Interest-free versus Conventional banks- A Comparative Study using Linear and Nonlinear Panel Regression: Empirical Evidence from Turky and 6 MENA countries

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Abstract[2]

This paper contributes to the empirical literature on interest-free finance by investigating the feature of interest-free and conventional banks in Turky and 6 MENA countries over the period 2005–2014. To distinguish between interest-free and conventional banks [in terms of Profitability, Liquidity, Credit and Insolvency risk, and Stability], we use two-sided t-test, linear regression model, Non linear Panel model (Random Logit and Pooled Probit), and *Discriminant function analysis.* Using a sample of 115 banks (80 conventional and 35 interest-free banks), **univariate** results based on t-test show that interest-free banks (IB) are, on average, less profitable, more liquid, less stable, and have higher credit risk but are more solvent, than their conventional peers (CB). We find also that the difference between the 2 banking types **was** significant pre and post the **GFC.** IB are more profitable Pre GFC and more solvent post GFC. Results from **linear regression** models show that the two types of banks may be differentiated in terms of, bank characteristic, Size, Cross countries, and Maket Share. **Small** IB are more profitable, more capitalized, and more stable than Small **CB** (with or without islamic window). From the Pooled Probit model (Random Logit) results, banks which have more liquidity, which are better capitalized, more solvent, and which are less stable (less stable), are more likely to be IB. We find also that there is no difference between pre and post the GFC. From *Discriminant function analysis*, **AGE** was the strongest predictor in discriminating the two types of banks while **Z-score** was the next in importance as a predictor.

JEL classification: G01 G21 G28 G32 Z12
Keywords: Financial stability, Profitability, Liquidity, Credit and Insolvency risk, 6 MENA countries and Turky, interest-free banking, **GFC** ,Panel Non linear model (Logit, Probit), Univariate analysis, Linear regression.

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I. Introduction

Our study investigates the differences between interest-free (islamic) and conventional banks in terms of financial characteristics. **Four** hypothesis will be investigated. The first one is about **profitability**, the second is about **liquidity**, the third is about **credit** and insolvency **risks,** and the forth is about **stability**. This paper contributes to the empirical literature on interest-free finance by investigating the feature of interest-free (IB) and conventional banks (CB) using a sample of 115 banks (80 conventional and 35 interest-free banks) from Turky and 6 MENA countries over the period 2005–2014. [3] Four technic are considered to do so. In a first stage, we give an univariate analysis based on t-test statistic. In the second stage, we run several linear regressions based on OLS method. And, in the third stage, a discrimination analysis based on **nonlinear panel model** for **Binary Outcome** Data such as **Probit and logit model** is conducted. In the Forth stage, a Discriminant function analysis is conducted.

Our first hypothesis is about bank profitability.[4] We use the return on assets (ROA) and the return on equity (ROE) as proxies for bank profitability. These two proxies are widely used in the empirical banking literature.[5] The main empirical results of previous studies showed that IB are more profitable than conventional banks (see (Iqbal, 2001); (Olson & Zoubi, 2008); (Abedifar, Molyneux, & Tarazi, 2013); (Beck, Demirguc -Kunt, & Merrouche, 2013); (Bourkhis & Nabi, 2013)). Hence, we formulate our first hypothesis as follows:

H_1 : IB are **more profitable** than CB.

Our second hypothesis is about liquidity. In general, banks face liquidity problem due to excess withdrawal from current and savings accounts and bank run. If withdrawals significantly exceed new deposits over a short period, then banks get into liquidity trouble. **Cash** ratios measure the bank'sability to meet its short-term obligations. Higher ratios denote higher liquidity. Thus, **higher** liquidity ratios are generally associated with **less** risk. We use liquidity ratios cash to assets ratio, and the cash to deposits ratio. (CTA, and CTD), as proxies for liquidity.

[3] The countries are : Turky, Egypt, Tunisia, Bahrain , UAE, Quatar, and Jordan.

[4] (Hassoune, 2002) shows that islamic banks (IB) are more profitable than their conventional peers.

[5] The main empirical results of previous studies showed that interest-free banks are more profitable than conventional banks.

IB does not have enough investment opportunities since it is allowed to invest only in Sharia approved projects.[6] Therefore, IB are likely to maintain high capital buffers to mitigate liquidity risk. Previous empirical studies showed that interest-free banks maintain higher level of liquidity ratios compared to conventional banks (see (Metwally, 1997); (Bourkhis & Nabi, 2013)). Hence, we formulate our second hypothesis as follows :

H_2 : IB hold **higher liquidity** than CB.

Our **third hypothesis** is about credit and insolvency **risks**. Previous empirical results suggest that the two groups of banks may be differentiated in terms of risk (Metwally, 1997).

Credit risk is the possibility that a borroweror counter party will fail to meet its obligations for repayment in accordance with the conditions stipulated in the contract. A failure to repay leads to a loss for the creditor and therefore becomes a risk for the bank. IB may have lower credit risk compared to conventional banks due to the religiosity of clients that enhances loyalty and mitigates default and/or due to their special relationship with their depositors (Abedifar, Molyneux, & Tarazi, 2013).

Islamic finance requires symmetry of information and transparency in transactions since Islam prohibits excessive uncertainty (gharar). Also, gambling (maysir) is banned, meaning that excessive risk taking is not permitted. Some types of Islamic financial modes based on mark-up (e.g. Murabaha, Ijaras, and Istisnaa) require investors to engage in the real economy and hence that a real asset underlies the financial transaction. This feature allows the IB to have a clearer view on the allocation of its funds and to reduce their exposure to speculative behavior. Respect of these principles should decrease the moral hazard problems. Therefore, the risk level should be **lower** for interest-free banks than for their conventional peers.

Most empirical studies suggest that IB are less risky than conventional banks (see, (Abedifar, Molyneux, & Tarazi, 2013); (Beck, Demirguc -Kunt, & Merrouche, Islamic vs. conventional banking: business model, efficiency and stability, 2013)). However, (Čihák & Hesse, 2010) argue that the more difficult access to liquidity put pressures on IB to be more conservative (resulting in less moral hazard and risk taking).

[6] Interest-free banks also have restricted access to the inter-bank market and the central bank (as lender-of-last resort), which challenges liquidity management.

We use **six indicators** : 4 of credit risk [the ratio of loan loss reserves to gross loans (LLR)[7] , Non-performing loans to gross loans (NPL), Loans to assets (LTA) and Loans to deposits (LTD)][8] and 2 for insolvency risk [Deposits to assets (DTA) and **Z-score**]. All these proxies are widely used in the empirical banking literature (see (Olson & Zoubi, 2008); (Abedifar, Molyneux, & Tarazi, 2013); (Beck, Demirguc -Kunt, & Merrouche, 2013); (Bourkhis & Nabi, 2013), (Ben Khediri, Charfeddined, & Ben Youssef, 2015)).

High debt to assets ratio (DTA) is assumed to be indicator of **high** leverage and therefore **higher risk** of insolvency. Hence, a **low** value of DTA implies that the bank is more capitalized and so **more solvent**.
Hence, we formulate our hypothesis as follows:

H3 : IB are **less risky** than CB.

Our **forth** hypothesis is about stability. In regard to financial stability, the theory and practice of Islamic banking do not give a clear answer concerning whether IB should be more or less financially stable than traditional banks. On the one hand, the pass-through role and risk-sharing arrangements of IB might be a risk-reducing factor. Specifically, interest rate risk – well known feature of any risk management tool and stress test of conventional bank – should be absent from IB. In addition, *adverse selection* and *moral hazard* concerns might be reduced in interest-free banks if depositors have stronger incentives to monitor and discipline. Further, IB can be assumed to be more stable than conventional banks, as they are not allowed to participate in risky trading activities. On the other hand, the restrictions of IB to certain asset classes, the limited use of hedging instruments and the lack of high-quality liquid assets such as Sharia-compliant government bonds can increase the riskiness of Sharia-compliant financial institutions.

In regard to financial stability, the theory and practice of Islamic banking do not give a clear answer concerning whether Islamic banks should be more or less financially stable than traditional banks. The first line of argument supporting the idea that Islamic banks should be more stable is based on the use of profit/loss sharing (PLS) contracts in Islamic banking. This is believed to act as a financial buffer to absorb shocks with investment accounts holders so that any shocks to the assets of PLS contracts can be absorbed on the liabilities side ((Bourkhis & Nabi, 2013) (Čihák & Hesse, 2010)).

[7] As a proxy for credit risk, LLR represents managers' assessment of the quality of the loan portfolio, including performing and non-performing loans. LLR takes into account the past performance and the expectation for future performance of the existing loan portfolio.
[8] LTA and LTD are proxy for credit risk exposure.

Most empirical studies suggest that interest-free banks are less stable than conventional banks. The research employs the Z-score variable for comparison of stability between the both types of banking.[9] For a review see (Boyd & Runkle, 1993); (Čihák & Hesse, 2007); (Iwamoto & Mori, 2011); (Laeven & Levine, 2009); (Lown, Osler, Sufi, & Strahan, 2000); (Maechler, Worrell, & Mitra, 2007) ; and (Alqahtani & Mayes, 2018).

Hence, we formulate our hypothesis as follows:

H_4 : IB are **less stable** than CB.

This study proceeds as follows: After a brief introduction (section I) listing the hypotheses to be tested in this study, section II give an empirical review. Section III describes the data and defines the ratios used in the study. Section IV gives a univariate descriptive comparative study between IB and CB based on *t-test* statistic. Section V presents some OLS *linear regession* model results, while Section VI discusses results for non linear Panel model and discrimination analysis based on *Logit and Probit* models (non linear models) and on *Discriminant function analysis*. Section VII concludes.

II. Empirical Review

All over the world, many countries currently experience a dual banking system where Islamic banks operate side by side with conventional banks. In the last two decades, the number of Islamic banks significantly increased and their geographical spread has grown exponentially to cover all continents. In view of the rapid growth of Islamic banking, recent researches have examined and compared different aspects (Profitability, efficiency, liquidity, risk, stability, etc.) of this new form of banks and conventional ones using financial ratios.

A vast empirical literature compares IB and CB in terms of their **financial indicators** (e.g. (Ahmad & Hassan, 2007); (Awan, 2009); (Bashir, 2003); (Beck, Demirgüç-Kunt, & Merrouche, 2013); (Chowdhury, Haque, & Masih, 2016); (Jaffar & Manarvi, 2011); (Kassim & Abdulle, 2012); (Miniaoui & Gohou, 2013); (Olson & Zoubi, 2008); (Olson & Zoubi, 2011); and (Parashar & Venkatesh, 2010).

However, empirical studies investigating the **financial stability** of IB are still limited (see (Abedifar, Molyneux, & Tarazi, 2013); (Beck, Demirguc -Kunt, & Merrouche, 2013); (Bourkhis & Nabi, 2013); (Čihák & Hesse, 2010); (Rajhi &

[9] The higher the Z-score is the lower is the bank's default risk.

Hassairi, 2013), (Alqahtani & Mayes, 2018)).[10] Taking **size** into account and regarding the impact of the GFC (Global Financial Crisis), the results indicate that **large** commercial banks tend to be *more stable* than large IB and small IB are more stable than **small** commercial banks (Abedifar, Molyneux, & Tarazi, 2013); (Čihák & Hesse, 2010), and (Alqahtani & Mayes, 2018)). [11]

Other literature compares interest-free and conventional banks in the question of **operational efficiency** (e.g. (Abdul-Majid, Saal, & Battisti, 2010); (Bader, Mohamad, Ariff, & Hassan, 2007); (Brown, Hassan, & Skully, 2007); (Rosman, Wahab, & Zainol, 2013); (Srairi, 2010); (Sufian, 2007); (Yahya, Muhammad, & Hadi, 2012)).

In addition some previous studies reveal that Islamic banks hold more **capital** than conventional banks. In fact, (Olson & Zoubi, 2008) show that liabilities to shareholder's capital ratio are significantly smaller at Islamic banks in GCC countries. (Metwally, 1997) shows also that total capital to asset ratio is a good discriminator between Islamic and conventional banks.[12] (Iqbal, 2001) argues also that capital to asset ratio is higher for Islamic banks.[13]

The present study contributes to the ongoing debate by conducting a formal empirical analysis, taking account of a **range of considerations** that to the best of our knowledge have not been considered by prior studies for Turky and MENA zone.

III. Data Analysis

We use banks from the MENA region and Turkey over the period 2005–2014 covering the 2008 GFC. We use a sample that comprises only countries with both conventional and interest-free banks. Bank-level data is collected from the Bankscope database. We also double check the categorization of IB in Bankscope with information from Islamic Banking Associations and country-specific sources. [14] The sample includes 80 CB and 35 IB operating in **seven** different

[10] In short, without taking size into account, (Bourkhis & Nabi, 2013) ; (Čihák & Hesse, 2010); and (Rajhi & Hassairi, 2013) find IB are **more** financially **stable** than CB, whereas ; (Beck, Demirguc -Kunt, & Merrouche, 2013) find the opposite.

[11] For more details on empirical review see Table A 2 in Annexe.

[12] Metwally (1997) suggests that the lower is total deposits to assets ratio, the more likelihood that the bank is an Islamic one. He suggests also that the higher is the capital to asset ratio, the higher the probability that the bank is an Islamic one.

[13] (Samad & Hassan, 2000) reveal that Islamic banks have lower debt to asset ratio compared to conventional banks in Malaysia.

[14] We remplace outliers in all variables by means within each country.

countries (Turky, Egypt, Tunisia, Bahrain, United Arab Emirates, Qatar, and Jordan), consisting of 996 bank-year observations.

Table 1 lists the number of CB and IB and observations in each country. Bank list by country is given at **Table A 1** in Annexe.

In this paper, fourteen financial ratios have been considered. In **Table 2**, we classify these ratios into five groups**: profitability** ratios (ROA, and ROE), **liquidity** ratios (CTA, and CTD), **credit risk** (LLR, NPL, LTA, LTD), **insolvency** risk (DTA), and **asset structure** ratios (FAA, OBSIA). Regarding the later ratios, we use fixed assets to assets ratio, and off-balance sheet items to assets ratio to account for the operating leverage, and off-balance sheet activities, respectively.[15]

We use the Z-score as measure of bank **stability**; this indicates the distance from insolvency, combining accounting measures of profitability, leverage and volatility, which has been widely used in the literature [see for example (Laeven & Levine, 2009), (Houston, Lin, Lin, & Ma, 2010), etc].[16] Z-score indicates the multiple of a **bank's equity buffer** before it falls into the state of default. In this sense, the **higher** the Z-score the **lower** is the bank's default risk.

We present **descriptive statistics** (average value for conventional and interest-free banks for each variable, number of observation, as well as standard deviation) at **Table A 3** (see Appendice A). In first stage, we compare volatilities. Z-score and FAA are more volatil for Conventional Banks, while CAP, ROA, CTD, and LTD are more volatil for IB.

In second stage, in order to investigate the evolving behavior of all banks, we do an univariate analysis over the pre-crisis period (2005–2008) and the post-crisis period (2009–2015). In **Table 3** and **Figure 1,** we compaire means for all variables Pre and Post GFC.

Concerning the **profitability**, the mean values of ROA and ROE of all banks **Pre** GFC are 2.4% and 13.61%, respectively, while the corresponding figures for all banks **Post** GFC are 1.05% and 9.69%. The differences between the two periods are statistically significant. In terms of evolution, there is slight **decrease** in

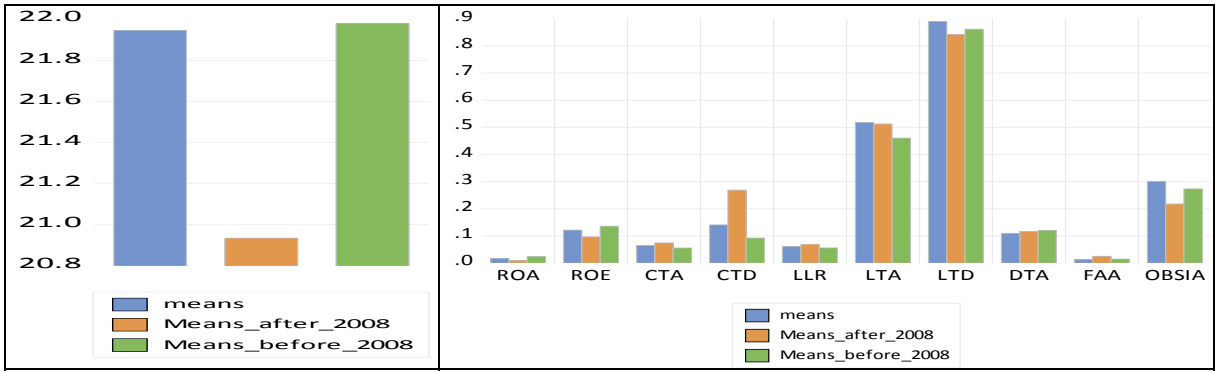
[15] These ratios are used in the previous empirical banking literature (see (Pasiouras & Kosmidou, 2007), (Srairi, 2010), and (Ben Khediri, Charfeddined, & Ben Youssef, 2015).

[16] The variable Z-score can be calculated as Z-score $_{ijt} = \frac{ROA_{ijt}+(EQ/TA)_{ijt}}{\sigma_{ROA}}$, for bank i, country j, in year t, where ROA is the standard measure of return on asset, Equity to Assets ratio (ETA= EQ/TA), and σ_{ROA} is the fluctuation of ROA indicated by the standard deviation.

profitability for all banks. This is a clear indication that the financial crisis has a **negative** impact on the **profitability** for all banks.

Second, evidence shows that the **liquidity** of all banks, measured by either cash to assets ratio (CTA) or cash to deposits ratio (CTD), is statistically different during the two periods (before and after GFC). The mean values of CTA and CTD of all banks Pre GFC are 5.6% and 9.25%, respectively, while the corresponding values Post GFC are 7.5% and 26.89%. The differences between the two periods are statistically significant (at 1% and 10% level respectively). In terms of evolution, there is an **increase** in **cash holdings** after the crisis for all banks.

Third, regarding the asset **quality**, as measured by loans to assets ratio (LTA), loans to deposits ratio (LTD), and non-performing loans to loans ratio (NLP), we do not find any significant differences Pre and Post the financial crisis for LTD. While for LTA and NPL differences Pre and Post GFC are significant (at 5% level). In terms of evolution, there is an **increase** in **credit risk**.
However, in respect to loans loss reserves to loans ratio (LLR), the difference Pre and Post GFC is statistically significant at 10% level, indicating that all banks have **more credit risk** after the crisis. Regarding the **insolvency** risk, evidence shows that leverage, as measured by debt to assets ratio (DTA), there is no difference for overall periods even at 10% level. Moreover, all banks are better capitalized **(CAP)** after crisis. CAP is bigger but difference is not significant. The Z-score mean value is lower Post GFC but difference with pre GFC mean value is not significant for all banks. Finally, regarding the **asset structure**, evidence shows that all banks have, on average, **lower o**ff-balance sheet items to assets ratio (OBSIA), **bigger** Size, and **higher** fixed assets to assets ratio (FAA) after the GFC. However, FAA is bigger Post GFC but difference is not significant.



Z-score **Others**

Figure 1: Comparison of means for all variables Pre and Post GFC.

Table 1: Sample description **(Turkey & MENA) :**[17]

Code	Country	IB		CB		IB (%)
		No bank	No obs	No bank	No obs	
1	Turky	4	35	17	155	19.05
2	Egypte	2	12	15	118	11.76
3	Tunisia	2	20	14	121	12.5
4	Bahreïn	16	135	7	66	69.57
5	UAE	4	44	11	92	33.33
6	Qatar	3	24	6	58	33.33
7	Jordan	3	22	10	94	23.08
	Total	**35**	**292**	**80**	**704**	**30.43**

Table 2: Definition of variables.

Ratios	Definitions
Profitability	
ROA	Return on assets = Net income/Total assets
ROE	Return on equity = Net income/Stockholders' equity
Liquidity	
CTA	Cash to assets = Cash/Total assets
CTD	Cash to deposits = Cash/Total customer deposits
Credit risk	
LLR	Loans loss reserves to gross loans
NPL	Non-performing loans to gross loans
LTA	Loans to assets = Loans/Total assets
LTD	Loans to deposits = Loans/Total customer deposits
Insolvency risk	
DTA	Deposits to assets = Deposits/Total assets
Asset structure	
FAA	Fixed assets to assets = Fixed assets/Total assets
OBSIA	Off-balance sheet items to assets = Off-balance sheet items/Total assets

Table 3: Univariate Analysis, comparison of means **Pre and Post crisis** for **all banks.**

	2005-2014		2005-2007		2008-2014		Difference t-test
Variable	**Obs**	**Mean**	**Obs**	**Mean**	**Obs**	**Mean**	**p-value**
Zscore	**996**	**21.2469**	**298**	**21.97839**	**698**	**20.9346**	**0.4250**
CAP	1,005	.1781033	300	.1726107	705	**.1804406**	0.5626
ROA	1,002	.0145563	300	**.0240201**	702	.0105119	**0.0110**
ROE	995	.1086696	298	**.1360589**	697	.0969594	**0.0233**
NPL	679	.0717421	229	.0564999	450	**.0794986**	**0.0258**
CTA	1,002	.0693615	298	.0560346	704	**.0750027**	**0.0016**
CTD	855	.2107176	282	.0924885	573	.2689036	0.0761

[17] MENA: Middle East and North Africa. Source : Bankscope.

LLR	803	.0643819	290	.0562836	513	.0689598	0.0706
LTA	907	.4941354	327	.4608932	580	**.5128772**	**0.0153**
LTD	869	.8491909	313	.8619567	556	.8420044	0.6643
DTA	970	.1178643	289	.1208797	681	.1165846	0.7192
FAA	989	.0223785	305	.015441	684	.025472	0.5431
OBSIA	895	.2349003	272	**.2737671**	623	.2179312	**0.0010**
Size	1,006	3.111136	299	2.957979	707	**3.175908**	**0.0372**

Notes: This table reports the mean of financial ratios for all banks, and the p-value for the t-test of differences in means between the two periods.

IV. Univariate analysis : comparing **CB and IB** banks

A. For overall period

At **Table 4**, we present mean for each variable for all banks, average value for conventional and IB as well as the p-value of a two-sided t-test. The univariate analysis shows that IB are significantly **different** from conventional banks at 5% level with respect to the most variables used in this study, see **Table 4**. **The profitability**, as measured by the ROE, is higher for conventional banks than for interest-free peers. The ROE of 12.8% for conventional banks versus 6.08% for IB is significantly larger at the 5% level. This finding is not in line with the first hypothesis (H_1). However, when we use the ROA as proxy of profitability, we do not find any significant difference between IB and CB.[18]

Regarding the second hypothesis, when the differences in **liquidity** between IB and CB are significant, interest-free **banks are more liquid.** We find that IB hold more cash to deposits, CTD averages 46.1% for IB versus 13.1% for conventional banks. The difference is statistically significant at the 1% level. This result corroborates the second hypothesis (H_2). But in terms of cash to assets (CTA), it does not seem that the two types of banks are different. CTA averages 6.5 % for IB versus 7.1% for conventional banks. The difference is not statistically significant even at the 10% level.

Regarding the credit risk exposure, the average loans to assets ratio (LTA) of IB stands at 47.38% versus 50.25% for CB and the average loans to deposits ratio (LTD) for the two bank types are 98.66% and 79.73%, respectively. The difference is statistically significant only for the LTD ratio at 1% level.[19] Regarding the third hypothesis, when the differences in insolvency **risk,** in term

[18] (Abedifar, Molyneux, & Tarazi, 2013) argue that the religious depositors may be more loyal and prepared to take lower returns, refusing from withdrawing deposits even if the performance of the bank deteriorates. Therefore, the IB's profitability is less volatile than that of the conventional one.

[19] These results show that IB intermediate more of the deposits they receive and engage more in financing economic activity via lending compared to conventional banks.

of dept to asset ratio (DTA), between IB and CB are significant, IB have lower average (8.9%) than conventional bank (12.8%). This implies that the interest-free bank is **more capitalized** and so **more solvent**. We also consider the importance of **stability**. The pairwise analysis suggests that overall, **conventional** banks are on average significantly **more stable** as indicated by **Z-scores**, and also have a lower probability of default than IB over the entire period.[20]
Interest-free bank are then less profitable, less stable, more liquid, have **higher credit risk** but are **more solvent than conventional banks.**

Table 4 : Comparison **of means** between **CB vs IB** : Descriptive statistics for both types of banks, with p-values for Student t statistic.

Variable	ALL	CB	IB	Difference t-test p-value
Zscore	**21,2469**	24,56965	12,83398	**0.0000**
Capital adequaty ratio CAP	**0,1781033**	**0,1258643**	**0,3113774**	**0.0000**
Return on assets ROA	0,0145563	0,0148787	0,0137452	0.8338
Return on equity ROE	**0,1086696**	**0,1276067**	**0,0607897**	**0.0001**
Cash to assets CTA	0,0693615	0,071153	0,0648099	0.2998
Cash to deposits CTD	**0,2107176**	**0,130259**	**0,4609902**	**0.0024**
Non-performing loans to gross loans NPL	0,0717421	0,071239	0,0730088	0.8703
Loans loss reserves to gross loans LLR	0,0643819	0,0660568	0,0602344	0.4342
Loans to assets LTA	0,4941354	0,5025245	0,4738117	0.2052
Loans to deposits LTD	**0,8491909**	**0,7973383**	**0,9866655**	**0.0001**
Debt to assets DTA	**0,1178643**	**0,1281966**	**0,0895002**	**0.0017**
Fixed assets to assets FAA	0,0223785	0,0252381	0,0151735	0.5513
Off-balance sheet items to assets OBSIA	**0,2349003**	**0,2521895**	**0,1940171**	**0.0006**
Size	3,111136	3,119207	3,090518	0.7875

Note : Two sided p-value.

B. For post and pre GFC

Again, in order to investigate the evolving behavior of IB and CB and to test the sensitivity of our results, we repeat the univariate analysis over the pre-crisis period (2005–2008) and the post-crisis period (2009–2015). **Table 5** reports comparison of means for all ratios Pre (Panel A) and Post (Panel B) Global Finance crisis (GFC) beween **IB and CB**. Based on the evolution of the ROA (and ROE), we conclude that the IB **outperform** the conventional banks before (and post) the financial crisis. The **Z-score** and OBSIA evolution are **lower** for

[20] These findings are in line with those of (Beck, Demirguc -Kunt, & Merrouche, Islamic vs. conventional banking: business model, efficiency and stability, 2013) and (Alqahtani & Mayes, 2018) but contradict previous evidence of (Čihák & Hesse, 2010) and (Rajhi & Hassairi, 2013).

IB pre and post GFC with significant difference. But FFA evolution are lower for IB only pre GFC with significant difference. Evidence shows that the **liquidity** (Capital adequaty) of IB, measured by cash to deposits ratio CTD (CAP), is statistically **higher** during the **two** periods (before and after GFC). Regarding the **insolvency** risk (**credit rik**), evidence shows that leverage as measured by debt to assets ratio DTA (asset quality measured by LTD) is **lower** (higher) for interest-free banks for only post (pre) GFC periods.

Table 5: Descriptive statistics of variables (average values) and Difference t-test

	Panel A : Pre-crisis period **2005-2007**						**Panel B : Post-crisis** period **2008-2014**				
	Obs CB	**CB**	**Obs IB**	**IB**	**Difference t-test p-value**		**Obs_CB**	**CB**	**Obs_IB**	**IB**	**Difference t-test p-value**
Zscore	**222**	**25.05958**	**76**	**12.97805**	**0.0000**	**Zscore**	**492**	**24.34858**	**206**	**12.78082**	**0.0000**
CAP	223	**.130612**	**77**	**.2942432**	**0.0000**	**CAP**	**499**	**.1237425**	**206**	**.317782**	**0.0000**
ROA	222	**.0160953**	**78**	**.0465755**	**0.0000**	ROA	495	.0143331	207	.0013744	0.0652
ROE	222	.1298856	76	.1540914	0.2769	**ROE**	**491**	**.1265763**	**206**	**.0263677**	**0.0000**
NPL	159	.0522647	70	.06612	0.3775	NPL	327	.0804651	123	.0769293	0.8047
CTA	221	.0579152	77	.0506372	0.5539	CTA	498	.0770276	206	.0701075	0.3209
CTD	**213**	**.0740567**	**69**	**.1493868**	**0.0069**	**CTD**	**434**	**.1578422**	**139**	**.615671**	**0.0046**
LLR	203	.0573145	87	.053878	0.7420	LLR	369	.0708662	144	.0640747	0.5001
LTA	226	.4687335	101	.4433497	0.3954	LTA	416	.5208821	164	.4925719	0.3651
LTD	**223**	**.78645**	**90**	**1.049046**	**0.0067**	**LTD**	**408**	**.8032896**	**148**	**.9487318**	**0.0073**
DTA	221	.1218992	68	.1175665	0.8269	**DTA**	**490**	**.1310369**	**191**	**.0795081**	**0.0008**
FAA	**219**	**.0170884**	**86**	**.0112458**	**0.0150**	FAA	489	.028888	195	.0169058	0.6231
OBSIA	**193**	**.2953927**	**79**	**.2209349**	**0.0125**	**OBSIA**	**436**	**.2330652**	**187**	**.1826455**	**0.0143**
Size	222	2.962104	77	2.946085	0.9304	Size	501	3.188821	206	3.144505	0.7328

Notes: This table reports the mean of financial ratios for IB and CB, and the p-value for the t-test of differences in means between the two groups of banks.

V. Regression analysis: Comparing IB, WB and CB

Using univariate analyisis, there is significant evidence that banks are less profitable, more liquid, riskier, and less stable **post GFC**. Compaired to conventional banks, interest-free banks are **riskier** and less stable, but have a higher liquidity, and are **less** profitable. This is true also for pre GFC as well as for post GFC. While univariate comparisons show significant differences between IB and CB, these differences could be driven by other bank and/or country characteristics. This is to be done within **regression estimation**. Different regression models are considered in this section. First, we Compare interest-free and CB controlling for *bank characteristics*. Second, we Compare IB and CB cross different *Size groups*. Third, we do analyse *cross countries* difference. Forth, we take account of *Market share* side for each type of banks.

All the variables under the study must be **stationary otherwise spurious regression** may be found. Henceforth, Levin, Lin & Chu, ADF - Fisher Chi-square, and PP - Fisher Chi-square Unit Root Tests for PANEL data have been implemented to ensure that all the bank specific variables in the regression equation are **stationary**.[21] The result is shown in **Table A 8**: Panel A for all banks (see Appendice A). All considered bank caracteristic variables are stationary except OBSIA and Size. Five of Bank specific variables are not stationary : Z-score, NPL, LLR, DTA, and CAP. [22] A **trend** variable will then be added in regressions for non stationary variables. Focusing on a sample of countries with both types of banks allows us to control for unobserved time-variant country-specific effects by introducing **country-year** dummies, thus a clearer identification of such differences than when comparing banks from different countries.

C. Controlling for bank characteristics

While univariate comparisons show significant differences between IB and CB, these differences could be driven by other bank characteristics. To assess differences in Profitability, Liquidity, Credit risk, Insolvency, and stability across different bank types, we therefore run the following regression:

[21] For a discussion on the choice of adequate test see Appendice B. Hence, for our case, none of reported sample conditons in Table B1 is true. Results depend also on stability hypothesis of considered series. Looking at time series plot (by country) for each variable (not reported in this paper for space constraint), instability can be present at date indicated at **Table A 8**. So these results are not accurate. We have rather to apply unit root test which take account of possible structural change in considered series.

[22] Panel B for Conventional banks, and Panel C for IB.

$$Y_{i,j,t} = \mu + \beta Trend_t + \gamma\, IB_i + \boldsymbol{\alpha}\, \boldsymbol{CB_i} + \mu_{jt} C_j Y_t + \boldsymbol{\delta}\, X_{i,j,,t} + \pi D2008 + u_{ijt} \quad (1)$$

where $X_{i,j,,t}$ is vector of Bank **caracteristics**,

$$X_{i,j,,t} = (\text{AGE}_{i,j,,t}\ , \text{Size}_{i,j,,t}, \text{Growth}_{i,j,,t}, FAA_{i,j,,t}, \text{OBSIA}_{i,j,,t})',$$

where

Age = Number of years since the bank was incorporated,

Size = Log(Total asset),

Growth = Log(Total assets) - Log(Total assets$_{-1}$),

$Y_{i,j,t}$ is one of our measures of Profitability, Liquidity, Credit risk, Insolvency, and stability of bank i, for country j, in year t, $C_j Y_t$ are **country-year-fixed effects,** IB_i is a **dummy** taking the value one for interest-free **banks**, CB_i is a **dummy** taking the value one for conventional bank, WB_i is a **dummy** taking the value mines one for conventional bank with islamic window (IW), $D2008$ is a dummy variable for GFC (taking the value one from year > 2008), and u_{ijt} is an error term. We thus compare IB and CB with or without IW.

The results in **Table A 4** show that within countries and years, IB have higher Cash to deposits (CTD) and higher CTA, higher Loans to deposits (LTD), higher LTA and NPL, higher Capital adequaty ratio (CAP), lower Debt to assets (DTA), and lower Z-score than **conventional** banks (with or without IW). **IB show then higher liquidity and credit risk, are more capitalized and more solvent, and have lower stability**. The magnitude of these differences is also meaningful, with IB having a 39.9% point higher Cash to deposits, 27.8% point higher Loans to deposits (LTD), 7.8% points higher CAP, 5.13% points lower Debt to assets (DTA), and a 485.12% point lower Z-score. **Table A 4** is summed up at **Table 6**. Also from these Tables**,** we can say that conventional banks without IW have lower liquidity (20.13%), lower credit risk (LTA) and NPL, and higher Debt to assets (DTA), CAP, and Z-score than IB and WB.

Table 6: Significant factors for IB and CB: Controlling for bank characteristics (Equation(1)).

	Capitalisation	Profitability	Liquidity	Credit risk		Insolvency	Stability
IB	+		+	+	-	-	-
CB	+		-	-	-	+	+

Note : For credit risk, signs are given respectively for LTA, LTD, LLR, and NPL. In this Table results of Profitability is measured by ROA and ROE, Liquidity is measured by CTA and CTD, Insolvency is measured by DTA, and instability is measured by Z-score. . Empty cells suggest that the determinant was not significant.

D. Cross different Size groups

Here we split the sample of all banks according to their asset **Size**. Specifically, we split the sample into banks above the 50th percentile (**Large** banks) and banks below the 50th percentile (**Small** banks). [23]

Taking into account differences **in Size**, we use additional specifications, including interacting the IB dummy with Size dummies. We allow for clustering of the error terms on the bank level, i.e. correlation among the error terms across years within banks. We therefore run the following regressions:

$$Y_{i,j,t} = \mu + \beta\, Trend_t + \gamma\, LIB_i + \alpha\, LWB_i + \delta\, LCB_i + \mu_{jt} C_j Y_t + \pi D2008 + u_{ijt} \quad (2)$$

Where $Y_{i,j,t}$ is one of our measures of Profitability, Liquidity, Credit risk, Insolvency, and stability of bank i, for country j, in year t, $C_j Y_t$ are **country-year-fixed effects**, LIB_i (SIB_i) is an Inetraction term between **large** bank and IB (a dummy variable equal to 1 if IB is large (Small), 0 otherwise)**,** LWB_i (**SWB_i**) is an Inetraction term between large bank and conventional bank with window (a dummy variable equal to -1 if conventional bank with IW is large (Small), 0 otherwise) , LCB_i (**BCB_i**) is an Inetraction term between large bank and conventional bank without window (a dummy variable equal to 1 if conventional bank without IW is large (Small), 0 otherwise), $D2008$ is a dummy variable for GFC (taking the value one from year > 2008, and u_{ijt} is an error term. We thus compare IB and CB with or without IW.

The results in **Table A 5** show that **small** IB have higher Return on equity (5.8% ROE), higher LTA (9.9%), higher Capital adequaty ratio (4.4% CAP), and higher Z-score (6.5%) than Small **conventional** banks (with or without IW). While Small **conventional** banks have higher LTD (31.27%), higher LTA (16.3%), lower Z-score (-14.99%), higher CAP (10.45%), and lower ROE (-5.3%) than small IB and small WB.

Table A 5 is summed up at **Table 7**. As shown from **Table 7**, there are significant differences between IB and CB of different Sizes and that many of the findings so far on differences between IB and CB are **driven by smaller** IB.

[23] Large Bank = Dummy variable equal to 1 if bank is large (size > median), 0 otherwise.

Table 7: **Significant** factors for IB, WB, and CB : Cross different **Size** groups (Equation(2)).

	Capitalisation	Profitability	Liquidity	Credit risk	Insolvency	Stability
LIB	-	-		-		-
LWB	+	-	- +	- + +		
LCB	-	+	+	- - -		+
D2008	+	-	+ +	+ + +		

Note : For credit risk, signs are given respectively for LTA, LTD, LLR, and NPL. In this Table results of Profitability is measured by ROA and ROE, Liquidity is measured by CTA and CTD, Insolvency is measured by DTA, and instability is measured by Z-score. Empty cells suggest that the determinant was not significant.

E. Cross countries

To controll for **country** caracteristic in assessing the differences across different bank types, we therefore run the following regression:

$$Y_{i,j,t} = \mu + \beta Trend_t + \sum_j \beta_j \boldsymbol{C_j IB_i} + \pi\, D2008 + \boldsymbol{\delta}\, X_{i,j,,t} + \mu_{jt} \boldsymbol{C_j Y_t} + u_{ijt} \quad (3)$$

where X is vector of Bank caracteristics,

$$X_{i,j,t} = (\mathrm{AGE}_{i,j,,t}\ , \mathrm{Size}_{i,j,t}, \mathrm{Growth}_{i,j,t}, FAA_{i,j,t}, \mathrm{OBSIA}_{i,j,t}),$$

where $\mathrm{AGE}_{i,j,,t}$ is the Number of years since the bank was incorporated, $\mathrm{Size}_{i,j,,t}$ = Log(Total Asset), $\mathrm{Growth}_{i,j,,t}$ = Log(Total Assets/Total Assets$_{-1}$), $Y_{i,j,t}$ is one of our measures (of Profitability, Liquidity, Credit risk, Insolvency, and stability) of **bank i, for country j**, **in year t**, C_j is indicator vriable for country j = 1, …, 7, IB is dummy variable equal to 1 if bank i is islamic and zero otherwise, $\boldsymbol{Y_t}$ is a dummy variable equal to 1 for year t and zero if not, $C_j Y_t$ are **country-year-fixed effects**, $C_j IB_i$ **is a country-IB** indicator**,** $D2008$ is a dummy variable for GFC (taking the value one from year > 2008), $Trend_t$ is for non stationary dependent variable, and u_{ijt} is an error term. We thus compare IB and CB. OLS results of regression (3) for each group of considered measures are given at **Table A 6**.

Table A 6 presents results using regression Equation (3) where we interact the IB dummy with country dummies to explore whether the differences between conventional and IB vary across our 7 countries. As we interact the IB dummy with all 7 country dummies, we drop the IB dummy itself. In addition, the interaction term with country-year dummy is not reported for all variables as the number of interactions is large. The results in **Table A 6** show a large cross-country variation in the differences between IB and CB. Take the example of **profitability**; IB are **less** profitable than conventional banks in Egypt (-1.3%) and

Turky (-1.1%), while in Tunisia IB have more ROA(0.9%).[24] There is a large variation in the differences between IB and CB in **credit risk** across our sample countries, with riskier IB (having higher LTA in Turky (10.8%) and Jordan (11.1%), more LTD in Egypt (10.4%), UAE (37.2%), Quatar (27.4%), and Jordan (183.8%), more LLR (10.2%) and NPL (19.4%) in Egypt).[25] The difference in **liquidity** (CTA) between IB and CB again varies across countries; though IB show higher liquidity in Turky (4.9%), and lower liquidity in Quatar (-2.3%). The differences are not significant for other countries. Where the differences in **stability** (Z-scores) between IB and CB are significant. IB are **less** stable, with he exception of Turkey, Bahrain, and UAE where they are significantly more stable. The differences in **insolvency** (DTA) between IB and CB are significant in 4 countries. On the other hand, IB are better **capitalized** (CAP) than conventional banks in Bahrain (27.9%) and Quatar (2.8%), with an opposite case for Egypt (-4.7%) and Turkey (-5.2%) where IB are significantly less capitalized than conventional banks. The positive (negative) and significant coefficient on the IB dummy post GFC is **true** in the CTA, CAP, DTA, and Z-score (ROE and LTA) regressions. All these results are summed up in **Table 8** here after. As it is clear from **Table 8,** and in accordance with univarite results, Negative P**rofitability** is driven by Egyptian and Turkish IB, **Liquidity** is driven by Turkish IB, **Instability** is driven by Egyptian, Tunisian, Quatarian and Jordanian IB, while **credit risk** is driven by all IB except Tunisian IB which are more profitable. **Solvency** of IB is driven by Turkish, Egyptian, Tunisian, and Bahreïnien IB.

Table 8 : **Significant** factors for IB by country (Equation(1)).

Country	Profitability	Liquidity	Credit risk	Insolvency	Stability
1 Turky	-	+	+ - -	-	
2 Egypte	-		+ + +	-	-
3 Tunisia	+		- -	-	-
4 Bahreïn			+ - -	-	
5 UAE			+ -		
6 Qatar		-	+ -		-
7 Jordan			+ + -		-

Note : For credit risk, signs are given respectively for LTA, LTD, LLR, and NPL. In this Table results of Profitability is measured by ROA, Liquidity is measured by CTA, Insolvency is measured by DTA, and instability is measured by Z-score. Empty cells suggest that the determinant was not significant.

In the following section, we therefore explore whether some of these cross-country differences are driven by different market shares of interest-free banks.

[24] **Table A** 6 results suggest that IB in Egypt and Turky have lower ROA.

[25] While having lower LTA in Tunisia, lower LTD in Turky, lower LLR in Turky, Bahrain, and Jordan, and less NPL in Tunisia, Bahrain, UAE, and Quatar.

F. Market share

Taking into account differences in **Market share**,[26] we use additional specifications, including **interacting** the IB dummy with Market share variable. We therefore run the following regression: [27]

$$Y_{i,j,t} = \mu + \beta\, Trend_t + \gamma\, ShareIB_i + \delta\, IB_i + \mu_{jt} C_j Y_t + \pi D2008 + u_{ijt} \quad (4)$$

where

$ShareIB$ = Market share * IB,

Market share = Bank total assets /Country banks total assets * 100%,

IB_i is a **dummy** taking the value one for interest-free **banks,** $C_j Y_t$ are country-year-fixed effects**,** $D2008$ is a dummy variable for GFC (taking the value one from year > 2008), $Trend_t$ is for non stationary dependent variable, and u_{ijt} is an error term.

Then, we split the sample all banks according to their Market share. Specifically, we split the sample into banks above the 50th percentile (**high** Market share banks) and banks below the 50th percentile (**Low** Market share banks). We use additional specifications, including **interacting** the IB dummy with high Market share dummy. We therefore run the following regression :

$$Y_{i,j,t} = \mu + \beta\, Trend_t + \gamma\, HShareIB_i + \delta\, HShareCB_i + \mu_{jt} C_j Y_t + \pi D2008 + \boldsymbol{\delta}\, X_{i,j,t} + u_{ijt} \quad (5)$$

Where

HShare = 1 if Share ≥ Median market share = 0.0528857

HShareCB = HShare * CB

HShareIB = HShare * IB

$X_{i,j,t} = (\mathrm{AGE}_{i,j,,t}$, $\mathrm{Size}_{i,j,,t}$, $\mathrm{Growth}_{i,j,,t})$,

and CB_i is a **dummy** taking the value one for conventional bank, $HShareIB_i$ is an Inetraction term between high Market share bank and IB (a dummy variable equal to 1 if IB has high Market share, 0 otherwise)**,** $HShareCB_i$ is an Inetraction term between high Market share bank and conventional bank (a dummy variable equal to 1 if conventional bank has high Market share, 0 otherwise)**,** $D2008$ is a dummy variable for GFC (taking the value one from year > 2008), $Trend_t$ is for non stationary dependent variable, and u_{ijt} is an error term. We thus compare high Market share IB and high Market share CB. OLS results of regressions (4)

[26] Market share is the percentage of comparison between banks total asset and banks (see (Purboastuti, Anwar, & Suryahani, 2015) and (Aminah, Soewito, & Khairudin, 2019)).

[27] We allow for clustering of the error terms on the bank level, i.e. correlation among the error terms across years within banks. We prefer to cluster on the bank- rather than country-level, as some of the countries in our sample host significantly more banks than others and we have only 7 countries.

and (5) for each group of considered measures are given at **Table A 7** respectively in Panel A and Panel B.

The results in **Table A 7** show significant variation in the differences between conventional and IB across countries and years with different market shares of IB.[28] **In Panel A (equation (4))**, we introduce an interaction term between the market share of banks and the IB dummy. We also include country-year dummies and the IB dummy. **In Panel B (equation (5))**, we replace the IB dummy with two interaction terms of the bank dummy with dummies indicating country-year pairs with the IB share above the median market share of IB and the CB share above the median market share of conventional banks. While the **Panel A** results allow us to gauge the continuous variation of differences between IB and CB with different market shares of IB, **Panel B** allows us a direct comparison between countries and years with high market shares of IB and with high market shares of CB. Results of **Table A 7** are summed up at **Table 9**.

The **Panel A** regressions results of **Table 9** show that IB have relatively higher **liquidity** ratios (20.7%) and **lower credit** risk (-21.6% in NPL) than conventional banks in countries and years with **higher market** share of IB. While IB have **highe**r capitalisation (16.2%) and credit risk (4.7% in LTA and 18.6% in LTD) than CB. We continue to find that IB have **lower stability** (- 4940.0%) but **lower capitalisation** (-121.5%) than conventional banks in countries and years **with higher market** share of IB (although these differences do not vary significantly with IB). We continue to find also that IB have **less profitability** ratios (- 4.5%) and are **more solvent** (- 9.3%) than CB.

The **Panel B** results suggest that the higher liquidity of IB visa- vis conventional banks is driven by markets with higher market shares of IB. We also find that IB that are **more solvent** and are less **stable** (- 30.4% and - 65.5% respectively) in markets with above-median IB market shares, as the IB dummy enters significantly for these markets and is significantly lower than the IB dummy in markets with higher median IB market share (- 9.3% and - 4.3% respectively). While the lower credit risk ratio holds only for IB in markets with higher median IB market shares.

In summary, some of the cross-country variation in the differences between IB and CB (specially for insolvency and stability), established in **Table 8,** can be explained with differences in market shares for interest-free banks.

[28] One of the reasons why we observe the large cross-country variation in differences between conventional and IB might be different relative market shares of conventional and IB. Higher market shares for IB **might indicate** more established Sharia-compliant finance with repercussions for efficiency and regulatory approach but also for competitive responses by conventional banks.

Table 9 : **Significant** factors Comparing interest-free and conventional banks – controlling for **market shares**.

Panel A : Equation (4)

	Capitalisation	Profitability	Liquidity	Credit risk	Insolvency	Stability
IB	+	-	+	+ +	-	-
ShareIB	-		+	-		-
Panel B : Equation (5)						
	Capitalisation	**Profitability**	**Liquidity**	**Credit risk**	**Insolvency**	**Stability**
HShareIB			+	-	-	-
HShareCB	+			- -	+	+

Note : For credit risk, signs are given respectively for LTA, LTD, LLR, and NPL. In this Table results of Liquidity is measured by CTA, Insolvency is measured by DTA, and instability is measured by Z-score. . Empty cells suggest that the determinant was not significant.

VI. Discrimination study between IB and CB

We consider a binary outcome in which Y_{it} takes only the values 0 and 1. The dependent variable to be predicted is a categorical variable taking on the value of one for an Islamic bank and zero for a conventional bank ;

$$Y_{it} = \text{ 1 if Bank i is IB and zero if not}$$

Parametric model to consider is then the Panel probit or Panel Logit (non linear) regression. These models suppose that the probability of dichotomous outcome Y_{it} is related to a set of potential predictor variables X in the forms:[29]

$$P_i = P(Y_{it} = 1 \,/X) = \begin{cases} \Phi(\beta_{i0} + \sum \beta_k X_{kit}) \\ \Lambda(\beta_{i0} + \sum \beta_k X_{kit}) \end{cases} \quad (6)$$

where Φ is the standard normal cumulative distribution fonction (cdf) for Probit model, and

$$\Lambda(\mathrm{z}) = \frac{\exp(z)}{1+\exp(z)} \quad (7)$$

is the logistic cdf for Logit model,[30] P_i is the probability of the outcome of interest, β_{i0} is the intercept term (individual-specific effect), β_k for k ∈ (1, . . ., K)

[29] The dependent variable in equation (7) is the logarithm of two probabilities of the outcome of interest. These variables are usually selected for inclusion by using some form of backward or forward stepwise regression technique (Pampel, 2000).

[30] Or $P_i = \frac{1}{1+\exp -(\beta_{i0} + \sum \beta_k X_{kit} + u_{it})}$. Logit model is considered in (Toumi, Viviani, & Belkacem, 2010) for a panel of 545 observations with 250 of these observations being for Islamic banks, from 18 countries over the period 2004-2008. They show that the lower the size and the lower debt to asset ratio, the more the probability that the bank operate under Islamic principles.

represents the real coefficient associated with the corresponding explanatory variable X_{kit}. [31]

The assumption that β_{i0} is unrelated to X_{it} produces the **random effects model** so that the conditional distribution f ($\beta_{i0}| X_{it}$) is independent of X_{it}. The **random effects** Model assumes that the individual effects are normally distributed, with β_{i0}~N(0, σ_{β}^2).[32] If that distribution is unrestricted, so that β_{i0} and X_{it} may be correlated, then we have what is called the **fixed effects model** (Greene, 2012, p. 716).

It is useful to consider the pooled model that results if we simply ignore the heterogeneity, β_{i0}. If individual-specific effect are not present, then an alternative to the random effects model is a pooled binary model that simply specifies that :[33]

$$P(Y_{\mathrm{it}} = 1 \ /\mathrm{X}) = F(\ X_{it}\beta)$$

where F ≡ Φ for Probit model and Λ for logit one.

If the fixed effects model is appropriate, the pooled MLE that ignores fixed effects will be inconsistent. Ignoring the random effects in a pooled model produces an attenuated (inconsistent-downward biased) estimate of β. The fixed effects model encounters an **incidental parameters problem** that renders the maximum likelihood estimator inconsistent (Greene, 2012, p. 717). So, in this paper only Pooled and random effect models will be estimated.[34]

The classification results of logistic regression are sensitive to high correlation between the explanatory variables. Hence, because of the problem of multicolinearity, we excluded some of the explanatory variables. Only 8 predictor variables out of 12 will be considered. The Pearson correlation coefficients are

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[31] For binary data the conditional probability is also the conditional mean.

[32] Random effects estimation is more commonly used because of inconsistency of the fixed effects estimator. $\sigma_{\beta}^2 = \frac{\rho}{1-\rho}$, $\rho = corr(\beta_{i0}, \beta_{j0})$.

[33] Fixed effects estimation is possible for the panel logit model, using the conditional MLE, but not for other binary panel models such as panel probit.

[34] The problems with the fixed effects estimator are statistical. The estimator relies on *T* increasing for the constant terms to be consistent-in essence, each β_{i0} is estimated with *T* observations. But, in this setting, not only is *T* fixed, it is likely to be quite small. As such, the estimators of the constant terms are not consistent (not because they converge to something other than what they are trying to estimate, but because they do not converge at all). The estimator of β is a function of the estimators of β_{i0}, which means that the MLE of β is not consistent either. This is the **incidental parameters problem** (Greene, 2012, p. 721).

reported in Table A 9.[35] In addition, the maximization of the log-likelihood function (LLF) is usually applied when the Probit and logistic regression models are used.[36]

Estimation results of Pooled ($\beta_{i0} = \beta_0 \; \forall \; i$) Probit model and of Pooled Logit model for overall period (2005-2014), for Pre GFC period (2005-2008), and for Post GFC period (2009-2014) are given at **Table 10** . Estimation results of random effect Probit model and random effect Logit model are given at **Table 12** (β_{i0} is a random bank specific effect).[37] The fitted values from regression are the estimated probabilities for $Y_{it} = 1$ for each observation i.[38]

We consider the test of the hypothesis that the coefficients of overall model do not differ between different sub-period models: Pre and Post GFC models. Economists call the test for such hypothesis the stability **Chow** test. This test is applied respectively for Pooled Probit and Pooled Logit models. Results are Given at **Table 11**. We cannot reject the hypothesis that the logistic (probit) regression model applied to each sub-period are identical at any reasonable significance level. We conclude that there is **no difference between sub-periods** and overall period results (both models are stable).

Again, based on **random** Logit [probit] model, **Chow** test concludes that no difference is present **between sub-periods** and overall period results (LR chi2(10) = - 67.84 with p-value = 1.0) and [LR chi2(10) = - 47.06 with p-value = 1.0]. We conclude that there is **no difference between sub-periods** and overall period results. Then, only results for **overall period** results will be compaired for both

[35] All these results are summed up at the following Table :

	Z-score	CAP	ROA	ROE	CTD	LTA	LTD	NPL	CTA
CAP	+								
ROA	+ + +	+							
ROE		– –	+ +						
CTD	+ +	+ +		–					
LTA	- –			+					
LTD	- –		+			++ +			
NPL			-	- – –		- –	- –		
CTA	+		+ +		+ +	+ +			
LLR		+	- –	- –		- -	- –	+ +	+
DTA						–			

Note : Red sign is for significant coorelations for CB. Black sign is for significant correlation for all banks. Yellow sign is for significant correlation for IB.

[36] Given that both logit and probit are non-linear models, they cannot be estimated by OLS. While the parameters could, in principle, be estimated using non-linear least squares (NLS), maximum likelihood (ML) is simpler and is invariably used in practice.

[37] Statistical inference should then be based on panel-robust standard errors. Standard errors and *t*-ratios can be calculated and hypothesis tests can be conducted in the usual fashion.

[38] The slope estimates for the linear probability model can be interpreted as the change in the probability that the dependent variable will equal 1 for a one unit change in a given explanatory variable, holding the effect of all other explanatory variables fixed.

considered models. The choice of one specification Pooled Probit (Logit) rather than the other ; Random Probit (Logit) for overall period can not be based on the **likelihood ratio** test, because of the two likelihoods are not comparable.[39] (Hausman, 1978)'s specification test is a natural one to use here for the choice of one specification (Pooled) rather than the other (random effect model) for overall period. The choice between **Pooled Probit (Logit)** model and **Random Probit** (Logit) models for overall period will be based on **Hausman** test. (Hausman, 1978)'s specification test, compares an estimator β_c that is known to be **consistent** (under H_o and H_a) with an estimator β_e that is **efficient** under the assumption being tested H_o (but inconsistent under H_a). Under the **null hypothesis of homogeneity,** $H_o : \boldsymbol{\beta_{i0} = \beta_0} \; \forall \; \boldsymbol{i}$, usual maximum likelihood estimator for pooled model is efficient (but inconsistent under alernative). Maximum likelihood estimator for random model is consistent under null hypothesis **of homogeneity** and under the alternative but non efficient under null hypothesis **of homogeneity**.

If **null hypothesis of homogeneity** is the case, there should be no systematic difference between the two estimators. If there exists a systematic difference in the estimates, we have reason to doubt the assumptions on **homogeneity**. The Hausman statistic is distributed as χ^2 and is computed as

$$H = (\beta_c - \beta_e)' \, (Vc - Ve)^{-1} (\beta_c - \beta_e),$$

where β_c is the coefficient vector from the consistent estimator, β_e is the coefficient vector from the efficient estimator, Vc is the covariance matrix of the consistent estimator, Ve is the covariance matrix of the efficient estimator.

We reject **homogeneity** hypothesis for lage value of statistic H (p-value is inferior than level $\alpha\%$). Hence, by **Hausman** test, we test H_o : **Pooled Logit** model vs H_a: **Random Logit** model. H_o is rejected since $H \equiv chi2(9) = 67.78$ with p-value = 0.000. So **Random Logit** model for the overall period is significant at 1% levels. We test also H_o : **Pooled Probit** model vs H_a: **Random Probit** model. H_o is not rejected since $H \equiv chi2(9) = 10.63$ with p-value = 0.3017. So **Pooled Probit** Model for the overall period is significant at 1% levels. Then only **Random** Logit model and Pooled Probit Model results (from respectively **Table 12** and **Table 10**) for the overall period will be discussed.

[39] Standard errors and *t*-ratios can be calculated and hypothesis tests can be conducted in the usual fashion.

Looking at **Table 10** (first column), from the Pooled Probit model results for the whole period (2005–2014), only 7 predictor variables out of 8 are statistically significant and so can be used to discriminate between IB and CB.[40] These variables are: measure of bank stability (Z-score), Capital adequaty ratio (CAP), Cash to deposits (CTD), deposits to assets ratio (DTA), Number of years since the bank was incorporated (AGE), off-balance sheet items to assets ratio (OBSIA), and fixed assets to assets ratio (FAA). Interpretation of the coefficients needs slight care. The overall rate of correct classification for this model is estimated to be 79.42% (Log-likelihood = - 256.0739), with 91.24% of the normal weight group correctly classified (specificity) and only 41.82% of the low weight group correctly classified (sensitivity).[41] Area under ROC curve = 0.8579 indicates acceptable discrimination for the model (see Figure 2).[42]

The coefficient on Cash to deposits (CTD) is **positive** and significant at 10% level, which indicate that IB are more likely to be more liquid. Hence, the **second** hypothesis, pertaining liquidity, is supported by Pooled Probit model results. The **positive** and significant (at 1% level) coefficient on Capital adequaty ratio (CAP) variable confirms that interest-free banks are more likely to be better capitalized than their conventional peers, suggesting that IBs are **less risky** than conventional banks. The deposit to assets ratio (DTA) shows **negative** coefficient and significant at 1% level, which indicate that IB are more likely characterized by a **lower** level of deposit to assets ratio compared to CBs and then more capitalized and more solvent.[43] Hence, the **third** hypothesis, pertaining risk, is supported by the Discrimination results. However, the negative and significant (at 1% level) coefficient on Z-score indicate that IB are **more likely** to have **lower stability**. Hence, the **forth** hypothesis, pertaining stability, is supported by the Discrimination results. Also, the **negative** coefficient on off-balance sheet items to assets ratio (OBSIA) indicates that IBs are more likely to be less involved in off-balance sheet activities than CBs. The **negative** coefficient on fixed assets to assets ratio (FAA) indicates that IB are more likely to hold less fixed assets than

[40] All considered variable are significant except return on equity (ROE).

[41] Sensitivity is the fraction of $Y_{it} = 1$ observations that are correctly classified. Specificity is the percentage of $Y_{it} = 0$ observations that are correctly classified.

[42] A model with no predictive power would be a 45° line. The greater the predictive power, the more bowed the curve, and hence the area beneath the curve is often used as a measure of the predictive power. A model with no predictive power has area 0.5; a perfect model has area 1. For a classic text on ROC techniques, see (Green & Swets, 1966).

[43] The negative sign of debt to asset ratio reflects higher capital and lower leverage at IBs. This suggests that IBs may be more protected against asset's losses more than CBs and reflects a better shock absorbing capacity. The lower value of this ratio revealsalso that IBs have a greater capacity to sustain the assets losses. This result is in accordance with ones reported by (Metwally, 1997), (Samad & Hassan, "The performance of Malaysian Islamic Bank During 1984-1997: An Exploratory Study, 2000), (Samad, 2004), (Olson & Zoubi, 2008) and in (Toumi, Viviani, & Belkacem, 2010).

CB, suggesting lower operating **leverage** for the former. Finally, results indicate that the profitability cannot discriminate between the two groups of banks. Hence, this result is not consistent with our first hypothesis.

From the **Pooled Probit** model results**, banks which are less stable, have more liquidity, are better capitalized, and are more solvent are more likely to be interest-free** bank. The reminder of variables is not statistically significant according to Pooled probit model. This result reveals that no difference exists between the two types of banks with respect to financial characteristics represented by ROE.

Marginal effect of predictor variables at the mean of these variables are measured and given at **Table 13**.

Looking at **Table 12** (second column), from **Random Logit** model for the whole period (2005–2014), only 2 predictor variables out of 8 are statistically significant and so can be used to discriminate between IB and CB. These variables are: measure of bank stability (**Z-score**) and Number of years since the bank was incorporated (**AGE**). Again, the negative and significant (at 1% level) coefficient on Z-score indicate that IB are **more likely** to be **less stable**. And then, the **forth** hypothesis, pertaining stability, is supported by the **Random Logit** model. Also, CBs are likely to be older than IBs.

As the binary **Random** logistic regression, Discriminant function analysis is also used to determine which variables are the best predictors to discriminate between IBs and CBs. The dependent variable to be predicted is a categorical variable :

$$Y_{it} = 1 \text{ if Bank i is IB and zero if not.}$$

The independent variables were the 8 defined variables. **Table 14** provides the standardized regression coefficients in multiple regression. The larger the standardized coefficient, the greater is the contribution of the respective variable to discriminate between IBs and CBs. **AGE** was the strongest predictor in discriminating the two types of banks while **Z-score** was the next in importance as a predictor. These two ratios are followed respectively by the Capital adequaty ratio **CAP**, Debt to assets **DTA**, OBSIA, Cash to deposits CTD, and ROE. Like the binary logistic regression, the results of the discriminant analysis confirm that financial ratios can be used to discriminate between IB and CB. Both the **Random** logistic regression and discriminant analysis suggest that IBs and CBs don't seem to differ much in terms of the profitability ratios ROE. This result is also in line with those of previous sections.

Table 10: Panel Data Binary Choice Models results: **Pooled** Probit and **Pooled** Logit model.

	Overall period 2005-2014		**Pre GFC 2005-2008**		**Post GFC 2009-2014**	
Model **Variables**	**Probit**	**Logit**	**Probit**	**Logit**	**Probit**	**Logit**
Zscore	**-.02554499*****	-.0432039***	-.02882181***	-.04759096***	-.02449967***	-.04170468***
CAP	**3.2573606*****	5.5485669***	3.1720239**	5.4700857**	3.149643**	5.2775427**
ROE	**-.15984028**	-.2738662	.67972802	1.0777664	-.46484939	-.74067655
CTD	**.18915151***	.31926324*	1.5833408	2.5924994	.16899768*	.28819515*
DTA	**-3.4049817*****	-5.667720***	-3.1422514***	-5.4608451***	-3.8199735***	-6.2131363***
AGE	**-.0413593*****	-.0695400***	-.04072201***	-.06958886***	-.04148696***	-.06918171***
OBSIA	**-.54282776****	-.8815858*	-1.0915118**	-1.875337**	-.42215639	-.67369338
FAA	**-18.03947*****	-31.85208***	-34.621378**	-61.812104**	-13.618308*	-24.105823*
_cons	**1.1233485*****	1.8828708***	1.2069307**	2.0921645**	1.1454289***	1.9025512***
N	690	690	227	227	463	463
Khi2	5.8447698		4.370864		1.7119645	
Log-likelihood value	-256.0739	-258.99628	-79.869628	-80.72561	-172.37782	-174.56325
Pseudo R^2	0.3253	0.3176	0.3327	0.3255	0.3358	0.3274
Hausman :chi2(9)	67.78(0.000)					
Classification accuracies	79.42%	79.42%	81.06%	81.50%	79.48%	79.91%

Legend: * p<.1; ** p<.05; *** p<.01.

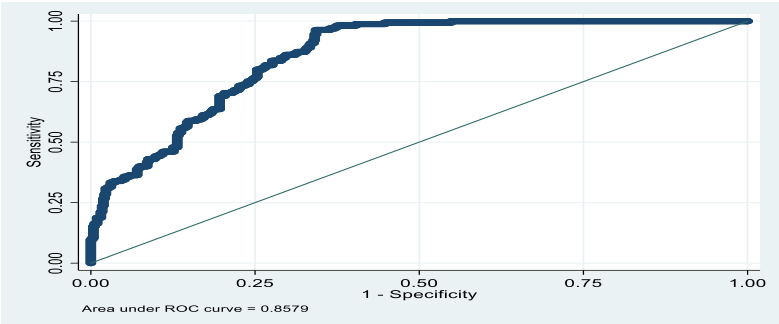

Figure 2: ROC curve for the **Pooled** model for **Overall period**

Table 11: Chow test results for **Pooled** models (Likelihood-ratio test).

Logit model	Probit model
LR chi2(9) = 7.41	LR chi2(9) = 7.65
Prob > chi2 = 0.5940	Prob > chi2 = 0.5695

Table 12: Estimated Parameters for Panel Data Binary Choice Models : **Random** Probit and **Random** Logit.

	Overall period 2005-2014		**Pre GFC 2005-2008**		**Post GFC 2009-2014**	
Model **Variables**	**Probit**	**Logit**	**Probit**	**Logit**	**Probit**	**Logit**
Zscore	-.06190831**	**-.32638282*** **	-.128897**	-.32502333***	-.1231375***	-.45558583***
CAP	8.1578291*	**34.514679**	19.739536**	16.118575	17.904686***	39.946671**
ROE	-.30258485	**-1.197222**	4.3330709	3.0506585	-1.0491346	-1.7945866
CTD	.34013304	**1.0758146**	3.3624849	7.6644748	.78443762	2.1334912*
DTA	-4.5931341*	**-11.731213**	-11.765837**	-11.456936	-6.8069156	-19.608087
AGE	-.10421142***	**-.61335791*** **	-.42652857***	-.44225396***	-.2228548***	-.50270902***
OBSIA	-.5639359	**-3.5682963**	-2.7282366	-4.965162	-.76205751	-2.0949839
FAA	-30.811834	**-119.21984**	-285.97632***	-360.10022**	-38.132767	-25.504169
_cons	1.9995475	**10.642075** **	7.8199974**	6.9664952	1.4107931	9.0874909*
/lnsig2u	3.1880642***	5.7473894***	4.6576148***	5.7365676***	4.3218458***	5.6393873***
Statistics :						
N	690	690	227	227	463	463
ρ	.9603826	.9896108	.9906001	.9894989	.9868986	.9884396
LR test of ρ=0	394.82	417.06	88.06	86.09	252.05	255.71
Log-likelihood	-58.664358	-50.468138	-35.838219	-37.679445	-46.35492	-46.707629
Wald	27.71	73.29	71.73	38.08	57.24	51.29
Hausman:chi2(9)		10.63(0.3017)				

Legend: * p<.1; ** p<.05; *** p<.01.

Table 13 : Marginal effect at means from Pooled Probit Model.[44]

Pooled Probit	**dy/dx**	**Std. Err.**	**z**	**P>z**
Zscore	-.0039299	.0009202	-4.27	0.000
CAP	.5011189	.1868593	2.68	0.007
ROE	-.0245902	.0455354	-0.54	0.589
CTD	.0290994	.0155744	1.87	0.062
DTA	-.5238292	.116602	-4.49	0.000
AGE	-.0063628	.0010141	-6.27	0.000
OBSIA	-.0835097	.0444168	-1.88	0.060
FAA	-2.775228	.7843334	-3.54	0.000

[44] Mean for each considered variable:

Zscore	= 23.08074	AGE	= 35.75652
CAP	= .1450023	DTA	= .1143521
ROE	= .1106816	OBSIA	= .2484412
CTD	= .1791631	FAA	= .0221559

Table 14: Standardized canonical discriminant function coefficients.

Zscore	CAP	ROE	CTD	AGE	DTA	OBSIA	FAA
.519574	**.4679121**	.0717945	.0845841	**.6229849**	.3563569	.169839	.0471622

VII. Conclusion

This paper contributes to the empirical literature on interest-free finance by investigating the feature of IB and CB using a sample of 115 banks (80 conventional Bank and 35 interest-free banks) from Turky and 6 MENA countries over the period 2005–2014. We contribute to Islamic finance empirical literature by testing 4 hypotheses examining the profitability, liquidity, credit and insolvency risk, and stability of IB and CB.

Three technic are considered to do so. In a **first stage**, we give an univariate analysis based on t-test statistic. In the **second stage**, we run several linear regressions based on OLS method comparing CB (with or without IW) and IB in controlling for bank caracteristics, in controlling for cross different size groups, in controlling for cross countries, and in controlling in term of maket share. In the **third stage**, a **discrimination** analysis based on **nonlinear panel model** for **Binary Outcome** Data such as **Probit and logit model and** Discriminant function analysis is conducted.

This study documents several interesting findings.

First, using univariate analysis, we show that IB and CB behave somewhat differently. Mean tests results show that IB are more liquid, more capitalized, less stable, less profitable, more solvent, and have more credit risk than their conventional peers. In addition, taking account of GFC, IB are found to be more profitable pre GFC and more solvent post GFC.

Second, regression analysis, on the other hand show that :

i) in controlling for bank caracteristic, we find similar results than univariate analysis investigation.

ii) in controlling for Size, S**mall** IB are more profitable, more capitalized, and more stable than Small **CB** (with or without IW).

iii) in controlling for cross countries, and in accordance with univarite results, negative P**rofitability** is driven by Egyptian and Turkish IB, **Liquidity** is driven by Turkish IB, **Instability** is driven by Egyptian, Tunisian, Quatarian and Jordanian IB, while **credit risk** is driven by all

interest-free banks except Tunisian IB which are more profitable. **Solvency** of IB is driven by Turkish, Egyptian, Tunisian, and Bahreïnien IB.

iv) in controlling in term of maket share, and in accordance with univarite results, we continue to find that IB are **more solvent**, are less **stable** but have **lower capitalisation** than conventional banks in countries and years **with higher market** share of interest-free banks.

Third, from the **nonlinear regression** model (*Pooled Probit Model*) results, banks which are less stable, have more liquidity, are better capitalized, and are more solvent are more likely to be interest-free **bank**. From the *Random Logit* model results, banks which are less stable are more likely to be interest-free **bank.** We find also that there is no difference between pre and post the GFC. From *Discriminant function analysis*, **AGE** was the strongest predictor in discriminating the two types of banks while **Z-score** was the next in importance as a predictor.

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ANNEXE :

Bank List

Table A 1 : List of banks covered in this study.[45]

Country	Conventional Banks	Islamic Banks	*Islamic window* or Branch
1Turky	• Turkiye Garanti Bankasi A.S, • T.C. Ziraat Bankasi A.S., • Akbank T.A.S., • Yapi Ve Kredi Bankasi A.S., • Turkiye Halk Bankasi A.S., • Turkiye Vakiflar Bankas TAO-, • Denizbank A.S., • Finansbank A.S., • Turk Ekonomi Bankasi A.S., • ING Bank A.S., • HSBC Bank A.S., • Sekerbank T.A.S., • Alternatifbank A.S., • Citibank A.S., • Anadolubank A.S., • Burgan Bank AS, • Tekstilbank-Tekstil Bankasi A.S.,	• Asya Katilim Bankasi AS-Bank Asya, • Kuveyt Turk Katilim Bank Turkowait , • Turkiye Finans Katilim Bankasi AS, • Albaraka Turk Participation Bank	T.C. Ziraat Bankasi A.S (2014)
2Egypte	• Al Watany Bank of Egypt, • Arab African International Bank, • Arab International Bank, • Bank Audi SAE, • Bank of Alexandria, • Banque du Caire SAE, • Banque Misr SAE, • Barclays Bank - Egypt S.A.E., • BNP Paribas SAE, • Commercial Internt Bank (Egypt), • Credit Agricole Egypt, • HSBC Bank Egypt S A E,	• Al Baraka Bank Egypt SAE, • Faisal Islamic Bank of Egypt,	• Al Watany Bank of Egypt, • Banque Misr SAE • National Bank of Egypt,

[45] Source : Islamic financial instituitions, Global investment and Business Center , USA 2009

	• National Bank of Egypt, • Société Arabe Intern de Banque, • Suez Canal Bank,		
3Tunisia	• Banque Internt Arabe Tunisi, • Banque Nationale Agricole, • Société Tunisienne de Bank, • Amen Bank, • Banque de l'Habitat, Attijari Bank, • Arab Tunisian Bank, • Banque de Tunisie, • Union Internl de Banque, • Union Bancaire Comrce et l'Industrie, • North Africa International Bank – NAIB, • Arab Banking Corporation – Tunisie, • Alubaf International Bank, • Banque Franco-Tunisienne, • Ahli United Bank BSC	• Albaraka Bank Tunisia, • Banque Zitouna	
4Bahreïn	• Arab Banking Corporation BSC, • BBK B.S.C, • BMI Bank BSC, • Future Bank B.S.C., • Gulf International Bank BSC, • National Bank of Bahrain, • Abu Dhabi Commercial Bank	• Albaraka Islamic Bank BSC, • Al-Salam Bank-Bahrain B.S.C, • First energy bank, • International Investment Bank, • Kuwait Finance House, • Albaraka Banking Group B.S.C., • ABC Islamic Bank (E.C.), • Citi Islamic Investment Bank, • Gulf Finance House BSC, • Bahrain Islamic Bank B.S.C., • Khaleeji Commercial Bank, • Elaf Bank, • Investors Bank BSC, • Arcapita Bank B.S.C., • Venture Capital Bank BSC (c)-VCBank, • Seera Investment Bank BSC,	• Arab Banking Corporation BSC, • BBK B.S.C, • BMI Bank BSC, • Gulf International Bank BSC,
5UAE	• Arab Bank for Investment & Foreign, • Bank of Sharjah, • Commercial Bank International P.S.C, • Emirates NBD PJSC, • First Gulf Bank, • Union National Bank,	• Emirates Islamic Bank PJSC, • Dubai Islamic Bank PJSC, • Tamweel PJSC, • Sharjah Islamic Bank,	• Arab Bank for Investment & Foreign, • First Gulf Bank, • Mashreqbank, • National Bank of UmmAl-Qaiwain,

	• National Bank of Fujairah, • National Bank of Abu Dhabi, • Mashreqbank, • Ahli Bank QSC, • National Bank of Umm Al-Qaiwain		• Commercial Bank International P.S.C • Emirates NBD PJSC • Union National Bank,[46] • National Bank of Fujairah, • National Bank of Abu Dhabi
6Qatar	• Al Khalij Commercial Bank, • Commercial Bank of Qatar, • Doha Bank, • International Bank of Qatar Q.S.C., • Qatar National Bank, • Arab Bank Group outlet[47]	• Barwa Bank, • Qatar International Islamic Bank, • Qatar Islamic Bank SAQ,	• Al Khalij Commercial Bank • Doha Bank, • Qatar National Bank, • Arab Bank Group[48]
7Jordan	• Arab Bank Plc , • Arab Banking Corporation Jordan , • Bank of Jordan Plc , • Cairo Amman Bank , • Capital Bank of Jordan , • Housing Bank for Trade & Finance • Jordan Ahli Bank Plc , • Jordan Commercial Bank , • Jordan Kuwait Bank , • Société général de Banque-Jordanie,	• Islamic International Arab Bank, • Jordan Dubai Islamic Bank, • Jordan Islamic Bank	• Arab Banking Corporation • Cairo Amman Bank , • Société général de Banque-Jordanie, • Jordan Kuwait Bank

Empirical Review

Table A 2 : Some selected papers and their main findings, including whether they examined the effects of the 2008 Global Financial Crisis (GFC).

AUTHOR(S)	TOPIC(S)	Sample	# Banks	FINDING(S)	GFC
(Čihák & Hesse, 2010))	**Stability** with **Z-score**	1993–2004 19 countrie	474 banks (77 IB)	(1) overall, Islamic banks (IBs) more stable	NO

[47] (Combined) has four branches in Qatar, along with an Islamic banking

[48] merged with Abu Dhabi Commercial Bank in 2019

				than conventional banks (CBs) (2) small IBs more stable than small CBs (3) large CBs tend to be more stable than large IBs; and (4) small IBs more stable than large IBs.	
(Beck, Demirguc -Kunt, & Merrouche, Islamic vs. conventional banking: business model, efficiency and stability, 2013)	**Efficiency** and **stability** with **Z-score** and liquidity ratio	1995–2009 22 countries with dual banking systems	510 banks (88 IB)	IBs significantly less stable than CBs using Z-score but not different in terms of liquidity. During the GFC, there were no significant differences.	YES
(Bourkhis & Nabi, 2013)	**Stability** with **Z-score**	1998–2009 16 countries	68 banks (34 IB)	Overall, IBs more stable than conventional banks, but no significant difference between IBs and CBs in terms of the effect of the GFC on banking soundness	YES
(Rajhi & Hassairi, 2013)	**Stability** with **Z-score**	2000–2008 16 countries	557 (90 IB)	IBs have higher stability than CBs. Credit risk and income diversity are the most common determinants of insolvency for IBs.	NO
(Abedifar, Molyneux, & Tarazi, 2013)	**Credit risk** with the ratio of loan loss reserves to gross loans, and **insolvency risk** with **Z-score**	1999–2009 24 countries	553 banks (118 IB)	Small IBs more stable than small CBs. Large IBs exhibit lower stability than large CBs. Credit risk of IBs is less sensitive to **interest rates**. IBs had lower credit risk than CBs prior and during the GFC	YES
(Ben Khediri, Charfeddined, & Ben Youssef, 2015)		4 GCC countries.[49] 2003-2010	43 conventional banks and 18 Islamic banks	Islamic banks are on average less **involved** in off-balance sheet activities and have more operating leverage than their conventional peers. The two types of banks may be differentiated in terms of **credit and**	YES

[49] (Bahrain, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates)

				insolvency risk, operating leverage and off-balance sheet activities, but not in terms of **profitability and liquidity**. **GFC** has a time shifted negative impact on the **profitability** for both Islamic and conventional banks.[50]	
(Kabir, Worthington, & Gupta, 2015)	**Credit risk** wih accounting based as well as market based	2000 -2012 13 countries	193 banks (37 IB)	Islamic banks have lower credit risk using market-based measures stability measure. Islamic banks have higher credit risk using accounting-based credit risk measures. During GFC, no significant difference in Islamic and conventional bank credit risk	YES
(Louhichi & Boujelbene, 2016)	**Credit risk**	10 OIC countries[51] 2005 -2012	87 conventional bank and 30 islamic bank.	Results support the "bad management" hypothesis for conventional banks. Results support the moral hazard and skimping hypotheses for both banks‟ type. Islamic banks behave differently to **credit risk** dilemma.	NO
(Alqahtani, Mayes, & Brown, 2016)	**Stability** with **Z-score** and DD[52]	2000-2013 six economies of GCC region[53]	76 banks (24)	Islamic banks are more stable when they operate at a small scale. Small Islamic banks demonstrated a relatively better handling of the economy *downturn than large Islamic banks.*	YES
(Mansor, Aun, & Rizvi, 2017)	**Stability** with **Z-score**	13 countries.[54] 2000-2014	45 Islamic banks	Larger Islamic banks are more **stable** at least	NO

[50] Global financial crisis :GFC.

[51] (Organization of Islamic Cooperation)

[52] Distance to Default.

[53] Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates.

[54] (Bangladesh, Bahrain, Egypt, Indonesia, Jordan, Kuwait, Malaysia, Pakistan, Qatar, Saudi Arabia, Tunisia, Turkey and the United Arab Emirates).

	and NZ-score.			when they surpass a certain **threshold size**.	
(Miah & Uddin, 2017)	**Stability**	GCC 2005-2014	48 conventional banks and 28 Islamic banks	Conventional banks are more efficient in managing cost. Islamic banks are more solid in terms of short-term **solvency** but no such difference exists as far as the long-term **stability** is concerned. Highly **capitalized** banks are more **stable**.	NO

Definitions of Islamic financial instruments

Mudaraba

This product is used to finance a borrower (entrepreneur) who has ideas and expertise to use the funds in productive activities. The bank provides the finances and the business provides the labor. Profit is shared between the two parties based on an agreed upon ratio. The bank is a passive partner. If any loss is occurred, it is borne by the bank provided if there is no intent of the Mudarib of the loss (Gunputh, 2014).

Musharaka

It is a partnership contract between the bank and the client in which both the partners invest their capital in a project in a proportion. An Islamic bank provides part of the equity plus working capital for a specific project and shares in profits and/or losses. Specifications are provided by the purchaser. They share profit or loss in a way that the loss is shared between the partners in the proportion they invested their capital, but the profit is shared in a predetermined proportion with mutual consensus (Mehtab, Zaheer, & Ali, 2015). This product is generally used in home loans (for construction and renovation purposes).

Murabaha

An Islamic bank buys an asset on behalf of its client and then sells the same asset to its client after adding a mark-up to the purchase price. This product is used to finance the businesses. It is a contract to sell the goods with a mark-up profit on the cost of the goods. The client instructs the bank to purchase the goods from a third party. The bank then sells the goods to the client on the price that includes cost plus the profit. This product is also used to finance the business (Shahid, Hassan, & Rizwan, 2015).

Ijara

The Islamic bank purchases a piece of equipment selected by the entrepreneur and then leases it back to him; he pays a fixed fee. This product is mostly used for the purchase of vehicles like cars, delivery vans, etc. the bank purchases the vehicle

for the client and the client pays monthly rentals.When the cost of the vehicle plus the profit amount is paid by the client, the ownership is transferred to the client (Chhapra, Ahmed, Rehan, & Hussain, 2018).

Ijara wa iktina

The transaction resembles Ijara, except that the client is committed to purchase the equipment at the end of the rental period (Olson & Zoubi, 2008).

Bai al salam

A contract for sale of goods where the price is paid in advance and the goods are delivered in the future.

Istisna

A contract to acquire goods on behalf of a third party. The price is paid to the manufacturer in advance and the goods are produced and delivered at a later date.

Appendice A

Data Analysis Descriptive statistics for all variables

Table A 3: Descriptive statistics of variables (average values)

	Conventional banks*			Islamic banks		
Variable	**N.Obs**	**Mean**	**Std_Dev**	**N.Obs**	**Mean**	**Std_Dev**
Zscore	714	24,56965	**20,20792**	282	12,83398	**11,36676**
CAP	722	0,1258643	0,0934357	283	0,3113774	**0,2994792**
ROA	717	0,0148787	0,0321819	285	0,0137452	**0,1353901**
ROE	713	0,1276067	0,2256616	282	0,0607897	0,2953963
CTA	719	0,071153	0,0901989	283	0,0648099	0,0787702
CTD	647	0,130259	0,5567002	208	0,4609902	**2,580818**
NPL	486	0,071239	0,1148336	193	0,0730088	0,1544408
LLR	572	0,0660568	0,085119	231	0,0602344	**0,117228**
LTA	642	0,5025245	0,3055482	265	0,4738117	0,3211485
LTD	631	0,7973383	0,3891334	238	0,9866655	**1,058071**
DTA	711	0,1281966	0,1852995	259	0,0895002	0,1140078
FAA	708	0,0252381	**0,2804092**	281	0,0151735	0,0602311
OBSIA	629	0,2521895	0,2173852	266	0,1940171	0,2634909
Size	723	3,119207	1,540432	283	3,090518	1,457905

Regression analysis outputs

IB vs CB

Table A 4 : Comparing **IB** and **CB** (without islamic windows), Controlling for bank caracteristics (Equation (1)).

	Profitability		Liquidity			Credit risk
Variable	**Return on assets ROA**	**Return on equity ROE**	**Cash to assets CTA**	**Cash to deposits CTD**	**Loans to assets LTA**	**Loans to deposits LTD**
IB	-.00131809	-.0274705	-.00486521	**.39935675***	.00089511	**.27799425****
CB	.00083411	.00860275	**-.02132765****	.10945292	**-.09782926****	.04852452
D2008	.02268643	-.12601063***	.03917042	2.4381321	-.12495226**	-.11758747
AGE	.0001232*	.00061288**	-.00014746	.00014839	-.00028675	-.0018281**
Size	-.01095397**	.00118162	.00312913	-.10204495	.00511793	.00389605
Growth	-.00368288	.00915229	-.00901799	.10203085	-.00411829	.12981585
FAA	-.0072477	-.00874076	-.00441178**	-.0225279	-.32867001	5.3832895**
OBSIA	-.00739299	-.01429781	-.00996845	.06857875	.08811055**	.02673856
_cons	.02717594***	.15167431***	.05682289***	-.03694218	.64789176***	.88942532***
N	718	715	723	622	595	570
R^2	.12773841	.37682835	.24394082	.11381136	.59224339	.21175537

	Credit risk		**Reglementary risk**	Insolvency	Stability
Variable	**Loans loss reserves to gross loans LLR**	**Non-performing loans to gross loans NPL**	**Capital adequaty ratio CAP**	**Debt to assets DTA**	**Zscore**
IB	-.01010428	**-.03168178****	**.07838778*****	**-.05127249*****	**-4.8512003****
CB	-.00409616	**-.02141421****	**.02481937*****	**.03633445****	**4.263354***
D2008	-.03784701	-.23981646**	.10067978	.28875856**	47.188523**
AGE	-.00042517***	-.00045941**	.00008391	-.00027035	.02520304
Size	.00716095**	.00004928	-.05265779***	-.02839877***	2.9479675***
Growth	-.00480142	.00513505	.02831289	.02037432	4.0281364
FAA	.32566984	.77580376	.00398767	-.00770816**	1.8350413***
OBSIA	-.00093942	-.04816153**	-.03742087	.00444747	1.8542205
Trend	.00004415	.00028337***	.0001222	-.00026349**	-.03225342**
_cons	.03731369**	.05092613*	.12425668***	.09626793***	13.699881***
N	544	482	721	698	716
R^2	.38841486	.34850992	.37948952	.26459964	.29445683

Legend: * p<.1; ** p<.05; *** p<.01.

Size case

Table A 5 : Comparing Large IB, Large CB with islamic windows, and Large conventional banks (Equation (2)).

	Profitability		Liquidity		Credit risk	
Variable	**Return on assets ROA**	**Return on equity ROE**	**Cash to assets CTA**	**Cash to deposits CTD**	**Loans to assets LTA**	**Loans to deposits LTD**
*Large IB	-.00723235	**-.05829901***	-.00372531	-.30334947	**-.09886059*****	-.01577765
*Large CB with I W	-.00225805	**-.02857776****	**-.01935719****	**.34616984****	**-.06468014***	**.12544312*****
*Large CB	-.0004109	**.05321622****	.0001226	-.15102502	**-.162649*****	**-.31270577*****
D2008	**-.01303622*****	**-.03840177*****	**.01849386*****	**.22684579****	**.05762941*****	-.00064149
Trend				.00059757**		
_cons	.0243485***	.1278499***	.05338017***	-.15588034	.4966474***	.94245318***
N	1002	995	1002	855	907	869
R^2	.00771978	.02323118	.01780355	.02537746	.07069984	.03919808
F	3.8940209	6.2680002	4.567443	2.4400927	18.339277	14.765331

	Reglementary risk	Credit risk		STABILITY	Insolvency
Variable	**Capital adequaty ratio CAP**	**Loans loss reserves to gross loans LLR**	**Non-performing loans to gross loans NPL**	**Zscore**	**Debt to assets DTA**
*Large IB	**-.04493257****	-.0030305	-.02667033	**-6.5146272*****	-.01997406
*Large CB with I W	**.13694217*****	.00920558	**.02871305****	-2.6226973	-.01103017
*Large CB	**-.10452904*****	.00465215	**-.02700856****	**14.99668*****	.02146158
D2008	**.02489974****	**.01336193****	**.0260175*****	-1.3097236	-.00401132
Trend	.0001623***	-.00002753***	.00002403**	.0073956***	.00003058**
_cons	.11791965***	.07282696***	.05496213***	15.35307***	.09943672***
N	1005	803	679	996	970
R^2	.11376794	.01904817	.01766274	.14320072	.00942074
F	24.571359	4.9434367	2.0606064	28.15765	2.5249349

Legend: * p<.1; ** p<.05; *** p<.01.

Cross country

Table A 6**:** Comparing Islamic and conventional banks, testing for **cross-country** variation ; Equation(3).[55]

	Profitability		Liquidity			Credit risk
Variable	**Return on assets ROA**	**Return on equity ROE**	**Cash to assets CTA**	**Cash to deposits CTD**	**Loans to assets LTA**	**Loans to deposits LTD**
IB*Country						
1 Turky	**-.01085864***	.01161412	**.04922647*****	-.07709583	**.10796479*****	**-.217707*****
2 Egypt	**-.01318139*****	-.0160245	-.00165703	.00225581	.03658055	**.10403444****
3 Tunisia	**.00903234****	-.27294949	.00371337	-.00547917	**-.13524802****	-.13616107
4 Bahrain	-.00016239	-.06582343	-.00514191	.21747514	.04077061	.05020969
5 UAE	.00567938	-.0065544	.0095595	-.01920457	.07053243	**.37331453***
6 Quatar	.00262085	-.01731075	**-.02375965****	.37175875	.06689766**	**.27435259***
7 Jordan	.00312645	.02411544	.0134236	2.4677476	**.1106443*****	**1.8378451****
D2008	.02206542	**-.12667874*****	**.0458446***	2.3753649	**-.09288863***	-.06921298
AGE	.00011409*	.0006511**	-.00012144	.0010766	-.00029192	-.00165695***
Size	-.01100503**	.00115967	.00404676	-.11228195	.00882058	-.01037939
Growth	-.00385804	.00843426	-.01054619	.12078432	-.01341804	.13585113
FAA	-.00743362	-.00820469	-.00503729***	-.02628621	-.21255325	5.8195402***
OBSIA	-.00493326	-.03095817	-.01601574	.17756814	.10494953***	.18769266
_cons	.02826042***	.16116496***	.0330497**	.03624224	.5379753***	.91566152***
N	718	715	723	622	595	570
R^2	.12968328	.38733703	.24857186	.15179409	**.58727804**	.33634261

Table 7 (suite)

	Credit risk		Reglementary risk	Insolvency	Stability
Variable	**Loans loss reserves to gross loans LLR**	**Non-performing loans to gross loans NPL**	**Capital adequaty ratio CAP**	**Debt to assets DTA**	**Zscore**
IB*Country					
1 Turky	**-.0171253*****	-.01475118	**-.05189546*****	**-.09795127*****	-1.6356474
2 Egypt	**.10167456****	**.19444614****	**-.0475668*****	**-.03411482****	**-6.533131****
3 Tunisia	-.04051233	**-.18797017*****	-.01224329	**-.10146369*****	**-29.707037*****
4 Bahrain	**-.04301231*****	**-.06265221*****	**.27851912*****	**-.10873746*****	-4.3979103
5 UAE	-.00895559	**-.02868109****	.01797368	.00579515	-.51430417
6 Quatar	-.00273575	**-.02374091****	**.02860464****	**-.13281333*****	**-20.105154*****
7 Jordan	**-.02814794*****	.04748187	.08070704	-.01614552	**-10.01156*****
D2008	.00048101	-.12539114	**.2776818****	**.29885507****	**58.512291*****

[55] Country-year-fixed effects are not reported in this table.

AGE	-.00044406***	-.0004751**	-.00012969	-.00030349	.01821726
Size	.00616054**	-.00103783	-.05473244***	-.0301909***	2.7776759***
Growth	-.00332748	.00495965	.02971374	.02508149	4.4445088
FAA	.26605557	.60748673	.00233864	-.00563511	1.9976982***
OBSIA	.00541596	-.0422643*	.01004406	.00458119	-.0488952
Trend	8.938e-06	.00017638**	-.00006784	-.00028165**	-.04450324***
_cons	.0376486***	.0425092*	.16920691***	.13794154***	19.664365***
N	544	482	721	698	716
R^2	.45200615	.41390478	.47245168	.27822532	.31800541

Legend: * p<.1; ** p<.05; *** p<.01.

Market shares

Table A 7 Comparing Islamic and conventional banks – controlling for market shares.

Panel A : Equation(4)	**Profitability**			**Liquidity**		**Credit risk**
Variable	**Return on assets ROA**	**Return on equity ROE**	**Cash to assets CTA**	**Cash to deposits CTD**	**Loans to assets LTA**	**Loans to deposits LTD**
IB	.00472551	**-.04516391***	-.00647867	**.47809767***	**.04664336****	**.18681026***
ShareIB	-.08041396	-.16845447	**.20765798*****	-2.228413	-.19288695	.38411658
D2008	**-.00740972***	**-.11050394*****	**.0666991*****	2.126281	-.068322	**-.19106492***
Bank level controls	No	No	No	No	No	No
_cons	.01832499***	.17050609***	.01698266***	-.00852361	.51726665***	.87445171***
N	998	994	1002	854	820	784
R^2	.09247766	.27595341	.20620806	.10690814	.49435269	.15289427
F	4.4778103	4.3284387	10.95548	.	.	11.614263

Panel A (Suite)	**Credit risk**		**Reglementary risk**	**Insolvency**	
Variable	**Loans loss reserves to gross loans LLR**	**Non-performing loans to gross loans NPL**	**Capital adequaty ratio CAP**	**Debt to assets DTA**	**Zscore**
IB	-.00204889	.00661781	**.16225613*****	**-.09324424*****	**-4.2738217*****
ShareIB	.05606239	**-.21562191****	**-1.2148434*****	-.13149506	**-49.400001*****
D2008	-.0448917	**-.20285754***	**-.35824212*****	**-.37592779***	**78.176837*****
Bank level controls	No	No	No	No	No
Trend	.00006338	.00024274**	.00043403***	.00029774	-.05781326***
_cons	.03395612*	.02052063	.05593597***	.06433303**	26.139141***
N	720	613	1004	970	996
R^2	.21985581	.25190219	.37160166	.14500489	.23535374
F	.	.	6.6029235	11.601783	8.5684394

Panel B : Equation(5)	**Profitability**			**Liquidity**		**Credit risk**
Variable	**Return on assets ROA**	**Return on equity ROE**	**Cash to assets CTA**	**Cash to deposits CTD**	**Loans to assets LTA**	**Loans to deposits LTD**
HShareIB	-.04471589	-.13014302	**.1660079****	.09464414	-.36752792	.30725938
HShareCB	.02339405	.66404933	-.09840285	.13813993	**-.47057463*****	**-1.0137188*****
Size	-.00276544	-.00763345	.00588821**	-.11315543**	.04130944***	.05023796**
AGE	-.00008039	.00068379**	-7.421e-06	-.00115754	-.00106262***	-.00325064***
Growth	-.01025769	-.04711955	-.0007459	.10814698	.00426771	.11702422
D2008	.00024387	**-.122041****	**.0403241***	**2.3939621**	**-.22092181*****	**-.38062779*****
_cons	.02382112***	.12952622***	.02887519***	.18297494	.60886177***	1.1068725***
N	881	877	885	749	709	680
R^2	.08769795	.35417866	.22747985	.09837896	.52239596	.15316326

Panel B (Suite)	**Credit risk**		**Reglementary risk**	**Insolvency**	

Variable	Loans loss reserves to gross loans LR	Non-performing loans to gross loans NPL	Capital adequaty ratio CAP	Debt to assets DTA	Zscore
HShareIB	-.01303533	**-.16841351****	-.08642947	**-.30447872*****	**-65.459708*****
HShareCB	-.05553694	-.05844042	**.46704904*****	**.9718865****	**68.125234*****
Size	.00067132	-.00445393	-.06963587***	-.0203697**	1.5207558**
AGE	-.00061941***	-.00068404***	-.0007706**	.00028765	-.01893517
Growth	.01024335	.03047509**	-.00523836	.03000435	-2.2807655
D2008	.05495926	-.02161826	-.17544307	-.15933235	**64.841155*****
Trend	-.0000256	.00009208	.00043909***	.00013512	-.04927048***
_cons	.05881233***	.05184742**	.13550236***	.00660804	19.97159***
N	622	539	886	856	879
R^2	.23228855	.27987779	.38125708	.21791733	.2896816

Legend: * p<.1; ** p<.05; *** p<.01

Unit root tests and order of integration

Table A 8: Unit root test results: All Banks.

	Determinstc trend		Test statistic and instability			Conclusion
	constant	trend	Possible dates of change	ADF	PP	
Z-score		✓	2009→2012	0.0954 0.5380	-2.77280 0.0028	**I(0)**
NPL		✓	2008→2012	-0.2892 (0.3862)	0.2892 0.3862	**I(1)**
LLR		✓	2008-2012	1.9779 0.9760	-1.28917 0.0987	**I(1)**
DTA	✓		2012	0.6079 (0.728)	0.6079 (0.7284)	**I(1)**
OBSIA	✓		2011-2012	1.2010 0.8851	1.2010 0.8851	**I(1)**
Size		✓	2008→2012	0.8854 (0.8120)	0.8854 (0.8120)	**I(1)**
CAP	✓		2011	2.2973 0.9892	0.05044 0.5201	**I(1)**
ROE	✓		2008→2011	-6.9588 (0.0000)	-6.9588 (0.0000)	I(0)
ROA	✓		2008-2009	-9.2279 0.0000	-9.2279 0.0000	I(0)
CTA		✓	2009, 2013	-4.2186 0.0000	-4.8592 0.0000	I(0)
LTA	✓		2011-2012	-1.9821 0.0237	-6.1035 0.0000	I(0)
LTD	✓		2011	-9.6266 0.0000	-6.3186 0.0000	I(0)
CTD	✓		2008-2009	-5.3393 (0.0000)	-5.3393 (0.0000)	I(0)
FAA	✓	✓	2011	-2.1158 0.0172	-2.1158 0.0172	I(0)

Note : p-value is given for Inverse Normal Z –test Fisher-type unit-root test based on augmented Dickey-Fuller tests.

Correlation matrix

Table A 9: correlation matrices : All Banks

	Zscore	NPL	CAP	ROA	ROE	CTD	CTA	LLR	LTA	LTD	OBSIA	FAA
Zscore	1.0000											
NPL	-0.0457	1.0000										
	0.2610											
CAP	0.0005	0.0434	1.0000									
	0.9884	0.2837										
ROA	0.0847*	-0.0059	0.0490	1.0000								
	0.0075	0.8833	0.1225									
ROE	0.0626*	-0.0934*	-0.1292*	0.4686*	1.0000							
	0.0484	0.0214	0.0000	0.0000								
CTD	0.0129	0.0358	0.2684*	-0.0244	-0.0406	1.0000						
	0.7075	0.4063	0.0000	0.4776	0.2370							
CTA	0.0669*	-0.0275	-0.1075*	0.0696*	0.0558	0.1903*	1.0000					
	0.0350	0.4978	0.0007	0.0280	0.0791	0.0000						
LLR	-0.0698	0.7875*	-0.0412	-0.0110	-0.1039*	-0.0258	-0.0683	1.0000				
	0.0623	0.0000	0.2698	0.7682	0.0055	0.5173	0.0673					
LTA	-0.0687*	-0.0702	-0.0931*	0.0650	0.0051	-0.0160	-0.0281	-0.0964*	1.0000			
	0.0495	0.0741	0.0076	0.0630	0.8834	0.6671	0.4226	0.0072				
LTD	-0.0945*	-0.0317	0.0324	0.0662	-0.0201	0.0434	-0.0971*	-0.0596	0.5028*	1.0000		
	0.0082	0.4254	0.3645	0.0641	0.5751	0.2556	0.0066	0.1021	0.0000			
OBSIA	-0.0460	-0.1215*	-0.1728*	-0.0114	0.0462	0.0022	0.0163	-0.1056*	0.1348*	0.1331*	1.0000	
	0.1894	0.0030	0.0000	0.7443	0.1873	0.9538	0.6401	0.0055	0.0002	0.0003		
FAA	0.0098	0.2660*	0.0138	-0.0194	-0.0079	-0.0059	-0.0077	0.2958*	-0.0890*	-0.0205	-0.0272	1.0000
	0.7684	0.0000	0.6770	0.5584	0.8129	0.8684	0.8172	0.0000	0.0102	0.5656	0.4192	

Note : Empirical correlation and p-value.

Appedice B : Applicability conditions for U R Tests

Panel-data model with autoregressive components is

$$\Delta y_{it} = \phi_i y_{it-1} + z'_{it}\gamma_i + \sum_{j=1}^{K} \varphi_{ij} \Delta\, y_{i,t-j} + \varepsilon_{it},$$

where $\varepsilon_{it} \sim WN$. $\phi_i = \phi$ for LLC, HT and Breitung tests. $z'_{it}\gamma_i$ represents panel-specific means and linear time trends if $z'_{it}\gamma_i$= (1, t) and if $z'_{it}\gamma_i$ = 1, it represents panel-specific means (fixed effects).

Panel unit-root tests are used to test the null hypothesis $H_0 : \phi_i = 0$ for all i versus the alternative $H_a : \phi_i < 0$.[56] Under the null hypothesis of a unit root, y_{it} is nonstationary.

HT, LLC, and Breitung tests make the simplifying assumption that all panels share the same autoregressive parameter so that $\phi_i = \phi$ for all i.[57]

The Im-Pesaran-Shin (IPS) (2003) test relaxes the assumption of a common ϕ and instead allows each panel autoregressive parameter to be panel specific (to have its own ϕ_i). Im, Pesaran, and Shin assume that ε_{it} is independently distributed normal for all i and t, and they allow ε_{it} to have heterogeneous variances σ_i^2 across panels.

PP - Choi Z-stat or ADF - Choi Z-stat tests conduct **unit-root tests** for each panel individually, and then **combine the p-values** from these tests to produce an overall test. Fisher type test combines p-values using the inverse chi-squared, inverse-normal, and inverse-logit transformations. **Null Hypothesis is Unit root (individual unit root process). Choi's (2001) simulation results suggest that the inverse normal Z statistic offers the best trade-off between size and power. These tests assume that T tends to infinity**. If the number of panels, N, is fixed, then these tests are consistent against the alternative that at least one panel is stationary.

For Hadri Z-stat, null hypothesis is Stationarity. Hadri tests are appropriate for panel datasets in which **T is large** and N is moderate. Asymptotically, the Hadri LM test is justified as T $\rightarrow\infty$ followed by N $\rightarrow\infty$. The Hadri LM test requires that the panels be strongly balanced Depending on the considered test, alternative H_a may hold, for one i, a fraction of all i or all i.[58]

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[56] A major limitation of the LLC, HT, and Breitung tests is the assumption that all panels have the same value of ϕ=ϕ_i for all i. For HT, ε_{it} is assumed to be independent and identically distributed (i.i.d.) normal with constant variance across panels. Breiyung test assumes that the error term ε_{it} is uncorrelated across both i and t.

HT test has favorable size and power properties for N greater than 25. HT (1999) derived a unit-root test that assumes that the time dimension, T, is fixed. Breitung test has good power even with small datasets (N = 25, T = 25).

[57] The inclusion of a fixed-effect term in a dynamic model causes the OLS estimate of ϕ to be biased toward zero. The LLC method produces a bias-adjusted t statistic that has an asymptotically normal distribution. LLC (2002) recommend using their test with panels of "moderate" size, which they describe as having between 10 and 250 panels and 25 to 250 observations per panel.

[58] The alternative hypothesis is that there is a fraction of panels are stationary. Specifically, if we let N_1 denote the number of stationary panels, then the fraction N_1/N tends to a nonzero fraction as N tends to infinity. This allows some (but not all) of the panels to possess unit roots under the alternative hypothesis.

Except for the **Fisher tests**, all the tests require that there be **no gaps** in any panel's series.

Table B 1: Differences in applicability conditions among the various unit root tests.

Test	$z'_{it}\gamma_i$	**Sample size**	ϕ_i **under Ha**	**Panel Data**
LLC	noconstant	$\sqrt{N}/T \to 0$	common	balanced
LLC		$\sqrt{N}/T \to 0$	common	balanced
LLC	trend	$\sqrt{N}/T \to 0$	common	balanced
HT	noconstant	$N \to \infty$, T fixed	common	balanced
HT		$N \to \infty$, T fixed	common	balanced
HT	trend	$N \to \infty$, T fixed	common	balanced
Breitung	noconstant	$(T,N) \to_{\text{seq}} \infty$	common	balanced
Breitung		$(T,N) \to_{\text{seq}} \infty$	common	balanced
Breitung	trend	$(T,N) \to_{\text{seq}} \infty$	common	balanced
IPS	trend	$N \to \infty$, T fixed or N and T fixed	panel-specific	unbalanced
IPS	Lag()	$(T,N) \to_{\text{seq}} \infty$	panel-specific	unbalanced
IPS	Lag(), trend	$(T,N) \to_{\text{seq}} \infty$	panel-specific	unbalanced
Fisher type		$T \to \infty$, N finite or infinite	**panel-specific**	unbalanced
Hadri LM		$(T,N) \to_{\text{seq}} \infty$	(not applicable)	balanced
Hadri LM	trend	$(T,N) \to_{\text{seq}} \infty$	(not applicable)	balanced

In this paper, since considered panel data are balanced with fixed T (T=10) and fixed N=115 (large number of banks), and some gaps, **Fisher type-test** (**PP - Choi Z-stat or ADF - Choi Z-stat)** will be used for accurate results of panel unit root test.