiency models removes any over-estimation of inefficiency scores when these two factors are not taken into account. Moreover, the mean inefficiency results show that the exclusion of the E variable from the preferred specification results in higher inefficiency levels than does the exclusion of the PROV variable from the same specification.

Table 6: The mean inefficiency estimates

	Half-normal distribution model			
	Traditional model	Preferred model Eq. (13)	No Equity	No Provisions
Cost function	0.0839	0.0807	0.0837	0.0806
	(0.0469)	(0.0456)	(0.0468)	(0.0457)
Standard profit function	0.3312	0.2904	0.3235	0.3014
	(0.1849)	(0.1694)	(0.1813)	(0.1739)
Alternative profit function	0.3594	0.3138	0.3383	0.3345
	(0.2101)	(0.1865)	(0.1995)	(0.1974)

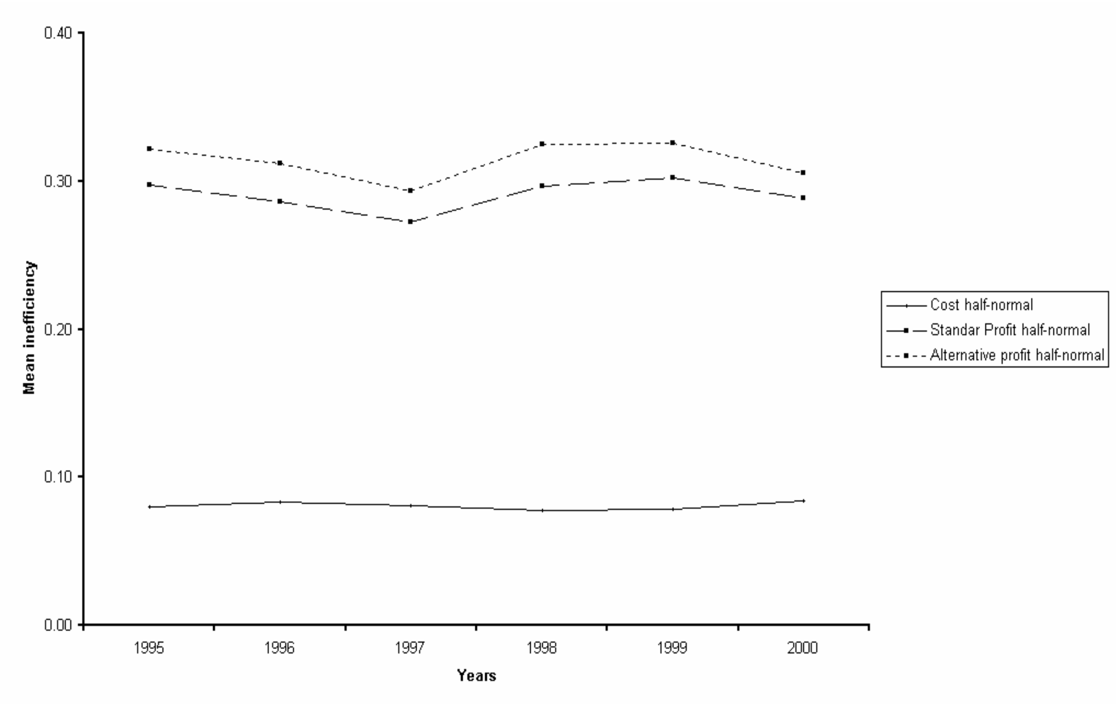
The mean cost efficiency from the preferred model is about 91 per cent. In other words, about 9 per cent of costs are wasted on average relative to a best-practice bank. The economic interpretation of the cost inefficiency level is that, given their particular output level and mix, on average, banks need to reduce their production costs by roughly 9 per cent in order to use their inputs as efficiently as possible. Overall, the levels of the mean cost inefficiency are consistent with inefficiency levels found by parametric studies on European, Japanese, and US banking markets. For example, Altunbas et al. (2000), Berger and Mester, (1997), Ferrier and Lovell, (1990), and Berger (1993) found the average cost inefficiency of commercial banks to range from anywhere between 5 per cent (Altunbas et al., 2002 on European banks) and 40 per cent (Berger, 1993 on US banks). There is a general consensus, however, that cost inefficiency typically ranges between 5 per cent and 15 per cent (see Berger and Humphrey, 1997).

On the profit side, the mean inefficiencies derived from the standard and alternative profit functions are close to each other, given that the mean inefficiency of the alternative profit function is about 3 per cent higher than standard profit mean inefficiency scores. The interpretation of the inefficiencies on the profit side is not so different from the cost side. In both standard and alternative profit functions, the inefficiency results indicate that nearly one third of the profits that could be earned by the best practice bank are lost to inefficiency. The profit level of inefficiency is found to conform to the findings of a number of previous studies that found profit inefficiency to fall in the same range; for example, Lozano (1997) found that the average profit inefficiency of the Spanish depository institutions was 28 per cent. In contrast, profit inefficiency is found to be higher in the US banking sector. So, for instance, Berger and Mester (1997) report profit inefficiency ranging between 46 and 54 per cent. In general, profit inefficiency in US banking is found to be, on average, around 36 per cent (see the review by Berger and Humphrey, 1997). It is worth mentioning that, in accordance with previous profit efficiency studies (for example, those of Berger and Mester, 1997; and Al-Jarrah, 2002), the results in Table 6 show that profit inefficiencies are higher than cost inefficiencies. This finding is consistent across various model specifications. The cost inefficiency calculates wastes of resources only on the input side. Profit inefficiency accounts for inefficiencies on both the input and output sides. This generally results in higher inefficiency estimates on the profit side. Furthermore, when banks face higher operating costs that may be reflected in bank product prices, the profit function can also capture this source of inefficiency. In addition, profits are more variable than costs and can be affected more dramatically on account of economic downturns, unforeseen losses, and so on. Given the greater variation in profitability, it is therefore less surprising that inefficiency tends to be much larger compared to cost inefficiency.

In accordance with the literature, it is also observed from Table 6 that mean alternative profit inefficiencies are higher than standard profit inefficiencies. The standard profit function takes prices of outputs as given and leaves the output quantities to change freely. In contrast, the alternative profit function allows output prices to move freely and takes output levels as given. This implies that the alternative profit function may report inefficiency levels higher than standard profit inefficiencies because of market power conditions, service quality, and other endogenous or exogenous sources that may affect output prices and profitability. For markets with high levels of concentration, such as in the GCC banking industry, the standard profit function is less able to take into account the ability of banks to exercise market power without much change in output levels, whereas the alternative profit estimates are believed to capture this phenomenon. Moreover, when banks tend to offer services of low quality with low prices relative to the best practice bank, the alternative profit function can capture this source of inefficiency. Given these reasons, alternative profit inefficiency estimates are often likely to be higher than standard profit inefficiency estimates.

In the examination of how mean inefficiency levels change over the study period, Figure 2 shows the pattern of mean inefficiencies over time for all banks in our sample using the three different efficiency concepts. Generally, the figure shows a similar pattern in inefficiency levels over time with no discernable increase or decrease, although they tend to show a slight decrease in profit inefficiency over 1995-1997 and 1999-2000. The year 1998 witnessed a rise in loan loss problems (mostly due to the effect of a sharp oil prices decrease in 1998) resulting in a noticeable increase in profit inefficiency. Overall, however, both cost and profit efficiency seem to be relatively stable over time, indicating that market conditions, such as the competitive environment and regulatory changes, did not much affect industry's cost and profit functions during the second half of the 1990s.

Figure 2: Inefficiency in the GCC banking industry over the study period



Regarding the efficiency comparisons across GCC countries, Figure 3 shows the mean inefficiencies for each country. These inefficiency measures are presented for the preferred Eq. (13) cost and profit inefficiencies estimated under the half-normal distribution.

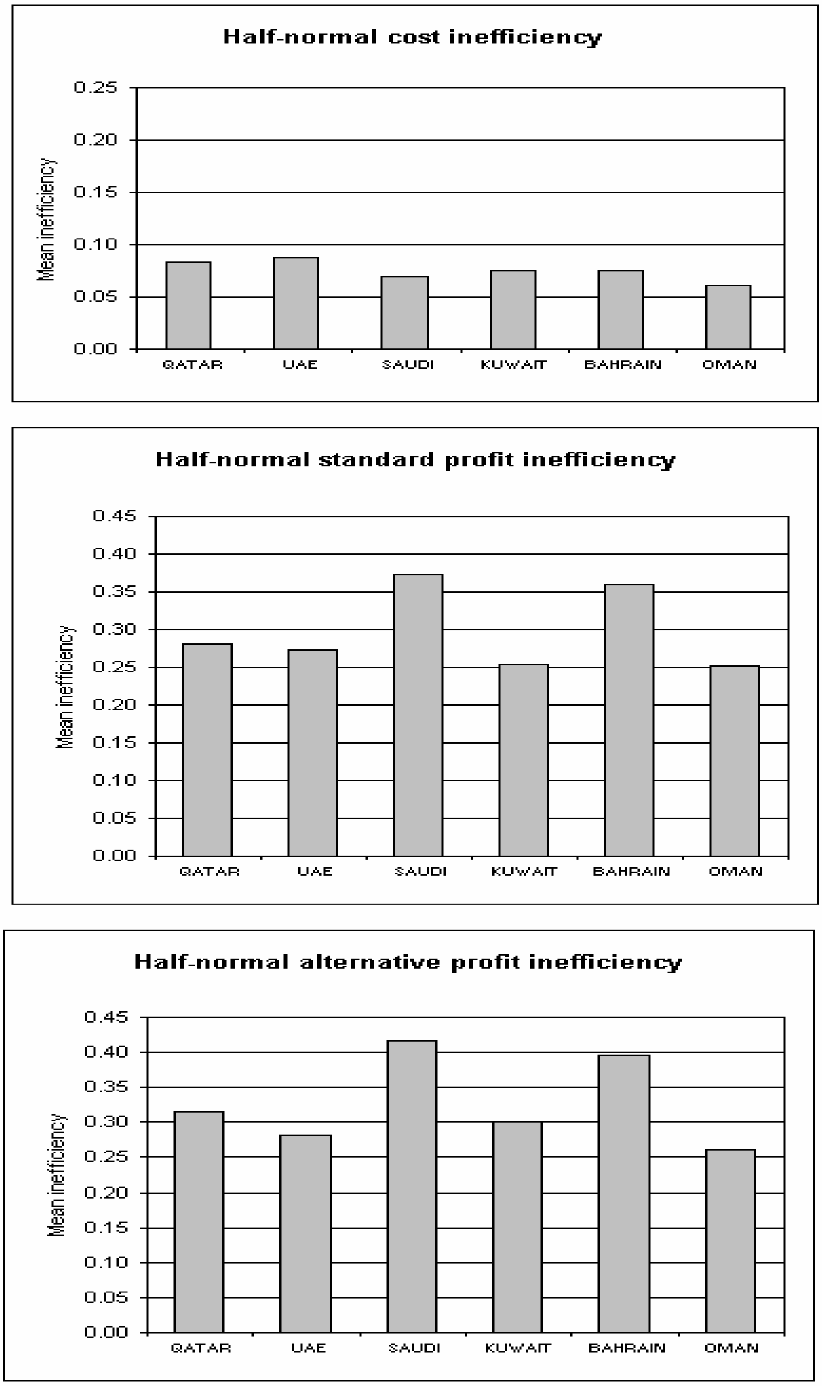
In general, cost inefficiency estimates across GCC countries are more or less similar to each other. However, Figure 3 indicates that Omani banks appear to be the least cost inefficient (i.e. the most efficient), scoring a level of 7.1 per cent cost inefficiency. The next least cost inefficient banks are Saudi banks, with cost inefficiency levels of 7.9 per cent. Bahraini and Kuwaiti banks occupy the middle ground of GCC cost inefficiency with levels of 7.5 per cent. Qatari and UAE banks have been the most cost inefficient with cost inefficiency levels of 8.3 and 8.8 per cent respectively.

On the profit side, standard and alternative profit inefficiencies across GCC countries tend to vary. In general, Figure 3 shows that banks from Saudi Arabia and Bahrain are the most profit inefficient, with a profit inefficiency difference of at least 7 percentage points higher than for other GCC countries' banks.

Omani banks remain the least profit inefficient, while the rest of the GCC countries' banks fall in the middle positions. It may not be surprising that Omani banks are the least cost inefficient in the GCC banking industry, although the differences in inefficiency scores are relatively small between these countries. In addition, although the number of the Omani banks included in the sample is relatively small (6 banks), the Omani banking system witnessed the most active M & A (Merger and Acquisition) activity taking place in the GCC region over the study period, enabling Omani banks to show the highest cost and profit efficiency scores. These mergers have been stimulated by authorities' encouragements.

The question why one country's banks are more cost or profit efficient than another can be related to the size of banks in a country. For instance, with reference to Figure 3, countries that have relatively small banks, such as the UAE and Qatar, tend to show higher cost inefficiency but lower profit inefficiency. On the other hand, banking industries that are dominated by larger banks, such as those in Saudi Arabia, Bahrain, and Kuwait, tend to show lower cost inefficiency but higher profit inefficiency. In fact, large banks may have lower cost inefficiencies because their per unit cost decreases as the scale increases. However, scale effects may induce profit inefficiency because large banks may face more difficulty in generating revenues efficiently. Berger and Mester (1997, p. 936) state that '[t]he cost and profit efficiency results together seem to imply that as banks grow larger, they are equally able to control costs, but it becomes harder to create revenues efficiently.' Moreover, this finding is consistent with the conventional fact that small banks typically have higher profitability ratios than larger banks. Having said this, however, the scale effects that induce profit inefficiency are unlikely to be large.

Figure 3: Cost and profit inefficiencies across GCC countries – Preferred model



5.4 Economies of Scale

Scale economies measure how a unit change in output affects total costs.[22] The economies of scale results shown in Table 7 are calculated for both the traditional and preferred specifications estimated using the half-normal models.

With reference to the cross-country scale economies comparisons, the results in Table 7 show that Saudi and Kuwaiti banks as realising scale economies over the period under study. Moreover, Bahraini banks experience constant returns to scale. However, UAE, Omani, and Qatari banks exhibit scale diseconomies.

Table 7: Scale economies in the GCC banking industry - by country

	Half-normal	
	Traditional model	Preferred Eq. (13)
GCC	1.167	1.108
QATAR	1.288	1.222
UAE	1.228	1.166
SAUDI ARABIA	0.956	0.903
KUWAIT	0.924	0.886
BAHRAIN	1.072	1.027
OMAN	1.342	1.256

[22] Scale economies are calculated using the following equation:

$$Scale\ economies = \sum_{i=1}^{2} \frac{\partial \ln TC}{\partial \ln Q_i} = \sum_{i=1}^{2} \alpha_i + \sum_{i=1}^{2}\sum_{j=1}^{2} \delta_{ij} \ln Q_j + \sum_{i=1}^{2}\sum_{j=1}^{2} \rho_{ij} \ln P_i$$
$$+ \mu_i \sum_{i=1}^{2} \left[-a_i \sin(Z_i) + b_i \cos(Z_i) \right]$$
$$+ 2\mu_i \sum_{i=1}^{2}\sum_{j=1}^{2} \left[-a_{ij} \sin(Z_i + Z_j) + b_{ij} \cos(Z_i + Z_j) \right].$$

If *scale economies* >1, < 1, or = 1, then there are diseconomies, economies of scale, or constant returns to scale respectively.

When risk and quality factors are taken into account, the preferred model again shows that Saudi and Kuwaiti banks exhibit scale economies at slightly higher levels. Bahraini banks are also close to unity, indicating constant returns to scale. UAE, Omani, and Qatari banks have not much been influenced by the introduction of risk and quality factors since these countries continue to exhibit scale diseconomies. In sum, closeness to unity of the scale estimates of banks in Saudi Arabia, Kuwait, as well as Bahrain may lead us to deduce that these countries' banks tend to show the range between economies and constant returns to scale, unlike banks in the UAE, Oman, and Qatar, that apparently show diseconomies of scale. Overall, on average, the sample shows that the GCC banking industry has been exhibiting scale diseconomies driven mostly by banks that belong to the GCC countries' exhibiting scale diseconomies (namely those in the UAE, Oman, and Qatar).

5.5 Logistic Regression and Efficiency Correlates

This part of the paper examines the determinants of banking sector inefficiency in GCC banking systems over the study period 1995-2000. For this purpose, we use the logistic regression model, in which we regress inefficiency variables (cost inefficiency and profit inefficiency measures) on a variety of bank and market-specific variables that we believe are most likely to influence inefficiency levels.

As noted earlier, estimated coefficients of logistic regressions indicate relationships in terms of correlation rather than the power and size of impact or the causality relationship. The logistic regression model is preferred over the linear regression approach since the former is more appropriate to model the relationship between variables for which a dependent variable is bounded between zero and one, the range in which inefficiency scores fall.

In order to avoid double consideration of risk and asset quality variables when examining inefficiency determinants, the logistic model is estimated using inefficiency measures derived from the frontier estimation of the traditional model that does not incorporate equity and provisions. In addition, the estimates of inefficiency used here are for the traditional cost and profit functions estimated using the half-normal distribution.

As for the logistic parameters estimates, the results in Tables (8 and 9) show that the correlation between the cost and profit inefficiency measures regressed on the same set of the independent variables almost conform to expectations.[23]

Starting with the relationship between inefficiency and financial capital, in both cost and profit inefficiency determinants, the coefficient EQUITY is negative and is significantly different from zero. This indicates that banks with low inefficiency levels tend to hold higher levels of capital. Note that in our previous analysis in this section, we found that if we remove the capital variable from our preferred model, this results in a slight increase in the level of cost and profit inefficiency. This means that when financial capital is introduced in the model, it controls and takes into consideration the fact that banks with strengthened capital have a better cushion against risk and this seems to make them become more efficient. However, one must caution that this does not necessarily mean that efficient banks should always have higher capital and thus have lower risk (Mester, 1996). This is because higher levels of financial capital level may distort managers' incentives in a way that makes them keener to take riskier activities (moral hazard). Generally, in this analysis, the results suggest that more efficient GCC banks generate higher earnings, which are translated into higher levels of capital.

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[23] Although R^2 has a low value, it is not an appropriate measure of closeness of fit in the context of logistic regressions (see Thomas, 1997).

Table 8: The logistic regression parameter estimation

Dependent variable	Cost inefficiency (CN)		
Variable	**Coefficient**	**Std. error**	***T*-value**
Constant	8.13E-02	7.71E-03	10.548
EIQUITY	-4.12E-08	1.33E-08	-3.108
ROA	-0.2483704	4.46E-02	-5.575
PROV	8.23E-02	4.27E-02	1.928
FOREIGN	2.59E-02	4.18E-03	6.203
LTA	-5.05E-02	8.63E-03	-5.857
FIX	2.42E-08	2.57E-08	0.943
TA	2.14E-09	1.35E-09	1.59
TBGDP	-3.45E-04	8.38E-04	-0.412
CN[-1][24]	0.4309832	3.61E-02	11.942
Durbin-Watson Statistic =	1.91243	Rho =	0.04379
Adjusted R-squared =	0.46058		
Observations =	558		

[24] The lagged dependent variable is used to remove auto-correlation.

Table 9: The logistic regression parameter estimation

Dependent variable	Standard profit inefficiency (SN)		
Variable	Coefficient	Std. error	*T*-value
Constant	0.2588479	3.13E-02	8.274
EQUITY	-2.66E-07	5.65E-08	-4.705
ROA	-1.006451	0.18616	-5.406
PROV	1.11E-02	0.18015	0.062
FOREIGN	8.52E-03	1.62E-02	0.527
LTA	-7.09E-02	3.53E-02	-2.005
FIX	-9.05E-08	1.08E-07	-0.838
TA	2.33E-08	5.74E-09	4.069
TBGDP	1.99E-03	3.53E-03	0.564
SN[-1][25]	0.5102705	3.46E-02	14.757
Durbin-Watson Statistic =	1.95567	Rho =	0.02217
Adjusted R-squared =	0.38476		
Observations =	558		

[25] The lagged dependent variable is used to remove auto-correlation.

The results also show that accounting profits (denoted as ROA) is negative and is significantly different from zero as well. The ROA coefficient in both cost and profit inefficiency regressions confirms that more efficient banks may be expected to achieve, on average, better accounting profits performance than less efficient banks. Therefore, this may underline the perception that more efficient banks can consolidate their capital through better profits performance, enabling them to accumulate higher capital, in turn making them less risky firms.

With respect to loan quality, both the cost and profit inefficiency dependent variables are positively correlated with the level of provisions (PROV); the PROV variable is significant at the 10 per cent level in the cost inefficiency regression but insignificant in the profit inefficiency regression. This positive correlation suggests that inefficient banks are forced by regulation to increase the level of provisions when their loans are facing default problems. In other words, a high level of provisions indicate loan quality deterioration and, as a result, inefficiency generally increases in response to the higher level of problem loans. This may also suggests that efficient banks with lower levels of loan provisions are better at evaluating credit risk (see Mester, 1996; Berger and Humphrey, 1997; Altunbas et al., 2000).

Turning to the issue of ownership, the binary variable FOREIGN shows a positive and statistically significant relationship with cost inefficiency but a statistically insignificant relationship with profit inefficiency. Taking at least the relationship between cost inefficiency and the variable FOREIGN, we infer that the existence of foreign banks has contributed to the inefficiency level in the GCC banking industry during the study period. In fact, regulatory restrictions on foreign bank business, such as restrictions on bank size, taxes, and bank branching, could also be the main factors inducing foreign banks to contribute to inefficiency in the GCC banking industry.

As for the rest of the control variables, the negative correlation between the loan to assets ratio (LTA) and the inefficiency levels indicate that banks with higher proportions of lending business in their balance sheets are more efficient. This result contrasts with previous studies' findings (for example, Altunbas et al., 2000, found a positive correlation between inefficiency and the loan to assets ratio in the case of Japanese banks). This result, however, may indicate that the GCC countries' larger banks have emphasized lending business during the second half of the 1990s in order to respond to market demand.

Moreover, total assets (TA), which approximates the size of a bank, shows a clearer relationship between bank profit inefficiency and bank size (than bank cost inefficiency and bank size). As we previously noted, large banks usually experience higher profit inefficiency than small banks, here, the statistically significant and positive relationship between TA and profit inefficiency indicate that as banks increase in size, their profit inefficiency increases. Nevertheless, this relationship is not evident in case of cost inefficiency since the TA coefficient is not significant, although its sign is positive.

Taken together, the main results from our logistic regression are that the strengthening of financial capital is a central element explaining bank efficiency in the GCC region. On the other hand, the erosion in loan quality reduces banking sector efficiency. Overall, the policy implication is that regulations in the region need to focus on building a safe and sound banking system with adequate and prudential rules, and this should ultimately feed into improved banking sector efficiency levels.

6. Conclusions

This paper empirically analyses the efficiency of the GCC banking sector over the period 1995-2000. It presents and compares the results using three efficiency concepts: cost efficiency, standard profit efficiency, and alternative profit efficiency.

The findings of the empirical analysis show that the level of inefficiency in the GCC banking industry ranges between 8 and 10 per cent for cost inefficiencies, and between 30 and 32 per cent for the profit inefficiencies. There are no major differences in banks efficiency levels among GCC countries. Moreover, the mean efficiency across countries shows almost a stable trend over the study period 1995-2000. With reference to the cross-country scale economies comparisons, the results show that Saudi and Kuwaiti banks are realising scale economies over the period under study. Moreover, Bahraini banks experience constant returns to scale. However, UAE, Omani, and Qatari banks exhibit scale diseconomies.

The findings show also that the risk and quality factors provide information influencing bank inefficiency levels when we use either the cost or profit function models. When risk and quality factors are considered, the mean inefficiency measures show a slight decrease. In the logistic regression, cost and profit inefficiency is found to be negatively related to risk. There is also evidence that inefficiency is positively related to loan quality variables, suggesting that banks with enhanced financial capital and high loan quality are more efficient.

Overall, the results suggest that greater consolidation in the industry could be encouraged between GCC banks. This may improve cost efficiency as costs are seen to decline with size. (While consolidation may increase profit inefficiency, these inefficiencies are unlikely to be much bigger than other sized banks). In essence, large GCC banks will be in a position to realise greater scale and X-efficiency. Moreover, larger bank size and levels of banking sector competition will help allay policy-makers fears concerning greater financial system openness. Moreover, GCC governments need to continue to implement financial reform packages that strengthen banking system soundness, foster banking competition, and also devise incentive schemes to improve managerial efficiency in order that GCC banks are better placed to meet the challenges of greater openness.

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CHAPTER FOUR

Analysing Service Quality in the UAE Islamic Banks

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1. Introduction

Service quality is about meeting customers' needs and requirements, and how well the service level delivered matches customer expectations. In banking, it is generally agreed that service quality is a significant issue facing this industry. Raddon (1987) reported in this regard that 40% of those customers switching financial institutions in the USA did so because of service problems. Allred and Addams (2000) also indicated that 50 percent of total respondents they surveyed reported that they had stopped using a financial service provider because of poor service performance.

In the UAE there are two Islamic banks, Dubai Islamic Bank and Abu Dhabi Islamic Bank. The number of branches of Dubai Islamic Bank is larger than those of Abu Dhabi Islamic Bank. For example in 2001 Dubai Islamic Bank have 12 branches compared with 6 branches in the case of Abu Dhabi Islamic Bank. This is mainly because Abu Dhabi Islamic Bank is a new bank; it was established in 1997,whereas Dubai Islamic Bank was established in 1975.

Abu Dhabi Islamic Bank is the first Islamic bank worldwide. The Bank has indicated in its mission: "By partnering with our customers in halal earnings, employing best business practices, the financial services technologies and placing our

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trust in Allah, we are confident of our success."(see Abu Dhabi Islamic Bank, 2001). It can be concluded that Abu Dhabi Islamic Bank has committed itself to employ best business practices, which means providing a high standard of service quality.

Abu Dhabi Islamic Bank has defind its mission as follows: "Our mission is to become the premier universal Islamic financial institution, operating in accordance with Shari'a principles, by sharply focusing on customer needs, offering innovative products and service delivery system,while maximizing investors and shareholders' returns"(Abu Dhabi Islamic Bank, 2002). Regarding the service quality, the bank has indicated in its annual report 2001: " we are focused on 100% customer satisfaction by delivering quality services where and when the customer needs these services.

In 2001 the number of branches of the UAE Islamic banks was (21) branches, compared with (412) branches of the conventional banks, representing 5.1% of the total branches of the UAE commercial banks. The total assets of these two Islamic banks was AED 21,447 million in 2001(about $5,840 million), compared with AED 261,025 million (about $ 71,076 million)of the conventional banks, constituting around 7.5% of total assets. The total deposits of the two Islamic banks in 2001 was AED 17,409 milliom (about $4,740 million)compared with AED 193,663 million (about 52,733 million) of the conventional banks comprising around 9% .These three indicators reflect the small market share of the two Islamic banks in the country's banking industry market.

Given that the UAE is an Islamic country, Islamic banks have a good opportunity to expand their activities and to attract more customers and consequently to have more branches. These evidence gave us an indication that Islamic banks in the UAE are somehow not widely accepted for some reasons. One of the possibles reason is related to the issue of service quality, which represents the subject of this study. Therefore, the objective of this study is to analyze and compare service quality between the Dubai Islamic Bank and the Abu Dhabi Islamic Bank. This is intended to help the UAE Islamic banks to assess and improve their service quality in order to create a perception of uniqueness in the mind of customers to gain an advantage in the marketplace**.** Undoubtedly, service quality is crucial for banks and to maintain their competitive advantage and theerefore in order to attract more customers, banks need to continuously evaluate service quality.

2. Literature Review

2.1 Service Quality Concept and Measurement

Service quality defined by Gronroos (1983) as the fulfillment of customers expectations. Parasuraman et al.(1985) defined service quality as the gap between customers' expectations of service and their perception of the service experience. In the service quality literature, expectations are viewed as desires and wants of customers.

Parasuraman et al. (1985) have originally identified ten determinants of service quality generic to the service industry. These determinants were Tangibles, Reliability, Responsiveness, Competence, Courtesy, Credibility, Security,Access, Communication, and Understanding the customer. At a later stage, Parasuraman et. al. (1988) developed a twenty-two item instrument, recognized as SERVQUAL, that has become widely used as a generic instrument for measuring service quality.

SERVQUAL consists of two sections. A twenty-two item section measuring service quality expectations within a specific sector and a corresponding twenty-two item section measuring the perception of service quality of a particular company in that sector (Prasuraman et, al. , 1988, 1991). SERVQUAL scores were defined as the differences between the expected service quality and the perceived one.

The innovators Parasuraman, Zeithaml and Berry have further developed, and promoted *SERVQUAL* through a series of publications (Parasuraman et al.1985; 1988; 1990; 1991; 1994; 1997; Zeithaml et al.1990;1992;1993;1996, Berry and Parasuraman,1997*)*. Parasuraman et al. (1988) for example discussed the development, testing, and potential applications of *SERVQUAL*, an instrument for measuring customer perception. In addition, in 1991 Parasuraman and Berry revealed findings from a follow-up study, in which they refined *SERVQUAL* Cronin and Taylor (1992) suggested that service quality is a vital antecedent of customer satisfaction. They have examined a performance-based measure of service quality, called SERVPERF in four industries (banking, pest control, dry cleaning and fast food). SERVPERF is composed of the 22 perception items in the SERVQUAL scale, and therefore excludes any consideration of expectations. They found that this measure explained more of the variance in an overall measure of service quality than did SERVQUAL (see also Oaks, 2001 and Lassar et al. 2000).

In their article in 1996 Parasuraman et al. also reviewed existing literature about the relationship between service quality and profits, and empirically examined several relationships between consumer behavioral intention and service quality. Their findings support their claim that improving service quality impact behavioral intention of customers.

Since its introduction in 1988, *SERVQUAL* has attracted considerable attention and has been used to study service industries such as health care, banking and other professions. *SERVQUAL* examines five dimensions that have been consistently ranked by customers to be most important for service quality, regardless of service industry. The five dimensions of service are:

Reliability- the ability to perform the promised service dependably and accurately.

Tangibles-appearance of physical facilities, equipment, personnel and communication materials.

Responsiveness-willingness to help customers and provide prompt service.

Assurance- knowledge and courtesy of employees and their ability to convey trust and confidence.

Empathy- this dimension refers to the level of caring and individualized attention the firm provides its customers.

Based on this instrument, a large number of published studies employed and evaluated *SERVQUAL* (see for example: Getz et al. 2001;Nielson and Host 2000; Hussey 1999; Mehta, 2000 and Dabholkar et al. 1996). Some empirical studies adopted the original SERVQUAL and some of them used a modified SERVQUAL. In current study a modified version of SERVQUAL will be used. It was, however, challenged in a number of subsequent studies (Carman, 1990; Babakus and Boller 1991; Cronin and Taylor 1992, 1994; Teas 1993, 1994; and Van Dyke and Kappelman, 1997) .

2.2 Measuring Service Quality in Banking

Howcroft (1991) indicated service quality in banking that it implies consistently anticipating and satisfying the needs and expectations of customer. Unlike manufacturing firms that are able to appraise the quality of their product objectively by the degree to which output meets a technical specification, for the service firm(e.g.banks), excellent service quality is present only if the customer perceives and values it. LeBlane and Nguyen(1988) stated in this connection:" The problem of evaluating service quality is more difficult and complex than product quality due to the intangible nature of services".

In the banking industry, gap analysis has been accepted as a critical tool to measure current levels of service quality (see for example, see Lewis, 1991). A key existing problem facing the banking industry is the determination of a clear and precise definition of quality (see Nielsen and Host, 2000). Generally speaking, service quality in banking plays a significant role since it is directly linked to profitability. The relationship between service quality and profitability have been examined in some empirical studies (e.g. Rust et al., (1995); Ittner and Larcker (1996); Easton and Jarrell; (1998); Zeithaml (2000). The results of all these studies indicate the existence of a positive relationship between service quality and profitability.

There has been a number of empirical studies that dealt with service quality in banking industry in general and the application of *SERVQUAL* instrument in commercial banks (See Kwan and Lee , 1994; Blanched and Gallway, 1994), Jun et al. 1999 ; Natarajan et al.1999; Joseph et al.1997; Angur et al.1999 ; Bahia and Nantel

1998; Lassar et al.2000; Allred and Addams, 2000) . The following is a brief review of some of these studies.

Blanched and Gallway (1994) used the *SERVQUAL* technique in examining quality in retail banking. In order to provide useful insights into how service might be improved, the authors attempted to develop an alternative model. They, however, adopted most of the items of the original model (SERVQUAL) in their survey. They claimed that their model was general enough to be widely applicable, and specific enough to give actionable diagnostic information.

Kangis and Voukelatos (1997) conducted a comparative study of Greece private and public banks. They found that expectations and perceptions of services received were marginally higher in the private than in the public sector banks in most of the dimension measured.

Angur et al. (1999) investigated the applicability of alternative measures of service quality in two major Indian banks. They concluded that overall results support a multidimensional construct of service and suggested that the SERVQUAL scale provide greater diagnostic information than the SERVPERFE scale.

Jun et. al. (1999) studied the service quality of delivering loan products. They found that substantial differences existed between bankers and customers groups in the perceived importance of service quality dimensions.

Hussey (1999) pointed out to the problem arising from having discomfiture gaps of different signs. To address this problem, he introduced the concepts of categorical, linear, and quadratic service quality loss. He compared these measures to the classical SERVQUAL. He concluded that using a single measure of service quality is over simplistic and suggested constructing an overall service quality profile using the measures of SERVQUAL, the categorical loss and quadratic loss.

Lassar et al. (2000) adopted two techniques in their study for service quality perspectives and satisfaction in private banking, the first was *SERVQUAL* and the second was a measure of Technical/Functional Quality. In the second approach, technical quality involves what is provided while functional quality considers how it is provided.These two service quality measures were subsequently compared and contrasted as their ability to predict customer satisfaction. The study provides initial support in favor of the idea that SERVQUAL – and Technical/Functional Quality-based models may be unequally or asymmetrically applicable across differing settings and situations. The authors suggested to employ both of these two measures in varying situations and contexts, as well as with different customer groups.

Finally, Jabnoun and Al-Tamimi (2002) developed and tested an instrument measuring service quality in the UAE commercial banks based on SERVQUAL. The instrument was based on the five dimensions of SERVQUAL. Unlike SERVQUAL that measures the differences between expected and perceived service quality, this instrument collected only perceptions data. Factor analysis resulted in three dimensions namely Human Skills, Tangibles, and Empathy. The three dimensions were reliable and valid. The Human Skills dimension consisted mainly of items that were originally included in the Reliability and assurance dimensions. Tangibles consisted of items that belonged originally to the same dimension of Tangibles. Finally, the Empathy dimension consisted of items that were part of the two original dimensions of Empathy and Responsiveness. The authors also compared between the importance of the three dimensions and found Human Skill to be the most important one.

2.3 Service Quality in Islamic Banking

There are few empirical studies that dealt with the application of *SERVQUAL* instrument in Islamic banking industry. Metawa and Almossawi (1998) examined banking behavior of Islamic banks customers in the State of Bahrain. The study sample comprised 300 customers. One of the most important results in this study, customers were found to be most satisfied with the products/services they use most, with the investment accounts receiving the highest satisfaction score. Islamic banks employees received the highest satisfaction score among the elements of the service delivery system. Metawa and Almossawi recommended that Islamic banks design and implement viable service quality programs. Failure to provide the full range and the right quality of the services will inevitably lead to serious difficulties in retaining current customers and attracting new ones. According to the authors Islamic banks may find it useful to examine the practices of successful conventional banks in order to upgrade their programs for improving the quality of their services.

Naser et al.(1999) studied customer satisfaction and preferences in the Jordanian Islamic banks. In their study, an attempt was made to assess the degree of customer awareness and satisfaction towards an Islamic bank in Jordan. The analysis of a sample of 206 respondents revealed a certain degree of satisfaction of many of the Islamic banks facilities and products. The respondents expressed their dissatisfaction with some of the Islamic banks services. Although the respondents indicated that they are aware of a number of specific Islamic financial products like Murabaha, Musharaka and Mudaraba, they show that they do not deal with them.

3. Research Methodology

3.1 Research Hypotheses

Based on the stated purpose of the study , the following hypotheses are formulated:

1. There is a significant positive relationship between overall service quality and the quality dimensions in the UAE Islamic Banks
2. There is a significant difference between the level of overall service quality in the Dubai Islamic Bank and the Abu Dhabi Islamic Bank.
3. There is a significant difference in the level of service quality offered by the UAE Islamic Banks based on customers' gender.
4. There is a significant difference in the level of service quality offered by the UAE Islamic Banks based on customers' nationality.
5. There is a significant difference in the level of service quality offered by the UAE Islamic Banks based on customers' age categories.
6. There is a significant difference in the level of service quality offered by the UAE Islamic Banks among customers with different education levels.

7. There is a significant difference in the level of service quality offered by the UAE Islamic Banks based on customers' number of years with the bank .

To test these hypotheses, we will use some statistical measures like correlation coefficient, regression analysis and ANOVA.

The first hypothsis is a standard one and reflects the expected relationship between the overall service quality and the quality dimensions in the UAE Islamic Banks. In the second hypothsis we assumed that there is a difference between the level of overall service quality in the Dubai Islamic Bank and the Abu Dhabi Islamic Bank. The logic behind this assumption is based on the fact that these two banks are not the same and they are competing each other and they should have different views of the services provided. In hypothesis three to hypothsis seven, the objective is to examine customers' point of view about the level of service provided by the UAE Islamic Banks from different angles namely, customer's gender, customer's nationality, customer's age categories, customer's education levels, and customer's number of years with the bank .

3.2 Instrument

SERVQUAL instrument suggested by Parasuraman et al. 1988 consists of two sections. A twenty-two item section measuring the service quality expectation within a specific sector and a corresponding twenty-two item section measuring the perception of service quality of a particular company in that sector. In this study a modified SERVQUAL is adopted in which expectations and perceptions scores are combined into a single measure (see Dean and White, 1999). The definition of service quality adopted in this study, is "the degree of discrepancy between customers' normative expectations for the service and their perceptions of the service performance" (Parasuraman et al. 1988). Thus, the study pursues the UAE Islamic Banks' customers" perceptions of the quality they receive, compared to their expectations in a one-column format (Table I).

Table I: An Example of the One-Column Format Questionnaire

	Completely failed to meet my expectation						Far exceeded my expectation
1. Ease of understanding brochures and forms.	1	2	3	4	5	6	7

Furthermore, the items of the modified SERVQUAL were weighted in terms of the relative importance that the UAE Islamic banks' customers attach to them.This procedure proposed by Zeithaml et al.(1990) requires an additional series of items which capture the importance consumers place on each of the dimensions of the SERVQUAL scale.Service quality is given by the following formula

Service Quality = (Perceptions-Expectations) * Importance

The developed questionnaire includes two parts: the first one consists of some demographic sample attributes such as the respondent's age, country of origin, gender, education background, and customers' number of years with the bank. The second part is devoted to key issues of the study questions. It includes thirty six items (factors). Seven items correspond to the Tangible dimension, seven items correspond to the Reliability dimension. Seven items correspond to the Assurance dimension, five items to the Responsiveness dimension and nine items to the Empathy dimension. The individual factor scores were summed –and- averaged into the five dimensions. The questionnaire also included one question that measure overall service quality. As indicated in Table I, the items in the questionnaire were measured on a seven- point scale ranging from "completely failed to meet my expectations" to "far exceeded my expectations" .The questionnaire was designed in two versions, Arabic and English because some customers do not master the English language.

To assess the scales' content validity, the authors asked five experts, two academicians and three practitioners to examine it, as it was suggested by Devellis (1991). Accordingly the authors made many changes on the first draft in terms of eliminating , adding or rewording some of the items included in that draft.

4. Sampling and Data Collection

The population from which our sample was selected consists of the customers of the two UAE Islamic Banks. Questionnaires were distributed in two different ways: some of the questionnaires were handed to branch managers who were kindly requested to pass the questionnaires to their customers, while others were hand-delivered by the authors. From the 700 questionnaires distributed to bank customers we received 351 responses, of which 40 were excluded because of incomplete data. The remaining 311 usable questionnaires represent a response rate of 44.4% .This response rate is considered acceptable. Nunnally(1978) indicated that a sample of 300 respondents is sufficient to test measurement scales. There were 140 participating respondents (45%) from the Abu Dhabi Islamic Bank and 171 respondents (55%) from the Dubai Islamic Bank .

5. Data Analysis and Results

5.1 The Profiles of the Study Respondents

Table II provides information on the profiles of the respondents, first of all, according to their country of origins. Accordingly, the sample size is divided into 64.4% nationals and 35.6% expatriates. The high percentage of nationals among the respondents indicates that most of the UAE Islamic Banks' customers are locals. The sample consists of 83.3% males and 16.7% females which reflects the main feature of the Emirates society in which males are dominant. Regarding education, the table indicates that around 53% of the sample have bachelor and or graduate degrees,whereas around 47% held degrees below a bachelor degree (i.e., high diploma, secondary school and below secondary school). The last classification was according to duration of banking relationship with Islamic Banks. The table shows that 54% of the sample have a relationship with Islamic Banks for four years and more, whereas 46% of the sample have a relationship with Islamic Banks for less than four years .

Table II: Respondents Characteristics

Characters	No.	Percentage
Nationals	201	64.6%
Expatriates	110	35.4%
Female	52	16.7%
Male	259	83.3%
Education:		
Below Secondary School	18	5.8%
Secondary School	28	9.0%
High Diploma	99	31.8%
College/Bachelor	149	47.9%
Above College	17	5.5%
Duration of Banking Relationship with Islamic Bank:		
Less than 2 Years	58	187%
Two years to Less than Four Years	85	27.3%
Four Years to Less than Six Years	94	30.2%
Six Years and More	74	23.8%

Table **III** provides descriptive statistics for the overall service quality (OVERALL) and the five dimensions of service quality, Tangible (TAN), Reliability (REL), Responsiveness (RES), Assurance (ASS) and Empathy (EMP). Mean values shown in Table III reveals a mean for the unweighted overall service quality of 5.12 and 28.52 for the weighted overall service quality. These values indicate that the UAE Islamic banks' customers are satisfied with the overall service quality. The table also shows that the Tangible dimension has the highest mean in the case of the unweighted SERVQUAL dimensions, whereas Reliability dimension has the highest mean in the case of the weighted SERVQUAL dimensions.

Table III: Summary of Means

	Means Unweighted SERVQUAL Dimension	Maximum	Means Weighted SERVQUAL Dimension*	Maximum
OVERALL	5.12	7.0	28.52	49.0
TAN	5.58	7.0	28.62	49.0
REL	5.44	7.0	34.12	49.0
RES	4.97	7.0	26.22	49.0
ASS	5.45	7.0	24.19	49.0
EMP	5.21	7.0	27.43	49.0

* The Weighted SERVQUAL dimension attained by multiplying the average of each dimension score by the importance factor score.

5.2 Reliability of the Measures

Reliability of the measures was assessed with the use of Cronbach's alpha. Cronbach's alpha allows us to measure the Reliability of the different dimensions. It consists of estimates of how much variation in scores of different variables is attributable to chance or random errors (Selltzm,Wrightman and Cook, 1976). As a general rule, a coefficient greater than or equal to 0.5 is considered acceptable and a good indication of construct Reliability (Nunnally,1976). Cronbach's alpha for the five dimensions of service quality based on the adjusted SERVQUAL Framework range from .7889 to 0.9036 for the weighted adjusted SERVQUAL and from 0.650 to 0.7759 for the unweighted adjusted SERVQUAL. The values of Cronbach's alpha show that these measures are reliable(see Table IV).

Table IV:The Five Dimensions and their Internal Consistency

SERVQUAL Dimension	Cronbach's alpha (Weighted SERVQUAL Dimension)	Cronbach's alpha (Unweighted SERVQUAL Dimension)
Tangibles	0.81	0.78
Reliability	0.85	0.74
Responsiveness	0.79	0.67
Assurance	0.79	0.65
Empathy	0.90	0.77

5.3 Intercorrelations

Pearson correlation was used to analyze correlations among the modified five SERVQUAL dimensions and between these dimensions and the variable of overall service quality.Table V reveals the correlation coefficients between the unweighted SERVQUAL dimensions. The table shows that all were significantly correlated with one another and with the variable of overall service quality at the 0.01 level**.** The results of intercorrelations were consistent with those reported by Mehta,Lalwani and Li Han (2000).

Table V:The Correlation Coefficients between the Unweighted SERVQUAL Dimensions and the variable of overall service quality

	TAN	REL	RES	ASS	EMP	OVERALL
TAN	1.000					
REL	.654*	1.000				
RES	.561*	.763*	1.000			
ASS	.553*	.736*	.736*	1.000		
EMP	.578*	.690*	.676*	.760*	1.00	
OVERALL	.395*	.470*	.475*	.520*	.505*	1.00

*Correlation is significant at the 0.01 level (2-tailed)

Table VI, on the other hand, reveals the correlation coefficients between the weighted(i.e.weighted by importance) SERVQUAL dimensions and the variable of overall service quality. This table indicates that all the unwighted SERVQUAL dimensions were significantly correlated with one another and with the variable of overall service quality at the 0.01 level. However, the correlation coefficients between the weighted SERVQUAL dimensions were stronger than those of the unweighted SERVQUAL dimensions,which reflects the effect of the importance customers placed on each of the dimensions of service quality captured by the SERVQUAL scale. The results intercorrelations were consistant with those reported by Mehta, Lalwani and Li Han (2000).

Table VI: The Correlation Coefficients between the Weighted SERVQUAL Dimensions and the variable of overall service quality

	WTAN	WREL	WRES	WASS	WEMP	WOVERALL
WTAN	1.000					
WREL	.675*	1.000				
WRES	.897*	.594*	1.000			
WASS	.909*	.593*	.932*	1.000		
W EMP	.911*	.589*	.916*	.946*	1.00	
WOVERALL	.685*	.413*	.657*	.683*	.696*	1.00

*Correlation is significant at the 0.01 level

5.4 Results of Testing the Research Hypotheses

In order to assess the predictive ability of the alternative measures of service quality, linear regression analysis was performed with overall service quality(OVERALL) as the dependent variable. The five dimensions of service quality, Tangible (TAN) , Reliability(REL),Responsiveness(RES), and Empathy

(EMP), as the independent variables. This analysis was undertaken to assess which of the alternative measures of service quality explained more of the variation in the overall measure of service quality.

Table VII reveals the regression results of the first model, which includes the unweighted overall service quality as a dependent variable and the unweighted modified SERVQUAL dimensions as independent variables. The unweighted model has the following form:

OVERALL = f (TAN,REL,RES,ASS, EMP)

Table VII shows the regression results of the first model .It can be seen from the results provided in Table VII that the R square is .313. This indicates that the five independent variables explain 31.3% of the variations in overall service quality. This R square is significant at the 0.01 level. Results indicate that Assurance and Empathy were the most important dimensions.

Table VII: LS Regression Results- The Unweighted Model

R	R Square	Adjusted R Square	F
. .559	.313	.303	27.767

	Beta	t	Sig.
(Constant)		1.125	.262
TAN	.073	1.124	.262
REL	.046	.528	.598
RES	.106	1.304	.193
ASS	.226	2.632	.009
EMP	.189	2.408	.017

To explore the impact of importance factor, Table VIII reveals the regression results of the second model, which includes the weighted overall service quality as a dependent variable and the weighted modified SERVQUAL dimensions as independent variables. The weighted model has the following form:

WOVERALL = f (WTAN,WREL,WRES,WASS, WEMP)

Where

WOVERALL = weighted overall service quality

WTAN= weighted Tangible dimension

WREL= weighted Reliability dimension

WRES= weighted Responsiveness dimension

WASS= weighted Assurance dimension

WEMP= weighted Empathy dimension

The table shows that R square is 0.503. This indicates that the five independent variables explain 50.3% of the variations in overall service quality . This R square is significant at the 0.01 level .The R square in this model is much higher than the one reported in the first model which again gives a strong evidence about the impact of the importance customers placed on each of the dimensions of service quality captured by the SERVQUAL scale . It is interesting to note that Empathy and Tangible appear to be the most important dimensions. These results are expected because Islamic banks customers normally give more attention to empathy aspects. In addition to Empathy, the Tangible dimension is also expected to be considered as an important dimension by the Islamic banks customers and by banks customers in general. As a matter of fact, this is understandable as almost everyone would like to see his/her to have for example a nice appearance of its branches or to have employees competent or to have a nice layout or to use modern equipments and the likes. Reliability, Responsiveness and Assurance dimensions, however, appear to be less important. This is consistent with the results reported by some other studies like Angur, Nataraajan and Jahera, 1999. This varying importance accorded to the five dimensions provides some support for the multidimensional nature of service quality (Parasuraman et al. 1994)

Table VIII: OLS Regression Results- The Weighted Model

R	R Square	Adjusted R Square	F	
.709	.503	.494	61.650	.

	Beta	T	Sig.
(Constant)		3.803	.00
WTAN	.299	2.699	.007
WREL	-0.056	-1.052	.393
WRES	-.015	-.127	.899
WASS	.116	.784	.433
WEMP	.362	2.630	.009

The above-mentioned results confirm the first hypothesis of this study that there is a significant positive relationship between overall service quality and the quality dimensions in the UAE Islamic Banks.

In order to test the remaining six hypotheses ,a one way ANOVA was run. The results of the analysis will be ordered according to the research hypotheses.

Hypothesis Two: There is a significant difference between level of overall service quality in the Dubai Islamic Banks and the Abu Dhabi Islamic Banks. Table IX reveals that there is no significant difference.

Table IX:The Results of Analysis of Variance for Abu Dahbi Islamic Bank and Dubai Islamic Bank

Source	SS	DF	MS	FValue	Sig.
WTAN					
Between Groups	58.321	1	58.321	.512	.475
Within Groups	35201.683	309	113.921		
Total	35260.004	310			
WREL					
Between Groups	12.852	1	12.852	.182	.670
Within Groups	21841.636	309	70.685		
Total	21854.488	310			
WRES					
Between Groups	333.666	1	333.665	2.844	.093
Within Groups	36249.838	309	117.313		
Total	36583.502	310			
WASS					
Between Groups	13.990	1	13.990	.146	.703
Within Groups	29689.285	309	96.082		
Total	29703.275	310			
WEMP					
Between Groups	18.324	1	18.324	.145	.703
Within Groups	38947.322	309	126.043		
Total	38965.646	310			
OVERALL					
Between Groups	56.275	1	56.278	.636	. 427
Within Groups	27332.452	309	88.455		
Total	27388.730	310			

between the overall service quality in the Dubai Islamic Bank and Abu Dhabi Islamic Bank, that means hypothesis two is not supported. These results were not expected because it is assumed that each of these two banks has its own vision and mission, therefore the level of service quality should be different.

Hypothesis Three: There is a significant difference in the level of service quality in the UAE Islamic Banks based on customers' gender. Table X shows that there is no significant difference in the service quality between males and females. This might be attributed to the small proportion of the females (i.e. 16.7%) in the sample of this study. The results do not support hypothesis three.

Table X: The Results of Analysis of Variance : The Respondent's Gender

Source	SS	DF	MS	F Value	Sig.
WTAN					
Between Groups	31.511	1	31.511	.276	.599
Within Groups	35228.493	309	114.008		
Total	35260	310			
WREL_					
Between Groups	1.246	1	1.246	.018	.894
Within Groups	21853.241	309	70722		
Total	21854.488	310			
WRES					
Between Groups	192.185	1	192.185	1.632	.202
Within Groups	36391.317	309	117.771		
Total	36583.502	310			
WASS					
Between Groups	54.510	1	54.510	.568	.452
Within Groups	29648.766	309	95.951		
Total	29703.275	310			
WEMP					
Between Groups	142.995	1	142.995	1.138	.287
Within Groups	38822.651	309	125.640		
Total	38965.646	310			
OVERALL					
Between Groups	236.504	1	236.504	1.620	.204
Within Groups	45099.065	309	145.952		
Total	45335.569	310			

The Fourth Hypothesis stated a significant difference in the level of service quality in the UAE Islamic Banks biased on customers' nationality. Table XI reveals that there is no significant difference in the service quality between locals' and expatriates' customers in the UAE Islamic banks.That is to say hypothesis four is not confirmed. Nationality was expected to be significant in determining the level of service quality in the UAE Islamic Banks. This expectation is based on the assumption that most of the expatriates normally live in the UAE for a short period. For that reason their views about the services provided by the UAE Islamic Banks should differ from those who have dealt with these banks for several years which is the case of the nationals and not the expatriates.

Table XI: The Results of Analysis of Variance : The Respondent's Nationality

Source	SS	DF	MS	F Value	Sig.
WTAN Between Groups Within Groups Total	115.868 35144.137 35260.004	1 309 310	115.868 113.735	.1.040	.314
WREL_ Between Groups Within Groups Total	129.392 21725.096 21854.488	1 309 310	129.392 70.308	1.840	176
WRES Between Groups Within Groups Total	12.938 36570.564 36583.502	1 309 310	12.938 118.351	.109	.741
WASS Between Groups Within Groups Total	55.241 29648.034 29703.275	1 309 310	55.241 95.948	.576	.449
WEMP Between Groups Within Groups Total	133.733 38831.913 38965.646	1 309 310	133.733 125.670	1064	.303
OVERALL Between Groups Within Groups Total	372.130 44963.439 45335.569	1 309 310	372.130 145.513	2.557	.111

Hypothesis Five: There is a significant difference in the level of service quality in the UAE Islamic Banks based on customers' age categories. The results provided in Table XII indicate that there is a significant difference in the level of service quality in the UAE Islamic Banks based on customers' age categories. All dimensions also showed significant differences between age categories except Reliability. It can be concluded that hypothesis five is accepted.

Table XII: The Results of Analysis of Variance : The Respondent's Age

Source	SS	DF	MS	F Value	Sig.
WTAN Between Groups Within Groups Total	985..494 34274.511 35260.004	3 309 310	328.498 111.643	2.942	.033
WREL_ Between Groups Within Groups Total	243.796 21610.691 21854.488	3 309 310	81.265 70.393	1.154	.327
WRES Between Groups Within Groups Total	1148.765 35434.737 36583.502	3 309 310	382.922 115.423	3.318	.020
WASS Between Groups Within Groups Total	1099.702 28603.573 29703.275	3 309 310	366.567 93.171	3.934	.009
WEMP Between Groups Within Groups Total	1218.845 37746.801 38966.646	3 309 310	406.282 122.954	3.304	.021
OVERALL Between Groups Within Groups Total	1906.116 43424.453 45335.569	3 309 310	635.372 141.464	4.491	.004

Hypothesis Six: There is a significant difference in the level of service quality in the UAE Islamic Banks among customers with different education levels. Table XIII reveals that there is a significant difference in the level of overall service quality and Reliability dimension in the UAE Islamic Banks between customers with different education levels. The calculated F values were lower than the tabulated value and statistically insignificant in the case of the other four dimensions. However, and because the overall service quality is statistically significant at 004% level, we can conclude that hypothesis six is confimed. That is to say respondents' view about the level of service quality is different according to their education background.

Table XIII: The Results of Analysis of Variance : The Respondent's Education

Source	SS	DF	MS	FValue	Sig.
WTAN					
Between Groups	310.622	3	103.541	.910	.437
Within Groups	34949.382	307	113.842		
Total	35260.004	310			
WREL					
Between Groups	734.335	3	244.778	3.558	.015
Within Groups	21120.153	307	68.795		
Total	21854.488	310			
WRES					
Between Groups	244.693	3	81.564	.689	.559
Within Groups	36338.809	307	118.367		
Total	36583.502	310			
WASS					
Between Groups	227.321	3		.789	.538
Within Groups	29475.955	307	75.774		
Total	29703.275	310	96.013		
WEMP					
Between Groups	406.843	3	135.614	1.080	.731
Within Groups	38558.804	307	125.599		
Total	38965.646	310			
OVERALL					
Between Groups	190.287	3	63.429	.431	.004
Within Groups	45145.282	307	147.053		
Total	45335.569	310			

Hypothesis Seven: There is a significant difference in the level of service quality offered by the UAE Islamic Banks based on customer's number of years with the bank. Table XIV shows that customer's number of years with the bank is significant in determining the level of overall service quality and the Tangible Responsiveness dimensions. The calculated F values were statistically insignificant in the case of the other three dimensions. Overall service quality is statistically significant at .0694% level which is less than 0.1. It can be concluded that hypothesis seven is accepted.That is to say that there is some significant difference between level of service quality in the UAE Islamic Banks and the customer's number of years with the bank

Table XIV :The Results of Analysis of Variance : The Respondent's Number of Years with the Bank

Source	SS	DF	MS	F Value	Sig.
WTAN					
Between Groups	742.999	3	247.666	2.203	.088
Within Groups	34517.005	307	112.433		
Total	35260.004	310			
WREL					
Between Groups	405.674	3	135.225	1.935	.124
Within Groups	21448.813	307	69.866		
Total	21854.488	310			
WRES					
Between Groups	920.663	3	306.888	2.642	.049
Within Groups	35662.839	307	116.166		
Total	36583.502	310			
WASS					
Between Groups	513.660	3	171.220	1.801	.147
Within Groups	29189.615	307	95.080		
Total	29703.275	310			
WEMP					
Between Groups	742.403	3	247.468	1.988	.116
Within Groups	38223.244	307	124.506		
Total	38965.646	310			
OVERALL					
Between Groups	625.829	3	208.610	2.393	.069
Within Groups	26762.902	307	87.176		
Total	27388.730	310			

6. Conclusions

This paper has discussed and analysed service quality in the UAE Islamic Banks. The research findings can be summarised as follows:

First: The analysis of the sample responses revealed that the UAE Islamic Banks' customers were satisfied with overall service quality.

Second: The relationship between overall service quality and the SERVQUAL dimensions in the UAE Islamic Banks was positive and statistically significant.

Third: There was no significant difference between the levels of overall service quality in the Dubai Islamic Bank and the Abu Dhabi Islamic Bank.

Fourth: It was found that Empathy and Tangible were the most important dimensions.

Fifth: There was no significant difference in the level of service quality in the UAE Islamic Banks based on customer's gender and customer's nationality. However,there was a significant difference in the level of service quality in the UAE Islamic Banks based on customer's age, customer's education levels and customer's number of years with the bank. Based on the above mentioned results, the following recommendations can be made:

First: The UAE Islamic Banks should give attention to all the five SERVQUAL dimensions in order to improve the level of service quality.

Second: In order to create a perception of uniqueness in the mind of the customer and to gain an advantage in the marketplace, the UAE Islamic Banks should continually evaluate service quality. This can be done by formulating and implementing an effective and rigorous service quality policies. This practice will lead to have different levels of service quality provided by each bank and consequently to provide better services to customers. Furthermore, this practice will help the UAE Islamic Banks to compete with conventional banks.

Third: In order to improve the level of service quality, the two UAE Islamic Banks should focus their attention on the service quality dimensions that matters most to customers namely, Tangible and Empathy. In other words the emphasis should be directed towards having better appearance of branches and employees, simplified and understandable brochures and forms, using the latest technology in the banking industry. Regarding Empathy dimension the UAE Islamic Banks should give attention to some aspects like satisfying customer's specific needs, making cash machines accessible at any time, expanding branch network, having customer's interest at heart and privacy of customers personal matters. Reliability, Responsiveness and Assurance, however, appear to be less important dimensions.

Fourth: For providing new services and even in providing current services, the UAE Islamic Banks should take in their consideration the preferences/desires of their customers primarily based on three factors, namely customers' age, customers' education background and customers' number of years with the bank. To implement this objective, the two Islamic banks require conducting from time to time a survey when they decide to launch a new service or in order to improve the current services.

The above mentioned recommendations might be useful for other Islamic banks in other parts of the world, as they are presumably providing similar services.

Research Limitations

The researchers tried to distribute all the questionnaires by themselves in order to explain how to answer the questionnaire.However, because of time limitations this was not possible,so around 50% of the questionnaires were distributed through the branch managers.Therefore,this may raise the problem of the accuracy of the collected data.The second problem related to the sample selection, the procedure followed was to distribute randomly the questionnaires to customers of the UAE Islamic Banks in four Emirates, namely Abu Dhabi, Dubai, Sharjah and Fujairah.For that reason it is difficult to generalize the results of this research because the study did not cover all the seven UAE Emirates.

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Part Two

Stock Market Development in Arab Countries

CHAPTER FIVE

Using CAPM and TPFM to Estimate Tunisian Bank Cost of Equity

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1. Introduction

The Capital Asset Pricing Model (CAPM), initiated by Sharpe [1964] and Lintner [1965], posits that the covariance of a stock's return with the excess return to a market portfolio is sufficient to explain its excess return over the risk-free rate. However, a large body of literature have identified many patterns in average stock returns that cannot be explained by the one-factor CAPM. These studies have documented that alongside beta, average stock returns in the US are related to size (Banz [1981]), earning-price (Basu [1983]), past long-term returns (De Bondt and Thaler [1985]), leverage (Bhandari [1988]), past short-term returns (Jegadeesh and Titman [1993]), past sales growth (Lakonishok *et al.* [1994]) and book-to-market equity (Rosenberg *et al.* [1985], Chan *et al.* [1991], Fama and French [1992]). Because these patterns in average stock returns are not explained by the CAPM, they are typically called anomalies.

Among these anomalies, size and book-to-market equity have been found to be the most significant in capturing the cross-section of average stock returns (Fama and French [1992,1993]). Fama and French [1993] argue that the expected return on a portfolio in excess of the risk-free rate is explained by the sensitivity of its returns to three factors: (i) the excess return on a broad market portfolio; (ii) the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks and (iii) the difference between the return on a portfolio of high-book-to-

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market stocks and the return on a portfolio of low-book-to-market stocks. In support of their findings, cross-sectional and time-series studies have documented significant predictive power in explaining expected stock returns (Kothari and Shanken [1997], Pontiff and Schall [1998], Lewellen [1999]).

There is an ongoing debate about the economic rationale behind these average return anomalies. Fama and French [1992,1993,1995] argue that this pricing is rational and conjecture that the book-to-market premium is associated with a relative distress factor as did Chan and Chen [1991]. However, Kothari *et al.* [1995] argue that a substantial part of the premium is due to survivor bias; the date source for book equity in Compustat contains a disproportionate number of high-BE/ME [1] firms that survive distress, so the average return for high-BE/ME firms is overstated. Other explanations suggest that the distress factor is just data snooping; academics fix on variables that are related to average return, but only in the sample used to identify them (Black [1993], Mackinlay [1995]). A third explanation put forth by De Bondt and Thaler [1985], Lakonishok *et al.* [1994] and Haugen [1995] argues that these results are due to irrational pricing; investors overreact to firm performance and tend to place higher value on investment opportunities for growth stocks that seem to present stronger fundamentals (value strategies outperform glamour strategies because contrarian strategies «exploit suboptimal behaviour of the typical investor and not because the strategies are fundamentally riskier», Lakonishok *et al.* [1994], p.1541). The fourth explanation suggests that investors may be drawn to firm characteristics that are not related to an asset's covariance with any economic factor. Daniel and Titman [1997] find that firm characteristics (that is size and book-to-market equity (BE/ME)) explain returns better than factor loadings from the Fama and French model. They argue that the common variation of portfolios that share similar BE/ME or size properties is due to the fact that these stocks share common characteristics such as similar industries or related business line. They are more likely to become distressed in the same time which leads to high BE/ME ratios and smaller market capitalisation.

[1] *This is the ratio of book value equity (BE) to market value equity (ME).*

The Three-Factor Pricing Model (TFPM) captures most market anomalies except the momentum anomaly (Fama and French [1996], Asness [1997]). Jegadeesh and Titman [1993] were the first to show that strategies that involve taking a long (short) position in well (poorly) performing stocks on the basis of past performance over a short period of time (3 to 12 months) tend to yield significantly positive abnormal returns for the following year. The results are confirmed by other tests in the US (Fama and French [1996], Chan *et al.* [1999], Jegadeesh and Titman [2001]), in European markets (Rouwenhorst [1998]), in Asian markets except Japan and Korea (Chui *et al.* [2000]) and in emerging markets (Rouwenhorst [1999]).

A number of studies in non US-markets have documented that size, book-to-market equity, momentum and prior returns explain the cross-section of average returns. Fama and French [1998] show that value stocks outperforms growth stocks. Elfakhani *et al.* [1998] examine the incidence of beta, size and book-to-market equity on average stock returns in the Canadian stock market and report only a significant size effect and a strong BE/ME effect after 1984 in average stock returns. Chan *et al.* [1991] and Wong [1989] find significant value premiums for stocks in the Japanese and Singapore stock exchanges. Claressens *et al.* [1995] find limited evidence of a small firm effect in 19 emerging markets and Fama and French [1998] document a premium for small and value stocks in 17 emerging markets. Herrera and Lockwood [1994] report both a small firm effect and a market beta effect in the Mexican stock exchange. Chui and Wei [1998] find in five Pacific-Basin emerging markets no market beta effect, a strong BE/ME effect in Hong-Kong, Korea and Malaysia, and a significant value premiums in all markets except Taiwan. Wong [1989] finds that the returns on common stock are significantly correlated to size in the Singapore market. Rouwenhorst [1998] reports significant size and book-to-market effects on annual stock returns and stocks exhibit momentum. Aksu and Önder [2002] find in Turkey that the market factor is significant but not sufficient to explain all the variation in excess returns. Applying a TFPM version, they report that the market and size are the only significant factors.

Estimating cost of equity is crucial for many financial decisions of privately owned companies such as capital budgeting, capital structure, performance valuation using EVA[2], valuation and the pricing of services in some regulated industries. In a survey, Bruser *et al.* [1998] find that the most common method favoured by practitioners for estimating cost of equity is the CAPM. This widespread use of the CAPM in practice is no doubt due to its strong theoretical foundation and its simplicity. The work of Fama and French and of others, who have addressed size and BE/ME issues, challenge the validity of the CAPM because under the CAPM the only risk factor is beta (security's systematic risk). But some argue that the TFPM is empirically inspired and lacks strong theoretical foundations. As Fama and French [1996] suggest, «we do not take a stance on which is the right asset pricing model», we use both the CAPM and the TFPM in order to estimate bank costs of equity.

The purpose of this study is to estimate cost of equity of the Tunisian commercial banks using both CAPM and TFPM. Our research makes three contributions :

- It is the first paper that focuses on the estimation of cost of equity of Tunisian banks using two models, that is the CAPM and the TFPM. The econometric approach is also interesting which is based on a random-coefficient model in the context of panel data analysis.

- It is done in a period where the Tunisian bank industry is undergoing huge reforms (mergers, disinvesting, recapitalization, and so forth). The results of the paper will give Tunisian banks a benchmark for all their ongoing restructuring financial decisions.

- It will pave the way for estimating cost of equity of banks in other MENA countries according to similar nice methodological and technical approach.

The paper is organized as follows: Section II presents the Tunisian financial system with an emphasis on the banking sector. Section III outlines the data and methodology. The findings are reported in the next section and the paper concludes with a summary and policy implications.

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[2] Economic Value Added.

2. The Tunisian Financial System: An Overview

In the early 1980's, the inefficiencies and distortions of the Tunisian financial system were exacerbated by the emergence of severe macroeconomic difficulties. In order to tackle their mounting financial problems and enhance growth prospects, the Tunisian government reformed several times the financial system in the framework of the Tunisian's structural adjustment effort of the late 1980's and early 1990's. These reforms involved a liberalization of the financial sector under the auspices of the IMF. Besides, these reforms were intended to improve the capacity of financial institutions to mobilize domestic savings, lead to more efficient allocation of financial resources, increase competition among banks and strengthen their financial soundness.

The initial phase of financial reforms [1987-1993] aimed at gradual dismantling of the debt economy. It involved a gradual liberalization of interest rates, a gradual suppression of directed credit policies and a reinforcement of the prudential regulations in line with international standards. Thereafter, financial reforms aimed at paving the way for the strengthening of a financial market economy [1994-present].

The implementation of these reforms was articulated around the following pillars :

- **Liberalizing interest rates and credit allocation decision by commercial banks** : interest rates were liberalized in 1987 and were allowed to be set freely within a spread of three percentage points of the money rate except for lending rates to priority sectors. By 1996, deposit and lending rates have been fully liberalized, although limited controls on some deposit rates remained. A gradual relaxation of requirements that bank lend to the treasury, to public enterprises and priority sectors was sustained by the move to a more market-based financing of the budget. In addition, the requirement for prior authorization by the Central Bank (BCT) for credit decisions was eliminated in 1988.

- **Promoting the equity market** : the Tunisian Stock Exchange (TSE) was first created in 1969, but not until 1994 when it was privatised did it become an integral part of the Tunisian financial market (the capital is split equally between the

28 brokerage firms in the market). The financial market was reformed according to international standard in 1994. The CMF (Conseil du Marché Financier)[3] was set up to reinforce the transparency of the market. Parallel to this, the STICODEVAM[4] (Société Tunisienne Interprofessionnelle pour la Compensation et le Dépôt des Valeurs Mobilières) was created in order to clear transactions and to act as the central depository for the market. After experiencing two difficult years in 1996 and 1997, the TSE regained strength in 1998 as reforms were put in place to increase efficiency and transparency. They included the introduction of a new trading system based on the SuperCAC electronic trading system and the implementation of new accounting standards consistent with best international norms. In parallel with legal and technical consolidation, the Tunisian government has recently put in place fiscal advantages to incite companies in listing in their stock on the TSE and the investor to buy securities. Finally, foreigners can participate within the limits of fifty percent of the offering of a company. Above fifty percent, an authorization is required. Foreigners currently account for twenty-five percent of the total capitalization.

- **Introducing new indirect monetary policy** : treasury bills were redesigned in order to make them more liquid and attractive to investors. In parallel, the legal framework for new private investments such as certificates of deposit, commercial papers, mutual funds and corporate bonds was reinforced, although many of these instruments are scarcely used.

- **Moving to more market-based government financing** : in 1991, the treasury stopped issuing low-interest, long-term government bonds, the amount of treasury bill that banks were required to hold was reduced. Besides, the government securities market (85 percent of the stock of bond instruments) was modernized with the introduction of standardized instruments (bon du trésor assimilable) and the establishment of systematic auction-based issuance and a group of primary dealers.

- **Opening the financial sector to foreign financial institutions** : this is done by opening banks' capital to foreign participation, by allowing foreign banks to

[3] A regulatory body equivalent to the SEC in the US. CMF could be translated as Financial Market Council.
[4] A national organization that provides highly automated record keeping and depository services and facilitates the clearing and settlements of transactions.

open branches and operate onshore, and by allowing offshore banks to collect deposits in dinars (the local currency) from residents with some restrictions.

- **Strengthening prudential regulations and banking supervision** : domestic banks were required to meet the Basle-risk-weighted adequacy ratio by 1999. Moreover, the authorities implemented a plan to restructure Non Performing Loans (NPLs) to public enterprises[5], but the continuing high level of NPLs suggests the need for further improvements in bank credit policies.

Table 1 summarises all the reforms undertaken by the Tunisian government from 1997 to 2002. All these reforms have contributed to strengthen the financial sector and its main characteristics today according to the IMF [2002]. The commercial banks (14 institutions) dominate the financial sector with 64 percent of total assets of financial institutions, and the state-controlled banks dominate the banking sector (the state controls the three largest banks and more than half the banking system's asset). These banks are allowed to collect deposits of any maturity, provide short-and-medium-term credit and may engage in long-term credit operations. The extension of their networks gives them an operational advantage with respect to development banks. The development banks (6 institutions) represent only 4 percent of total financial assets and suffer from high levels of NPL's (BDET and BNDT, two Tunisian development banks, have merged in 2000 with the commercial bank STB[6]). They are joint ventures between the Tunisian government and governments of other Arab states. The initial mission was to finance investment projects over the medium and long term and to participate in the capital of private firms. Their importance in the financial sector decreased gradually because of the wider scope of activity permitted to commercial banks by the 1994 amendments to the banking law (commercial banks are allowed to grant medium-and-long-term credits) and the development of non bank financial markets (the increase in the activity of the stock exchange after the 1994 reform). Offshore banks (8 institutions) represent less than 5 percent of total assets of financial institutions and were initially created to provide financial services to offshore companies.

[5] NPLs were reduced in half between 1992 and 1999.
[6] See the list of the ten commercial banks which constitute the individual cross-sectional units in the sample with the corresponding abbreviation (French initials) in the appendix.

Table 1- Main reforms in the monetary and financial sectors

Year	Monetary sector	Financial sector
1987	- Lending rates are liberalised (except for priority sectors) but retention of ceiling of 3 percent points above TMM. - Rates for deposits of at least three months are free.	- Introduction of comprehensive bank prudential regulations.
1988	- Rediscount operations limited to priority sectors. - BCT introduces credit auction; refinance standing facility; and end of day repo operations.	- Merger of two banks (BNT and BNDA). - Reform of legislation on investment and collective investment institutions. - BCT approval for granting bank loans is eliminated. - Introduction of interbank transactions.
1989	- Reactivation of non-remunerated reserve requirement.	- Introduction of treasury bill auctions.
1991		- Relaxation of mandatory bank holding of government securities. - Minimum term for CDs increased from 10 to 90 days and introduction of treasury bills with maturity over one year.
1992	- Ceiling on individual lending rates replaced by ceiling on average lending rates per bank set at TMM+3. - Reduction of scope of credits at preferential rate.	- Strengthening of prudential regulations. - New financial instruments are introduced (investment trusts, priority shares and equity loans).
1993		- Adoption of new auditing standards for the financial statements of banks.
1994		- Commercial banks are allowed to grant medium- and long-term credits. - Development banks are allowed to grant short-terms loans. - New stock exchange legislation sets private stock market and creates independent supervisory body (CMF). - Introduction of negotiable treasury bill and investment trusts.
1995		- Venture capital companies are authorised.
1996	- Lifting of all restrictions on lending rates. - Elimination of mandatory lending requirements for priority sectors.	
1997	- BCT intervention in money market becomes main monetary instruments.	- Implementation of a plan to restructure NPL's on public enterprises. - BTS is created (Microfinance). - Implementation of a "mise à niveau program". - Adoption of general regulations of BVMT. - Creation of Maghreb Rating.
1998		- Minimum capital ratio rises from 5 to 8 percent. - Issue of fungible treasury bonds.
1999		- Exposure to a single group reduced to 25 percent of capital. - New statute for market intermediaries. - Adoption of CMF regulation covering public offer of securities.
2000		- Merger of two development banks with a commercial bank. - Enactment of a new business corporation code.
2001		- Enactment of a new banking law and law on collective investment institutions. - Preparation of draft laws on holdings.

Source: IMF [2002].

They also extend limited loans in foreign currency to Tunisian residents and their ability to raise deposits from residents is strictly limited. The security market is still small relative to the banking industry and constitutes only a small portion of financial system's assets. The number of firms listed on the TSE increased from 13 to 44 between 1990 and 2002. Despite a sharp increase of volume of trading and capitalization, in 2000, market capitalization represented only 14 percent of GDP and the annual value of trading amounted to 4 percent of GDP which is very small compared to other emerging markets. Moreover, the bond market is dominated by government securities which represent over 85 percent of outstanding bond instruments and the secondary market is in its infancy. The other main bond issues are banks and leasing companies. Finally, non bank financial institutions (insurance companies, pension funds, collective investment institutions and investment companies) play a relatively small role in the Tunisian economy. Their assets represent only 22 percent of GDP.

Table 2- Structure of the financial system (As an end-2000)

Type of institution	Assets (in millions of DT)	Percent in total assets	Number of institutions	As a percentage of GDP
Commercial banks	19612,5	63,6	14	72,8
Development banks	1118,6	3,6	6	4,2
Offshore banks	1429.6	4,6	8	5,3
CCP	1000	3,2	1	3,7
CENT	800	2,6	1	3,0
Leasing companies	860,7	2,8	9	3,2
Factoring companies	29,7	0,1	2	0,1
SICAV	1398	4,5	28	5,2
SICAF	469	1,6	85	1,7
SICAR	207	0,9	26	0,8
Insurance companies	1300	4,2	16	4,8
Brokerage houses	n.a	n.a	26	n.a
Pension funds	2500	8,1	2	9,3
Total	30819,1	100	366	114,5

Source: IMF [2002].

Table 2 describes the present situation of the Tunisian financial system. On the whole, while significant progress has been realised during the 1990's to reform the financial sector, residual weakness will need to be tackled before fully liberalizing the capital account. According to the IMF [2002], the authorities need to implement several measures in order to strengthen the financial sector. The more essential of them consist in reducing the extent of state-ownership in the banking sector and removing obstacles to the establishment of foreign financial institutions, undertaking a review of provisioning policies by encouraging a better provisioning through removing limits on tax deductibility which can be facilitated by the current level of profitability, strengthening the supervisory frameworks through expanded training and the promotion of greater functional independence, conducting a study aimed at implementing a deposit insurance mechanism, accepting any government and private commercial papers that satisfy minimum credit worthiness criteria as collateral for the Central Bank refinancing operations, and by accepting a firm commitment to market funding of the fiscal deficit.

Table 3- Some statistics on the Tunisian banks

Banks	Size[7]	Ownership	Foreign Ownership	Specialisation
AB	134,2	Private	-	No specialisation
ATB	101,5	Private	64,24 percent	No specialisation
BH	172,5	State	-	Real estate
BIAT	224	Private	0,21 percent	No specialisation
BNA	149	State	-	Agriculture
BS	160,8	State	13,43 percent	No specialisation
BT	234,5	Private	17,91 percent	No specialisation
STB	197,8	State	3,74 percent	No specialisation
UBCI	231	Private	50 percent	No specialisation
UIB	83,3	State	-	No specialisation

The Tunisian listed commercial banks are the biggest companies in the TSE. Nine out of the ten biggest firms in the TSE come from the banking industry. Besides, fifty percent of the banks are state-owned and only two have significant foreign participation in capital (ATB and UBCI). Only two banks are specialised (BNA in agriculture and BH in real estate). Comparing the banking sector to other sectors in the TSE, some comments must be made. First, the banking sector is one of the most represented sector in the TSE (ten of fourteen banks are listed in the TSE). Second, banks are one of the least liquid sector in the TSE (the turnover rate[8] is 7,17 percent in the banking sector compared to the 21,53 percent average rate in the TSE in 2001).

[7] *Size is computed as the product of the share price by the number of outstanding shares on 31 December 2000. The number is expressed in millions of Tunisian Dinars (local currency).*
[8] *The turnover rate is computed as the ratio of exchanged capital over total market capitalisation.*

Third, banks represent fifty percent of the total market capitalisation and more than twenty percent of the number of listed companies in the TSE in 2000.

3. Data and Econometric Modelling

3.1 Data Sources

We examine the monthly returns from the three factors $R_M - R_f$, SMB and HML on the Tunisian Stock Exchange (TSE) over the period [July 1996-June 2001]. Data relative to financial statements, monthly stock returns and firm market equity (number of shares outstanding times the stock price) come from the TSE electronic database. The market return is an equally-weighted return computed from the BVMT index. Returns from the risk-free asset are estimated from the «TMM» (Money market rate) which is the smallest rate (to match monthly return data with monthly money market-rate, we use the rates for the month in which the return is calculated). Book equity is computed as the book value of stockholder's equity. All observations with a negative book equity are excluded from the sample. Finally, all stock returns are adjusted for stock splits, right offerings and dividend payment.

3.2 Portfolio Formation

The construction of the size and book-to-market portfolios is similar to those of Fama and French [1993,1995]. To be included in a portfolio, a company must be listed in the TSE both in December_{t-1} and in June_t. Also it must have a fiscal year end of December 31 which is the case of all listed companies in the TSE. The number of firms that fulfil the data requirements range from 25 in 1995 to 44 in 2001. Market capitalization of equity is computed as the stock's price times the number of shares outstanding in June_t. In Tunisia, the listed firms must publish their financial statements within three months, but some financials are not disseminated until May or June. Since the TSE is likely to be less efficient than the developed markets, a time period of six months, from December_{t-1} to June_t, is fixed as sufficient for the investors to react to the information made public in the annual reports.

The market value and book value of equity used to compute BE/ME for year_t are the December_{t-1} values. Accordingly, the stock returns from July 1_t to *June* 30_{t+1} are calculated for portfolio based on December_{t-1} BE/ME values and June_t sizes. We have constructed the size and book-to-market portfolios in keeping with Fama and French [1993]. The stocks in the sample are first sorted each year from smallest to largest in terms of market capitalization. We then use a 50 percent break point for size to allocate stocks in two groups that is S (for small) and B (for big). The firms are then sorted, again each year, into three book-to-market equity partitions designated as L (for low), M (for medium) and H (for high). The BE/ME partitioning is based on the break points for the bottom 30 percent, middle 40 percent and the top 30 percent of the book-to-market equity values for the TSE stocks. We form six size-BE/ME portfolios that is S/L (small size and low book-to-market equity), S/M (small size and medium book-to-market equity), S/H (small size and high book-to-market equity), B/L (big size and low book-to-market equity), B/M (big size and medium book-to-market equity) and B/H (big size and high book-to-market equity). The ranking is redone each year and the portfolio composition changes due to the modifications in the size and book-to-market equity values of the TSE firms. The six portfolios are used to compute the risk premiums related to small size and high book-to-market equity which are used as exogenous variables in the TFPM of Fama and French explained below.

3.3 Theoretical and Econometric Modelling

As mentioned earlier, more attention will be made to the more common theoretical models used in relation with the valuation of financial assets. The Capital Asset Pricing Model (CAPM) argues that there is always a positive linear correlation between expected returns on securities and their market returns. Even more, the slopes of those simple regressions (βs) suffice to explain the cross-section of expected returns. In this case, the expected return on stock i which means the cost of equity for bank i, $i = 1, \cdots, n$, is defined by the following expression :

$$(1) \qquad E(R_i) = R_f + \beta_i (E(R_M) - R_f) \quad i = 1, \cdots, n$$

where R_f [9] and R_M indicate, respectively, the risk-free interest rate and a weighted value of market portfolio. The coefficient β_i is the risk of stock i. It is indeed the slope of regression of its excess return on the market excess return. A simple regression could be considered for each bank i as follows :

$$(2) \qquad R_{it} - R_{ft} = \alpha_i + \beta_i (R_{Mt} - R_{ft}) + \varepsilon_{it} \quad i = 1, \cdots, n \text{ and } t = 1, \cdots, T$$

We saw that the more important extension of this initial model was proposed by Fama and French [1993] rising the Three-Factor Pricing Model (TFPM)[10]. According to this new formulation, the expected return on stock i, $i = 1, \cdots, n$, is defined by the following expression :

$$(3) \qquad E(R_i) = R_f + \beta_i (E(R_M) - R_f) + s_i E(SMB) + h_i E(HML) \quad i = 1, \cdots, n$$

where β_i, s_i and h_i are the slopes in the following multiple regression :

$$(4) \; R_{it} - R_{ft} = \alpha_i + \beta_i (R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + \varepsilon_{it} \quad i = 1, \cdots, n \text{ and } t = 1, \cdots, T$$

Equations (2) and (4) could be rearranged, respectively, in a matrix form as follows :

$$(5) \qquad y_i = X_i \delta_i + \varepsilon_i \quad i = 1, \cdots, n$$

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[9] In the empirical study, the risk-free interest rate is the TMM (Money market interest rate). Such rate has been chosen because it is the smallest interest rate in the market.

[10] More recently, a new generation of models are those that introduce a forth factor. We speak about the FFPM models. The additional variable introduced is called Winners Minus Losers (WML). See for the moment L'Her et al. [2001].

with $y_i = R_i - R_f$ a Tx1 vector which indicates the same dependent variable in both CAPM and TFPM. X_i determines the matrix of the time series observations of explanatory variables of bank i. This matrix is defined by $X_i = [S \quad R_M - R_f]$ for the CAPM and is of dimension Tx2 whereas it has the dimension Tx4 in the case of the TFPM and is defined by $X_i = [S \quad R_M - R_f \quad SMB \quad HML]$. The corresponding vector of the coefficients relative to each cross-sectional unit is, respectively, $\delta_i = [\alpha_i \quad \beta_i]'$ for the CAPM and $\delta_i = [\alpha_i \quad \beta_i \quad s_i \quad h_i]'$ for the TFPM. S and ε_i are Tx1 vectors of ones and errors respectively. Precisely, the errors ε_i are assumed to be both contemporaneously and serially independent but heteroscedastic across banks with different variances σ_i^2, $i = 1, \cdots, n$. According to the random-coefficient model of Swamy [1970][11], the vector of coefficients δ_i, $i = 1, \cdots, n$, could be estimated efficiently in an appropriate context of panel data analysis. This kind of econometric models is interesting because when the coefficients of the regression are assumed to be random, one is able to account for interindividual heterogeneity. So we have the possibility to look for the variation of the parameters across cross-sectional units. This heterogeneity is due to a stochastic variability.

For the purpose of estimation and tests, we assume that the coefficients δ_i are randomly distributed with mean vector δ and covariance matrix Γ[12] of order kxk[13]. Therefore, they are assumed to be randomly drawn from the same non-singular multivariate distribution[14]. An efficient estimation of the mean vector δ is conducted by the feasible GLS procedure. A best linear unbiased estimator is so obtained and defined by the following expression :

$$(6) \qquad \hat{\delta} = \left(\sum_{i=1}^{n} X_i' \hat{\Phi}_i^{-1} X_i \right)^{-1} \left(\sum_{i=1}^{n} X_i' \hat{\Phi}_i^{-1} y_i \right) = \sum_{i=1}^{n} \hat{W}_i \hat{\delta}_i$$

where :

[11] See also Greene [1993], Hsiao [1986] and Swamy [1971].

[12] This matrix shelters coefficients which indicate variability between coefficients. Its estimation will give the estimated dispersion of the coefficients.

[13] For the empirical analysis, we have k=2 in the CAPM case and k=4 in the TFPM case.

[14] It could be the multivariate normal, but this supplementary restriction is not necessary for the moment.

$$(7) \qquad \hat{W}_i = \left(\sum_{i=1}^{n} \left(\hat{\Gamma} + \hat{\sigma}_i^2 \left(X_i{}' X_i \right)^{-1} \right)^{-1} \right)^{-1} \left(\hat{\Gamma} + \hat{\sigma}_i^2 \left(X_i{}' X_i \right)^{-1} \right)^{-1} \quad i = 1, \cdots, n$$

and :

$$(8) \qquad \hat{\Phi}_i = X_i \hat{\Gamma} X_i{}' + \hat{\sigma}_i^2 I_T \quad i = 1, \cdots, n$$

First, we note that the GLS estimator $\hat{\delta}$ is a matrix-weighted average of OLS estimators for each cross-sectional unit $\hat{\delta}_i$. Second, it is easily proved that $\hat{\delta}$ is asymptotically efficient and normally distributed when T is high and n fixed. The asymptotic covariance matrix is $n^{-1}\Gamma$ estimated by $n^{-1}\hat{\Gamma}$.

In practice, the estimation procedure starts by computing OLS estimators $\hat{\delta}_i$ [15] for each bank. Next, the residuals $\hat{\varepsilon}_i = y_i - X_i \hat{\delta}_i$, $i = 1, \cdots, n$, serve in the estimation of the variances σ_i^2, $i = 1, \cdots, n$. When the estimated procedure is accomplished, individual vectors δ_i, $i = 1, \cdots, n$, could be predicted providing a good idea about the behaviour of each cross-sectional unit. Predictors that are best linear unbiased estimators are determined as a matrix-weighted average of OLS estimators $\hat{\delta}_i$ and the GLS estimator of the mean vector $\hat{\delta}$. So, we carry the following expression :

$$(9) \qquad \hat{\delta}_i^p = \left(\hat{\Gamma}^{-1} + \frac{1}{\hat{\sigma}_i^2} \left(X_i{}' X_i \right) \right)^{-1} \left(\hat{\Gamma}^{-1} \hat{\delta} + \frac{1}{\hat{\sigma}_i^2} \left(X_i{}' X_i \right) \hat{\delta}_i \right)^{-1} = \hat{A}_i \hat{\delta} + \left(I_k - A_i \right) \hat{\delta}_i$$

$$i = 1, \cdots, n$$

where:

[15] *The estimators* $\hat{\delta}_i$ *are also best linear estimators of* δ. *In fact, they could serve to rank individuals in comparison to* $\hat{\delta}$ *since they constitute the distribution in the sample of* δ_i *around the mean value* δ.

$$(10) \qquad \hat{A}_i = \left(\hat{\Gamma}^{-1} + \frac{1}{\hat{\sigma}_i^2} \left(X_i{}' X_i \right) \right)^{-1} \hat{\Gamma}^{-1} \quad i = 1, \cdots, n$$

In order to validate the random-coefficient structure of Swamy, we adopt the indirect test of variation of the coefficient across the cross-sectional units. An important question is now to prove, according to the empirical application, that the regression coefficients so obtained are really varying across cross-sectional units. Among the available testing procedures, we could choose the way which consists to test whether or not the coefficient vectors δ_i are all equal to the mean vector δ. This corresponds to the following null hypothesis :

$$(11) \qquad H_0 : \delta_1 = \cdots = \delta_n = \delta$$

If the null hypothesis is true, this signify that the individual coefficient vectors must be considered as fixed and they are all equal to the mean. Rather, acceptation of the alternative hypothesis is interesting because it leads to confirm the randomness assumption of the coefficient vectors. Swamy [1970] has constructed the appropriate statistic of the test which is asymptotically distributed as chi-square with (kx(n-1)) degrees of freedom under the null hypothesis and is defined as follows :

$$(12) \qquad \chi_1^2 = \sum_{i=1}^{n} \frac{\left(\hat{\delta}_i - \hat{\delta}^* \right)' X_i{}' X_i \left(\hat{\delta}_i - \hat{\delta}^* \right)}{\hat{\sigma}_i^2}$$

where :

$$(13) \qquad \hat{\delta}^* = \left(\sum_{i=1}^{n} \frac{1}{\hat{\sigma}_i^2} X_i{}' X_i \right)^{-1} \left(\sum_{i=1}^{n} \frac{1}{\hat{\sigma}_i^2} X_i{}' X_i \hat{\delta}_i \right)$$

Another kind of test could be conducted in order to verify which methodology has proven to apply from a statistical point of view, that is the CAPM or the TFPM. This corresponds to the following null hypothesis :

$$(14) \qquad H_0 : s = h = 0$$

Since $\hat{\delta}$ is asymptotically efficient and normally distributed when T is high and n fixed[16], one could derive the appropriate statistic of the test which is distributed as chi-square with 2 degrees of freedom under the null hypothesis and is defined as follows :

$$(15) \qquad \chi_2^2 = n\left(R\hat{\delta}\right)'\left(R\hat{\Gamma}R'\right)^{-1}\left(R\hat{\delta}\right)$$

where R is a matrix of two restrictions defined as follows :

$$(16) \qquad R = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

4. Empirical Results

Table 4- Monthly CAPM and TFPM explanatory returns and monthly excess returns over the period [1996-2001]

Year	Months	$R_i - R_f$	SMB	HML	$R_M - R_f$
1996-1997	July	-0,0176	0,0792	-0,0721	-0,0239
	August	-0,0301	0,008	-0,00281	-0,0146
	September	0,0145	-0,0252	0,0508	-0,0312
	October	0,0146	-0,0375	0,0824	-0,0039
	November	-0,0212	-0,0236	0,0568	-0,0163
	December	-0,015	-0,0344	0,0546	-0,0543
	January	-0,115	-0,0995	0,0548	-0,155
	February	-0,0376	0,166	0,0244	0,0147
	March	-0,000473	0,0442	0,0339	0,0525
	April	-0,0617	-0,00659	0,0365	-0,0476
	May	-0,0659	0,0311	0,0498	-0,035
	June	-0,117	0,0103	-0,00617	-0,073
1997-1998	July	-0,04	0,0521	0,0526	-0,02
	August	-0,0602	0,057	0,0309	-0,0205
	September	0,0111	-0,0465	0,0848	0,006
	October	0,0571	0,022	-0,013	0,0658
	November	-0,0286	0,0333	-0,0175	-0,0123

[16] In the empirical study, the test will be conducted only on the mean vector δ because $\hat{\delta}$ is normally distributed which permits to constitute a statistic of the test with a usual distribution.

		Table 4	Continued		
Year	Months	$R_i - R_f$	SMB	HML	$R_M - R_f$
	December	-0,0428	-0,0289	0,105	-0,0469
	January	-0,04	-0,00562	-0,0316	0,0039
	February	-0,0115	0,0315	0,0743	-0,0007
	March	-0,00253	-0,00483	0,00573	0,0017
	April	-0,0295	0,0334	0,00725	-0,0067
	May	-0,0358	0,0289	0,0171	-0,0122
	June	-0,0421	0,03	-0,0207	-0,0161
1998-1999	July	-0,0259	0,0483	-0,0185	-0,0137
	August	0,00112	-0,00741	-0,00987	0,0095
	September	-0,011	0,000963	-0,024	-0,003
	October	-0,019	0,00519	0,0156	-0,0003
	November	-0,0108	0,0415	-0,0122	-0,0091
	December	-0,0127	0,111	-0,0198	-0,0025
	January	0,0217	0,014	0,104	0,0498
	February	0,247	-0,115	0,0412	0,179
	March	-0,0673	0,0601	-0,0195	-0,0129
	April	-0,0402	0,0365	0,0271	-0,0121
	May	-0,0147	0,0222	0,0153	0,0393
	June	-0,0353	0,0412	-0,0078	-0,0223
1999-2000	July	0,0146	-0,0232	0,00824	0,0439
	August	0,035	-0,0407	0,0727	0,105
	September	-0,0057	0,0215	-0,059	0,0379
	October	0,0209	-0,026	-0,066	0,128
	November	-0,022	0,0179	-0,054	-0,0099
	December	0,000471	-0,0177	-0,0388	0,0036
	January	0,0494	0,0109	0,0998	0,217
	February	-0,0194	-0,0276	-0,00473	0,0041
	March	-0,0263	0,000712	0,0421	0,0629
	April	0,00101	-0,00414	-0,0175	-0,0333
	May	-0,0306	0,0172	0,0116	0,0509
	June	-0,0201	-0,052	-0,0264	0,0779
2000-2001	July	-0,00294	0,0437	0,0172	0,151
	August	-0,00452	-0,0355	-0,0222	0,0229
	September	0,0374	-0,0303	0,0698	-0,0181
	October	-0,0526	0,0626	-0,0116	-0,0888
	November	-0,0163	0,0289	-0,0261	0,0644
	December	0,0309	0,0794	0,0594	0,042
	January	-0,0428	-0,0352	-0,0944	-0,0282
	February	-0,0186	0,0126	0,0314	-0,0907
	March	0,000256	-0,0424	0,0416	-0,0245
	April	0,0170	0,00477	0,12	-0,0591
	May	-0,000679	-0,0563	-0,0184	0,0559
	June	-0,0265	0,024	-0,00284	-0,117
Mean		-0,0127	0,00846	0,0147	0,0059
Standard deviation		0,0474	0,0466	0,0468	0,0643
# of negative observations		43	24	27	35
Proportion in the sample		71,66	40	45	58,33
t-value		-2,06	1,394	2,412	0,704

For the variable $R_i - R_f$, mean value over the ten banks is considered for each month. t-value is obtained by dividing the mean of monthly returns (Mean) by its standard error that is $(\text{Std.Dev})/(T-1)^{0,5}$. The number of negative observations is in fact the number of negative monthly returns. We give also the proportions of these observations in the total sample.

Table 4 documents the monthly average excess returns for the dependent and the explanatory variables of both CAPM and TFPM for the 60 months between July 1996 and June 2000, that is the monthly average excess returns for all the deposit banks $\left(R_i - R_f\right)$, the monthly excess market returns $\left(R_M - R_f\right)$, the difference in average returns to the three small and three big firm portfolios (SMB), and the difference in average returns to the two high and two low book-to-market equity portfolios (HML). Mean values and standard deviations of these monthly excess returns are shown at the bottom of the table. The premiums for market risk, small size and relative distress are expected to be positive. Surprisingly, table 4 reports that the three risk factors of $\left(R_M - R_f\right)$, SMB and HML are negative in 58,3 percent, 40 percent and 45 percent, respectively, of the 60 observations under study. These relatively high proportions of negative monthly excess returns are explained by high volatility of TSE and highly depressed market during the period of study[17]. This high volatility is measured by the annual standard deviation of TSE market index over the [1996-2000] period which is 35,77 percent. In comparison, Fama and French [1996] report that $\left(R_M - R_f\right)$ returns are negative in only 10 of the 30 years they studied. On the other hand, Aksu and Önder [2002] report 27 negative monthly excess returns of the 52 months under study (about 52 percent of the total sample) which are inferior to those obtained for the TSE. The excessive number of negative excess returns for the risk factors (HML and SMB) suggests that there is not a perfect effect of size and BE/ME in the TSE. However, the equally weighted mean values of the monthly market, size and distress premiums are still positive (0,6 percent, 0,84 percent and 1,47 percent per month, respectively) with the lowest premium observed for excess market returns and the highest for distress risk factor. The premiums in the TSE are higher than the ones observed in the US market (Fama and French [1993]) but lower than those reported in the emerging markets (Fama and French [1998]). In general, the standard deviations from observed mean values of the factor premiums are very high, even higher than those reported for the US stocks.

[17] We observe negative returns on the TSE index in 1996 (-10 percent), 1997 (-6 percent) and 2001 (-30 percent).

Table 5- Annual mean premiums obtained by comparable studies (in percentages)[18]

Study	Country	Period	$R_M - R_f$	SMB	HML
Fama and French [1996]	USA	1964-1993	5,94	4,92	6,33
Davis et al. [2000]	USA	1929-1997	8,34	2,43	5,66
Bauman et al. [1998]	Canada	1986-1996	5,40	-	1,20
Arshanapalli et al. [1998]	Canada	1975-1996	-	0,68	3,43
Liew and Vassalou [2000]	Canada	1978-1996	-	4,85	7,44
Molay [2000]	France	1992-1997	5,88	4,8	0,84
Aksu et Önder [2002]	Turkey	1993-1997	27,24	18,24	10,32

The standard deviation for the average market premiums is the largest with a value of 6,43 percent, while it is 4,68 percent per month for HML and 4,66 percent per month for SMB. Average monthly HML return is the only premium significantly different from zero with a t-value of 2,43 which is in concordance with the results obtained for the US market (Fama and French [1996]). Therefore, HML premium is the closest to present an arbitrage opportunity in the TSE, while the size premium seems to fulfil that role in the Turkish Stock Exchange (Aksu and Önder [2002]). However, the excessive number of negative monthly returns and their high standard deviations imply that these premiums do not present a perfect arbitrage opportunity.

Table 6 presents the results of estimation for the CAPM and TFPM specifications carried out using the econometric methodology presented in section III[19]. Firstly, the random coefficient specification is adopted according to the empirical results issued from the test (expressions (11)-(13)) which confirm significantly the variation of the coefficients across the cross-sectional units. So, the coefficient vectors δ_i could not be assumed as fixed and are not all equal. Refuting the null hypothesis means that sample units under study are heterogeneous with a sensible random varying behaviour. For both the CAPM and TFPM, the estimated value for the statistic of the test (expression (12)) is, respectively, 30,417 and 60,167 which are above the corresponding critical values of chi-square at the 5 percent level.

[18] The means are annualised in order to make comparable the results across studies.
[19] *An appropriate algorithm was written on TSP43 software.*

Table 6- Random coefficient estimates and predictors of CAPM and TFPM

Banks	CAPM		TFPM			
	Intercept	$R_M - R_f$	Intercept	$R_M - R_f$	SMB	HML
AB	-0,0698	0,339	-0,0624	0,325	-0,125	0,179
	(3,11)	(0,102)	(28,0391)	(0,728)	(0,158)	(0,401)
ATB	-0,0344	0,372	0,017	0,51	-0,79	0,0124
	(2,00787)	(0,11)	(16,313)	(0,444)	(0,164)	(0,245)
BH	-0,078	0,358	0,0025	0,704	-0,238	0,157
	(3,517)	(0,0997)	(17,412)	(0,47)	(0,162)	(0,26)
BIAT	-0,0736	0,37	-0,0164	0,644	0,0542	0,224
	(2,48)	(0,106)	(8,556)	(0,269)	(0,181)	(0,15)
BNA	-0,0433	0,331	-0,02	0,408	-0,274	0,136
	(1,371)	(0,114)	(4,386)	(0,189)	(0,189)	(0,109)
BS	-0,0458	0,248	-0,0162	0,308	-0,413	0,0925
	(1,979)	(0,111)	(7,632)	(0,25)	(0,184)	(0,14)
BT	0,0473	0,495	-0,00544	0,271	-0,161	0,14
	(2,62)	(0,197)	(3,901)	(0,186)	(0,244)	(0,102)
STB	0,0149	0,315	-0,0112	0,21	-0,0818	0,156
	(1,269)	(0,174)	(2,158)	(0,172)	(0,241)	(0,0931)
UBCI	0,0462	0,689	-0,0152	0,428	-0,187	0,154
	(3,556)	(0,214)	(3,619)	(0,183)	(0,244)	(0,1)
UIB	-0,0564	0,436	-0,0238	0,562	-0,159	0,174
	(1,872)	(0,111)	(5,392)	(0,207)	(0,188)	(0,118)
Mean vector	-0,0293	0,395	-0,0151	0,437	-0,237	0,142
	(-0,00218)	(0,0524)	(-0,00235)	(0,0533)	(0,0779)	(0,0201)
Statistic χ_1^2	30,417			60,167		

For predictors, the figures given in parentheses are the estimated standard deviations of the coefficients computed from matrices defined by expression (20). They are the square roots of the diagonal elements of these estimated covariance matrices.
For the mean vector, the figures given in parentheses are the estimated standard deviations of the coefficients which are indeed the square roots of the diagonal elements of the estimated covariance matrix (equation (17)) normalized by the number of cross-sectional units (10). It is noted that the value obtained for the intercept is negative ! It is a statistical risk recognized by the econometricians of panel data analysis.

The results presented in table 6 show that the mean beta for the banking sector is very low (around 0,4 for the two models) which means that Tunisian banks are less exposed to market risk than the average companies in the TSE. Although the average beta are the same in the two specifications, the individual bank coefficients (the individual predictors) differ sensibly from one model to the other. The two main reasons for this difference are the relative instability of the coefficient (instead of using sectors as individuals, we included firms) and the introduction of two new risk factors in the Fama and French model (TFPM). The coefficients associated to SMB are in the whole negative and relatively small (inferior to 0,8 in absolute value) indicating that bank industry is represented by big firms compared to other companies listed in the TSE. In other words, it means that banks are less exposed to risk than other smaller companies in the TSE. Also, the coefficients associated to HML are positive but small again (less than 0,22) which implies that Tunisian deposit banks are value stocks than under-performed in the period under study.

The cost of equity could be estimated either for each bank i or for the whole sector. To do this, we will use the estimated predictors $\hat{\delta}_i^p$ given by expression (9) for banks i, $i = 1, \cdots, n$ and the GLS estimator of the mean vector $\hat{\delta}$ given by expression (6) for the whole sector. According to CAPM approach, the used formulae are defined as follows :

$$(17) \qquad E(R_{i0}) = R_{f0} + \hat{\beta}_i^p \left(\overline{R_M - R_f}\right) \qquad i = 1, \cdots, n$$

$$(18) \qquad E(R_{s0}) = R_{f0} + \hat{\beta}\left(\overline{R_M - R_f}\right)$$

where R_{i0} and R_{s0} are, respectively, the cost of equity of bank i and that of the bank industry both computed at December 2001. On the other hand, R_{f0} is the money market rate (TMM) observed also at December 2001 that is $R_{f0} = 5{,}9375$. $\overline{R_M - R_f}$ is the annualised average market premium that is the historical premium over the period [1996-2001].

For TFPM approach, we obtain in a similar fashion the following formulae :

$$(19) \qquad E(R_{i0}) = R_{f0} + \hat{\beta}_i^p \left(\overline{R_M - R_f}\right) + \hat{s}_i^p \overline{SMB} + \hat{h}_i^p \overline{HML} \qquad i = 1, \cdots, n$$

$$(20) \qquad E(R_{s0}) = R_{f0} + \hat{\beta}\left(\overline{R_M - R_f}\right) + \hat{s}\overline{SMB} + \hat{h}\overline{HML}$$

We add now $\overline{SMB}$ and $\overline{HML}$ as the annualised average SMB and HML premiums, respectively, over the same period of study.

Table 7- Estimated and predicted costs of equity for the 10 deposit banks at the 31st December 2001

Banks	CAPM		TFPM			
	β_i	Cost of equity	β_i	s_i	h_i	Cost of equity
AB	0,339	8,344	0,325	-0,125	0,179	10,134
ATB	0,372	8,576	0,51	-0,79	0,0124	1,748
BH	0,358	8,478	0,704	-0,238	0,157	11,288
BIAT	0,37	8,561	0,644	0,0542	0,224	15,0223
BNA	0,331	8,282	0,408	-0,274	0,136	8,451
BS	0,248	7, 976	0,308	-0,413	0,0925	5,557
BT	0,495	9,442	0,271	-0,161	0,14	8,711
STB	0,315	8,174	0,21	-0,0818	0,156	9,358
UBCI	0,689	10,816	0,428	-0,187	0,154	9,386
UIB	0,436	9,0256	0,562	-0,159	0,174	11,386
Sector	0,359	8,74	0,437	-0,237	0,142	9,145

Table 7 reports the estimated costs of equity for the 10 deposit banks at the 31st December 2001. It shows that CAPM and TFPM give quite the same costs of equity in average, since we obtain 8,74 percent and 9,145 percent, respectively. It means that investors in the TSE require quite 3 percent average risk premium to invest in the bank industry stocks. As one might expect, there are large differences between CAPM and TFPM when banks are individually compared. For the CAPM specification, the individual values are more concentrated around the average value of the whole banking sector and range from 7,976 percent (BS) to 10,816 percent (UBCI), meaning a variation of 3 points of percentage. This band is very large for the TFPM (13 points of percentage) reflecting a big dispersion of banks in comparison with average value obtained for the whole banking sector. The differences between the CAPM and the TFPM costs of equity are largely determined by the SMB and HML slopes in the three-factor regressions. Part of the dispersion of the TFPM cost of equity is caused by estimation error in SMB and HML slopes. But the risk loadings are in fact a small part of the cost of equity estimation problem. Uncertainty about the market, SMB and HML premiums in CAPM and TFPM is more important (Fama and French [1997]). Thus, the choice of a CAPM or TFPM costs of equity will have a large impact on the valuation of investments.

Finally, considering CAPM as a nested model within the TFPM and applying the statistical test developed by expressions (14)-(16), we can conclude from an econometric point of view that the CAPM could be rejected in favour of the more general TFPM. In this sense, the estimated value for the statistic of the test (expression (15)) is 47,474 which is above the corresponding critical value of chi-square at the 5 percent level. This proves the importance of the presence of variables SMB and HML in the model. But as mentioned above, this statistical significance of TFPM against CAPM is confirmed despite the lack of theoretical foundations of this specification. Further, one could not neglect the preponderant effect of other factors like size and book-to-market equity in the valuation of financial assets.

5. Conclusions

This paper has explored the empirical feasibility of the two important theoretical models used for the valuation of financial assets and the direct implications when evaluating the cost of equity in the Tunisian banking sector. The period considered for this study is of interest since it coincides with the vast reforms undertaken by the Tunisian government in order to improve the performances of the whole financial system.

The empirical methodology developed in this study is based on the econometrics of panel data, especially the random-coefficient model of Swamy [1970] which invokes the variability of the coefficients taking into account a possible heterogeneity across cross-sectional units.

The obtained results argue that Tunisian banks are less exposed to market risk than the average companies in the TSE. So, investing in the banking securities seems to be a no risky activity since, as is it known, most of the banks operating in Tunisia are of a big size and weigh a lot on the national economy as a whole. Also, the empirical results must emphasize the importance of the calculus of cost of equity which constitutes a nice tool in order to improve the allocation of funds and the valorisation of assets.

Appendix: List of Tunisian Commercial Banks

AB	Amen Bank
ATB	Arab Tunisian Bank
BH	Banque de l'Habitat
BIAT	Banque Internationale Arabe de Tunisie
BNA	Banque Nationale Agricole
BS	Banque du Sud
BT	Banque de Tunisie
STB	Société Tunisienne de Banque
UBCI	Union Bancaire pour le Commerce et l'Industrie
UIB	Union Internationale des Banques

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CHAPTER SIX

Testing Stock Market Efficiency in Oman

Hatem Al-Shanfari[a]

1. Introduction

The Efficient Market Hypothesis (EMH) was developed by Eugene Fama in the 1960s. This hypothesis suggests that share prices are very efficient in incorporating any new information and quickly adjust to such new information to reflect their true values. It assumes that prices are perfect, adjustment to new information is done instantaneously and the prices at any given time reflect the true intrinsic value of listed share prices. Shiller (1981) defines current share prices in the efficient markets model as the expected present discounted value of future dividends payments, as in Equation (1):

$$P_t = E(D) / (1 + r) \qquad (1)$$

<u>Where</u>:

P_t : *is the current price of listed shares*

E(D) : is the expected dividend

r : is the discount rate

Fama (1970) assumes that there is no transaction cost when buying shares, public information is available to all market participants at no cost, and that market participants are uniformly interpreting the effect of any new information on current prices. The author acknowledges that even though such assumptions are not realistic in stock markets, they are sufficient for market efficiency but not necessary. In order to test the efficient market

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hypothesis, Fama (1970) divides the hypothesis into three forms: the weak form, the semi-strong form and the strong form market efficiencies. But the empirical tests of the pervious three categories of the efficient market hypothesis were redefined and renamed; tests of return predictability; event studies; and tests for private information (see Fama (1991)). The method of testing the event studies and the tests for the private information has not changed much from the earlier definition of the semi-strong and the strong forms of efficiency, but the method of testing for return predictability has changed. Therefore, we will be focusing in this paper on the method of testing for return predictability.

The rest of this paper is organized in the following sections: The next section provides a background on the development of the local stock market in Oman during the period from 1989 to 1999. The third section presents a review of studies for testing the concept of efficient market hypothesis in developed and emerging stock markets. Testing for unit roots and the concept of cointegration in testing for market efficiency are presented in the fourth section. The data used in this paper is presented in the fifth section. In sixth section, the empirical results of return predictability tests are presented. The final section concludes.

2. Background

The local stock market, which is known as the Muscat Securities Market, started to operate in May 1989 when there were a total of 83 listed companies which had a market value of R.O. 415[b] million, listed in the secondary market. The primary market issuing activities increased from 11 new issues at a value of about R.O. 29 million in 1989 to 47 issues at a market value of about R.O. 440 million in 1998. It then decreased to 20 issues at a market value of R.O. 189 million in 1999. Figure 1 shows the primary market activities in the period from 1989 to 1999. The new issue activities include the establishment of new companies, increasing the capital of established companies, establishing new closed joint stock companies, the issuing of new government bonds and the establishment of new investment funds. The first issue of government bonds in the

[b] The exchange rate for one Omani Rial (R.O.) = US $ 2.6.

primary market was launched in 1991 and the first investment fund was launched in 1994.

The increasing number and value of the issuing activities in the primary market have an important indication for the local stock market development. Therefore, it is possible to state that the local stock market has witnessed a significant development in the period from 1992 to 1998, based on the activities in the primary market.

In the secondary market, the number of listed companies has increased from 83 companies with a market capitalization of R.O. 415 million in 1989 to 220 companies with a market capitalization of R.O. 2,262 million in 1999 (see Figure 2). By the end of 1999, there were 134 joint stock companies, six investment funds, 11 outstanding government bonds and 69 closed companies listed in the secondary market. The total market value (capitalization) of listed companies measures the stock market size and it peaked in 1997 at R.O. 3,364 million.

Demirguc-Kunt and Levine (1996) argue that the ratio of market capitalization to the GDP, which is another indicator of stock market development, has a significant positive correlation to mobilising financial resources and reducing the risk of holding financial assets. This ratio is also important in measuring the size of the stock market (see Figure 3).

The ratio of the market capitalization for the local stock market to the GDP has increased from 12 percent in 1989 to 55 percent in 1997 before it dropped to 38 percent in 1999.

There are two other indicators that measure the stock market liquidity. These are known as turnover ratios. The first ratio is measured by dividing the total traded value of listed shares by the GDP. The second ratio is measured by dividing the total traded value by the market capitalization. These two turnover ratios are shown in Figure 4. The two indicators of stock market liquidity show a high ratio during 1997 which coincided with the high activities in both the primary and the secondary markets. However, it is possible to point out that apart from the period from 1996 and 1999, the liquidity is rather low in the local stock market.

The ten largest listed companies, in terms of their market capitalization in the local stock market, account for about 51 percent of the total market value at the end of 1997. This implies a very high market concentration when compared to the usually very low concentration ratio of less than 20 percent in some well-developed stock markets, such as the USA. Having high market concentration is one indication of low liquidity in a stock market, as shown in Figure 4.

In addition to measuring the market size, liquidity and concentration, the regulatory framework, which includes foreign ownership, restriction on capital repatriation and applied accounting standards, is equally important to the development process of a stock market. In this regard, almost all the listed companies allow foreign ownership of up to 49 percent of the total capital and the law permits higher foreign ownership up to 70 percent. There are no taxes on dividends or capital gains and no restriction on capital repatriation by foreign investors. The listed companies are required to prepare their accounts in accordance with the International Accounting Standard (IAS) and the market publishes regular information on the financial results of listed companies.

The general price index of the local stock market measures the price changes in the 36 largest companies that are listed in the secondary market (in December 1999) and it is a value-weighted index[c]. The price level of the general price index and the traded value in the local stock market are shown in Figure 5 below.

The value of traded shares in the local stock market in the period from January 1993 to December 1995 was relatively low and did not exceed R.O 30 million in any month. During this period, the average annual return on the General Price index was

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[c] A value-weighted index is calculated by dividing the current total market value of all the shares included in the index by the base year total market value, multiplied by the prices index for the base year.

12.45 percent. The peak period in terms of the traded value and annual returns on the general price index was between January 1996 and October 1998. The annual returns on the general price index, in the period from 1993 to 1999, is shown in Table 1. The best yearly performance for the index was in 1997 when it recorded the highest stock market return in the world and the worst yearly performance for the index was in 1998 when it recorded a negative return of about 53 percent. The sharp drop in the index performance led to a steady downward trend in the value of traded shares.

Table 1: Annual Returns on the Market Price Index in Oman:1993-1999.

Year	Return (%)
1993	0.62
1994	28.54
1995	8.19
1996	26.07
1997	141.06
1998	-52.46
1999	9.54

Source: Muscat Securities Market.

The general price index is the aggregate price index of three main sectors into which the market is divided. These sectors are: the Banking and Investment sector, the Manufacturing sector and the Services sector.

In the first price indicator, which is the Banking and Investment sector price index, there were a total of 13 companies weighing 66 percent in the general price index at the end of December 1999. This sector price index includes the share prices of commercial banks, investment companies, finance companies and brokerage companies. The second price indicator is the Manufacturing sector price index which has 15 listed companies and weighed 22 percent in the general price index. The listed companies in this sector are mainly small-scale factories. The third price indicator is the Services sector price index which includes 8 listed companies and its weight in the general price index was 12 percent, at the end of December 1999. Having provided the background on the development of the stock in Oman, the next section presents the concept of market efficiency and reviews number of studies on tests of return predictability.

3. Studies of Tests for Return Predictability

Are stock markets efficient in factoring publicly available information at all times? It is possible to state that stock markets are neither at all times efficient or inefficient. Generally, stock markets, when not experiencing boom or bust, tend to be efficient in rapidly reflecting the available public information. The degree of efficiency is relatively higher in developed stock markets in comparison to the developing ones. Stock market inefficiency tends to be greatest during periods of speculative bubbles when share prices are highly volatile.

Tests of return predictability of the efficient market hypothesis are intended to verify whether expected returns can be forecasted using past returns and other fundamental variables, like dividend yield, interest rate and oil prices. According to the efficient market hypothesis, the expected returns of listed shares are not predictable because current prices reflect all publicly available information. As a result, market participants will not be able to use historical information or any other current information that is in the public domain to successfully predict their future behaviour and hence, achieve above average rate of returns. Furthermore, since the efficient market hypothesis states that returns are not predictable, this means that trading strategies based on using historical data to earn above average returns, such as using technical analysis methods, are not appropriate.

Empirical tests of return predictability used fundamental variables in forecasting future returns. Clare, Priestley and Thomas (1997) investigate the predictability of returns in Germany, Japan, the UK and the USA using monthly time series data in the period from January 1981 to December 1993. They regress the excess return on the four countries stock market indexes on the dividend yield, term structure of interest rate, interest rate variables plus a dummy variable. The authors have mixed results for the four countries. While the German and Japan stock indexes were not predictable, which points to the existence of an efficient market, the UK and the USA data show that it is possible to predict the excess return of their stock market indexes.

Furthermore, MacDonald and Power (1994) use the cointegration method to test the efficient market hypothesis in the UK stock market using weekly series in the period from January 1982 to June 1990. The authors test the possibility of cointegration between twenty-five listed companies and the FT all share index. They used both bivariate and multivariate methods of cointegration and conclude that in the case of bivariate cointegration tests, there was an indication of market efficiency. But when the multivariate method of cointegration was used, there was an indication of market inefficiency because the null hypothesis of no cointegration was rejected in favour of cointegration between the market index and the twenty-five listed companies in the London Stock Exchange.

For the developing stock markets, Harvey (1995) conducted a study on the predictability of returns in developing stock markets that included twenty countries[d]. He used monthly time series data from March 1986 to June 1992 and concluded that developing stock markets are more predictable than developed markets based on regression analysis.

From different empirical results which used daily, weekly and monthly time series to test the market efficiency in both developed and developing stock markets, it is possible to state that there is generally sufficient empirical evidence which contradicts the

[d] The twenty developing stock markets are; Argentina, Brazil, Chile, Colombia, Greece, India, Indonesia, Jordan, Korea, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Portugal, Taiwan, Thailand, Turkey, Venezuela and Zimbabwe.

notion of market efficiency. Even Fama (1991) acknowledges that return predictability tests have caused controversy about market efficiency.

4. Tests for Unit Roots and Cointegration Vectors

The principle of cointegration technique is based on having two or more series of data that have nonstationary levels but have stationary first differences. Such series would be known to have first order of integration; i.e. I (1). The order of integration can be verified by using augmented Dickey-Fuller unit root tests.

It is now common when determining the order of integration or testing the stationarity of a time-series data to use Dickey-Fuller unit root tests, which are based on Equations (2) and (3):

$$\Delta Z_t = \alpha_1 + \beta Z_{t-1} + u_t \qquad (2)$$

$$\Delta Z_t = \alpha_1 + \alpha_2 t + \beta Z_{t-1} + u_t \qquad (3)$$

The values of the t statistic for the β coefficient in the above Equations is known as τ (tau) statistic which have critical values that have been computed by Dickey and Fuller based on Monte Carlo simulations. This τ test is known as a Dickey-Fuller (DF) statistic. When testing the null hypothesis ($H_0 : \beta = 0$) for non-stationary series in the above two Equations, if the estimated absolute value of τ is greater than the DF absolute critical values at the 1%, 5% and 10% level of significance, then we reject the null hypothesis of non-stationarity in favour of stationarity. But if it is less than the critical values, we can not reject the null hypothesis of non-stationarity. When the error term (u_t) is serially correlated, in any of the above two Equations, then they are modified to remove the serial correlation in the error term by introducing an appropriate number of lagged variables for ΔZ_t, as in Equations (4) and (5) - which are known as the Augmented Dickey-Fuller (ADF) test and have the same critical values as the Dickey-Fuller statistic.

$$\Delta Z_t = \alpha_1 + \beta Z_{t-1} + \vartheta_i \sum^{k}_{i=1} \Delta Z_{t-i} + \delta_t \tag{4}$$

$$\Delta Z_t = \alpha_1 + \alpha_2 t + \beta Z_{t-1} + \vartheta_i \sum^{k}_{i=1} \Delta Z_{t-i} + \delta_t \tag{5}$$

If the level of a time series data is stationary, this means that the series is predictable because it tends to revert to its historic means. Whereas, non-stationary series implies unpredictability. For our purpose, to test cointegration between stock market price index (P_t), interest rate (I_t) and oil prices (O_t) variables, we use Johansen (1991) cointegration test; assuming a cointegrating relationship as specified by Equation (6):

$$P_t + a + b I_t + c O_t = u_t \tag{6}$$

When two or more series which have first order of integration are regressed and their residuals are stationary, then they form a statistical long-run equilibrium relationship. In this case, the null hypothesis of no-cointegration is rejected in favour of cointegration. This means that the dependent series is efficient and accurate in incorporating available public information about its underlying fundamental variable(s).

5. The Data

The test of return predictability using the cointegration method of analysis will be applied to Oman which is a net exporter of oil that contributes significantly to financing its public sector spending, which in turn is expected to stimulate its domestic economic activities. Due to lack of data on the dividend yield, we will consider instead interest rate and oil prices variables in order to test the predictability of returns. The source of these two variables is the Ministry of National Economy's Monthly Statistical Bulletin. Therefore, the return predictability test will be estimated based on the stock market price index of listed share prices, in local currency, as a function of the main interest rate and oil prices variables. A monthly time series data will be analysed in the period from January 1992 to December 1999.

The oil prices data is measured in US dollars per barrel and is based on Oman's crude one-month forward prices. The one-month forward prices of oil are normally available to the public, so, instead of using the contemporaneous oil prices with the share prices, we will be using the one-month forward oil prices. The data for all the three variables used in this paper has been transformed to the natural logarithm.

The estimated augmented Dickey-Fuller unit root tests for the level and the first difference of the oil prices variable are presented in Table 2. The level of oil prices variable offer to be a nonstationary time series because their estimated absolute values of τ are less than their critical values, which means that we cannot reject the null hypothesis for the series to have a unit root; i.e., is nonstationary. Since the ADF unit root test reveals that the level has unit roots, we test its first difference for stationarity.

Table 2: Unit Root Tests for the Oil Prices Variable

Variable	**ADF test ***	
	Without trend	**With Trend**
Level	-1.96	-1.82
First Difference	-4.23	-4.31

* *The critical value of the Augmented Dickey-Fuller statistic at 95% level of significance with intercept = -2.90 and with intercept and time trend is = -3.47*

From Table 2, it is evident from the ADF tests of the first difference for the oil prices variable that it is stationary in both cases of ADF unit root tests when constant is included and when constant plus trend is included. This means that this variable has first order of integration - i.e., it is I (1).

Table 3 shows the unit root tests for the level of the interest rate and the stock market price index variables. It is evident from the table below that the levels of the two variables are not stationary.

Table 3: Unit Root Tests for the level of the Interest Rate and Stock Market Price Index Variables

Variable	ADF test	
	Without trend*	**With Trend****
Interest Rate	-2.26	-2.01
Stock Market Price Index	-1.73	-2.24

** The critical value for the ADF statistic = -2.893*
*** The critical value for the ADF statistic = -3.459*

Therefore, it is important to test if the first differences of the levels have unit root, as presented in Table 4. Given that the critical calculated ADF - statistics are greater than their critical values, it is possible to state that the interest rate and the stock market price index variables have first order of integeration.

Table 4: Unit Root Tests for the first difference of the Interest Rate Variables

Variable	ADF test	
	Without trend*	**With Trend****
Interest Rate	-4.65	-4.77
Stock Market Price Index	-2.73	-2.80

** The critical value for the ADF statistic = -2.893*
*** The critical value for the ADF statistic = -3.459*

From Tables 2 and 4, it is not possible to reject the null-hypothesis of stationarity for the first differences of the three variables because the estimated ADF statistics are greater than their critical values. That means the oil prices, interest rate and stock market price index for Oman are integrated of the first order; i.e., they are all I (1).

6. Empirical Results

Having determined that the order of integration for the oil prices, interest rate and stock market price index series which are nonstationary of the same order, it is now appropriate to test if the three series are cointegrated, which means that they would form a long-run statistical equilibrium relationship. This can be achieved by regressing the level of the stock market price index (P_t) of Oman on the level of the interest rate (I_t) and oil prices (O_t) variables, as in Equation (7):

$$P_t = a + b I_t + c O_t + u_t \qquad (7)$$

Testing for cointegration among nonstationary variables that have the same first order of integration is also known in the literature as the tests of predictability. If the regression analysis reveals that the nonstationary variables are cointegrated, this means that dependent variables can be predicted on the basis of the independent variables. Table 5 presents the results from the linear regression analysis for Oman.

Table 5: Regression Analysis of Return Predictability Tests for Oman: January 1992- December 1999.

Model	R-square	F – statistic *
$P_t = 3.88 + 1.40\ I_t - 0.31\ O_t$ (6.57) (9.21) (-1.63)	0.48	43.58

The figures in parenthesis are the t-statistics.

* The critical value at the 5 percent level for F (2, 93) = 3.15

The result (from the above table) shows that forty eight percent of the variation in the stock market price index is explained by the variation in the interest rate and the oil prices variables. While the coefficient of interest rate variable is highly significant, the coefficient for the oil prices variable is only significant at the 10 percent level. Furthermore, the overall regression result is highly significant as indicated by the F-statistic, see Table 5. Is the regression result for Oman sufficient to decide that the three nonstationary variables are cointegrated to form a long-term statistical relationship? The answer is no. We need to first determine if the residual term of the above regression analyse is stationary in order to confirm if the variables are cointegrated. The ADF unit root test provides an insight to whether the residual term of the above regression for Oman is stationary or not. If the residual term (u_t), in Equation (7) is stationary, then the null-hypothesis of no-cointegration can be rejected based on the augmented Dickey-

Fuller unit root test of the residuals (see Table 6.) A rejection of the null-hypothesis means that the nonstationary variables in Equation (7) are cointegrated.

Table 6: The Unit Root Tests for the Residual Term from the Predictability tests: January1992-December 1999.

Country	ADF *
Oman	-1.21

** The critical value for the ADF statistic = -3.85*

The ADF unit root test of the residuals from the previous regressions, in Table 6, shows that the estimated value in the case of Oman is less than its critical value which means that the residual term is not stationary. That is, the null hypothesis of no cointegration cannot be rejected and the regression equation for Oman is spurious. In other words, the oil prices and interest rate variables do not have any predictive power for the stock market price index during this period of analysis. This result is consistent with the findings of Dahel and Laabas (1999) who tested the weak form of the EMH in Bahrain, Kuwait, Oman and Saudi Arabia, using weekly data in the period from September 1994 to April 1998. The authors tested market efficiency in the four GCC countries using unit root, variance ratio and autocorrelation of returns.

7. Conclusion

The empirical results from tests of return predictability for Oman show that oil prices and interest variables do not have significant power of prediction because they are not cointegrated, hence they are spurious regressions and do not form a long-run statistical equilibrium relationship with listed share prices in the stock mark. As a result, it is possible to state that the local stock market in Oman during the period from January 1992 to December 1999 was efficient.

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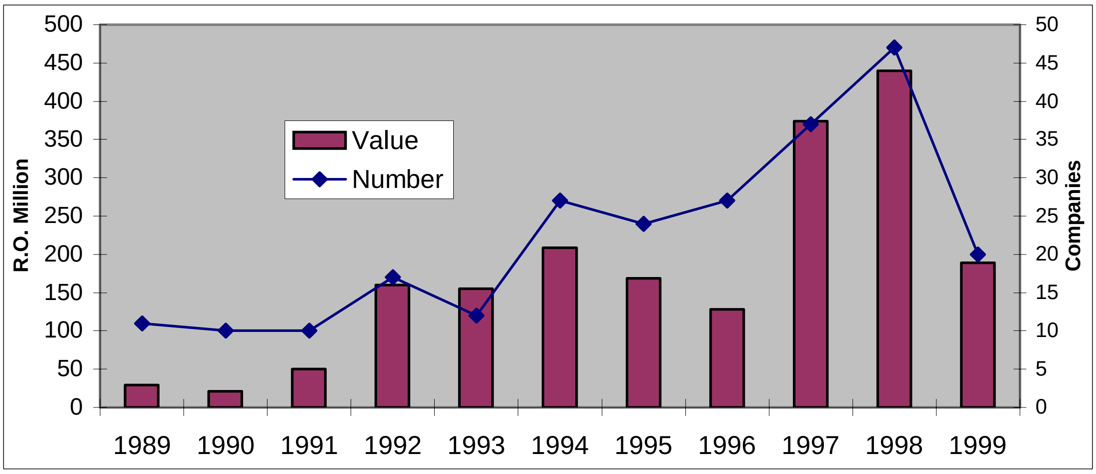
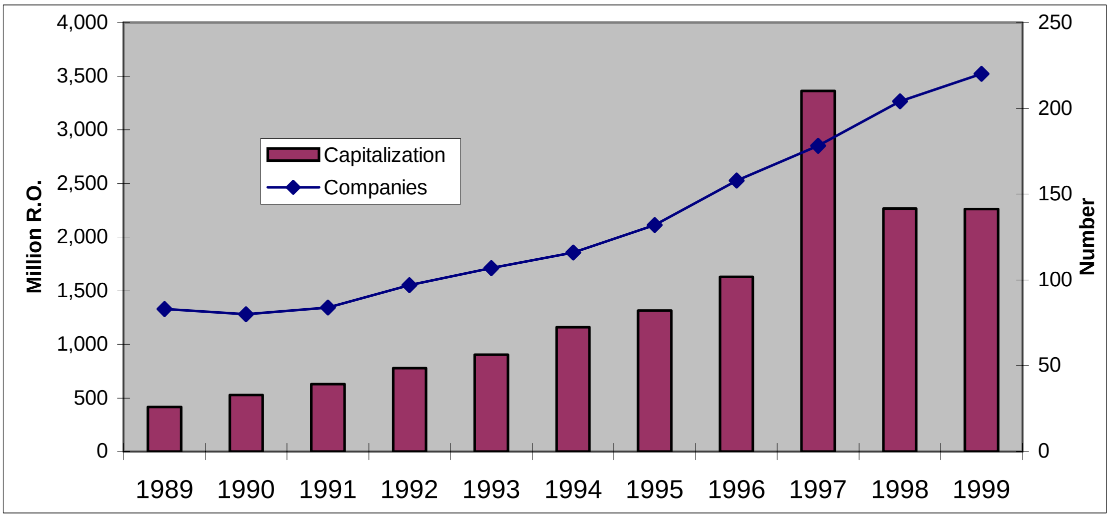
Figure 1: Primary Market Activities in Oman: 1989-1999.



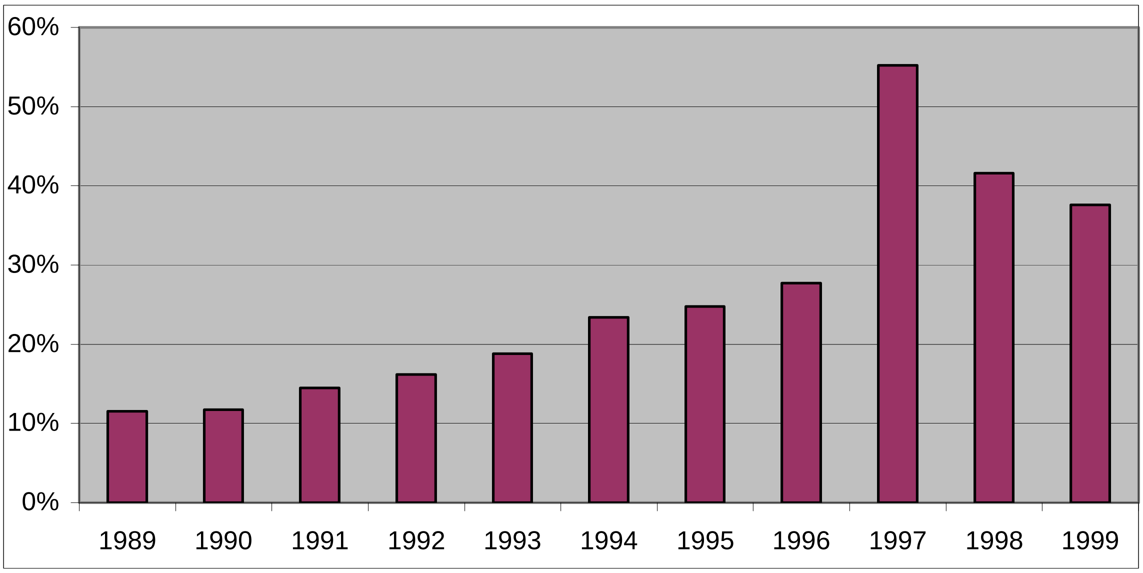
Source: Muscat Securities Market.

Figure 2: Secondary Market Activities in Oman: 1989-1999.



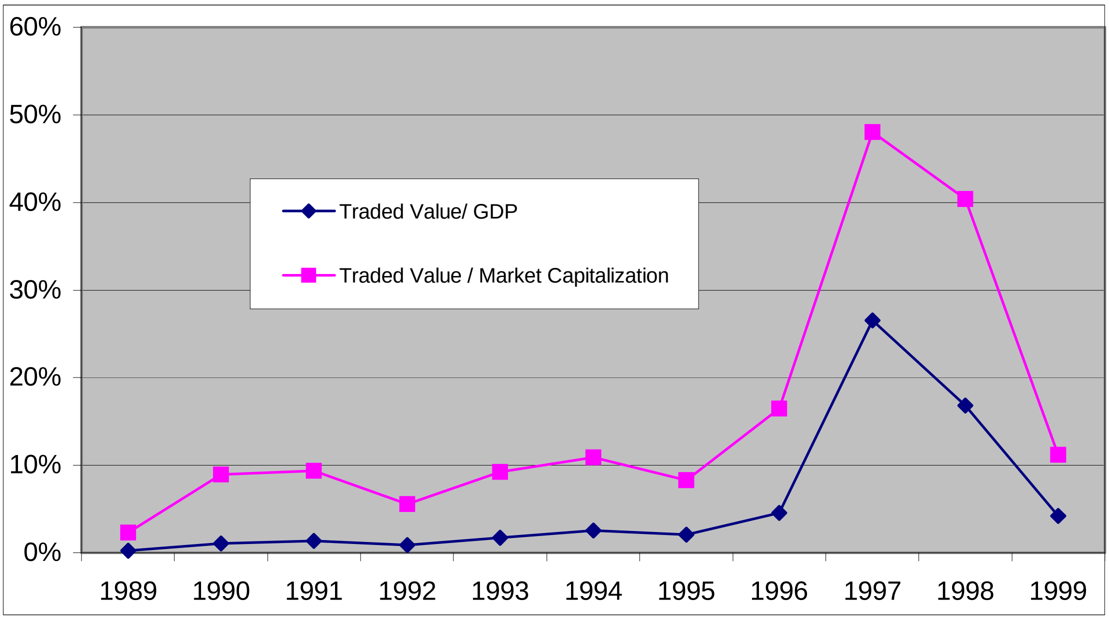
Source: Muscat Securities Market.

Figure 3: Market Capitalization Ratio to the GDP in Oman: 1989-1999.



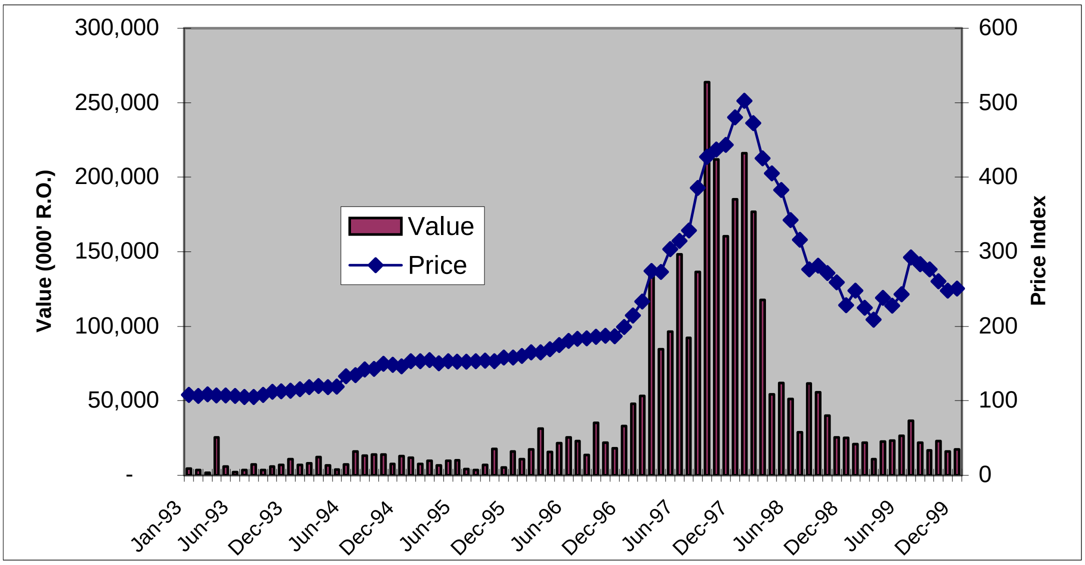
Source: Muscat Securities Market.

Figure 4: Market Liquidity in Oman: 1989-1999.



Source: Muscat Securities Market.

Figure 5: Market Price Index and Traded Value in Oman: January 1993- December 1999.



Source: Muscat Securities Market.

CHAPTER SEVEN

An Analysis of Day-of-the-Week Effects in the Egyptian Stock Market

Hassan Aly[a], **Seyed Mehdian**[b], and **Mark J. Perry**[c]

1. Introduction

A large number of studies have documented a day-of-the-week effect and other anomalies in asset returns in U.S. financial markets. One of these anomalies is the Monday seasonal effect, which occurs when asset returns are lower or negative on Mondays relative to other days of the week (see for example French (1980), Gibbons and Hess (1981), Lakonishok and Levi (1982), Smirlock and Starks (1986), Lakonishok and Smidt (1988), Wang, Li and Erickson (1997), Kamara (1997) and Mehdian and Perry (2001)). There are also studies that support the presence of stock return anomalies in international asset markets (see Gultekin and Gultekin (1983), Kim (1989), Jaffe, Westerfield and Ma (1989), Solnik and Basquest (1990), Dubois and Louvet (1996) and Mehdian and Perry (1999)).

The evidence of equity market anomalies contradicts the prediction of the efficient market hypothesis (EMH), at least in its weak form, because the predictable movements in asset prices provide investors with arbitrage opportunities. Therefore, the significant existence of stock market anomalies may indicate an inefficient flow of information in financial markets, which violates a necessary condition underlying the EMH.

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While seasonal effects in advanced equity markets have been investigated extensively, emerging markets have received much less attention. In emerging markets, it is possible that the dissemination of information is limited due to the possible manipulation of financial information by market participants and a lack of strict disclosure requirements imposed by the stock market regulatory agencies. We therefore focus on the stock market in Egypt to test for the presence of daily stock market anomalies in a typical emerging market. The Egyptian case is also interesting because it operates on a four-day per week trading cycle, in contrast to the more traditional five-day cycle of developed equity markets.

The objective of the present paper is to investigate equity return behavior and daily stock market anomalies in the Egyptian stock market using its major stock index, the Capital Market Authority Index (CMA), to shed some light on the degree of market efficiency in an emerging capital market. We examine daily stock market returns from April 26, 1998 to June 6, 2001, the period over which Egyptian equities were consistently traded on a four-day per week basis. The results of the paper indicate that Monday returns in the Egyptian stock market are positive and significant, but are not significantly different from returns of the rest of the week. We uncover no evidence to support the presence of any daily seasonal patterns in the Egyptian stock market, indicating that stock market returns there are consistent with the weak form of market efficiency.

The rest of the paper is organized as follows. Section II provides an overview of the Egyptian stock market. The data and methodology employed are described in Section III, and Section IV presents the empirical results. Finally, Section V contains a summary and conclusion.

2. An Overview of the Egyptian Stock Market

Egypt has a long and rich history of financial markets. By the late 1800s, Egypt had a sophisticated financial structure including a mature stock exchange in both Alexandria and Cairo (Wilson, 1995). The Egyptian stock market has experienced fundamental changes during four major periods from 1888-1958, 1959-1971, 1972-1992, and 1992-present. In the earliest phase, the market was active and growing at a remarkable rate. By the 1940s, both the Cairo and Alexandria exchanges were very active, and the combined Egyptian Stock Exchange ranked fifth in the world in terms of overall market capitalization. However, in the second period from 1959-1971, the Egyptian stock market was seriously marginalized by government intervention and restrictions that left it effectively inoperable (MohieEldin and Sourial, 2000). In the third period (1972-1992), serious attempts were made to revive the failing stock market to no avail, and the stock exchange continued to stagnate. Finally, in the 1990s (the fourth period), the Egyptian stock market went through a significant revival due to government liberalization policies. The restructuring of financial markets and privatization programs were key elements in stimulating economic development and capital investment in the 1990s.

Major changes in the organization of the Egyptian stock exchanges took place in January 1997 that significantly reformed the stock market. Today, the stock market once again encompasses the two exchanges at Cairo and Alexandria, both of which are governed by the same regulatory agency, and share a common trading, clearing and settlement system. Several important steps have been taken by the Egyptian government to modernize the stock exchanges. For example, a coherent organization structure with a clear division of authority and responsibilities has been created, a new state-of-the-art trading, clearing and settlement system conforming to international standards has been installed, new membership and trading rules have been legislated, and new arbitration and dispute resolution procedures were developed.

The Capital Market Authority (CMA) was established in 1990s, as the primary regulatory body for the Egyptian stock exchange and it is responsible for the issuance of licenses to all financial intermediaries including the Central Clearing and Depository Company. The CMA is also responsible for the introduction and revision of any laws and regulations pertaining to the efficiency and transparency of the market. The company Misr Central Clearing and Depository (MCCD) oversees the clearing and settlement of all securities transactions. MCCD is a private company whose primary shareholders are 16 banks, 15 brokerage houses and the stock market exchange itself. Together with the CMA, these two agencies work to guarantee that the market functions efficiently and transparently.

The market capitalization of the Egyptian stock exchange has grown by an average of 40% per year since the 1997 reforms, reaching $36.7 billion by May 2001. Egypt's recent economic reform, mainly the successful implementation of a large privatization program, is often cited as being largely responsible for the rapid growth in Egyptian stock market activities over the last five years. After the early momentum provided by modernization of the exchanges, privately owned companies are now the most active participants in primary and secondary stock offerings. Of the 1071 companies listed as of March 2001, over 90 are actively traded. More than 400 companies are classified as closed family corporations, which are listed to qualify for certain tax benefits (AMF, 2000).

The overall performance of the Egyptian stock market is measured by the Capital Market Authority (CMA) Index, which covers all listed companies and is calculated and released daily by the CMA. The Egyptian stock market has been included in the International Finance Corporation's composite stock index since January 1997, with a 1% weighting in the overall index. Furthermore, Morgan Stanley Capital International covers the Egyptian stock market on a standalone basis, although it has not yet included Egypt in its benchmark emerging markets index. See Table 1, Panel A, for more details.

3. Data and Methodology

The data set used in this paper consists of daily closing values for the major Egyptian stock market index, the CMA Index, from April 26, 1998 to June 6, 2001. Prior to April 1998, stock trading in Egypt took place from Monday to Thursday, and also occasionally on certain Fridays and Sundays, resulting in an irregular pattern of four-day, five-day and six-day trading weeks. The inception date of the sample period was selected here to coincide with the time period when a consistent four-day trading week (Monday through Thursday) was established (April 1998). The daily return for the CMA Index is computed as follows:

$$R_t = \log (I_t / I_{t-1}) \times 100 \qquad (1)$$

where R_t is the daily percentage return on the CMA Index on day t, I_t and I_{t-1} are closing values of the stock index on days t and t-1 respectively. Panel B of Table 1 displays summary statistics for the Egyptian stock returns calculated using equation (1). To first investigate the day of the week effect we estimate the following regression equation:

$$R_t = ß_1 D_1 + ß_2 D_2 + ß_3 D_3 + ß_4 D_4 + \varepsilon_t \qquad (2)$$

where R_t is the daily return as defined earlier, D_1 through D_4 are dummy variables such that if t is a Monday, then $D_1=1$ and $D_1 =0$ for all other days, if t is a Tuesday $D_2 = 1$ and $D_2 = 0$ for all other days, and so forth; ε_t is a random term and $ß_1$ -$ß_4$ are coefficients to be estimated using ordinary least squares (OLS). If the Egyptian stock market exhibits a traditional Monday effect, then a) the estimated coefficient $ß_1$ is expected to be negative and statistically significant and b) Monday returns should also be significantly less than returns during the rest of the week.

4. Empirical Results

Equation (2) is estimated for the CMA Index using Ordinary Least Squares and the estimated parameters and related statistics are presented in Table 2. A Chow test indicates that the estimated coefficients reported in Table 2 are structurally stable over the entire sample period. Note that the estimated coefficient for Monday returns is positive and statistically significant, indicating a positive mean return for Mondays in the Egyptian equity market. This is inconsistent with the results reported in the finance literature for a large number of countries, where significantly lower or negative Monday returns are reported (the traditional Monday effect). Note also that the other coefficients in Table 2 are all positive but none are statistically different from zero.

In order to further investigate the presence of a positive Monday seasonality in the Egyptian equity market, we next perform a difference-of-means test of the null hypothesis that the mean return on Monday is higher than the mean return during the rest of the week. As can be seen in Table 3, the difference-of-means test is not statistically significant, indicating that Monday returns are significantly positive, but not significantly different from the returns during the rest of the week. Therefore, the empirical results do not provide evidence to suggest that there is a significant Monday effect in the Egyptian stock market.

In addition, we note that the standard deviation of Monday returns is higher than the standard deviation during the rest of the week, and a difference-of-variance test shows that the difference is statistically significant. The significantly positive Monday returns for the CMA Index are consistent with the fact that Monday returns are significantly more risky than returns during the rest of the week. Taken together, the results in Tables 2 and 3 indicate that a) the Monday effect, to the limited extent that it exists in the Egyptian stock market, should not be considered a stock market anomaly and b) stock market returns are consistent with the weak form of the EMH.

Following the intra-month approach of Wang, Li and Erickson (1997), we further examine the nature of significantly positive Monday returns in the Egyptian equity market. Specifically, we investigate whether the positive Monday returns are caused by returns in the fourth and fifth weeks of the month, as Wang, Li and Erickson find in the U.S. stock market. In order to achieve this, Monday returns are first sorted by the five weeks of the month. We then divide the returns into Monday returns during the first three weeks of the month and Monday returns during the last two weeks of the month, and perform a difference-of-means test of the null hypothesis that Monday returns are equal in the two separate intra-month periods. The results of this investigation are presented in Table 4. As can be seen, the mean return during the first three weeks is higher than the return during the last two weeks, but this difference is not statistically significant (t-statistic = 1.17). These results suggest that the significantly positive Monday return for the CMA Index is not caused by the returns during the last two weeks of the month, as Wang et al. find for the U.S. market, providing further evidence of at least a weak-form efficient stock market in Egypt.

5. Summary and Conclusions

In this paper we examine daily returns for the CMA Index from 1998-2001 to test for the presence of a Monday effect in the Egyptian equity market. The Egyptian stock market provides a unique opportunity to test for seasonal anomalies in an emerging and recently modernized stock exchange where trading takes place on a four-day week basis (Monday through Thursday) as opposed to the more traditional five-day week. The empirical results indicate that while Monday stock returns are significantly positive, they are not significantly different from returns during the rest of the week. Furthermore, Monday returns are significantly more volatile than returns from Tuesday to Thursday. Hence, the significantly positive returns on Monday are associated with returns that are more risky.

In addition, an intra-month return analysis provides evidence to indicate that the significantly positive Monday returns are not caused by higher returns during the last two weeks of the month, as Wang, Li and Erickson have found for the U.S. stock market. The overall implication of this study of daily stock returns suggests that the emerging Egyptian market is at least weakly efficient. Therefore, no arbitrage opportunity can be exploited using trading rules based on daily or weekly return patterns to generate abnormal stock returns.

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Table 1. Summary Statistics for The Egyptian Stock Market

Panel A. Historical Data

	1994	1995	1996	1997	1998	1999	2000
Market Capitalization ($ Billion)	4.3	8.1	14.2	20.9	23.8	32.6	30.8
Market Capitalization (% of GDP)	8%	13%	21%	27%	28%	36%	31%
Number of listed shares	700	746	649	654	874	1,033	1,076
Annual Trading Value ($ Million)	741.2	1,115.8	3,179	7,020.2	6,772.2	11,329.3	10,674.1
Annual Volume of Listed Trading (Millions of shares)	29.3	43.7	170.5	286.7	440.3	841.1	952.7
Egyptian Stock Exchange Index	238.4	213.2	296.7	359.9	382.8	624.5	626.16

(Source; Cairo & Alex Stock Exchange Statistical Bulletin, CMA, Reuters), and available at http://www.sigma-cap.com/wwwhome2/ese.htm.

Panel B. Summary Statistics for Daily Returns for the CMA

Mean Return	.07425
Median	.03382
Maximum	3.2405
Minimum	-2.6099
Standard Deviation	0.7620
Skewness	0.4482
Kurtosis	4.6117
Observations	620
Sample Period	April 26, 1998 to June 6, 2001

Table 2. OLS Results for Day-of-the-Week Effects

Variable	Coefficient	Std. Error	t-Statistic	Probability
Monday	.1394	0.0626	2.2244	0.026
Tuesday	.0106	0.0612	0.1739	0.861
Wednesday	.0913	0.0608	1.5011	0.133
Thursday	.0599	0.0608	0.9851	0.325

Chow Test for Structural Stability
Breakpoint: October 26, 1999
F-test: .387
Probability: .817

Table 3. Monday Returns versus the Rest of the Week

	Returns on Monday	Returns during Rest of Week	Difference of Means Test	Difference of Variance Test
Mean	.1394	.0542	0.92	2.72***
Standard Dev.	1.0606	.6426		

Table 4. Monday Returns by Week of the Month

	First 3 Weeks	Last 2 Weeks	Difference of Test Means
Mean	.2327	.0266	t-statistic = 1.17
Standard Dev.	1.0472	1.0735	

CHAPTER EIGHT

Forecasting Value at Risk in Emerging Arab Stock Markets

C. Guermat[a], K. Hadri[b] and C. C. Kucukozmen[c]

1. Introduction

The importance of risk measurement and prediction has increased dramatically during the past few years. Value at Risk (VaR) has become a popular risk measure and has been estimated by a number of methods, including variance-covariance, historical simulation and Monte Carlo simulation methods (The Basle Committee, 1996; Beder, 1995; Hendricks, 1996; Mahoney, 1996; and Alexander and Leigh, 1997). These methods, however, are based on the whole distribution and may therefore fail under extreme market conditions. Extreme value (EV) theory concentrates on the tail of the distribution rather than the entire distribution. It has, therefore, the potential to perform better than other approaches in terms of predicting unexpected extreme changes. Dacorogna et al. (1995), Longin (1996, 1999), and Danielsson and de Vries (1997a) applied the EV distributions to extreme asset returns. Danielsson and de Vries (1997b) showed that the accuracy of the extreme event VaR approach outperforms other approaches, such as the historical simulation and variance-covariance approaches, at the extreme tails.

However, none of these studies has accounted for time-varying volatility. Empirical evidence shows that financial asset returns are conditionally heteroscedastic (see, Bollerslev et al., 1992; Bera and Higgins, 1993; and Bollerslev et al., 1994). Thus, the standard EV approach may understate or overstate the calculated risk measures. In the present paper, a volatility updated EV model is used to produce one step ahead forecasts

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for VaR statistics. Six years of daily data for Egypt, Jordan, Morocco and the US stock market returns are used.

The VaR approach is primarily concerned with the maximum loss to be experienced under a specific probability level. A VaR estimate tells how much a certain portfolio can lose within a given period of time for a given probability. A VaR thus corresponds to the left tail critical value of the portfolio profit and loss distribution. As with volatility, risk increases with increasing (absolute value) VaR measures. However, since the true VaR is unobservable, assessing VaR forecast performance requires measures that are different from used in the usual forecast comparisons. In this paper we use several accuracy measures and suggest a new measure based on a weighted cost function.

Emerging markets have drawn considerable interest. Errunza (1977, 1983) and Errunza and Rosenberg (1982) are among the earlier studies on emerging markets. Many have pointed out the potential benefits of investing in emerging markets. Bailey and Stulz (1990) and Bailey et al. (1990), for example, have shown that the potential benefits through diversification from the Pacific Basin stock markets are substantial. An effective diversification through investing in emerging markets may also result in reducing risk significantly (see Divecha et al. (1992), Wilcox (1992), Speidell and Sappenfield (1992), Mullin (1993), Errunza (1994)).

In a study of twenty new equity markets in emerging economies, Harvey (1995) found that the inclusion of emerging assets in a mean-variance efficient portfolio significantly reduces portfolio risk and increase expected returns. He also concluded that the amount of predictability found in the emerging markets is greater than that found in developed markets. Erb et al. (1996) discussed the characteristics of expected returns and volatility in 135 countries including Egypt, Jordan and Morocco. Bekaert and Harvey (1997) investigate the emerging market time-varying volatility and explored the forces that determine the difference of volatility in various emerging markets. Bekaert et al. (1998) detailed the distributional characteristics of emerging markets and explore how these characteristics change over time. However, Masters (1998) investigated the emerging market indexes and found them inherently inefficient and concluded that building a portfolio around a particular index may be less desirable in emerging markets than in other asset classes. Aggarval et al. (1999) examined the events which cause major shifts in emerging markets' volatility. They found that, unlike developed markets, large changes in volatility seem to be related to country-specific events. In all these papers, the analysis of risk was based on volatility models. In this paper, however, a different approach is proposed, which considers Value at Risk in three emerging Arab stock markets and the US stock market.

Because of the different economic and political circumstances, emerging markets might be considered to be more risky. Aggarval et al. (1999), for example, link shifts in risk (volatility) to country specific events. Arab countries suffer from political instability. The Middle East has always been highly volatile in this respect. Conflicts between Arab countries and Israel has led to three wars. Other conflicts involving Iran and Iraq still pose serious threats to the region's stability. In addition, the three Arab countries considered in this paper suffer from internal or local political instabilities. Egypt and Jordan have been threatened by the rise of fundamentalist terrorism, while Morocco has been in conflict with its neighbour, Algeria, since 1975. To the best of our knowledge, Value at Risk in the Arab countries has not yet been investigated. Risk in Arab stock markets has not drawn much interest in the literature. Among the few studies on volatility is the paper by Mecagni and Sourial (1999) who estimated stock market volatility in Egypt. El-Erian and Kumar (1995) found that emerging Arab countries are still struggling to internationalise their stock markets. They also confirmed that Middle Eastern stock markets suffer from three main problems, namely a negative perception of country risk, political instability, and institutional and legal rigidities. We intend to see whether such market instabilities are reflected in the Value at Risk measures with the US stock market as a benchmark.

The paper is organised as follows. The EV theory and the non-parametric Hill estimator are briefly reviewed in section 2. Section 3 discusses measures for evaluating VaR forecast accuracy. The data and preliminary statistics of the four stock markets are given in section 4. Section 5 discusses the empirical results, and section 6 concludes the paper.

2. Extreme Value Theory and the Hill Estimator

EV theory deals with the tail of distributions and the asymptotic behaviour of extreme order statistics of a random sample, such as the maximum or minimum order statistics. For a review of EV theory see Leadbetter et al. (1983), Embrechts et al. (1997) and Adler et al. (1998). A brief review of some of the most important EV results are given below.

Let X_1, X_2,...,X_N be a sequence of iid non-degenerate random variables with common distribution function F, such that $X_1 > X_2 > \ldots X_M > \ldots > X_N$. The fundamental theorem in EV theory is the Fischer-Tippett theorem (see Resnick, 1992, for a proof of the theorem). It states that there are three possible types of limiting distribution for normalised maxima or minima.

1. Gumbel distribution (Type I): $H_1 = \exp(-e^{-x}),\ \ x \in \Re$

The Normal, Gamma, Exponential, Logistic and Lognormal distributions belong to Type I extreme value distributions and are all thin-tailed distributions.

2. Fréchet distribution (Type II): $H_2 = \exp(-x^{-\alpha}),\ \ x > 0,\ \alpha > 0$

This type includes heavy tailed distributions such as Student-t, Pareto, Loggamma, Burr and Cauchy. Since financial returns exhibit fat tails the Type II family of extreme value distributions is commonly employed in financial applications.

3. Weibull distribution (Type III): $H_3 = \exp(-(-x)^{-\alpha}),\ x < 0,\ \alpha > 0$

Type III distributions have a finite upper limit on the range of the variables. The uniform and beta distributions belong to this family.

Danielsson and de Vries (1997a) suggested that for a heavy-tailed distribution $F(x)$, under mild regulatory conditions, a parametric form for the tail shape can be obtained by taking a second-order Taylor expansion of $F(x)$ as $x \to \infty$ as

$$F(x) \approx 1 - ax^{-\alpha}[1 + bx^{-\beta}], \ \alpha, \beta > 0 \tag{1}$$

where α is the tail index parameter, a determines the scale, and, b and β are second-order equivalents to a and α. For decreasing order statistics $X_1 > X_2 > \ldots X_M > \ldots > X_N$, given the threshold level M and an estimated α, they discuss the following estimator for the tail probabilities:

$$\hat{F}(x) = p = \frac{M}{T}\left(\frac{X_M}{x}\right)^{\hat{\alpha}} \tag{2}$$

for $x>M$. Here, M is the ordered rank of the start of the tail and T denotes the number of total observations. Hence, the extreme quantile estimator can be simply obtained by taking the inverse of $\hat{F}(x)$ as

$$\hat{x}_p = X_M\left(\frac{M}{pT}\right)^{\frac{1}{\hat{\alpha}}} \tag{3}$$

This result equally applies to the minima (i.e. the lower tails). For $p<M/T$, equation (3) gives the desired probability-quantile estimate (VaR estimate) pairs.

This estimator is conditional on the tail index parameter α, which can be estimated using the nonparametric Hill (1975) estimator. Other estimators can be found in Longin (1996), Embrechts et al. (1997) and Diebold et al. (1998). The maximum-likelihood estimator of α using T observations is given as

$$\frac{1}{\hat{\alpha}_{T,M}} = \hat{\gamma}_{T,M} = \frac{1}{M-1}\sum_{i=1}^{M-1}\log\frac{X_i}{X_M} \tag{4}$$

where M is the random threshold. Both parameters (α and M) determine the curvature of the tail. The estimator $\hat{\gamma}$ is consistent (Mason, 1982) and asymptotically normal with mean 0 and variance γ^2 (Goldie and Smith, 1987). However, $\hat{\gamma}$ depends also on the starting point in the tail, M. Increasing M reduces the variance but increases the bias.

Hall's (1990) subsample bootstrapping procedure is used here to estimate the optimal M. The procedure is summarised as follows:

1. Draw resamples of T_1 observations with replacement ($T_1<T$) and order the data.

2. Estimate the subsample optimal M_1^* by minimizing the subsample MSE

$$\min_{M_1} E[\{\gamma^*_{T_1,M_1} - \hat{\gamma}_T\}^2] \tag{5}$$

where $\hat{\gamma}$ is an initial full sample estimate with an arbitrary M_0.

3. Calculate the full sample M^* by setting $\beta=\alpha$ from

$$M^* = M_1^* \left[\frac{T}{T_1}\right]^{\frac{2\beta}{2\beta+\alpha}}. \tag{6}$$

4. Calculate the tail index parameter $1/\hat{\alpha}_{T,M}$ using the optimal threshold M^* for the full sample in equation (4), and use this result in equation (3) to calculate the quantile estimate at the desired probability levels.

The remaining problem is β. However, previous studies suggest two possibilities. The first is to set $\beta=\alpha$ (Hall, 1990) as many of the known distributions satisfy this condition. The second is to set $\beta=2$ (Danielsson and de Vries, 1997a) which satisfies the Student-t distribution with α being the degrees of freedom parameter. Dacorogna et al. (1995) found that results were not sensitive to the choice of β.

The standard EV approach assumes iid data. However, high-frequency financial asset returns are likely to be conditionally heteroscedastic. Thus, following (Hull and White, 1998), a simple procedure is used to incorporate volatility updating scheme into tail index estimation. A conditional volatility (GARCH) model is fitted to capture the volatility dynamics of historical profit-loss series. The data is then scaled using the estimated conditional volatility model. Finally, the tail index of the scaled data is estimated.

3. Evaluating VaR Forecast Accuracy

By their nature, VaR forecasts differ in many respects from other type of forecasts. The most obvious difference is that the ‘true’ VaR cannot be observed since we do not know the true potential profit and loss distribution. This is similar to the case of volatility forecasts, but for the latter a proxy, such as the squared actual returns or implied volatility, can be used (see Christodoulakis and Satchell, 1998, for a discussion). In VaR forecast, the only proxy available is the actual observations. Unfortunately, these are extremely noisy since the vast majority lie away from the left-hand tail. One alternative is to assume a distribution, estimate the quantiles and then use them as a benchmark. However, that would amount to comparing two different VaR approaches. The notion of forecast error is also different in VaR. By definition, VaR forecast should ‘underpredict’, for example, 95% of the times (at the 5% level). While the main concern in general forecasting is ‘how close the forecasts are to the actual data’, in VaR one major concern is ‘how many times did we overpredict’. Thus, most of the usual measures of forecast accuracy, such as the MSE and the MAPE, are not possible in the case of VaR forecasts. There are, however, alternative measures with which to compare VaR forecasts. A number of criteria have been discussed by Kupiec (1995), Lopez (1998), and Hendricks (1996). However, before discussing some of these criteria, a new criterion is presented first.

There are three important measures associated with VaR forecasts:

i. The Number or Proportion of Failures (shortfalls).

The number of shortfalls (failures) is a simple binary loss function. For each test period a VaR forecast is produced and compared with the actual loss. If the actual loss is more than the VaR forecast (in absolute value), then that particular forecast is considered a failure. The number of expected shortfalls (failures) depends on the length of the test period and the probability level. For example, for a 1000 day period, 50, 10, 5 and 1 failures are expected for the 0.05, 0.01, 0.005, and 0.001 levels respectively. Ideally, the VaR forecasts should not fail too often that is, the number of actual failures should not be significantly different from the expected number of failures. If the actual number of failures exceeds the expected number of failures then the model is inadequate.

ii. The Size of Failure (Failure Cost).

A model might produce the expected number of failures, say 1 in 1000 days at the 0.1% level. However, a single shortfall (underprediction) might be disastrous. The size of the shortfall is thus crucial to the investor, who is concerned about an extremely negative return that could wipe out so much capital that the risk of insolvency becomes very high. Failure Cost (FC) is the difference between the actual loss and the VaR when a failure occurs (i.e. when VaR is smaller than the loss in absolute value). Typically, the size of FC should be minimal, but the implications of FC is subjective and/or regulatory. However, as far as risk is concerned, higher FC means higher risk, all other things being equal.

iii. The Size of Coverage (Coverage Cost).

Ideally, at the 1% level, the VaR should cover 99% of actual profits/losses. This means that the VaR curve should be below the profit/loss curve in 99% of the cases. But this can only be done at a cost, since the investor or institution has to cover for potential losses by retaining a certain proportion of the capital, thus losing the opportunity to invest. This is what we call a coverage cost (CC), which is defined as the difference between the actual loss/profit and the predicted VaR when a success occurs (i.e. when the VaR is smaller than the profit/loss). As risk increases, the capital that needs to be held for protection against extreme losses also increases.

Thus, forecast accuracy can also be compared using measures such as average or total CC and FC. However, because there is a trade-off between CC and FC, a comparison is possible only if one market has lower measures (total and/or average) in both CC and FC. It should be more interesting to use both types of cost to measure accuracy.

The suggestion is that accuracy should be a function that combines the proportion of failures, failure cost and coverage cost. We propose the following accuracy measure which is based on an asymmetric cost function of FC and CC. First we need to adjust for the proportion of failure that would make the various VaR forecasts have identical coverage proportion. We use the idea of Hendricks (1996) by multiplying each VaR series by a constant that would make the number of failures exactly equal to the expected one. This results in new VaR forecasts, say VaR*, in which all series have identical coverage size. FC* and CC* are then evaluated based on VaR*. The accuracy criterion is a weighted mean square defined as follows:

$$R_w = \sum_{PL<VaR^*} \frac{w}{M}\frac{FC_i^*}{VaR_i^*} + \sum_{PL \geq VaR^*} \frac{1-w}{T-M}\frac{CC_i^*}{VaR_i^*}$$

where M is the number of failures, T is the total number of forecasts, and *w* is a weight which determines the relative importance of cost of failure. The VaR and costs are evaluated in absolute value so that R_w becomes equivalent to the mean absolute percentage error (MAPE) for *w*=0.5. Obviously, higher costs lead to higher value for the criterion and thus lower accuracy. The use of relative costs makes comparison across different portfolio sizes possible. However, for obvious reasons, FC is at least of equal importance to CC. The above function is symmetric for *w*=0.5 where investors give equal importance to failure cost and coverage cost. However, for most investors, *w* will be greater than 0.5. In the case where even a small shortfall size may lead to insolvency, for example, *w* should be set to 1 or very close to 1. The weighted costs are squared to penalise larger costs. Finally, it can easily be verified that $R_w \geq 0$.

We also consider two tests for bias based on the proportion of failures. The bias criterion for VaR forecast is based on the proportion of failures. For example, at the 5% level, the proportion of failures is expected to be very close to 0.05. The Likelihood Ratio (LR) statistic (Kupiec, 1995) and the Z (normal test) statistic (Hull and White, 1998) are used to test for the difference between actual and expected proportion of failures.

The LR test statistic is given by

$$2\log[(1-v)^{n-f} v^f] - 2\log[(1-p)^{n-f} p^f]$$

were *f* is the number of failures, *n* is the total number of forecasts, *v* is the actual proportion of failures, and *p* is the probability level. The LR has a chi-square distribution with 1 degree of freedom.

The Z statistic is given by $(v-p)/\sqrt{v(1-v)/n}$, and has a standard normal distribution.

Hendricks (1996) suggests comparing forecasts using the 'Multiple Needed to Attain Desired Coverage' (MNADC). This is basically the number that we should multiply all VaRs in order to obtain the expected number of failures at a given probability level. If the MNADC <1 it means that the forecasts produce less failures than expected, while MNADC >1 means that the model produces more failures than expected and is thus less accurate.

4. Data and Preliminary Statistical Analysis

In this section, using 6 years of daily data for Egypt, Jordan, Morocco and the US stock market indices, we compare the forecasting performance of VaR in the four markets. Because of its high capability of parsimonious approximation of conditional heteroscedasticity, we employ the simple GARCH(1,1) process for volatility estimation.

We use daily stock market price indices nominated in national currency of Egypt (EFG), Morocco (SE CFG 25), Jordan (AMMAN SE) and the S&P-500 (COMPOSITE) for the US stock market. Data for each of the four series were obtained from Datastream, for the six year period 01/04/1993-01/04/1999 (Datastream code PI).

Continuously compounded returns were calculated as the first difference of the natural logarithm of each series, which yields a total of 1566 daily observations for each series. Table 1 gives some useful statistics for each of the four return series. In particular, the table reports the first four moments of each series, the percentiles, the ARCH test on the squared returns, and the Ljung Box test for serial correlation in returns. The standard *t*-test results for skewness and excess kurtosis suggest that the underlying distributions of returns are positively skewed and leptokurtic. In addition, the extreme returns (i.e. the minimum and the maximum returns) are much larger than the standard 1st, 5th, 95th and 99th percentiles. More importantly, the ARCH tests on the squared returns provide evidence on the presence of conditional heteroscedasticity in Egypt, Jordan and the USA. The Ljung-Box statistics suggest that returns are serially correlated.

The statistics suggest a higher volatility in Egypt and Jordan compared with Morocco, and low stock market average return in Jordan which is around four times lower than Egypt and Morocco. The three Arab stock markets exhibit significant leptokurtosis and positive skewness, while the US data displays negative skewness.

The ARCH and Ljung-Box test results suggest that VaR forecasts based on the standard EV approach is likely to fail to cope with changing return volatility and serial correlation. Thus, it can erroneously overestimate or underestimate the implied risk. On the other hand, updating for volatility has the potential to cope with all of the observed characteristics of the return distributions presented in Table 1.

Table 1. Summary statistics of daily returns

	Egypt	Jordan	Morocco	USA
Mean	$8.56\ X10^{-3}$	$1.81\ X10^{-3}$	$8.64\ X10^{-3}$	$6.74\ X10^{-3}$
S.Deviation	$9.54\ X10^{-2}$	$8.09\ X10^{-2}$	$4.33\ X10^{-2}$	$8.73\ X10^{-2}$
Skewness	1.1514*	0.7129*	2.5042*	-0.5792*
Kurtosis	15.6181*	28.8265*	24.9515*	8.3544*
Minimum	-0.0634	-0.0973	-0.0246	-0.0711
01-%ile	-0.0221	-0.0188	-0.0088	-0.0227
05-%ile	-0.0116	-0.0100	-0.0041	-0.0132
95-%ile	0.0158	0.0125	0.0075	0.0141
99-%ile	0.0306	0.0275	0.0171	0.0228
Maximum	0.0953	0.0869	0.0533	0.0499
ARCH(2)	17.8749*	189.0200*	0.0021	18.7849*
ARCH(4)	8.9477*	124.7835*	0.0038	9.3780*
ARCH(8)	4.4549*	69.0522*	0.0050	7.1896*
Ljung-Box (4)	115.16*	24.14*	185.79*	3.37
Ljung-Box (8)	159.97*	26.73*	226.81*	11.77

(*) denotes significance at 1% level. N=1566

5. Empirical Results

Assuming a one-day holding period and using a moving window of 500 days data, we calculate 1000 daily VaR forecasts from the volatility updated EV for the four series at the 95%, 99%, 99.5% and 99.9% confidence levels. We concentrate on the left tail of the distribution (i.e. long positions in the underlying assets). For each period, 100 subsamples each with 100 observations is drawn with replication from the last 500 days historically simulated profit/loss series. We follow the three-step procedure outlined in the fourth section. For each series, we estimate the maximum-likelihood function of the GARCH(1,1) model 1000 times using the BHHH algorithm (Berndt et al., 1974) as a result of the 1000 test periods. This recursive estimation also allows for variation in the parameters of the conditional variance equation.

A rough idea can be drawn from the level of VaR forecasts themselves, since a VaR value gives the largest potential loss for a specific confidence level. The average one-day ahead VaR forecasts are given in Table 2. The two specifications provide very similar forecasts. As expected, the VaR forecast increases with increasing confidence level. On a country basis, Morocco has the lowest VaR, followed by Jordan. The result for Egypt and the USA is mixed. At the 0.05 and 0.01 levels Egypt has lower values, but at the extreme tail (0.005 and 0.001) the USA has lower VaR.

Table 2. Average VaR forecasts (million $)

P level	0.05	0.01	0.005	0.001
Egypt				
(β=α)	-1.27962	-2.31569	-3.01838	-5.73676
(β=2)	-1.28212	-2.31339	-3.01467	-5.74542
Jordan				
(β=α)	-0.98976	-1.77364	-2.28908	-4.17844
(β=2)	-0.99225	-1.77174	-2.28357	-4.15733
Morocco				
(β=α)	-0.51923	-0.82194	-1.01385	-1.7066
(β=2)	-0.53482	-0.81696	-0.99067	-1.59682
USA				
(β=α)	-1.40233	-2.36946	-2.98165	-5.13161
(β=2)	-1.43403	-2.35815	-2.93504	-4.93269

Table 3 and 4 display the VaR forecast accuracy statistics produced by the first specification (β=α). The results for the other specification (β=2) were virtually identical and are omitted.

In terms of proportion of failures, the null hypothesis that the actual proportion of failures equals the probability level is rejected only in three cases (Egypt at 5%, Morocco at 1%, and USA at 1%). However, if we concentrate on the lower tail (0.005 and 0.001), all actual proportions are accepted as significantly equal to the hypothetical probability level in all markets. The MNADC is close to one in general, but the most accurate forecasts in terms of the MNADC is Jordan, while the worst seems to be the USA.

The costs are based on a portfolio of $100 million. As expected, total failure cost decreases, while total coverage cost increases with decreasing probability levels. In terms of average and total FC and CC, Morocco produces the lowest figures, followed closely by Jordan. USA stock market produces the highest costs.

Table 4 shows the suggested index (R_w) of forecast accuracy at various weight values. At w=0.5 we assume that investors give equal importance to underpredictions (coverage cost) and overpredictions (failure cost). However, as w increases, more weight is given to failure cost. When w=1, only failure cost is taken into account. A desirable result would be for R_w to decrease rapidly with increasing w because it is important for investors that failure cost is minimal. This pattern is seen in all three stock markets. The forecast performance based on this index depends on the confidence level. For example, at the 95% level, Morocco produces the least accurate forecasts while the other markets are very similar. However, at the 99.9% confidence level it becomes clear that the Arab stock markets are more accurately predicted than the US stock market at all weights. The values of R_w are smaller for the Arab markets, which means that the combination of weighted failure cost and coverage cost are smaller and thus forecasts are more accurate. Moreover, the decay in R_w is very fast in the Arab markets and slow in the US market. At w=1, the average failure cost represents 0.03%, 1.77% and 2.28% of the VaR for Egypt, Jordan and Morocco respectively. However, for the same weight, the average failure cost represents 50.73% of the VaR in the US. The index for the 95% and 99.9% levels is shown in Figure 1 and 2.

Table 3. VaR Forecast Summary Statistics.

P	M	F	LR	Z	Av. FC	Av. CC	Tot.. FC	Tot. CC	MNADC
Egypt									
0.050	71	0.071	8.260*	2.585*	0.447	1.357	31.804	1260.799	1.140
0.010	13	0.013	0.830	0.837	0.754	2.286	9.805	2256.851	1.083
0.005	5	0.005	0.000	0.000	1.122	2.965	5.613	2950.180	1.000
0.001	0	0.000	_	_	_	5.673	0.000	5673.833	0.959
Jordan									
0.050	47	0.047	0.193	-0.448	0.388	1.065	18.244	1015.298	0.960
0.010	10	0.010	0.000	0.000	0.559	1.796	5.593	1778.255	1.000
0.005	7	0.007	0.715	0.759	0.449	2.302	3.144	2286.230	1.168
0.001	1	0.001	0.000	0.000	0.047	4.161	0.047	4156.707	1.000
Morocco									
0.050	56	0.056	0.731	0.825	0.228	0.638	12.773	601.841	1.044
0.010	19	0.019	6.473*	2.085*	0.176	0.905	3.343	887.477	1.128
0.005	6	0.006	0.189	0.409	0.274	1.080	1.646	1073.811	1.029
0.001	3	0.003	2.596	1.156	0.063	1.762	0.189	1756.226	1.062
USA									
0.050	61	0.061	2.388	1.453	0.715	1.606	43.609	1508.117	1.096
0.010	20	0.020	7.827*	2.259*	0.725	2.474	14.494	2424.353	1.218
0.005	9	0.009	2.596	1.339	0.839	3.044	7.549	3016.647	1.104
0.001	2	0.002	0.774	0.708	1.589	5.132	3.177	5121.268	1.111

(*) Denotes significance at the 5% level.

Table 4. Index of Forecast Accuracy.

W	95%	99%	99.5%	99.9%
Egypt				
0.5	0.8056	0.7517	0.7767	0.4974
0.6	0.7562	0.7019	0.7329	0.3980
0.7	0.7069	0.6522	0.6891	0.2986
0.8	0.6575	0.6024	0.6452	0.1992
0.9	0.6082	0.5527	0.6014	0.0997
1	0.5588	0.5030	0.5576	0.0003
Jordan				
0.5	0.7965	0.7219	0.5786	0.5096
0.6	0.7389	0.6630	0.4930	0.4112
0.7	0.6812	0.6041	0.4073	0.3128
0.8	0.6236	0.5452	0.3216	0.2145
0.9	0.5660	0.4862	0.2360	0.1161
1	0.5083	0.4273	0.1503	0.0177
Morocco				
0.5	0.9381	0.6709	0.7097	0.5375
0.6	0.8792	0.5854	0.6345	0.4346
0.7	0.8203	0.4998	0.5594	0.3316
0.8	0.7614	0.4143	0.4842	0.2287
0.9	0.7025	0.3288	0.4091	0.1257
1	0.6436	0.2433	0.3339	0.0228
USA				
0.5	0.8521	0.6643	0.7125	0.7632
0.6	0.7929	0.5879	0.6477	0.7120
0.7	0.7336	0.5115	0.5830	0.6609
0.8	0.6744	0.4351	0.5182	0.6097
0.9	0.6151	0.3586	0.4534	0.5585
1	0.5558	0.2822	0.3887	0.5073

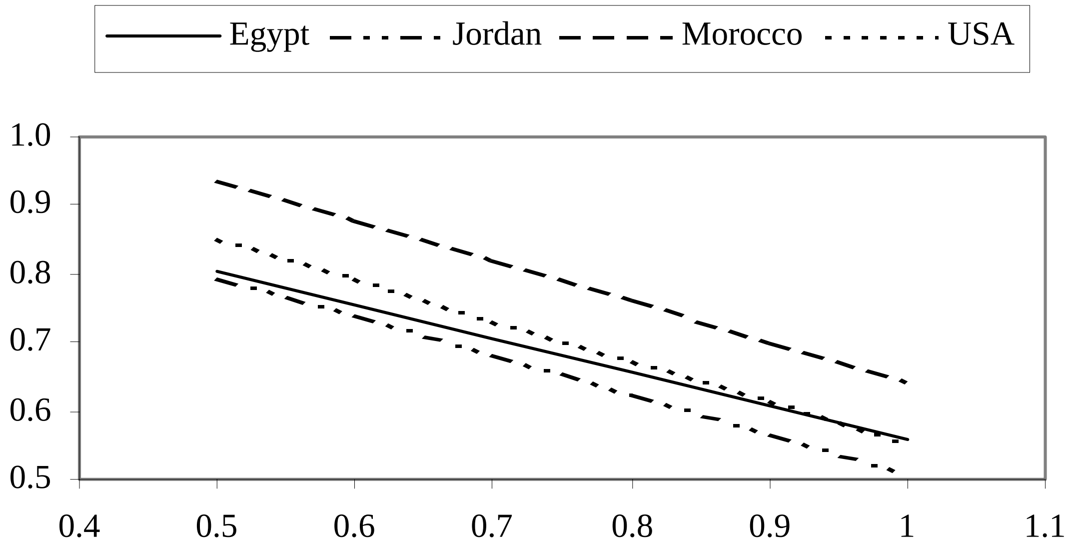
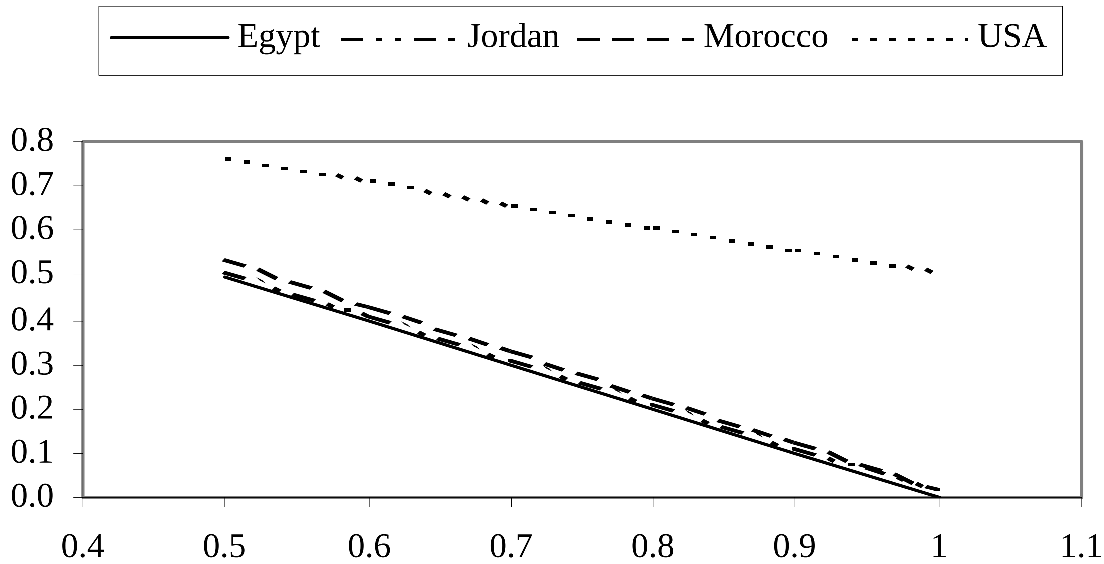


Figure 1. Forecast accuracy index (R_w) for the 95% level.

Figure 2. Forecast accuracy index (R_w) for the 99.9% level.



6. Conclusion

This paper considered comparing VaR forecast accuracy using measures which are adapted to the objectives of VaR. The comparison was based on the out of sample prediction of VaR using a volatility updated EV model. These measures were applied to three emerging Arab stock markets and one developed stock market. The EV models resulted in comparable proportions of failures, but the total and average costs were generally lower in the Arab stock markets. At the same time, the average and total coverage costs were also lower in the Arab stock markets. Our measure of forecast accuracy, however, shows that VaR forecast accuracy depends on two main factors. First, forecast accuracy may be different at different levels of confidence. In this study, for example, US forecasts were more accurate than Morocco forecasts at the 95% level, while the opposite was found at the 99.9% level. The second factor is the weight that should be given to both failure cost and coverage cost.

Overall, the various forecast accuracy measures employed in this paper indicate that forecasts produced for the three Arab stock markets are more accurate than those produced for the US stock market, especially at the extreme tail. As value at risk is primarily a measure of risk, the superiority of forecasts of Arab stock markets and more particularly, the lower failure and coverage costs associated with these forecasts, seem to suggest that there is relatively lower risk in Arab stock markets. However, strictly speaking, cross-country risk cannot be assessed unless the VaR for exchange rates between Arab currencies and the US $ is incorporated into the model. The possibility of combining the VaR for stock market returns and the VaR for exchange rate is left for future research.

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CHAPTER NINE

The Microstructure of the Jordanian Capital Market: Electronic Trading and Liquidity Cost

Ghassan Omet[a] and Fadi Mashharawe[b]

1. Introduction

The link between financial development and economic growth has long generated a lot of research interest. Following the early works of Gurley and Shaw (1955), Goldsmith (1969), McKinnon (1973), and Shaw (1973), many models emphasized the role of well-functioning financial intermediaries and markets in ameliorating information and transaction costs and thereby in fostering a more efficient allocation of scarce economic resources (Bencivenga and Smith, 1991; King and Levine, 1993a; Bencivenga et al., 1995). Moreover, while some theories provide various predictions about the relative importance of banks and stock markets in the performance of economies. (Stiglitz, 1985; Boyd and Prescott, 1986; Bhide, 1993), the importance of both banks and markets in economic growth has been analyzed (Levine, 1997; Boyd and Smith, 1998; Huybens and Smith, 1999; and Demirguc-Kunt and Levine, 2001)[1].

The burgeoning empirical works, which examined the importance of banks in economic growth, are provided by King and Levine (1993a,b). Based on a measure of bank development (total liquid liabilities of financial intermediaries divided by Gross Domestic Product) and other control variables, they show that this measure explains economic growth in a sample of about 80 countries. Moreover, using instrumental variable procedures and credit to the private sector as a proxy measure of bank development, Levine (1998, 1999) and Levine et al. (2000) confirm this finding.

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[1] For a non-technical survey of the literature that examines the relationship between financial structure and economic growth, see Dolar and Meh (2002).

Finally, Watchel and Rousseau (1995) and Rousseau (1998) use time-series data to confirm the positive impact of financial intermediary development on economic growth.

More recently, a number of empirical papers considered the impact of both bank and stock market development on economic growth. These include, among others, Atje and Jovanovic (1993), Jappelli and Pagano (1994), Harris (1997), Levine and Zervos (1998), Rousseau and Wachtel (2000), Levine (2001), Bekaert et al. (2001) and Beck and Levine (2002). This empirical literature supports the hypothesis that there is a relationship between stock markets and banks and economic growth.

Given the importance of stock markets in providing listed companies with long term finance, promoting the role of the private sector in stimulating growth (Khambata, 2000), enhancing the international risk process and improving the resource allocation process (Kim and Singal, 2000), prominent financial economists have developed a number of concepts that are known to be essential prerequisites for fulfilling their economic roles. These concepts include pricing efficiency and operational efficiency.

A stock market is said to be efficient (pricing) if current securities prices reflect all available information (Fama, 1970, 1991, 1998). This efficiency is an essential prerequisite in stock markets for fulfilling their primary role; the allocation of scarce capital resources. For example, stock prices (in an efficient market) provide investors with a good measure of firms' performance and their values. In other words, an efficient market can discipline managers and consequently improve the process of capital allocation.

A market that is operationally efficient allows investors to get their orders executed as quickly and as cheaply as possible. By immediacy it is meant that buyers and sellers expect to trade immediately rather than waiting for the arrival of sufficient orders on the other side of the trade. In this case, the price is expected to be closer to the price of the last known transaction.

Based on the above two definitions, we can see that they are interrelated. For example, a stock price in an efficient market provides investors with a good measure of any firm's performance and its value. In other words, an efficient market can discipline managers and consequently improve the allocational efficiency of capital. Moreover, an allocationally efficient market must be operationally efficient as well. Indeed if transaction costs are high, this tends to inhibit capital movements and hence discourage the efficient allocation of resources even if the market is pricing its securities in an efficient manner.

Given the importance of stock markets in general and operational efficiency in particular, the "microstructure" of securities markets has been attracting a great deal of attention. This work is basically concerned with "moment – to – moment aggregate exchange behaviour as an important aspect of such markets", (Garman, 1976, p.257). Specifically, this work examines various stock markets' trading mechanisms, actions of market participants and the behaviour of price changes. A number of papers review important elements of the market microstructure literature. These include, Cohen et al. (1986), Kiem and Madhavan (1998), Choughenour and Shastri (1999, Madhavan (2000) and Stoll (2002).

Based on the above, we can argue that one of the most important features that investors look for in organized stock markets is liquidity. Indeed, the ability to buy or sell significant quantities of a security anonymously and with relatively little price impacts is critical. Differences in trading costs and liquidity "are often cited as important factors in the international competition for order flow, and might shed light on the relative merits of different market designs. Cost considerations in emerging markets are especially relevant from a public policy perspective. For example, in emerging markets, large orders often result in substantial price movements raising concerns that foreign capital flows ("hot money") might destabilize domestic markets[2]. Large costs in emerging markets may also induce corporations to cross-list their stock in more liquid, developed markets, thereby hindering domestic market development. Finally, innovations in technology often are driven by cost consideration" (Domowitz, 2001, p.1).

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[2] Choe et al. (1999) provide an analysis of this issue for Korea.

Following the pioneering work of Demsetz (1968), a large number of theoretical and empirical papers examined the determinants of liquidity cost (bid-ask spread)[3]. Some of these studies include Branch and Freed (1977), McInish and Wood (1992) and Klock and McCormick (1999). Following Stoll (1978), the market maker's costs can be classified under three categories: order processing costs, inventory-holding costs and adverse selection (asymmetric information) costs. Based on this classification, many papers relate the spread to a vector of characteristics that are associated with the individual securities. These characteristics include risk of the security, trading volume, market value of the firm, information, competition and others. For example, Ho and Stoll (1980, 1981, 1983) show that uncertainty in the order flow limits the ability of dealers to maintain their optimal inventory position and consequently, as in Amihud and Mendelson (1980), increases in the variability of the order arrival process results in wider bid-ask spread. Stoll (1978) argues that stock price is a proxy for the minimum cost (spread). Chiang and Venkatesh (1988) argue that firm size is a significant determinant of the bid-ask spread. The well-known size of the firm anomaly is probably due to their illiquidity, which is reflected in larger spreads. Moreover, Demsetz (1986) argues that smaller firms might have a smaller number of insiders and hence retain more inside information and thus wider spreads[4]. In addition, a number of empirical studies examined the determinants of the spread in the bond markets. These studies include Schultz (1998), Hong and Warga (1998) and Chakravarty and Sarkar (1999).

Many stock markets around the world have reduced the minimum tick size. As argued by Harris (1991, 1994), Seppi (1997) and Biais et al. (2001), a tightening of a pricing grid results in a reduction in the bid-ask spread. To examine this issue, numerous papers have investigated the impact of tick size reductions on market quality including the bid-ask spread[5]. Some of these papers include Bacidore (1997), Ronen and Weaver (1998), Ahn et al. (1998), Bollen and Whaley (1998), Goldstein and Kavajecz (2000), Bourghelle and Declerck (2001), Jones and Lipson (2001) and many

[3] For a review of this literature, see Stoll (2002).
[4] Attig et al. (2002) investigate the impact of the ownership structure of Canadian corporations on the bid-ask spread.
[5] See Harris (1997) and Van Ness et al. (1999) for reviews of the literature.

others. On average, the results of these studies show that a reduction in the tick size leads to lower transacting costs.

As far as the Jordanian capital market (ASM) is concerned, the issue of its liquidity has not been investigated. However, the efficiency of the ASM has been investigated and found to be not efficient. For example, Omet et al. (2002) examined the efficiency of the Jordanian stock exchange and the relationship between returns and conditional volatility. Based on the estimated AR(1)-GARCH(1,1)-M model, the empirical results indicate significant departures from the efficient market hypothesis and returns tend to exhibit high persistent volatility clustering. Similarly, using a battery of econometrics tests on the daily closing price index during a pre-liberalization period (January 1993-May 1997) and a post-liberalization period (June 1997-December 2000), Maghyereh and Omet (2002a) find that in spite of the theory suggesting otherwise, market liberalization has not turned around the ASM to become weak-form efficient. Finally, Maghyereh and Omet (2002b) examined the efficiency of the Jordanian capital around the date of its automation (June 2000). Based on a multi-factor model with time varying coefficients and the GARCH-M model, the results show that the move to the electronic trading system has not had the desired impact on the pricing efficiency of the market.

It is well-known that Middle Eastern stock markets are much less integrated with international capital markets than Asian and Latin American markets. This observation might be due to good reasons like foreign ownership restrictions, availability of information, accounting standards, investor protection, economic risk, political risk, liquidity risk, high transaction cost and others. In addition to these factors, it can be argued that high trading costs can be important in the international competition for capital flows.

Relative to the above, the primary objective of this paper is to examine the Amman Securities Market (ASM) in terms of its operational efficiency. By examining this issue, it is hoped that results of this paper will not only introduce the Jordanian capital market to the international reader but also encourage some further work on the emerging markets of the Middle East. Specifically, the focus of this paper is on answering the following questions:

1. What is the cost of immediacy in the Jordanian stock exchange?
2. Are the factors that affect the cost of immediacy in developed stock markets and in the Jordanian market similar?

The empirical results indicate that the mean value of the spread (transacting cost) is equal to 1.002 percent. In other words, the results indicate that transacting cost in the Jordanian capital market is comparatively quite high. Moreover, as depicted by theory, the coefficients show that the spread increases as price volatility and stock price increase and decreases as trading volume decreases.

The rest of the paper is organized as follows. Section II provides some descriptive statistics about the ASM, describes the trading system, and presents the data. Section III reports and discusses the empirical results. Finally, section 1V summarizes and concludes the paper.

2. The Amman Securities Market: Basic Information, Trading System and Data

The ASM was formed on 1 January 1978. Since its formation, the market has experienced some growth in a number of aspects. Table 1 reports the number of listed companies and the ratios of market capitalization and size of new issues to GDP. When judged by the ratio of market capitalization to GDP, the increase from 37 percent in 1978 to about 76 percent in 2001 indicates the importance of the market in the national economy. Moreover, the relative size of new issues (stocks and bonds) to GDP is also an indication of the importance of the primary market.

The performance of ASM is less impressive if we consider the market value of traded shares. As Table 2 indicates, the market experienced sharp fluctuations (falls) in 1994-1996. Moreover, it must also be pointed out that 10 companies in each year accounted for a large proportion of the total trading volume. In other words, most listed shares are thinly traded on the secondary market. Indeed the fact that in 2000 and 2001 only 10 companies accounted for about 65% and 66% of the total market trading volume respectively and the market value of these companies' shares account for about

70% of the capitalization of all listed companies, we can state that the Jordanian stock exchange is highly concentrated in both market value of companies and trading volume.

Table 1: Listed Companies and Market Size

Year	No. of Listed Companies	Capitalization of the Market as a % of GDP	New Issues as a % of GDP
1978	66	37%	3%
1980	71	42%	5%
1984	103	46%	2%
1988	105	49%	1%
1992	103	65%	2%
1996	97	73%	4%
1998	99	79%	2%
1999	99	73%	1%
2000	101	59%	2%
2001	102	76%	1%

Source: Various ASM Annual Reports.

Table 2:Trading Activity on the Secondary Market

Year	Trading Volume as a % of Market Capitalization	Trading in Ten Most Active Shares as a % of Market Trading Volume
1978	2%	75%
1980	8%	66%
1984	6%	56%
1988	12%	50%
1992	39%	48%
1996	7%	53%
1998	11%	68%
1999	9%	61%
2000	10%	65%
2001	15%	66%

Source: Various ASM Annual Reports.

To put the size of the ASM in its Arab perspective, we report (Table 3) the size of all Arab stock exchanges in terms of total number of listed companies, market capitalization and weight of each market's capitalization in the market capitalization of all stock markets. The ASM ranks sixth in terms of market capitalization. However, when judged by the ratio of market capitalization to GDP, the mean proportion of 76 percent (2001) signifies the importance of the market in the Jordanian economy.

Table 3:Stock Markets in the Arab World (2001)

Stock Market	No. of Listed Companies	Capitalization ($ Million)	Weight of market in Total Capitalization
Bahrain	42	6601	4.34
Egypt	1110	24308	15.97
Jordan	102	6314	4.15
Kuwait	88	26661	17.51
Lebanon	14	1248	0.82
Morocco	55	9031	5.93
Oman	96	2634	1.73
Saudi Arabia	76	73201	48.09
Tunisia	45	2229	1.46
Total	1687	152230	100.00

Source: Various Arab Monetary Fund Annual Reports.

The order-driven market making system of the ASM has no designated liquidity providers and orders are prioritized for execution in terms of price and time. By submitting a limit order, a trader provides liquidity for other market participants who demand immediacy. In other words, investors can trade via market orders and consume liquidity in the market.

As it stands, the trading mechanism in ASE suffers from one major weakness; lack of immediacy. If, for example, there is an imbalance between buy and sell orders during a trading day, successive buy (sell) orders may well get noted on the trading board without counter sell (buy) orders arriving at the market. Furthermore, any imbalance between buy and sell orders would cause the price of a stock to change. This is due to the absence of somebody (dealer) who stands ready and willing to buy a stock at the bid and sell a stock at the ask. Indeed Cohen et al. (1983) analyzed the impact of the specialist on the standard deviation of daily price changes. In their simulation study, they showed that the presence of specialists reduces the standard deviation of daily transaction prices from an average of 1.44% to about 0.89%. In other words, the behaviour of price changes on ASE would be more continuous if there were specialists operating in the market. Moreover, investors would be assured of getting their orders executed immediately when they submit market orders. This is perhaps why the trading volume in the shares of only 10 companies accounts for more than 70 percent of the trading volume in the shares of all listed companies.

Given the importance of the ASM in the national economy, the Jordanian capital market has seen the introduction of a number of major changes. At the forefront of these changes is the June 2000 implementation of the Electronic Trading System (ETS). This system was bought from the Paris Bourse and its' cost (10.5 million French Francs) was funded by the French government. Moreover, the Paris Bourse provided the necessary training to ensure the successful implementation of the system. This event can be considered as a qualitative leap because it means more transparency and safety for traders and investors. The system ensures a fair and orderly entrance of all buying and selling orders into the computer and an accurate matching of supply and demand in the determination of securities prices. However, it must be noted that the market-making mechanism of the market has not changed. In other words, the "old" manual trading mechanism with which the market started has simply been replaced by an electronic system.

The June 2000 implementation of the Electronic Trading System has improved the market in terms of published information. For example, at the close of the market, the best bid and ask prices are now available. Moreover, since it is not possible to place a buy (sell) order above (below) the prevailing lowest ask (best bid) price, the best price is the one that can be executed at any given time. The quoted bid-ask spread is simply the difference between the prevailing lowest ask price and highest bid price. In markets like the ASM, where specialists do not exist, it can be argued that the difference between the highest bid price and lowest ask price (at the close of each trading day) constitute a measure of marketability. However, the fact that these prices (highest bid and lowest ask) are not published by the market continuously during trading days, we have no option but to use the highest bid price and lowest ask price at the close of each trading day as a proxy measure of marketability cost in the ASM. Having said that, we still believe that this measure is a good estimate of liquidity cost for two main reasons. First, most of the "closing" best bid and ask offers do not enter the system during the last few minutes of each trading day. Indeed, we can argue that the arrival time of the closing bid and ask offers is random. In other words, our estimate of transacting cost does not suffer from any abnormal trading patterns and procedures around the close of trading days. Second, given the fact that the mean (daily) number of contracts is very low (32 contracts), we do not expect any abnormal trading behaviour to occur at the end of trading days.

The basic data set used in the analysis is obtained from the ASM daily report. This report publishes a variety of information including the number of traded shares and trading volume during the day, closing prices, highest and lowest prices, and highest (lowest) prevailing bid (ask) prices at the close of each trading day. To estimate marketability cost, the daily closing best bid and ask prices are collected for a total of 10 listed companies during the time period 18 June 2000 until 31 December 2001. Due to the fact that the trading activity in the market is thin, most of the listed companies' shares do not register daily transactions. Moreover, most of the listed shares do not even have highest bid and lowest ask prices at the end of most trading days. This is why our sample includes a total of 10 companies only. However, these stocks provide a reasonable representation of the market. This is based on the fact that these stocks constitute about 70 percent of the whole market in terms of their combined market capitalization and trading volume.

Based on the discussion of the previous section, the following model is estimated:

$$BA_{i,t} = \alpha_0 + \alpha_1 \ln(V_{i,t}) + \alpha_2 \delta_{i,t} + \alpha_3 S_{i,t} + \alpha_4 P_{i,t} + \varepsilon_{i,t}$$

where $BA_{i,t}$ is the proportional bid-ask spread for share i and in day t. This is measured by the following expression: (highest ask - lowest bid) / (highest ask + lowest bid)*100. The variable $\ln(V_{i,t})$ is the natural logarithm of daily number of contracts in the stock of company i. The variable $\delta_{i,t}$ is the daily volatility of stock i which is measured by the highest transaction price minus lowest transaction price divided by the average daily price and S is the natural logarithm of company size (market capitalization). Finally, P is the inverse of price.

The above panel regression model is estimated using three methods: the ordinary least squares (OLS), seemingly unrelated regression (SUR) and the iterated Generalized Method of Moment (GMM). The GMM estimation provides convergent estimators and accommodates serial correlation in the residuals and conditional heteroskedasticity of an unknown form.

3. The Empirical Results

Table 4 reports the mean spread for each listed company during the time period 18 June 2000 until 30 September 2001 as well as the mean spread for 4 non-overlapping sub-periods. Similarly, Table 5 provides some summary statistics of the variables used in the statistical analyses.

Table 4: Mean Values of Spread

The spread is equal to (highest ask - lowest bid) / (highest ask + lowest bid)*100 (18 June 2000 until 31 December 2001). The whole time period is divided into 4 non-overlapping sub-periods.

Company	Total Period	1st Quarter	2nd. Quarter	3rd. Quarter	4th. Quarter
1	1.301	1.421	1.208	1.412	1.167
2	1.325	1.324	1.219	1.265	1.470
3	0.891	0.857	1.040	0.834	0.825
4	0.708	0.760	0.660	0.656	0.758
5	0.359	0.334	0.347	0.314	0.444
6	0.693	0.764	0.767	0.645	0.592
7	1.318	1.288	1.079	1.251	1.607
8	1.090	1.435	1.118	1.137	1.171
9	0.600	0.738	0.555	0.588	0.523
10	1.743	1.530	1.768	1.838	1.861

The summary statistics are based on the daily closing highest bid prices and lowest ask prices for a total of 10 listed companies during the time period 18 June 2000 until 30 December 2001. The variables are defined as follows: Spread is equal to (highest ask - lowest bid) / (highest ask + lowest bid)*100. Trading volume is the natural logarithm of daily number of contracts. Volatility is measured by the highest transaction price minus lowest transaction price divided by the average daily price. Size is the natural logarithm of company size (market capitalization). Finally, Price is the inverse of price.

Table 5:Summary Statistics of Variables

	Spread	Trading Volume	Volatility	Size	Price
Mean	1.002	1.241	1.167	7.549	0.668
Median	0.866	1.255	0.919	7.566	0.585
Maximum	7.407	2.593	8.929	9.768	1.563
Minimum	0.085	0.000	0.000	6.635	0.083
Std. Deviation	0.733	0.498	1.187	0.413	0.364
Skewness	2.348	-0.140	1.705	-0.218	0.476
Kurtosis	12.270	2.949	7.315	3.146	2.653
Jarque-Bera	12735 (0.000)	9.624 (0.008)	3567 (0.000)	25 (0.000)	121 (0.000)
Observations	2830	2830	2830	2830	2830

The most interesting observation is the mean value of the spread measure during the whole period as well as the 4 non-overlapping sub-periods (Table 4). With a maximum mean value of 1.743 percent (company 10) and a mean minimum value of 0.359 percent (company 5), we can argue that transacting cost in the Jordanian capital market is comparatively high. Indeed, the overall mean of the spread is equal to 1.002 percent (Table 3). For example, the equivalent cost in the USA is equal to 0.32 percent (Angel, 1997) and in Paris 0.297 percent (Bourghelle and Declerck, 2001). In addition, the mean values of the spread across all-sub-periods are quite high and reflect some consistent patterns (Table 2). In other words, following the adoption of the electronic system, the mean spreads do not show any signs of decrease. Indeed, company 10, which has the highest cost of transacting during the entire period, had the highest cost in each of the four sub-periods as well. Similarly, company 5 had the lowest mean spread during the overall period and during each sub-period.

Based on the results reported in Table 5, we can make the following comments. First, the standard deviation of the spread measure is quite high (73 percent). Moreover, the largest spread in our sample is equal to 7.047 percent while the minimum spread is equal to 0.085 percent. Second, our sample of companies includes companies whose market prices of their stocks are lower than their respective nominal prices. For example, the maximum price inverse value is equal to 1.56. Finally, the minimum value of volatility is equal to zero. This observation indicates that during some days, no transactions occur (no closing price) although best bid and offer prices (orders) exist.

Tables 6 and 7 report the correlation matrix between all the variables and the determinants of the spread respectively.

Table 6: Correlation Matrix

	Spread	Volume	Volatility	Size	Price
Spread	1.000				
Volume	-0.236	1.000			
Volatility	0.182	0.459	1.000		
Size	-0.223	-0.024	0.041	1.000	
Price	0.505	-0.149	0.209	-0.432	1.000

Spread is equal to (highest ask - lowest bid) / (highest ask + lowest bid)*100. Volume is the natural logarithm of daily number of contracts. Volatility is measured by the highest transaction price minus lowest transaction price divided by the average daily price. Size is the natural logarithm of company size (market capitalization). Finally, Price is the inverse of price.

Table 7: Regression Results

	OLS	SUR	GMM
Intercept	0.759 (2.577*)	0.284 (1.124)	1.062 (1.436)
Volume	-0.361 (-11.062*)	-0.294 (-12.020*)	-0.456 (-4.967*)
Volatility	0.174 (10.048*)	0.153 (14.429*)	0.152 (3.418*)
Size	-0.016 (-0.444)	0.032 (1.006)	-0.053 (-0.588)
Price	0.910 (25.017*)	0.952 (27.643*)	0.932 (6.024*)
Adjusted R^2	0.315	0.311	0.307
F-Statistic	326.127 (0.000)		
D-W Statistic	1.697	1.671	2.055

The Model: $BA_{i,t} = \alpha_0 + \alpha_1 \ln(V_{i,t}) + \alpha_2 \delta_{i,t} + \alpha_3 S_{i,t} + \alpha_4 P_{i,t} + \varepsilon_{i,t}$ where, $BA_{i,t}$ is the proportional bid-ask spread for share i and in week t. This is measured by the following expression: (highest ask - lowest bid) / (highest ask + lowest bid)*100. The variable $\ln(V_{i,t})$ is the natural logarithm of daily number of contracts in the stock of company i. The variable $\delta_{i,t}$ is the daily volatility of stock i which is measured by the highest transaction price minus lowest transaction price divided by the average daily price and S is the natural logarithm of company size (market capitalization). Finally, Price is the inverse of price. The regression is estimated using the Ordinary Least Squares (OLS), Seemingly Unrelated Regression (SUR) and the Generalized Method of Moments (GMM) techniques.

One of the more interesting observations is the correlation between the spread and price inverse (0.505). Indeed, this coefficient is the largest and implies that the major determinant of liquidity cost is the market price of the stock. As mentioned previously, there are some listed companies whose market capitalization is less than their nominal values. This observation is common in the Jordanian capital market. In other words, there are some listed companies (about 40) that are profitable and have not split their stocks and yet (perhaps due to inefficiency) their market prices are very low.

With the exception of company size, all other variables are consistently significant and have the expected signs (Table 7). Moreover, the OLS, SUR and the GMM estimation yield consistent results[6]. The coefficients show that the spread increases as price volatility and stock price increase and decreases as trading contracts decrease. Moreover, similar to the comment made earlier, the interesting observation that warrants some comments is the coefficient of stock price (price inverse). This coefficient is consistently the largest in magnitude. The reason for this observation is due to the minimum tick size. The fact that the minimum tick size for all companies included in our sample is equal to one pence makes the spread of some stocks (low priced stocks) relatively high. Indeed, the minimum (maximum) price inverse is equal to Jordanian Dinar 0.083 (1.563) and the standard deviation of stock prices (36 percent) is quite high (Table 5). Trading cost varies inversely with the number of trading contracts[7]. This conclusion is consistent with theory and reflects, for example, lower inventory costs on behalf of investors. The percentage spread varies directly with stock volatility and this reflects higher adverse and inventory risk associated with more volatile stocks.

[6] The same analysis was carried out for two non-overlapping sub-periods. The results yielded similar results.
[7] The natural logarithm of the daily trading volume yielded very similar results.

4. A Summary and Conclusions

Following the early works of Gurley and Shaw (1955), Goldsmith (1969), McKinnon (1973), and Shaw (1973), numerous papers have established that financial development fosters economic growth. Moreover, given the economic importance of stock markets, prominent financial economists have devoted a lot of attention to the concept of operational efficiency. Indeed, the difference in trading costs is often cited as an important factor in the international competition for order flow. Moreover, cost considerations in emerging markets are especially relevant from a public policy perspective. For example, large transacting costs may induce corporations to cross-list their stock in more liquid and developed markets, and thereby hinder domestic market development. Finally, the result shed light on the relative merits of different market designs and argues for the introduction of liquidity suppliers.

This paper raised the issue of transacting cost in the ASM. Indeed, this issue is well worth investigating given the fact that the market capitalization of the market constitutes about 76 percent of GDP. Based on a sample of the most actively traded ten listed companies, the results show that transacting cost in the Jordanian capital market is comparatively quite high. Moreover, as depicted by theory, the coefficients show that the spread increases as price volatility and stock price increase and decreases as trading contracts decrease.

The findings of this paper add to the growing evidence that shows that the ASM suffers from a number of major weaknesses. Indeed, if the market is not weak-form efficient (Omet et al. 2002), the June 2000 replacement of the manual system by a computerized trading mechanism has not made the market less inefficient (Maghyereh and Omet, 2002) and liquidity costs are quite high, these factors warrant some serious remedial policy measures if Jordanian policy-makers want the market to fulfill its economic role. Moreover, given the fact that the primary determinant of transacting cost is the market price of stocks, it is important to examine the reasons behind the apparent "low" prices. Indeed, the fact that there are many listed stocks whose market prices are lower than their respective nominal prices, transacting cost would always be high. If profitable and economically viable, the reasons behind their low prices must be examined and some remedial measures must be taken. Finally, the evidence presented in the paper is important for many reasons. First, it provides some evidence about the cost of transacting in an emerging market. This should encourage some further research work on the determinants of the bid-ask spread in the Jordanian capital market. For example, does the ownership structure of the listed companies affect the magnitude of the bid-ask spread? If the answer is yes, and the relationship is positive, regulators and law-setters should consider means that encourage less concentrated ownership structures. Second, the empirical findings may be of some use to the management of the exchange. More specifically, it is recommended that the issue of introducing designated market-makers must be examined and adopted if it is thought to increase trading activity and reduce liquidity cost. Third, it is hoped that the results of this paper will encourage similar work on other Arab stock exchanges.

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CHAPTER TEN

Multivariate Statistical Analysis of Risk Factors in the Egyptian Stock Market

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1. Introduction

The arbitrage pricing theory (APT) postulates that the expected return for a particular stock will consist of the risk free rate and the risk premium. The risk premium is a function of the stock's exposure to a number of risk factors (multifactor). The capital asset pricing model (CAPM) is a one-factor model according to the APT, where stocks' returns covariances are driven by the market risk. Multifactor models such as the widely used BARRA E3 have gained wide acceptance in the fund management industry (see Sharpe 1999, and Grinold and Kahn 2000). They can measure the portfolio exposures to different risk factors. Accordingly, the fund manager can adjust the portfolio holdings to increase its exposure to the factors that are expected to do exceptionally well in the future, and vice versa. They have also proved very useful in performance evaluation against a relevant benchmark. They can measure the fund manager's style and possible deviations from the fund investment policy. For example, large capitalization value managers should have large size and value stocks exposures and low growth stocks exposures.

The APT assumes that return R_{it} for the ith stock over the time series period t is generated from a multifactor model described by equation 1.

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$$R_{it} = a_i + \sum_{k=1}^{K} b_k F_k + \varepsilon_{it} \quad (1)$$

Where a_i is the expected return for stock i if all factors have a value of zero, F_k is the value of the kth factor that influences the stock's return, b_k's are parameter estimates of the factors exposures (sensitivities), and ε_{it} is the random error that is distributed with mean of zero and constant variance. The model assumes that the error term for stock i is uncorrelated with the error term for any other stock. It is further assumed that the error term is uncorrelated with any of the factors, F_k. The factors affect the returns on more than one stock and are the sources of covariance between stocks.

The APT is built around an arbitrage argument; two portfolios that have the same risk factors' exposures should have the same price, and therefore expected return. Otherwise, a riskless and investment free arbitrage opportunity with a positive expected return is created, and investors will rush to make use of it. The result is the return to equilibrium where prices and returns are functions of the risk factors exposures. At this point there will be an approximately linear relationship between the expected returns and exposures as in equation 2.

$$E(R_i) = R_f + \sum_{k=1}^{K} ((E(F_k) - R_f)b_k \quad (2)$$

Where $E(R_i)$ is the expected return for stock i, R_f is the risk free rate, $E(F_k)$ is the expected return on a portfolio that has a unit exposure to factor F_k and zero exposures to other factors.

The APT requires less restrictive assumptions than the CAPM. However, the APT does not specify the number and identity of factors to include in equation 1. It is worth noting that APT is not necessarily inconsistent with stocks priced according to the CAPM in equilibrium. In this case the CAPM beta will be a weighted average of b_k's and the covariances of the factors with the market portfolio.

Most research has focused on three types of factor models, macroeconomic, fundamental, and statistical. The macroeconomic factor model specifies macroeconomic variables as factors. Inflation shocks, yield spread between long- and short-term interest rates, yield spread between long-term corporate and treasury securities, business cycle, oil prices, and growth rate of gross domestic product can be factors that affect all the returns in the market to a less or great extent.

The fundamental factor model uses company and industry attributes as factors influencing stocks' returns. Accounting ratios such as debt-to-equity and fixed rate coverage can be combined with other relevant variables into financial leverage risk factor. Market information such as share turnover, trading volume and number of analysts following a company can be combined with other relevant variables into a trading activity risk factor. The BARRA E3 model that is widely used in the investment and fund management industry includes 13 composite risk factors (see Sharpe 1999). Historical average returns for each of these composites can be estimated by creating a portfolio that has a unit exposure to a particular factor, and zero exposure to all other factors.

The statistical factor model uses principal component analysis (PCA) to determine factors which are uncorrelated with each other but explain most of the variability in stock returns. Each of these factors is a linear combination of the stocks' returns. The first factor is chosen so that its variance explains the maximum possible percentage of variability in stocks' returns. The second factor is chosen so that it is uncorrelated with the first factor and explains most of the remaining variability. The same procedure is followed to obtain the rest of the factors.

The APT has been proposed by many authors as a solution for the problems associated with testing the CAPM, namely the Roll's (1977) critique. Roll (1977) argues that the CAPM may not be testable unless the market portfolio composition in known, observable and used in the test. Shanken (1982) has challenged the view that the APT is more susceptible to empirical testing than the CAPM.

The APT, however, offers a statistical framework that allows a comprehensive analysis of behavior in capital markets. Inferences can be drawn about the number of risk factors influencing the returns generating process. While these tests may not constitute tests of the APT, they provide useful insights into the functioning of capital markets. The current study sheds some light on the return-risk trade off in the emerging stock market of Egypt during 2001-2002. The study aims at identifying the number of risk factors in the Egyptian stock market using principal component analysis. Principal component analysis is used to identify the major risk factors that explain most of the variability in the stocks returns. The major problem with statistical factor models is that it is difficult to assign economic interpretation of each factor. However, in the emerging stock market of Egypt, data required for either the macroeconomic or fundamental factor models is not available. This leaves us with the statistical factor model as the only option.

The paper is divided into six sections, with the first containing the introduction. Section 2 offers a brief description of the Egyptian stock market. The data and the choice of which companies to include in the study sample are described in section 3. Section 4 briefly describes the principal component analysis (PCA) methodology. Section 5 applies the PCA to the stocks in the sample with the objective of identifying the risk factors in the Egyptian stock market. Section 6 concludes the study.

2. The Egyptian Stock Market

The Egyptian stock market is the oldest in Africa (established in 1883). It was one of the major stock exchanges in the world up to the end of the Egyptian monarchy in 1952. Gradual nationalization in the years that followed the 1952 political change led to the stock market activities dying out, although the market always kept its doors open. However, in the eighties the Egyptian government, encouraged by the International Monetary Fund (IMF), embarked on a series of privatization attempts that led to the opening up of the market to local and foreign investment.

The Egyptian stock market has witnessed an average annual growth rate in turnover of about 60% during the period from 1988 to 1997. The market is the second largest in Africa after the Johannesburg stock exchange. There are about 650 stocks registered although many of them are inactive. The market capitalization is 20.83 billion US$.

There are two major characteristics of the Egyptian stock market. First, like many in other emerging countries, it is illiquid and dominated by a small number of stocks. Second, historical data on equity and bond returns are not available for long periods of time. This makes it difficult to form long-term estimates of investors' expectations about equity returns and risk premiums.

3. Data

The data has been collected from Al Ahram newspaper. Al Ahram is the national newspaper in Egypt. The frequency used is weekly prices. Prices of stocks in Egypt do not change much on a daily basis. As a matter of fact prices of many stocks do not even change on a weekly basis. The methodology adopted in this paper is to use weekly volume of trade and number of transactions, during the period from 2 March 2001 to 26 October 2001, to determine active stocks. We could only collect 18 weekly Friday of Al Ahram newspapers during the period from 2 March 2001 to 26 October 2001. There were 356 stocks quoted in the newspaper during the period, along with some statistics about number of transactions and volume of trades.

Two statistics are computed and used to determine whether a stock is active or inactive. The first statistic, α, is the percentage of weeks the stock has been active to the number of weeks in the period. The second statistic, ω, is the average number of transactions for each stock during the period. The number of transactions is used instead of volume to avoid the problem of few transactions accounting for large volume of trade.

The average α is 32.9% and the average ω is 48 trades per week. A stock is considered active for the purpose of our study if it has α greater than 32.9% and ω greater than 48. Forty-two stocks only have passed the two conditions. This indicates that only 11.8% of the stocks quoted during this period could be considered active according to the definition adopted in the study.

It is interesting to note that thirty-two of the companies' chosen in our sample are included in the Standard & Poor's emerging markets data base (EMDB). The EMDB includes only stocks that are considered to be active according to a criteria used by Standard & Poor.

Weekly prices were then collected on these 42 companies and the general market index for publicly traded companies during the period from 14 December 2001 to 27 December 2002. Fifty weeks were obtained since there were no prices quoted on couple of Fridays because of public holidays. One company was deemed inactive during this period since its stock price did not change for many weeks. This company was excluded from the final analysis. This left a usable sample of 41 companies. The companies' names are included in the appendix.

The annual short-term risk free rate of return was obtained on a weekly basis from the Economist magazine except for the three weeks period from December 13-27, 2002, where the rate was obtained from Al Ahram newspaper. In line with the global recession and the continuous decline of interest rates in the world major economies, the short-term rate has declined from 7.87% on December 15, 2001 to 5.8% on December 27, 2002. The average annual short-term rate was 7.05% with 0.41% standard deviation. This implies a weekly short-term rate of 0.136% (7.05 / 52).

4. Methodology: Principal Component Analysis (PCA)

Let $\mathbf{x}^T = [X_1, \ldots\ldots, X_k]$ be a k-dimensional random vector with mean $\boldsymbol{\mu}$ and covariance matrix $\boldsymbol{\Sigma}$. We need to find a new set of variables $Y_1, \ldots, Y_k$, which are uncorrelated and whose variance decrease from first to last. Each *Y*j is a linear combination of the *X*'s, so that $Y_j = w_{1j}X_1 + w_{2j}X_2 + \ldots + w_{kj}X_k = \mathbf{w_j}^{\mathbf{T}}\mathbf{x}$, where $\mathbf{w}_j^T = [w_{1j}, \ldots, w_{kj}]$ is the loadings vector with the normalization condition that $\mathbf{w_j}^{\mathbf{T}}\mathbf{w_j} = 1$. The first principal component is ($Y_1 = \mathbf{w_1}^{\mathbf{T}}\mathbf{x}$) reached by finding $\mathbf{w_1}$ so as to maximize the variance of $\mathbf{w_1}^{\mathbf{T}}\mathbf{x}$ subject to the constraint that $\mathbf{w_1}^{\mathbf{T}}\mathbf{w_1} = 1$. The second principal component ($Y_2 = \mathbf{w_2}^{\mathbf{T}}\mathbf{x}$) is chosen by finding $\mathbf{w_2}$ so that Y_2 has the largest variance after Y_1 with the condition that Y_1 and Y_2 are uncorrelated ($\mathbf{w_2}^{\mathbf{T}}\mathbf{w_1} = 0$). The rest of the components are reached following the same procedure, they are uncorrelated and explain decreasing amount of total variability.

The variance of Y_1 is $\mathbf{w_1}^{\mathbf{T}}\boldsymbol{\Sigma}\mathbf{w_1}$. The covariance matrix $\boldsymbol{\Sigma}$ is a $K\times K$ symmetric and non-negative definite. A $K\times K$ symmetric matrix has K distinct characteristic (eigen) vectors that are orthogonal. The K corresponding characteristic roots, $\lambda_1, \lambda_2, \ldots, \lambda_k$, are real but need not be distinct. It is convenient to collect the K-eigen vectors in a $K\times K$ matrix whose *i*th column is the $\mathbf{w}_i$ corresponding to λ_i, $\mathbf{W} = [\mathbf{w_1}, \mathbf{w_2}, \ldots, \mathbf{w_K}]$, and the K characteristic roots in a diagonal matrix Λ. The covariance matrix $\boldsymbol{\Sigma}$ has an eigenvalue decomposition $\boldsymbol{\Sigma} = \mathbf{W}\Lambda\mathbf{W}^{\mathbf{T}}$. The $K\times 1$ vector of principal components is $\mathbf{y}=\mathbf{W}^{\mathbf{T}}\mathbf{X}$. The $K\times K$ covariance matrix of $\mathbf{y}$ is Λ. The eigenvalues can be interpreted as the respective variances of the different principal components. It can be easily shown (see Chatfield and Collins 1980) that the first principal component Y_1 is the characteristic vector $\mathbf{w}$ (denoted as $\mathbf{w_1}$) that corresponds to the largest eigenvalue λ (denoted as λ_1). The second principal component is $\mathbf{w_2}$ that corresponds to the second largest eigenvalue λ_2. Following the same argument, the *j*th principal component is obtained. Equation 3 indicates that the sums of the variances of the original variables are the same as the sums of the variances of their principal components.

$$\sum_{i=1}^{K} Var(Y_i) = \sum_{i=1}^{K} \lambda_i = \sum_{i=1}^{K} Var(X_i) \qquad \text{Equation 3}$$

This is due to the fact that

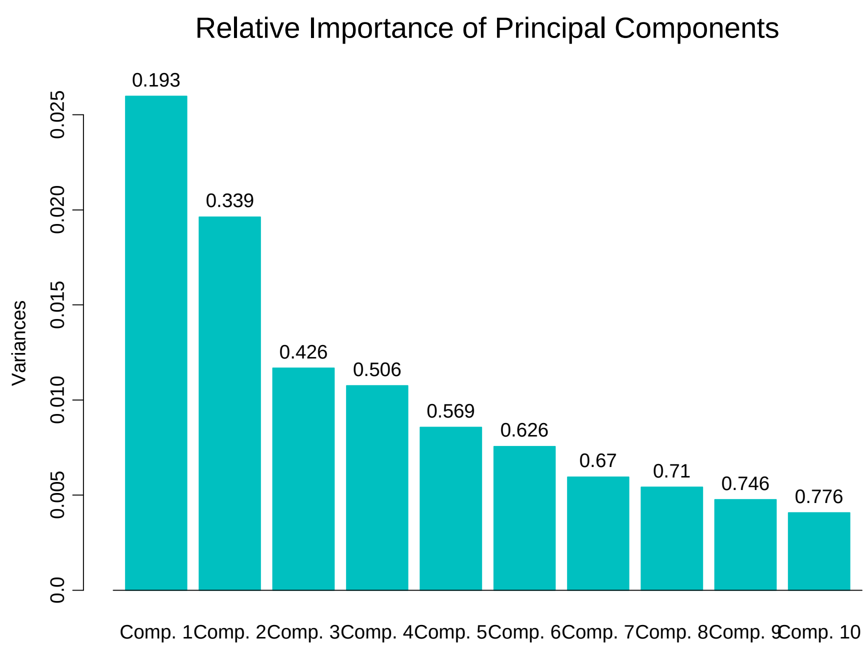
$$\sum_{i=1}^{K} \lambda_i = trace(\Lambda) = trace(\Sigma) \qquad \text{Equation 4}$$

Accordingly, the proportion of variance explained by the first *m* components is measured by

$$proportion = \frac{\sum_{i=1}^{m} \lambda_i}{\sum_{i=1}^{K} \lambda_i} \qquad \text{Equation 5}$$

The percentage of variance criterion is adopted in the current paper. The number of principal components is chosen so that the components explain 60% of the cumulative variance. Hair et al. (1998) report that it is common in social sciences where the data is often less precise to consider 60% as satisfactory.

Figure 1



5. Principal component analysis (PCA) of the risk factors in equity returns

Figure 1 shows that the first 5 principal components explain 62.6% of the variability in stock's returns. Figure 2 shows the most important companies included in the 5 principal components for which the loadings in the eigenvector are relatively large, either positive or negative.

The principal components are rotated in order to find a new set of components that are orthogonal and can be more easily interpreted. Orthogonal rotation maintains the axes at the 90-degree angle between the reference axes. This procedure ensures that the rotated components are mathematically independent. The primary goal of rotation is to obtain some theoretically meaningful components and if possible to simplify the components structure. Rotation helps in identifying patterns and classifying the variables in clusters. Each variable should be heavily loaded on as few components as possible.

The columns of the components matrix refer to the components while the rows refer to the loadings of each variable across the components. Orthogonal rotation methods aims to simplify either the rows of the components matrix by making as many values close to zero as possible, or the columns of the components matrix by making the high loadings as few as possible. This may help with the interpretation of the rotated components. The varimax method tries to simplify the columns of the components matrix. With varimax, the maximum possible simplification is reached when there are only ones and zeros in a column.

Figure 2: The largest loadings for the first five principal components that explain 62.6% of the variability in the forty-one sample of stocks' returns

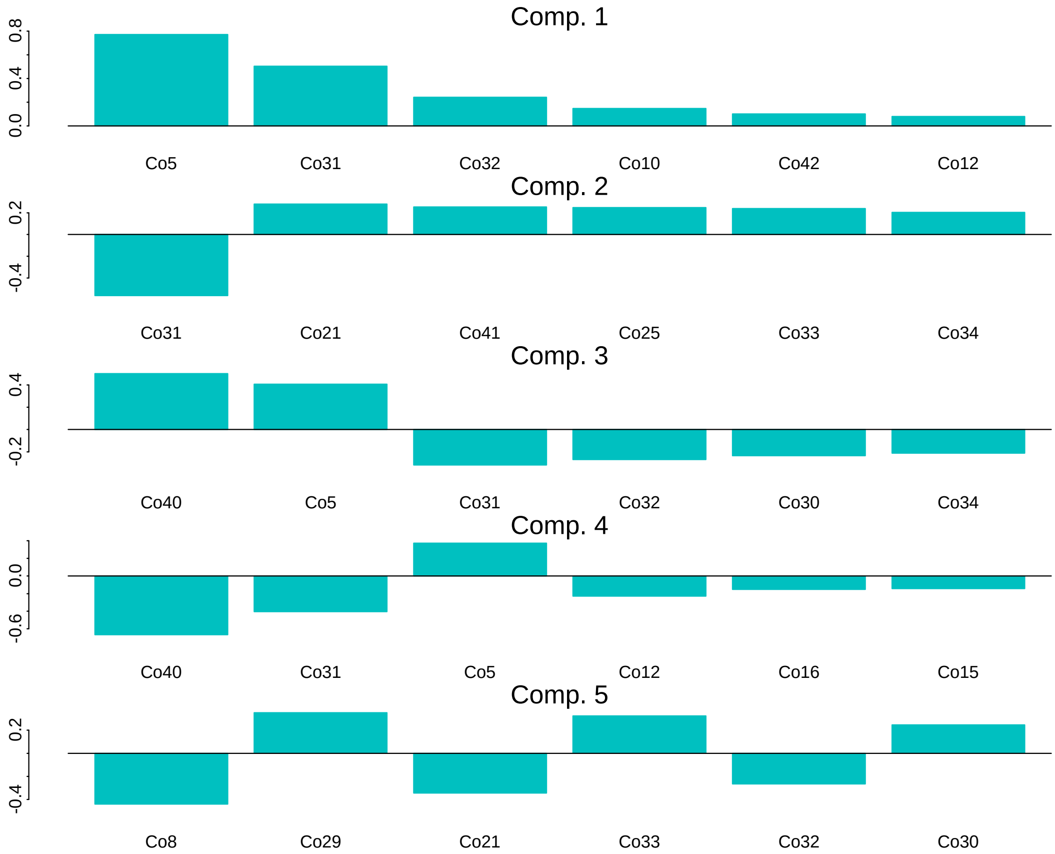
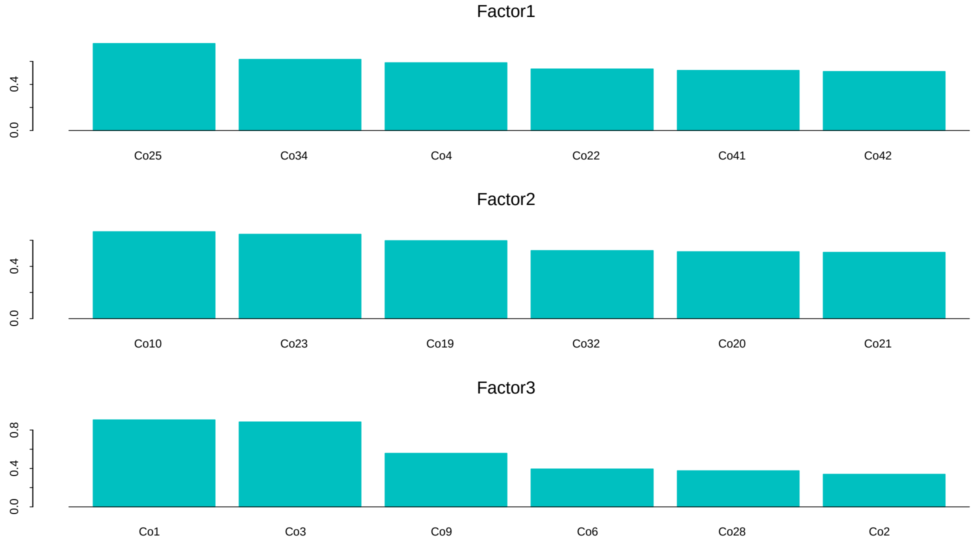


Figure 3: The three orthogonal rotated principal components using varimax



The varimax rotation was applied with the objective of finding three rotated components that perhaps can help in the interpretation. The results are in figure 3. The returns of the stocks identified in the figure (largest loadings) will be interpreted as surrogate variables, i.e. they are representatives of their corresponding components. The loadings on the three principal components are included in table 1. The six companies with the largest loadings in the first component are concentrated in the following sectors. Three in telecommunications and media, one in construction, one in consumer staples and one in industrials. The first component can be taken as some sort of how stocks in general did (e.g., Elton et al., 2003). In other words, the index that will explain most of the variation in returns is the general return index. As a matter of fact the loadings on the first component are close to be a weighted average of the six companies. It seems that these six companies have a significant influence on the returns generating process in the Egyptian stock market. Telecommunications have seen a rapid growth in Egypt due to the wide spread of the mobile phone. The Egyptian media production city is backed by the government, it has experienced massive investments and publicity in the last ten years. Nasr city housing and development is a large construction group. It is worth mentioning that construction is a very active sector in Egypt due to the fast population growth and the need to replace old ailing buildings.

The companies with large loadings in the second component are concentrated in three industries. Four in the materials industry, one in construction and one in industrials. The companies' activities range from cement, iron and steel and development. Accordingly, the second component could be labeled development and housing component. As mentioned earlier construction and materials required for construction should constitute an active segment of the Egyptian economy due to the massive investments required in building the infrastructure and housing.

The third component's companies are concentrated as follows. Four in consumer staples, one in chemicals and one in banks. The largest loadings are on the mills. Therefore, the component represents the activities in the food sector. Mills are very since bread and bakeries are the most important food items in Egypt. As a matter of fact Egypt imports huge amounts of wheat annually to meet demands for bread and bakeries products. To see how well these three components work, we can regress the returns on the general market index against the three components. The results are shown in table 2.

Table 1: Loadings in the three rotated principal components using varimax

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	Company	Sector	Factor 1	Factor 2	Factor 3
C1	East Delta Flour Mills	Consumer Staples			0.908
C2	Middle and West Delta Flour Mills	Consumer Staples			0.341
C3	Upper Egypt Flour Mills	Consumer Staples			0.885
C4	Alexandria Mills and Bakeries	Consumer Staples	0.590		
C6	The Eastern Tobacco Company	Consumer Staples			0.395
C9	Abu Qir for Fertilizers and Chemical Industries	Materials			0.560
C10	Misr Chemical Industries	Materials		0.667	
C19	Misr Cement/Qena	Materials		0.598	
C20	Sinai Cement	Materials		0.513	
C21	Egyptian Iron and Sreel	Materials		0.508	
C22	Egyptian Electric Cables	Industrials	0.534		
C23	International Electronics	Industrials		0.647	
C25	Egyptian Company for Mobil Phone Services	Telecommunication Services	0.756		
C28	Al Watany Bank of Egypt	Financials			0.377
C32	Development and Engineering Consultancies	Construction		0.521	
C34	Nasr City Housing and Development	Construction	0.619		
C41	Orascom Telecom	Telecommunication Services	0.523		
C42	Egyptian Media Production City	Media	0.513		

Table 2: Regression results.

The dependent variable is the returns on the general market index. The three regressors are the three principal components (PC). The α*'s* are parameter estimates.

	α_0 (intercept)	α_1 (PC 1)	α_2 (PC 2)	α_3 (PC 3)
Coefficient	0.00095	0.057*	0.044*	0.001
t-stat	1.27	8.73	5.75	0.155
P-value	0.212	3.09E-11	7.25E-07	0.878
R- Squared	90%		*Adjusted R- Squared*	79%
F	62.01*		*Significance F*	5.08E-16
Correlation between market and each PC		81.04%*	68.6%*	22.5%

* Refers to significance at the 5% and 1% levels.

The regression results indicate that changes in the three principle components explain 90% of the changes in the general market index. The first two components are significant at the 1%. The third component is not significant even at the 5%. The overall model is significant at the 1% level as indicated by the *F* statistic. The table also shows the correlation coefficient. The first component is highly correlated with the market with a correlation coefficient of 81.04%. This suggests that a weighted average of the six companies in the components could work as an indicator of the overall activities of the market. The second component has a correlation coefficient of 68.6% with the general market index, which indicates a high level of association. The third component is the least correlated with the market with a coefficient of 22.5%. Since the third component turns not to be significant, it seems that there is no need for extracting more principal components to explain the variability in the data. In other words, it seems that there are two major significant components impacting the general market return in Egypt.

6. Conclusions

The paper applied the multivariate technique of the principal component analysis to identify the risk factors in the thinly traded Egyptian stock market. Data on 356 companies were filtered using volume of trade and number of transactions to identify the most actively traded companies. Forty-one companies were identified. Thirty-two of those companies are regarded as active according to the S&P emerging market data base (EMDB).

The varimax orthogonal rotation technique was used to identify the most important three components that explain the variability in the returns on 41 active companies during the years 2001-2002. The heavily loaded companies were used as surrogate variables, i.e. they are representatives of their corresponding components. The first component is close to a weighted average of six companies, and reflects the general performance of the market. The six companies included in the component seem to be the major driving force in the stock market. The component's correlation with the general market index is 81.04%. The first component is heavily loaded on telecommunications, media and construction. The second component reflects activities in the development and housing sector, with companies ranging from cement to steel and construction. The component has a 68.6% correlation with the general market index. The third component is heavily loaded with consumer staples, especially mills. It is important to note that bread and bakeries are the most important food items in Egypt. The three components explain 90% of the variation in the returns on the general market. The issue of whether these three factors are priced according to the framework of the arbitrage pricing theory is left for future research.

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Appendix

Companies that are considered active according to number of weekly transactions and volume of trade. Company number 39 was excluded from the analysis since its stock turned to be inactive in 2002.

Number	Company	Sector
C1	East Delta Flour Mills	Consumer Staples
C2	Middle and West Delta Flour Mills	Consumer Staples
C3	Upper Egypt Flour Mills	Consumer Staples
C4	Alexandria Mills and Bakeries	Consumer Staples
C5	Arab Polavara Spinning and Weaving	Consumer Discretionary
C6	The Eastern Tobacco Company	Consumer Staples
C7	Egyptian International Pharmaceuticals	Health Care
C8	Pfizer Egypt	Health Care
C9	Abu Qir for Fertilizers and Chemical Industries	Materials
C10	Misr Chemical Industries	Materials
C11	Egyptian Financial and Industrial Company	Materials
C12	Ezz Ceramics and Porcelain	Industrials
C13	National Cement/Kawmia	Materials
C14	Suez Cement	Materials
C15	Al Ezz Steel Rebars	Materials
C16	Helwan Portland Cement	Materials
C17	Tora Portland Cement	Materials
C18	Misr Beni Suif Cement	Materials
C19	Misr Cement/Qena	Materials
C20	Sinai Cement	Materials
C21	Egyptian Iron and Sreel	Materials
C22	Egyptian Electric Cables	Industrials
C23	International Electronics	Industrials
C24	Alexandria Portland Cement	Materials
C25	Egyptian Company for Mobil Phone Services	Telecommunication Services
C26	Commercial International Bank	Financials
C27	Misr International Bank	Financials
C28	Al Watany Bank of Egypt	Financials
C29	Egyptian American Bank S.A.E.	Financials
C30	Export Development Bank of Egypt	Financials
C31	Cairo Housing and Development	Construction
C32	Development and Engineering Consultancies	Construction
C33	El Shams for Housing and Development	Construction
C34	Nasr City Housing and Development	Construction
C35	Mahmoudia Contracting	Construction
C36	Orascom Construction Industries	Construction
C37	Nile Matches	Industrials
C38	Olympic Group Financial Investment	Financials
C39	Holding for Financial Investment/Lakah	Financials
C40	Orascom Hotel Holdings S.A.E.	Consumer Discretionary
C41	Orascom Telecom	Telecommunication Services
C42	Egyptian Media Production City	Media

CHAPTER ELEVEN

Linear Versus Non-Linear Relationships between Financial Ratios and Stock Returns: Empirical Evidence from Egyptian Firms

Aiman A. Ragab[a]

1. Introduction

Financial statements are designed to assist users in identifying key relationships and trends. It is argued that these statements provide investors with essential information to evaluate their investment decisions. Since the work of Ball and Brown (1968) and Beaver (1968), many researchers have focused their work on the importance of financial statement information (e.g., Ou and Penman, 1989; Holthausen and Larcker, 1992; Lev and Thiagarajan, 1993; and Riahi-Belkaoui, 1997). The association between stock returns and financial ratios was first tested by Ou and Penman (1989) who used statistical procedures to identify the most relevant financial ratios. This study was extended by Holthausen and Larcker (1992) who identified value-relevant fundamental factors in the context of a return-fundamentals relation. Afterward, Riahi-Belkoui (1997) presented empirical evidence of the relevance of common financial ratios to equity valuation, both unconditionally and conditional on inflation rate.

The objective of this research is twofold. First, to show through extending the work of Lev and Thiagarajan (1993) and Riahi-Belkaoui (1997), the value relevance of common financial ratios and their usefulness in security valuation in Egypt. Such work would contribute empirical findings to the existing literature by studying a data set comprised of firms from the East which have been neglected in previous studies. Second, we test for not only a linear relationship between financial ratios and stock returns that might be misleading, but also for non-linear relationships, such

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relationship were introduced to the literature by Mramor and Kosta (1997), who presented empirical evidence of mostly nonlinear relationship between the excess rate of return on equity and financial ratios.

We estimate a multivariate linear model, and both bivariate and multivariate non-linear models, and test for the best fit for the relationship between financial ratios and stock returns. We compare various models and find that non-linear models provide better explanation for stock return behavior. However, it seems that return on equity (ROE) is the only significant common ratio for all models, suggesting investors in Egypt consider this ratio as the most important when making investment decisions.

The rest of the paper is organized as follows: In section 2 the data set is introduced. Methodology and empirical models are discussed in Section 3, followed by results in Section 4. Summary and conclusions are given in section 5

2. Data

To select the most active firms in the Egyptian stock market, we target all firms listed in the IFC global index (excluding the financial sector) over the period 1996 to 2000. The International Finance Corporation (IFC) indices are widely accepted in the international investment industry, forming the basis for index funds and structured financial instruments. Additionally, stocks included in the IFC indices are selected on the basis of market size, trading activity, and sector representation.
For this reason they have a better representation of the market, whereas emerging market stocks may not be representative since they include a large number of stocks that might be traded infrequently.

Data for stocks in the IFC indices were obtained from the Emerging Market Data Base (EMDB) and the Egyptian Capital Market Authority. Due to the limitation and unavailability of financial statements for some firms, the sample size contains only 46 firms. We calculate returns using monthly prices of securities for years starting from June 1996 until June 2000.

3. Methodology and Empirical Models

The intention of this paper is to evaluate the relationship between common financial ratios as independent variables and stock returns of the Egyptian firms as the dependent variable. As far as independent variables are concerned, we determine the most useful financial ratios that could be functional in security valuation by analyzing and comparing several relevant papers and texts. According to the existing literature the following table provides the most common financial ratios likely influencing stock returns, along with the hypothesized positive or negative relationships.

Table 1
Common Financial Ratios and the Prediction of their Relationship with Stock Returns

The table provides the most common financial ratios that might affect stock returns. For each financial ratio, we provide the way of calculation, the hypothesized positive or negative relationship with stock returns, along with the expected other forms of non-linear relationship between each ratio and stock returns.

Ratios	**Proxies**	**Proxies**	**Variables**	**Prediction of relationship**
Profitability	Return on Sales	Net income/sales	*ROS*	Positive and quadratic
	Return on assets	Net income/assets	*ROA*	
	Return on equity	Net income/equity	*ROEQ*	
	Earning per share	Net income/Number of shares	*EPS*	
Efficiency	Assets turnover	Sales/assets	*AT*	Positive and logarithmic or square root
	Inventory turnover	COGS/inventory	*IT*	
Liquidity	Current ratio	CA/CL	*CTR*	Negative and quadratic logarithmic or rational logarithmic
	Quick ratio	CA-inventory/CL	*QR*	
Leverage	Debt ratio	Total debt/total assets	*LEV*	Negative and linear
Coverage	Inversed time-interest earnings	Interest/EBTT	*INVT*	Negative and square roots

COGS: Cost of good sold.
CA: Current Assets.
CL: Current liabilities.
EBIT: Earnings before interest and tax.

With respect to the dependent variable, stock returns, there is no consensus on the appropriate methodology for calculating the long-run stock returns (see among other, Barber and Lyon, 1997; Brav and Gompers, 1997; Kothari and Warner, 1997; and Barber, Lyon and Tsai, 1999). Researchers use two methods to calculate long-run returns: buy-and-hold returns (BHRs), and cumulative returns (CRs). Since each method has been shown to yield different results, it would be appropriate to consider both methods in calculating long-run returns.

The first step in calculating both methods is to calculate rate of return on stocks. The rate of return on a given stock is the difference between the stock price at time *t* plus dividends at time *t-1* less stock price at time *t-1*:

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1} + div_{i,t-1}}{P_{i,t-1}},$$

(1)

where

$R_{i,t}$ is the return for security *i* for period *t*,

$P_{i,t}$ is the price of security *i* at time *t*,

$P_{i,t-1}$ is the price of security *i* at time *t*-1, and

$div_{i,t-1}$ is the dividend received for period *t*-1 for the firm *i*

Annual buy-and-hold return, the first model used to calculate long-run stock returns, is defined as:

$$BHR_{i,T} = \prod_{t=1}^{T} (1 + R_{i,t}) - 1 \qquad T = 12$$

(2)

where $t = 1$ indicates the first month of calculating the return.

Cumulative return is defined as:

$$CR_{i,s,e} = \sum_{t=s}^{e} R_{i,t},$$

(3)

where $CR_{i,s,e}$ is the cumulative return for security *i* from month *s* to month *e*, where *s* is the start month, which refers to the month of December or the month of June prior to the end of the fiscal year, and *e* refers to the month of December or the month of June after the fiscal year[1].

[1] Since the return on a given stock is based on a period extending from 9 months prior to the fiscal year-end and 3 months after the fiscal year-end, corresponding roughly with the period between announcing the financial statement, the starting month would be December for firms whose fiscal years end at June, the 30th and June for firms whose fiscal years end at December the 31st.

To build an empirical model using financial ratios, a linear relationship is first assumed. However, such assumption might be misleading in some cases. Mramor and Mramor- Kosta (1997) discuss non-linear relationships between returns and financial ratios and find mostly nonlinear association. Therefore, we use both bivariate and multivariate non-linear models to test for such relationships between financial ratios and stock returns, for Egyptian firms.

We follow a similar methodology of Belkaoui, (1997) and estimate the following regression a detailed explanation of all the variables are in table 1:

$$R_{i\,i,t} = \alpha + \beta_1 ROS_{it} + \beta_2 ROA_{it} + \beta_3 ROE_{it} + \beta_4 EPS_{it} + \beta_5 CTR_{it} + \beta_6 QR_{it} + \beta_7 AT_{it} + \beta_8 IT_{it} + \beta_9 LEV_{it} + \beta_{10} INVT_{it} + \varepsilon_{i,t} \qquad (2)$$

where

$R_{i,t}$ is the annual stock return of firm *i* at time *t*, measured as either BHR or CR,

ROS_{it} is the return on sales for firm *i* at time *t*,

ROA_{it} is the return on assets for firm *i* at time *t*,

$ROEQ_{it}$ is the return on equity for firm *i* at time *t*,

EPS_{it} is the earning per share for firm *i* at time *t*,

AT_{it} is the assets turnover for firm *i* at time *t*,

IT_{it} is the inventory turnover for firm *i* at time *t*,

CTR_{it} is the current ratio for firm *i* at time *t*,

QR_{it} is the quick ratio for firm *i* at time *t*,

LEV_{it} is the leverage for firm *i* at time *t* and,

$INVT_{it}$ is the inversed time-interest earned for firm *i* at time *t*, (i.e., the coverage ratio[2].)

[2] Originally, we calculated time interest earnings, but for calculation reason we replaced it with inversed time interest earnings. If the paid interest is zero, this means that the outcome of calculating time-interest earnings would yield infinity. Since the sample size contains many cases where interest paid is zero, it is sensible to consider the inverse ratio in order to avoid losing observations; hence, we calculate it by dividing interest paid by earnings before interest and tax.

To test for non-linear relationships, we first estimate bivariate models to determine the most appropriate form between each individual independent variable and stock returns, and then estimate multivariate models, which include all independent variables. Specifically, we follow the work of Mramor and Pahor, (1998), who used eight types of functions: linear, quadratic, logarithmic, exponential, power, square root, quadratic-logarithmic function and rational-logarithmic. The expected form of relationships between stock returns and financial ratios are given in Table 1 according to Mramor, D., Mramor-Kosta, N (1997).

4. Results

As mentioned in the methodology section, we employ both general and step-wise multiple regressions and estimate three different equations for both BHR and CR. The first one is performed to test for the relationship between common financial ratios and stock returns in the linear form by applying multiple and step-wise regression. Additionally, we consider the same relationship using the same techniques (the third equation), but after determining the most appropriate form of relationship for each individual explanatory variable and stock returns through the bivariate regression models (the second equation).

As far as the first set of regression analysis is concerned, the results from Table 2 show that stock returns are associated with only ROE and AT. These variables are positive and significant at the 5% and 10% level for BHR and CR, respectively. However, R-square is 18.5 % for the BHR and the p-value of the F ratio is significant at the 1% level, while R-squared for the CR model is 10.6% and the p-value of the F ratio does not pass the critical values at common significance levels, which means that these factors better explain stock returns using the BHR model. The Durbin-Watson statistic does not suggest any serious problems of autocorrelation in the residuals for both models.

Table 2
Multiple and Step-wise Regressions of the Linear Relationship between Financial Ratios and Stock Returns

The table shows the linear multiple and step-wise regressions of the relationship between explanatory variables, financial ratios, and stock returns utilizing both buy-and-hold return (BHR) and cumulative return (CR) methods. The relationship between stock returns and common financial ratios is estimated using the following equation: $R_{it} = \alpha + \beta_1 ROS_{it} + \beta_2 ROA_{it} + \beta_3 ROE_{it} + \beta_4 EPS_{it} + \beta_5 CTR_{it} + \beta_6 QR_{it} + \beta_7 AT_{it} + \beta_8 IT_{it} + \beta_9 LEV_{it} + \beta_{10} INVT_{it} + \varepsilon_{it}$, where R_{it} is the annual stock return of firm *i* at time *t*, which takes the form of BHR and CR. BHR is calculated as follows: $BHR_{i,T} = \prod_{t=1}^{T}(1+R_{it}) - 1 \quad T = 12$, where $BHR_{i,T}$ is buy- and- hold return for security i, in period T, T is the trading month number 12, and $t = 1$ indicates the first event month of calculating the return. The CR is calculated using the following equation: $CR_{i,s,e} = \sum_{t=s}^{e} R_{it}$, where $CR_{i,s,e}$ is the cumulative return for security *i* from the event month *s* to the event month *e*, where *s* is the start month, which refers to the month of December or the month of June prior to the end of the fiscal year, and *e* refers to the month of December or the month of June after the fiscal yea. ROS_{it} is the return on sales for firm *i* at time *t*, ROA_{it} is the return on assets for firm *i* at time *t*, ROE_{it} is the return on equity for firm *i* at time *t*, EPS_{it} is the earning per share for firm *i* at time *t*, CTR_{it} is the current ratio for firm *i* at time *t*, QR_{it} is the quick ratio for firm *i* at time *t*, AT_{it} is the assets turnover for firm *i* at time *t*, IT_{it} is the inventory turnover for firm *i* at time *t*, LEV_{it} is the leverage for firm *i* at time *t*, and NVT_{it} is the inversed time-interest earnings for firm *i* at time *t*. For each model, BHR and CR, we provide the estimate of each financial ratio and its P-value, along with the value of R^2 and the F-ratio for both multiple and step-wise regressions.

Explanatory Variables	BHR Method		CR Method	
	Estimate	P-Value	Estimate	P-Value
Constant	-0.058	0.005	-0.260	0.189
ROS	0.001	0.554	-0.006	0.768
ROA	-0.157	0.512	-0.060	0.239
ROE	1.010	0.017	1.405	0.099
EPS	1.087	0.934	0.578	0.698
CTR	-0.301	0.558	-0.338	0.213
QR	0.024	0.366	0.019	0.186
AT	0.375	0.031	0.076	0.095
IT	0.171	0.359	0.282	0.352
LEV	-0.521	0.304	-0.223	0.845
INVT	0.141	0.520	-0.020	0.905
The model	R^2 (%) F-ratio	18.49 20.06*	R^2 (%) F-ratio	10.59 1.4
Step-wise regression				
Constant	-0.361	0.002	-0.187	0.042
ROE	1.183	0.000	0.576	0.005
The model	R^2 (%) F-ratio	13.6 20.06*	R^2 (%) F-ratio	6 3.03**

* Significant at the 1% level
** Significant at the 5% level

In the next step, we utilize the step-wise regression to reach the final model that contains the significant explanatory variables and gives better explanation of the relationship. Consistent with the general regression models, the step- wises results confirm the above mentioned findings as ROE is the only significant variable at the 1 per cent level for both models, while the R-square for the BHR model is 13.6 per cent and only 6 per cent for the CR model.

The above analysis is based on the assumption that the relationship between financial ratios and stock returns is linear. However, we test this proposition by estimating bivariate regressions to determine whether or not there are other functions that reflect more appropriate form of the relationship between each individual explanatory variable and stock returns. We consider eight functions, including the linear form, to test which one best fits the relationship. The results given in Tables 3 and 4 indicate the most appropriate functional form of the relationship between each explanatory variable and stock returns.

For profitability ratios, the exponential function best fits the relationship between ROA, ROE, EPS, and stock return, while quadratic function provides the best result for ROS. The results differ using CR as the linear function is better for ROE and EPS, while rational logarithmic and exponential are the most appropriate functions for ROS and ROA, respectively[3].

With regard to efficiency ratios, results are similar for both BHR and CR. However, none of the eight functions are significant at any common level. Nevertheless, the quadratic logarithmic and rational logarithmic describe the relationship with AT and IT, respectively, better than other functions as they have the highest R-squared and lowest P-value.

[3] Even though some other functional forms have significant relationship with stock returns, we choose the most appropriate one based on R-square and P- value.

Table 3
Non-Linear Bivariate Relationship between each Financial Ratio and Stock Returns using BHR method

The table shows the non-linear biviriate relationship between each individual explanatory variable, financial ratio, and stock returns utilizing buy-and-hold return (BHR) method. We employ eight different functions to show which one gives better explanation to this relationship. BHR is calculated as follows: $BHR_{i,T} = \prod_{t=1}^{T} (1 + R_{i,t}) - 1 \quad T = 12$, where $BHR_{i,T}$ is buy- and- hold return for security i, in period T, T is the trading month number 12, and $t = 1$ indicates the first event month of calculating the return. ROS is return on sales, ROA is return on assets, ROE is return on equity, EPS is earning per share, CTR is current ratio, QR is quick ratio, AT is assets turnover, IT is inventory turnover, LEV is leverage, and INVT is inversed time-interest earnings. We provide the R^2 and the P value of each explanatory variable to determine which function fits better the relationship between these variables and stock returns based on a biviriate relationship.

Functions		Linear	Quadratic	Logarithmic	Exponential	Quadratic logarithmic	Rational logarithmic	Square root
Proxies	**Forms**	a+ b*x	a+ b x+ cx^2	a+ b lnx	a+ b^x	a+b$_1$ln x+ b$_2$ln^{2}x	a/x+ b* lnx /x	a+ b $\sqrt{x}$
ROS	**R^2 %**	0.720	4.0108	4.2726	0.000	4.8266	4.9232	2.3031
	P-value	0.3369	0.0743	0.0202	0.98611	0.0477	**0.0448**	0.0898
ROA	**R^2 %**	5.114	5.1319	3.3601	5.160	3.762	2.4323	3.9000
	P-value	0.0097	0.0339	0.0399	**0.0093**	0.0946	0.2199	0.0267
ROE	**R^2 %**	6.259	6.169	4.4266	6.124	5.1876	2.5936	5.348
	P-value	**0.004**	0.0164	0.018	0.004	0.0378	0.1987	0.009
EPS	**R^2 %**	2.9843	3.0318	1.5050	0.4703	1.6828	1.3692	1.986
	P-value	**0.0503**	0.1438	0.1711	0.4400	0.3521	0.4283	0.1155
CTR	**R^2 %**	0.2236	0.2734	0.1237	0.1068	0.3955	0.2339	0.1744
	P-value	0.5932	0.8404	0.6911	0.7119	**0.5775**	0.8618	0.6370
QR	**R^2 %**	0.0367	0.1190	0.000	0.04240	0.3037	0.3801	0.0110
	P-value	0.8287	0.9271	0.9982	0.8161	0.8243	**0.7851**	0.9056
AT	**R^2 %**	0.9936	1.0290	0.44292	0.8362	1.4119	0.7102	0.77231
	P-value	0.2592	0.5185	0.4519	0.3008	**0.2254**	0.6360	0.3201
IT	**R^2 %**	0.3669	1.5727	0.7145	0.0595	0.9574	2.1267	0.7194
	P-value	0.4936	0.3654	0.3390	0.7828	0.5429	**0.251**	0.3373
LEV	**R^2 %**	1.1977	1.1975	1.6718	1.1774	1.6911	2.1822	0.9270
	P-value	0.2152	0.4653	0.1611	0.2191	0.3718	**0.1581**	0.2758
INVT	**R^2 %**	1.4019	1.4762	1.2818	0.7351	2.0091	2.4568	2.8039
	P-value	0.1797	0.3889	0.2411	0.3321	0.3411	0.2676	**0.1291**

Table 4
Non-Linear Bivariate Relationship between each Financial Ratio and Stock Returns using CR method

The table shows the non-linear biviriate relationship between each individual explanatory variable, financial ratio, and stock returns utilizing cumulative return (CR) method. We employ eight different functions to show which one gives better explanation to this relationship. The CR is calculated using the following equation: $CR_{i,s,e} = \sum_{t=s}^{e} R_{it}$, where $CR_{i,s,e}$ is the cumulative return for security *i* from the event month *s* to the event month *e*, where *s* is the start month, which refers to the month of December or the month of June prior to the end of the fiscal year, and *e* refers to the month of December or the month of June after the fiscal yea. ROS is return on sales, ROA is return on assets, ROE is return on equity, EPS is earning per share, CTR is current ratio, QR is quick ratio, AT is assets turnover, IT is inventory turnover, LEV is leverage, and INVT is inversed time-interest earnings. We provide the R^2 and the P value of each explanatory variable to determine which function fit better the relationship between these variables and stock returns based on a biviriate relationship.

Functions		Linear	Quadratic	Logarithmic	Exponential	Quadratic logarithmic	Rational logarithmic	Square root
Proxies	**Forms**	a+ b*x	a+ b x+ cx^2	a+ b lnx	a+ b^x	a+$b_1$ln x+ $b_2 \ln^2$x	a/x+ b* lnx /x	a+ b $\sqrt{x}$
ROS	**R^2 %**	1.3355	7.094	6.1573	0.001	6.2126	6.2553	4.0653
	P-value	0.1871	**0.0053**	0.0051	0.9634	0.0194	0.0188	0.0236
ROA	**R^2 %**	6.0751	6.2791	3.7873	6.3572	4.830	2.7358	4.768
	P-value	0.0047	0.0163	0.0290	**0.0044**	0.0476	0.1816	0.014
ROE	**R^2 %**	13.718	15.269	7.5224	15.448	11.729	4.0457	11.45
	P-value	0.000	0.00	0.0019	**0.000**	0.00	0.0791	0.001
EPS	**R^2 %**	6.5086	5.86813	2.5571	7.33894	4.63518	1.06973	4.37243
	P-value	0.0035	0.0082	0.0737	**0.0032**	0.0540	0.5161	0.0188
CTR	**R^2 %**	0.0306	0.03371	0.0232	0.01468	0.06426	0.1959	0.02921
	P-value	0.8432	0.9788	0.8634	0.8912	0.9600	**0.8129**	0.8469
QR	**R^2 %**	.00001	0.05931	0.02105	0.004178	0.12550	0.0	0.0056
	P-value	0.9961	0.9630	0.8698	0.9418	**0.8214**	0.9718	0.9326
AT	**R^2 %**	1.8600	1.8840	1.2069	1.2080	2.2773	1.6312	1.6846
	P-value	0.1218	0.2989	0.2134	0.2132	**0.1131**	0.3519	0.1411
IT	**R^2 %**	0.3658	1.2037	0.6689	0.06988	0.8529	5.8197	0.6679
	P-value	0.4942	0.4635	0.3549	0.7653	0.5804	**0.0311**	0.3553
LEV	**R^2 %**	2.3461	2.5652	2.6853	2.16097	3.3442	1.4549	2.0233
	P-value	0.0819	0.1920	**0.0749**	0.0951	0.1391	0.4274	0.1064
INVT	**R^2 %**	0.8957	1.0461	1.9121	0.5356	2.59091	2.6436	2.1837
	P-value	0.2841	0.5128	0.1516	0.4080	0.2488	0.2417	**0.0947**

Similarly, there is no evidence of an appropriate functional form to describe the relationship between liquidity measures and stock returns. However, rational logarithmic and quadratic logarithmic present the best results for CTR and QR, respectively, utilizing the BHR model. Whereas quadratic logarithmic and rational logarithmic provide better outcome for CTR and QR, respectively, for the CR model.

Table 5
Multiple and Step-wise Regressions of the Non-linear Relationship between Financial Ratios and Stock Returns using CR method

The table shows the non-linear multiple and step-wise regressions of the relationship between explanatory variables, financial ratios, and stock returns utilizing cumulative return (CR) method. The relationship between stock returns and common financial ratios is estimated using the following equation:

$$R_{it} = \alpha + \beta_1 ROS_{it} + \beta_2 ROA_{it} + \beta_3 ROE_{it} + \beta_4 EPS_{it} + \beta_5 CTR_{it} + \beta_6 QR_{it} + \beta_7 AT_{it} + \beta_8 IT_{it} + \beta_9 LEV_{it} + \beta_{10} INVT_{it} + \varepsilon_{it}$$

, where R_{it} is the annual stock return of firm *i* at time *t*, which takes the form of CR. The CR is calculated using the following equation: $CR_{i,s,e} = \sum_{t=s}^{e} R_{it}$, where $CR_{i,s,e}$ is the cumulative return for security *i* from the event month *s* to the event month *e*, where *s* is the start month, which refers to the month of December or the month of June prior to the end of the fiscal year, and *e* refers to the month of December or the month of June after the fiscal yea. ROS_{it} is the return on sales for firm *i* at time *t*, ROA_{it} is the return on assets for firm *i* at time *t*, ROE_{it} is the return on equity for firm *i* at time *t*, EPS_{it} is the earning per share for firm *i* at time *t*, CTR_{it} is the current ratio for firm *i* at time *t*, QR_{it} is the quick ratio for firm *i* at time *t*, AT_{it} is the assets turnover for firm *i* at time *t*, IT_{it} is the inventory turnover for firm *i* at time *t*, LEV_{it} is the leverage for firm *i* at time *t*, and NVT_{it} is the inversed time-interest earnings for firm *i* at time *t*. For each model, , multiple and step-wise regressions, we provide the estimate of each financial ratio and its P-value, along with the value of R^2 and the F-ratio.

Functions		Linear	Quadratic		Logarithmic	Exponential	Quadratic logarithmic		Rational logarithmic		Square root
Proxies	**Forms**	a+ b*x	a+ b x+ cx^2		a+ b lnx	a+ b^x	a+b$_1$ln x+ b$_2$ln^{2}x		a/x+ b* lnx /x		a+ b$\sqrt{x}$
ROS	**Estimate**		-0.156	0.083							
	P-value		0.923	0.856							
ROA	**Estimate**					0.823					
	P-value					0.699					
ROE	**Estimate**					0.779					
	P-value					0.000					
EPS	**Estimate**					-0.782					
	P-value					0.239					
CTR	**Estimate**								0.414	0.349	
	P-value								0.819	0.817	
QR	**Estimate**										-0.135
	P-value										0.888
AT	**Estimate**						-0.302	-0.080			
	P-value						0.289	0.540			
IT	**Estimate**								0.269	0.218	
	P-value								0.688	0.582	
LEV	**Estimate**				-0.082						
	P-value				0.177						
INVT	**Estimate**										0.035
	P-value										0.945

The model	**F-Ratio 6.83***	**R2 27.95 %**
Step-wise regression	**Estimate**	**P-Value**
Constant	-1.1720	0.0000
ROE	0.857	0.0000
The model	**F-ratio 29.64***	**R^2 20.5%**

*** Significant at the 10% level *Significant at the 1% level

Table 6
Multiple and Step-wise Regressions of the Non-linear Relationship between Financial Ratios and Stock Returns using BHR method

The table shows the non-linear multiple and step-wise regressions of the relationship between explanatory variables, financial ratios, and stock returns utilizing buy-and-hold return (BHR) method. The relationship between stock returns and common financial ratios is estimated using the following equation:

$R_{it} = \alpha + \beta_1 ROS_{it} + \beta_2 ROA_{it} + \beta_3 ROE_{it} + \beta_4 EPS_{it} + \beta_5 CTR_{it} + \beta_6 QR_{it} + \beta_7 AT_{it} + \beta_8 IT_{it} + \beta_9 LEV_{it} + \beta_{10} INVT_{it} + \varepsilon_{it}$,where R_{it} is the annual stock return of firm *i* at time *t*, which takes the form of BHR. BHR is calculated as follows: $BHR_{i,T} = \prod_{t=1}^{T} (1 + R_{it}) - 1 \quad T = 12$, where $BHR_{i,T}$ is buy- and- hold return for security i, in period T, T is the trading month number 12, and $t = 1$ indicates the first event month of calculating the return. ROS_{it} is the return on sales for firm *i* at time *t*, ROA_{it} is the return on assets for firm *i* at time *t*, ROE_{it} is the return on equity for firm *i* at time *t*, EPS_{it} is the earning per share for firm *i* at time *t*, CTR_{it} is the current ratio for firm *i* at time *t*, QR_{it} is the quick ratio for firm *i* at time *t*, AT_{it} is the assets turnover for firm *i* at time *t*, IT_{it} is the inventory turnover for firm *i* at time *t*, LEV_{it} is the leverage for firm *i* at time *t*, and NVT_{it} is the inversed time-interest earnings for firm *i* at time *t*. For each model, multiple and step-wise regressions, we provide the estimate of each financial ratio and its P-value, along with the value of R^2 and the F-ratio.

Functions		Linear	Quadratic		Logarithmic	Exponential	Quadratic logarithmic		Rational logarithmic		Square root
Proxies	**Forms**	a+ b*x	a+ b x+ cx^2		a+ b lnx	a+ b^x	a+$b_1$ln x+ $b_2 \ln^2$x		a/x+ b* lnx /x		a+ b$\sqrt{x}$
ROS	**Estimate**								0.018	0003	
	P-value								0.654	0.649	
ROA	**Estimate**					1.552					
	P-value					0.410					
ROE	**Estimate**	0.8106									
	P-value	0.078									
EPS	**Estimate**	-0.005									
	P-value	0.792									
CTR	**Estimate**						0.0372	0.247			
	P-value						0.949	0.471			
QR	**Estimate**								0.117	0.016	
	P-value								0.887	0.969	
AT	**Estimate**						-0.140	-0.007			
	P-value						0.583	0.935			
IT	**Estimate**								0.408	0.299	
	P-value								0.449	0.319	
LEV	**Estimate**								-0.00	-0.00	
	P-value								0.748	0.662	
INVT	**Estimate**										0.0792
	P-value										0.857

The model	**F-Ratio 1.96*** **	**R^2 17.89 %**
Step-wise regression	**Estimate**	**P-Value**
Constant	-0.574	0.0024
ROE	0.779	0.0018
IT	0.532	0.0018
	0.366	0.0185
The model	**F-ratio 5.1***	**R^2 12.1%**

*** Significant at the 10% level *Significant at the 1% level

Lastly, logarithmic and rational logarithmic are the best functional forms for LEV using BHR and CR, respectively, while square root is the most appropriate function describing the relationship between stock prices and INVT.

After we determine the best functional form for each individual explanatory variable, we estimate multiple and step-wise regressions by including the new function for each explanatory variable, according to the results mentioned above, and stock returns using BHR model and CR model. The reason behind such analysis is to compare the findings of the new regressions with the previous analysis that assumed a linear relationship.

In Table 5 and 6, we present the empirical findings for the BHR and CR models. The results show that ROE is the only significant variable for both models with R-squared of 28% and 18% for BHR and CR, respectively. The F-ratio of the BHR model is significant at the 1% level, while it is significant at the 10% level for the CR model.

The Durbin-Watson statistics do not indicate any serious problems of autocorrelation in the residuals for both models. The results from the step-wise regressions shows that ROE is still the only significant variable for the BHR model at the 1% level with an R-squared of 20.5%. In the CR model, however, there are two significant variables: ROE and IT at the 1 and 5% level respectively. The R-squared of the stepwise CR regression is 12%. All significant variables have a positive sign, consistent with expectations and with previous findings in the literature.

Comparing the various models using linear and non-linear functions, results show that non-linear models provide better explanation for stock return behavior as the R-squared statistic is substantially higher for both BHR and CR models than for linear models. However, most importantly ROE is the only common ratio for all models, suggesting that investors in Egyptian firms, consider this ratio as the most important when making investment decisions.

5. Summary and Conclusion

The relationship between financial ratios and stock returns has been a popular issue in accounting and finance for a long time, yet little attention has been paid to equity markets of the Middle East region. Here, an analysis is undertaken to show the value relevance of the financial ratios and their usefulness in security valuation in Egypt based on a sample of 46 firms.

Three models are used to test for such linear and non-linear relationships: a multiple regression model of financial ratios and stock returns based on a linear relationship; bivariate models of independent financial ratios and stock returns by employing eight different function to determine the most appropriate form; and a multivariate model of financial ratios and stock returns using non-linear forms.

The results for the linear model, using step-wise multiple regressions, suggest that ROE is the only important determinant of stock returns.. However, the results from non-linear models confirm similar results as ROE is found to be a significant determinant using BHR, while AT with ROE are the only significant explanatory variables using CR model. Nevertheless, the R-squared values are higher for non-linear models compared with linear ones. One conclusion is that non-linear forms might serve better in explaining stock return behavior than linear models. Further, ROE seems to play a significant role in investment decisions in the Egyptian market.

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Summary of the Book

Over the 1990s, several Arab countries made substantial progress in financial reform as part of extensive structural adjustment programmes. The reform aimed at transforming the economy into a market-driven economy dominated by the private sector, improve the capacity of financial institutions to mobilise domestic savings, improve the effectiveness of monetary policy, and strengthen financial soundness. The design, sequence and speed of financial reforms varied across Arab countries.

This book is divided into two parts: Part one focuses on banking sector in nine Arab countries. It includes four papers that tackle issues related to operational efficiency, service quality and risk in Arab banking. Part two is devoted to stock markets in Arab countries where authors discuss and examine a variety of issues related to efficiency, volatility, hedging, and returns. The included papers are essentially technical and use the most up-to-date statistical and econometrics analysis.