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Estimation of Duration Gap and its Determinants for Islamic Banks: Empirical Evidence using Two-Step Robust GMM

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Abstract. *Banking industry is risk management business. One specific risk is the rate of return risk (ROR) in the banking book. This study estimates the duration gap of IBs and its determinants in the context of ROR risk. Using Duration Gap Model and Two-Step Robust Generalized Method of Moments (GMM), with a sample of 50 IBs from 13 countries, for the period 2007-2015, our empirical findings are: (a) time series and cross-sectional duration gap of IBs reflecting significant variations across the banks and countries; (b) IBs have a general tendency of maintaining a higher duration gap compared to their conventional counterparts, and are exposed to increasing ROR risk due to their larger duration gaps and severe liquidity mismatches; and (c) there is significant difference in the estimated coefficients of idiosyncratic factors influencing the duration gaps of IBs. This study provides direction to the IBs to reflect upon the significance of liquidity mismatch risk.*

Keywords: *ROR risk, Islamic banks, Duration Gap, IFSB, BCBS, GMM*

Abstrak. *Industri perbankan adalah bisnis manajemen risiko. Salah satu risiko spesifik adalah risiko tingkat pengembalian (ROR) dalam banking book. Studi ini memperkirakan kesenjangan durasi IB dan determinannya dalam konteks risiko ROR. Menggunakan Duration Gap Model dan Two-Step Robust Generalized Method of Moments (GMM), dengan sampel 50 IB dari 13 negara, untuk periode 2007-2015, temuan empiris kami adalah: (a) time series dan cross-sectional durasi gap IB yang mencerminkan variasi signifikan di seluruh bank dan negara; (b) IB memiliki kecenderungan umum untuk mempertahankan kesenjangan durasi yang lebih tinggi dibandingkan dengan rekanan konvensional mereka, dan terpapar pada peningkatan risiko ROR karena kesenjangan durasi yang lebih besar dan ketidaksesuaian likuiditas yang parah; dan (c) terdapat perbedaan yang signifikan dalam estimasi koefisien faktor idiosinkratik yang mempengaruhi kesenjangan durasi IB. Studi ini memberikan arahan kepada IB untuk merenungkan pentingnya risiko ketidaksesuaian likuiditas.*

Kata kunci: *Risiko ROR, Bank Syariah, Kesenjangan Durasi, IFSB, BCBS, GMM*

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Introduction

The modern global Islamic financial services industry (IFSI) has grown in magnitude and geographic coverage. It has now become an integral part of global finance. This integration with international financial markets and institutions today, along with the wide geographical expansion of market activities outside the traditional jurisdictions of Asia and the Middle East, demonstrates that Islamic finance has the potential to develop as a stable financial system (Sau Ngan and James, 2012). The IFSI's resilience, anchored by the specificities of Islamic finance and various inbuilt stabilisers such as unbridled leverage, lack of synthetic and exotic products, limited use of financial product engineering, stable funding base, etc., has been recognized to be an important asset to the global financial system, which can contribute to the growth and a new level of soundness, stability, and inclusiveness. Nonetheless, despite Islamic commercial banks' (ICBs) steady growth across the globe, they have not been immune[1] to risks and vulnerabilities, given that ICBs operate in the same financial and economic environment of dual banking (Chattha and Bacha, 2010).

From the perspective of the business model of an ICB, its activities are exposed to a variety of financial risks such as credit risk, liquidity risk, equity investment risk, market risk, benchmark rate risk or rate of return (ROR) [2] risk and operational risk (IFSB-1, 2005). Additionally, the economic and financial environment in dual banking systems inevitably exposes ICBs to the problems encountered by conventional commercial banks (CCBs), especially benchmark rate risk (Bacha, 2004; Chattha and Bacha, 2010; Chattha and Alhabshi, 2017, 2018; Chattha et al., 2019). In particular, the ROR risk in the banking book of an ICB, which is dealt with in Pillar 2 (IFSB-16, 2014) of the BCBS and the IFSB[3] standards, if not properly managed, has the potential to pose a substantial danger to an ICB's earnings and capital base. Consequently, an effective risk

[1] In particular, liquidity mismatches have played a role in bringing financial distress to ICBs (e.g. Ihlas Finans in Turkey in 2001 and Investment Dar Group in Kuwait in 2008).

[2] Interest rate risk (IRR) or 'profit rate risk' or 'benchmark risk' or 'rate of return' is used interchangeably in the study. Khan and Ahmed (2001) use 'benchmark risk' or 'ROR' terminology instead of 'IRR' so as to avoid unnecessary confusion since ICBs do not deal directly with interest rate. Subsequently, this term was used by the IFSB (2005) and other academicians and researchers (e.g. Ariss and Sarieddine, 2007, Chattha and Bacha, 2010, etc.).

[3] Basel II has three Pillars (BCBS, 2006). Pillar 1 is about minimum capital requirements, whereas Pillar 2 presents the supervisory review process of CCBs, while Pillar 3 covers the disclosure requirements of the CCBs. Building on this, the IFSB has outlined its equivalent standards, specifically IFSB-15 (2013), IFSB-16 (2014) and IFSB-4 (2007), corresponding to Pillar 1, 2 and 3 respectively.

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management process addressing the 'economic value perspective through duration gap model' is essential to ensuring the safety and financial soundness of an ICB. This perspective is not sufficiently addressed in the literature and is thus the focus of this study.

Benchmark rate risk has received considerable academic attention in recent years and has been developed from a number of different perspectives. This considerable eminence in the banking sector is due to various factors, including: (a) the increasing instability of benchmark rates, (b) financial market conditions including the reason for a flat yield curve and the risk of yield curve remaining flat for a longer period, and (c) the growing international emphasis on the supervision and control of banks' benchmark rates under Basel II. Existing literature has discussed IRR management extensively (David, 1995; Dermine, 1985; and Duan et al., 1995). One of the popular techniques used in conventional literature to measure the benchmark rates is the 'Duration Gap Model'. Many researchers including Bierwag et al. (2000), Bierwag et al. (1983), Bierwag and Kaufman (1985, 1992), Chattha and Bacha (2010), Gup et al. (2007), Kaufman (1984), and Sharma (2005), advocate that the duration gap can be considered a much better approach to quantify the effect of benchmark rate changes. While these studies provide important techniques to measure the duration gaps of CCBs, which can subsequently be adopted to calculate the duration gaps of ICBs, they fall short of identifying any specific causes which influence the duration gaps of financial institutions, in particular the ICBs.

While studies directly related to risk management, risk reporting and disclosure of ICBs have been conducted by Khan and Ahmad (2001) and Mohd. Ariffin (2005), risk management tools and practices are covered by Alam and Masukujjaman (2011), Chattha and Bacha (2010), Chattha and Alhabshi (2017, 2018), Fauziah et al. (2011), Hassan (2009), Khalid and Amjad (2012), Mohd. Ariffin et al. (2009), Ben Selma Mokni et al. (2014), Romzie (2009), Romzie and Abdul Rahim (2015), Sundararajan (2002) and Zainol (2015). However, no specific study has been conducted to explain time-series and cross-section variations in the ICBs' duration gaps for a longer period. In addition, the existing work also does not provide enough evidence on (a) whether ICBs have more gaps on a long-term basis compared to CCBs, (b) the main factors influencing the duration gaps, and (c) the implications of higher duration gaps for ICBs and their supervisors under Basel Pillar 2. These factors can enable the ICBs to be on a level playing field with their counterparts, the CCBs. These factors can be used by both ICBs, as a basis to conduct their internal assessment an their regulators.

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The current study attempts to bridge this research gap from an Islamic finance perspective. Based on the existing literature and the gaps identified in the previous studies as specified in Section 3, in the context of the ROR risk, this study seeks to address the following objectives: (a) estimation and magnitude of duration gap across the ICBs and countries, and (b) whether there is any significant difference in the estimated coefficients of idiosyncratic factors influencing the duration gaps of ICBs.

Using various quantitative techniques such as Duration Gap Model, Panel Generalized Method of Moments (GMM), supported by Fixed Effect and Random Effect Regression, with a sample of 50 ICBs from 13 countries (which have a significant presence of Islamic finance), for the period 2007-2015, our empirical findings reveal: (a) time-series and cross-sectional duration gap of ICBs reflects significant variations across the banks and countries; (b) ICBs have a general tendency of maintaining a higher (more) duration gap compared to their conventional counterparts, the CCBs; (c) ICBs are exposed to increasing ROR risk due to their larger duration gaps and severe liquidity mismatches, and (d) there is a significant difference in the estimated coefficients of idiosyncratic factors influencing the duration gaps of ICBs.

The following section discusses Islamic finance with its key specificities and explains the theoretical and regulatory framework for ROR risk for ICBs. Section 3 reviews the important arguments regarding the measurement of the ROR risk through the duration gap approach, followed by the identification of key determinants of the duration gap. Section 4 presents the description of the data and methodology, including the application of the Duration Gap model and Panel GMM. In Section 5, we cover the empirical results of the findings. Finally, the last section concludes the entire study, and includes a presentation of the key findings and the theoretical conclusion, and the practical implications.

Theoretical and Regulatory Framework

To comprehend the implications of the study, we need to understand the theoretical and regulatory considerations behind the purpose of this study.

Islamic Banking – Leading Segment of Islamic Finance

It is important to reflect on the key developments in the Islamic banking sector before presenting theoretical and regulatory considerations. According to the IFSB *Islamic Financial Stability Report* (2018), Islamic banking remains the

most dominant form of asset-based intermediation system. Aapproximately 80% of Islamic financial assets are held within the banking sector in different asset classes, products, and services. The industry's assets remain heavily concentrated in the Middle East region and a select few Asian countries – the top ten Islamic banking jurisdictions account for almost 94% of the global Islamic banking assets.

Moreover, the Islamic banking sector in some jurisdictions (e.g. Brunei, Kuwait, Malaysia, Qatar, Saudi Arabia, and the United Arab Emirates) is gradually becoming substantial. These jurisdictions seem to have achieved at least 15% market share for their Islamic banking assets than total banking assets. This suggests that these financial institutions account for more than 5% of the total global Islamic banking assets between them. The IFSB designates these jurisdictions as systemically important. This increasing prominence and higher market share of the industry poses a number of challenges for the stability of the financial systems where Islamic banks operate. In light of this, the vulnerability of ICBs to ROR risk remains a key concern, which is subsequently studied in this paper.

Given the backdrop of a diverse range of policy actions, from 'dovish' to 'hawkish', coupled with heightened geopolitical risks and conflicts affecting the financial sector in different regions, the key factors of success anchoring modern Islamic finance growth have progressed over time. These are outlined below.

First, the specificities of Islamic finance such as underlying assets which connect the financial sector with the economic sector, risk transformation and comingling, profit-sharing contracts, *Sharia*-compliance requirements, responsible and ethical investments, etc. have led to the exploration of alternative financial intermediation after the GFC. **Second**, due to the persistent weaknesses in advanced economies facing significant deleveraging and slowdown in economic growth in the wake of the GFC, the emerging markets (EMs), including Asia have been performing significantly better, experiencing robust domestic demand driven by strong private sector consumption. This performance, coupled with the petrodollar strenght in the Middle East, has led to the development and promotion of Islamic finance. However, in recent times, the oil sector has witnessed dramatically plunging oil prices. **Lastly,** the presence of a conducive regulatory framework and enabling infrastructure to promote Islamic finance has been a key factor explaining the growth of Islamic finance across jurisdictions.

One of the key elements of an ICB's specificities is the structural differences in its balance sheet composition, which is different from a CCB, and consequently

has different risk implications and effects on risk management. A closer examination of the schematic balance sheet of an ICB reflects a universal banking model where all the traditional intermediation functions (e.g. retail, core banking and investment banking) are performed. Additionally, this balance sheet exhibits peculiar features of the ICBs, which are different from their conventional counterparts, the CCBs. These specificities present various risks and implications for ICBs and play an important role at the supervisory level in developing of financial regulation for them. In this study, we address one of these risk implications for the ICBs.

Risks in Islamic Banking Industry - Key Gaps

While risks are an integral part of the banking industry, for both ICBs as well as CCBs, robust risk management differentiates and outlines the intensity of these risks and vulnerabilities to ensure financial stability and protection against other unintended economic consequences. However, the need for risk management at ICBs demands more attention due to the unique structure of their assets and liabilities.

Numerous studies have been conducted on the risk management aspects of CCBs and ICBs; however, there is still a shortage of literature on certain risks faced by ICBs. Over time, risk management has emerged to be an important discipline that should be improved in light of recent developments in the GFC. Hence, despite common names (such as credit, liquidity, and operational risk), the nature of the risks and the means of dealing with them are different due to the distinctive intrinsic features of Islamic finance. Consequently, risk assessment systems should anticipate and measure these risks (Chattha and Archer, 2016; Khan and Ahmed, 2001). Not many studies offer helpful insight into these developments, particularly with reference to ICBs' stability, duration gap, and the internal capital adequacy assessment process (ICAAP).

To address some of the key risks and distinctive risk features of Islamic financial transactions and contracts offered by the ICB, IFSB-1 (2005) provides comprehensive regulation on risk management controls through guiding principles. These controls are for both ICBs and their supervisors. According to risk, these 15 principles, which complement Pillar II of the Basel II, are grouped under six types (Figure 1). Figure 1 shows that ICBs are also exposed to other specific risks such as "*Sharia* non-compliance risk, fiduciary risk, ROR risk, and DCR", in addition to the customary banking risks (e.g. credit, market, and operational risks)**.**

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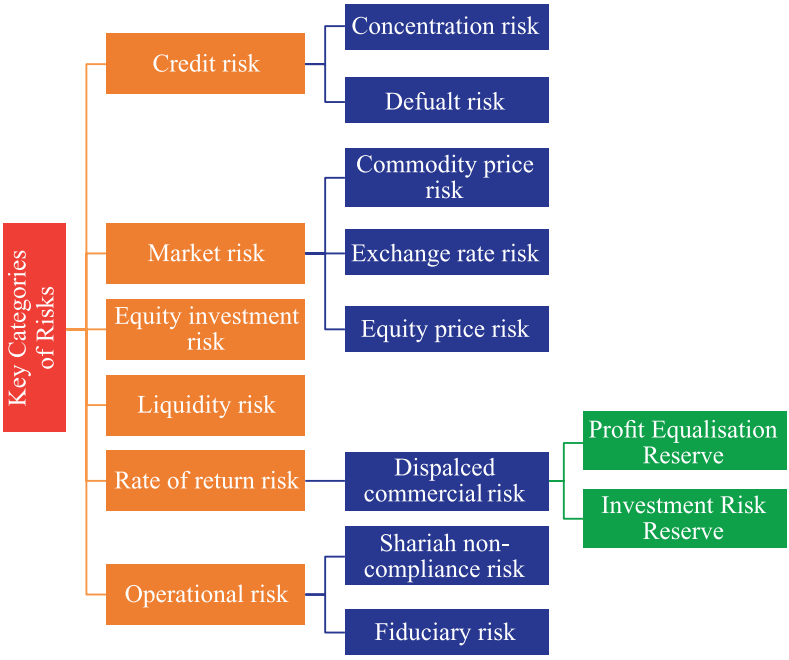
In addition to those mentioned above the existing literature on risk management practices and tools from an ICB's perspective shows a lot of variation yet seems to focus on general risk management practices without combining institutional and regulatory perspectives. There is a wide range of studies on risk management practices for ICBs in different countries for dealing with different types of risk (Al-Janabi, 2008; Alam and Masukujjaman, 2011; Al-Ajmi and Hameeda, 2012; Al-Tamimi and Al-Mazrooei, 2007; Ben Selma Mokni et al., 2014; Fauziah et al., 2011; Hassan, 2009; Hussain and Naysary, 2014; Mohd. Ariffin et al., 2009; Romzie, 2009; Romzie and Abdul Rahim, 2015; and Usman, Akhtar, and Ahmed, 2011). However, none of the above authors has explicitly demonstrated specifically the need to measure the ROR and its impact on the ALM through the duration gap. After a careful review of these studies, it is observed that these studies have merely focused on general risk management practices with a qualitative focus on perception and practices.

Figure 1: Categories of Risks in ICBs



Source: Authors' construction of the Figure based on IFSB-1.

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ROR Risk - Benchmark Rate in ICBs and Regulatory Dimension

Unlike CCBs, ICBs do not deal directly with the IRR or benchmark rate. However, as a matter of practice, most Islamic banking products and *Sharia*-compliant financial instruments are priced regarding to a conventional benchmark rate (e.g. the LIBOR). Therefore, changes in the market rates will have implications for ICBs in terms of their earnings, value of assets, management of liquidity, and funding cost (Chattha and Bacha, 2010). In ICBs, investment account holders' (IAH, also referred to as 'PSIA') funds are invested in fixed-return assets such as *Murābahah*; consequently, the IAH or depositors expect a return reflecting current market conditions. This return is related to market rates and relevant benchmark rates on the return on assets and on the returns payable on funding. This phenomenon is referred to as "ROR risk" by the IFSB. Therefore, contrary to an increase in benchmark rates (which may result in IAH having expectations of a higher ROR, while the returns on assets may be adjusting more slowly due to longer maturities), this scenario leaves the ICBs vulnerable from a risk management perspective, compared to their peers, and highlights an important consideration for their ALM (Chattha and Alhabshi, 2016; Chattha and Alhabshi, 2017, 2018).

For ICBs, various studies highlight the significance of the ROR risk from different perspectives (Akkizidis and Khandelwal, 2008; Ariss and Sarieddine, 2007; Ben Selma Mokni et al., 2014; Fauziah et al., 2011; Greuning and Iqbal, 2008; IFSB, 2005, 2010, 2011, 2014, 2015; Mohd. Ariffin et al., 2009; Romzie and Abdul Rahim, 2015; Vitria, 2008; and Zainol and Kassim, 2012). However, these studies do not capture and quantify the impact of ROR risk on ICBs through duration gaps. They also do not provide adequate guidance on identifying of variables that can serve as key determinants of duration gaps for ICBs.

A bulk of the initial literature on the ROR risk emanates from the works of the IFSB, which has played an important role in explicating the ROR risk from various perspectives such as definition of ROR risk (IFSB-1, 2005), ROR impact on ICBs and various disclosures of ROR risk (IFSB-4, 2007), a mechanism to measure the ROR risk and DCR (IFSB GN-4, 2011), ROR risk in stress testing (IFSB-13, 2012), ROR risk and sound benchmark rate risk management (IFSB-16, 2014), and the assessment of ROR risk under IMF-World Bank FSAP (IFSB-17, 2015). Moreover, IFSB-1 (2005) suggests the use of the terminology 'ROR risk' for ICBs as they do not have their own benchmark rate, and they tend to use the market rate or relevant benchmark rate, such as the London Interbank Offered Rate (knows as "LIBOR"), in pricing their financial instruments. For instance, in the *Murābahah* contract, the rate is formulated from the LIBOR plus risk premium

and is held constant throughout the contract's entire duration (Hassan and Lewis, 2007; Khan and Bhatti, 2008).

Following the GFC, the role of regulators and supervisors to highlight the adequacy and capability of an ICB's management of risks during their normal supervisory review process, has been intensified. Both the BCBS and the IFSB set clear guidelines on risk management from supervisory perspectives, particularly for ROR risk. IFSB-16 (2014) has highlighted that it is essential for ICBs to have benchmark rate risk measurement systems, including a number of generally accepted techniques (such as *gap* analysis and *duration gap* analysis) for measuring the benchmark rates risk exposure of both *earnings* and *economic value*. The IFSB's most recent work on ROR risk is in IFSB-17 (2015), also known as CPIFR (Core Principles for Islamic Finance Regulation), in which CPIFR 26 on ROR risk advocates that supervisory authorities should require ICBs (through policies and regulations) to have an appropriate ROR risk strategy and ROR management framework that provides a comprehensive ICB-wide view of ROR risk.[4]

What is Duration Gap? Duration Gap for Measuring ROR Risk

The discussions in the previous section indicated the key implications of ROR risk and how they are relevant to banks. One conclusion acknowledged above is that the ROR risk is due to the maturity mismatch of a bank's assets and liabilities. In addition, it was also established that one of the key tools to address the ALM is the duration gap approach. It is essential to define the duration gap concept to provide context for discussing relevant past studies on the issue in the next section.

Gup et al. (2007), citing Bierwag (1987), define duration as "the weighted average time (measured in years) to receive all cash flows from a financial instrument", and duration gap as the difference between the duration of a bank's assets and liabilities. In simple terms, it is defined as the "weighted average maturity in which the weights are stated in present value terms" (Chattha and Bacha, 2010: 16). On the other hand, similar to the BCBS, the IFSB provides an identical definition of duration measure, which is, "a measure of the percentage change in the economic value of a position that will occur given a small change in the level of benchmark rates" (IFSB-16, 2014: 40).

[4] Prior to issuing IFSB-17, the IFSB Working Paper (2014) entitled *"Evaluation by the IFSB of Core Principles Relevant to Islamic Finance Regulation"* identified the need for the assessment of ROR risk (Chattha et al., 2014).

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There are two strategies when managing duration gaps – aggressive and defensive (Chattha and Bacha, 2010). The former would alter the duration gap in anticipation of changes in interest rates. For example, if interest rates were expected to increase, management would want to shift from a positive to a negative gap position — it could do this by reducing the duration of assets (D_A) and /or increasing the duration of liabilities (D_L). It is also argued that the expectation of falling interest rates would, of course, produce the opposite type of portfolio adjustment. The latter strategy within this context would seek to keep the D_A equal to the D_L, thereby maintaining a duration gap of zero. Thus, while an aggressive strategy seeks to profit from expected rate movements, a defensive strategy seeks purely to immunise net worth (NW).

With the above considerations, this study offers deeper insight into the issue and gives ICBs guidance on managing their duration gaps. To the best of the authors' knowledge, this is a pioneer study in Islamic banking involving a sample of 50 full-fledged ICBs from 13 countries for the period 2007-2015. In this respect, the study provides profound value addition to the existing corpus of literature, as follows:

(a) enhancing the literature, with respect to Islamic finance, on the significance and calculation of the duration gaps of ICBs while factoring in country-specific and sector-specific differences,

(b) providing insight into the effectiveness of duration gap for managing the ROR in the banking book of ICBs, and how duration gap management can effectively help both the ICBs and the supervisory authorities with respect to ICAAP in the context of volatile ROR risk,

(c) determining the factors influencing the duration gaps of ICBs, as there could be various causes contributing to higher duration gaps.

The next section outlines relevant studies on this specific tool, i.e. duration gap for ROR risk.

Literature Review

Duration Gap Perspective and Relevant Studies

Many classical studies assert that ALM has its origin in the duration analysis suggested by Macaulay (1938) and Redington (1952). Alden (1983) and Bierwag and Kaufman (1985) concluded that gaps, computed as functions of the DA and DL, are a more meaningful measure of IRR exposure for depository institutions than the simpler ones and more commonly used maturity gaps.

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Duration gap analysis helps determine the exact amount by which the revenues from the assets increase or decrease depending upon the rise and fall of interest rates. Furthermore, in order to understand the classical work on the major highlights, developments and utilisation of duration gap theories and concepts, Bierwag and Fooladi (2006) provide a comprehensive historical perspective in the context of duration analysis. Bierwag and Fooladi (2006) argue that in much of the academic community, the concept of duration still remains something of a mystery and a curiosity, and it is often misunderstood and regarded as a flawed and oversold statistic.

Alden (1983) presents one of the classical works on gap management with respect to managing IRR in banks. His work is classified as one of the pioneering studies of intellectual contribution to ALM and IRR management. He thoroughly outlined and revealed the "serious shortcomings" in the existing gap models (during that time). After providing reasonable and logical explanations against the existing gap models[5], he explicitly supported the duration gap model, which is much more helpful in measuring the IRR exposure within banks. He provided technical calculations on the duration model in his work and suggested that duration analysis can be used for many purposes by banks, including hedging NW or MVE. Further extending his work on IRR management and ALM, he identified and described three ALM techniques: *maturity gap* approach*, simulation* approaches[6]*,* and *duration gap* approach.

Bierwag and Kaufman (1985), in their work on duration gaps, described a number of single-factor duration gap equations that may help financial institutions control the value of a desired 'target' account. They elucidated that duration gaps provide "a more accurate description of the overall IRR exposure of the institution" that accurately gauges IRR for on-balance-sheet accounts. After Alden (1983) and Bierwag and Kaufman (1985, 1988), Dembiec et al. (1989) contributed another illustrious study on the application of ALM and duration

[5] Alden (1983) in his study states that to use the basic model, a bank must provide four pieces of information: (a) the length of time over which net interest income is to be managed, and usually 'one year' is chosen for this 'gapping period'; (b) the bank must decide whether to protect the currently expected net interest income for the gapping period; (c) in the cases that the bank accepts an active strategy, an interest rate forecast for the gapping period is required; and (d) the bank must settle on the dollar amounts of the RSA and RSL.

[6] These are defined as computer designed modeling techniques with varying levels of sophistication, which provide results in a dynamic context. Regarding simulation models, it is argued that these models are often criticised as being 'black boxes', having unknown internal structures, and for their inability to reflect the actual environment of the institution or bank being modelled.

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gap to the industry. They defined duration analysis as an index measure(s) of interest rate sensitivity for any series of cash flows taking into account both cash flow timings and magnitude. In their study, after determining the assets and liabilities, they used the modified duration measurement and incorporated estimates of the D_A and the D_L.

Entrop et al. (2009) specifically evaluate the robustness of the standardised framework proposed by the BCBS (2004) to quantify the IRR of banks. Their paper provides an empirical application of the BCBS framework on IRR for CCBs. Their empirical methodology and analysis use and calculate the duration gap and modified duration gap for assets and liabilities of the sample banks. Scanella and Bennardo (2013) maintain that ALM activities are conducted in the context of a bank's sensitivity to interest rate changes, and IRR exposure can be measured by computing the gap between assets and liabilities, in each assets' and liabilities' maturity, and calculated for a set time horizon. They point out the two different approaches in measuring IRR exposure in banking. The first approach is the current *earning approach* based on the *maturity gap* model. The approach requires the accounting book value (historical-cost accounting). The latter approach, the *duration gap* model, is based on the *economic value* approach. The suggested application of these two approaches is consistent with the BCBS (2004).

Although the aforementioned studies offer essential details on the significance of IRR and the calculation of the duration gaps of the CCBs, nevertheless, as expected, they do not deal with the specificities of ICBs. However, there are a few studies from the perspective of ICBs conducted by Khan and Ahmed (2001), Bacha (2004), Chattha and Bacha (2010), Chattha and Alhabshi (2017, 2018), Chattha et al. (2019) and Sun et al. (2014), which suggest the use of duration gap technique by ICBs to manage their asset-liability mismatch. There seem to be, however, a lot of gaps in these studies as they do not provide empirical evidence on the use of such a duration gap approach using GMM for time-series and cross-section data, the magnitude of vulnerability of the ICBs to ROR exposure, and factors influencing the ICBs' duration gaps in cross-country analyses.

Determinants of ROR Risk with Duration Gap in ICBs

The study pointed out in the previous section that most of the existing studies pertaining to duration gap are concerned with the various dimensions of duration gap and how the duration gap of a bank could be calculated taking into account different steps. This reveals the fact that one of the significant gaps in the duration studies is the lack of work determining and explaining the idiosyncratic

factors influencing the duration gaps of CCBs and ICBs. From CCBs' perspective, there is a dearth of studies on this topic, and specifically in the case of ICBs, it is hard to find even a single study which captures and explains the duration gap in terms of explanatory variables. Therefore, we review the summary of available studies in this context.

Saporoschenko (2002) examines the asset/liability differences and presents the relationship between the market and IRR of various types of Japanese banks for the period 1986-1992, and a set of on-balance sheet financial characteristics. Using *Cross-Sectional Regression Model* with the *Bank Size*, *Total Deposits*, the ratio of *Deposits to Total Assets*, and *Assets Maturity* (defined as shorter term assets and liabilities (SHORT)), he determined that these variables were generally positively signed and significant with degree of interest rate exposure. He further argues that if the duration of the assets were longer than the duration of the liabilities these results would be expected.

Ballester et al. (2009) provide empirical evidence on the main determinants of the IRR exposure of 23 Spanish commercial banks for the period 1994-2006. In the determination of the IRR, the empirical results are obtained through estimation of the empirical duration coefficients, and the study then uses the absolute[7] value of empirical durations as the dependent variable in the panel estimation. The empirical results through *Panel Least Squares* and bank-specific *Random Effects* with *Cross-Sectional Regression* reveal that Spanish banks, overall, show a considerable degree of exposure to IRR during the period of study. Furthermore, the study indicates that IRR exposure is systematically related to some bank specific characteristics, and a significant positive association is found between *Bank Size*, *Derivative Activities*, and *proportion of Loans to Total Assets*, and banks' IRR exposure.

Entrop et al. (2012) empirically explored and analysed how interest risk premia and other risk components are priced in bank margins. Their study sample included the German commercial banking sector spanning 10 years (2000-2009), taking into account 'treatment of mergers and consolidation'. In their model, they ensured that all their regressions were estimated using *Fixed Effects Two-Stage Least Squares*. Using supervisory data and the information on *volumes* and *maturities* of different lender and borrower types, they calculated

[7] In their study, estimated empirical durations were found with 'both positive and negative signs', as it could be expected, but they took the 'absolute value for panel estimation'. They argue that a higher duration, regardless of its sign, implies a higher IRR for the bank (greater variation in the value of the firm for a given change in interest rates).

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modified duration gaps 'to proxy for on-balance IRR'.[8] The results indicated that duration gaps show positive effects, and almost all banking samples show a positive relationship with regard to duration gaps. In the context of duration gaps, their results also demonstrate that savings and cooperative banks have substantially larger duration gaps (DGAPs).

Ruprecht et al. (2013) observe that banks are exposed to IRR through their function of transforming short-term deposits into long-term loans. They state that IRR is visible on the balance sheet as the maturity mismatch or duration gap. They used *Cross-Sectional* and *Time-series Regression*. In one of their models' equations, they use *modified duration* gap as the dependent variable. Under the maturity gap, the other variables used as explanatory variables include *Size*, *Saving Deposits*, *Liquid Assets*, *Total Asset Growth*, *Customer Loans*, *and Loan Commitment*. They calculated the modified duration gap by first assigning the modified durations of the standard BaFin[9] approach to the maturity brackets, and then summing up the volume-weighted assets and liabilities' time-to-maturity brackets. They conclude that the maturity gap is largely determined by customer liquidity needs, whereas the decision to use swaps relies on the compliance with the interest rate risk regulation.

Esposito et al. (2013) rely on the methodology of *duration gap* approach, whereby banks describe their IRR exposure as the potential effect of a parallel upward shift of the entire term-structure of interest rates on the present value of their future cash flows. Their paper adopted the 'economic or capital perspective' and measured Italian banks' IRR following the guidelines proposed by the BCBS (2004). The study used *Panel Regression* for the period 2001-2011. The paper demonstrates the determinants of the on-balance sheet duration gap. The independent variables included in the study were: *Size*, *Non-Performing Loans/ Total Loans*, *Funding Gap*, *Tier-1 Ratio*, and *ROE*. The results concluded that the Italian banking system exhibited a limited exposure to IRR during the period under review, well below the regulatory alert threshold.

Racic et al. (2014) attempt to quantitatively assess and identify different balance sheet factors that have a statistically significant influence on banks' exposure to IRR in developed (USA) and developing (Serbia) financial markets. For USA they

[8] Entrop et al. (2012) explain that an important issue when modelling IRR is the effective maturity assigned to de facto non-maturing savings deposits, as applying legal maturities of 3 and 6 months would clearly overestimate the duration gap.

[9] The BaFin is the financial regulatory authority for Germany.

included 65 banks (2001-2010) and for Serbia 10 banks (2006-2010). A comparative analysis of the influence of the balance sheet characteristics was conducted based on the *Regression Panel Model* using the following variables as independent variables: *Total Assets (TA)*, *Equity to TA*, *Loans to TA*, *Deposits to TA*, *Net Interest Revenue to Average Assets*, *Non Interest Income to Net Income*, *Return on Average Equity*, and *Derivatives to TA*. The results reveal that an increase in the share of deposits in the total assets of the U.S. banks reduces exposure to IRR, while banks in the Republic of Serbia experience an opposite effect. The coefficients also suggest that there are 'some empirical factors, whose effects are universal'.

Khaliq et al. (2017) employ the duration gap analysis to measure the Islamic bank's sensitivity of bank assets and liabilities towards the rate of return risk due to the conventional interest rate volatility. Their empirical data and analyses covered a 5-year period using annually based data (2008 – 2012) for Malaysian Islamic banks only. Though, the quantitative results reveal that the majority of the Islamic banks are exposed to the interest rate risk but the study does not provide how the duration gap is estimated including estimating weighted duration of assets and liabilities and process of estimation. On one hand, this confirms the usage of the duration gap methodology; on the other hand, no explanation is provided how this methodology is used by the ICBs in their risk management and what are the implications.

In addition to the aforementioned studies, there are some other studies which are of relevance to the present study. For instance, according to the classical economist, Elijah (1985), the maturity bucket approach attempts to solve the intra-period problem by measuring the gap for each of several sub-intervals of the gapping duration. In addition, with respect to the size of the banks Ruprecht et al. (2013) indicate that *size* leads pure banking book institutions to take more, but trading book institutions to take less, IRR on the balance sheet. Banks with a higher share of *customer loan* volume indeed have a higher duration gap.

Landier et al. (2013) explore the transmission of monetary policy via banks' exposures to interest risk, or duration gap. This study statistically shows, first, that the sensitivity of bank profits to IRR is larger when the duration gaps are larger, and second, that duration gaps also predict the sensitivity of bank lending to interest rates. On the other hand, Ruprecht et al. (2013) measure the impact of regional GDP and duration gap, as GDP is expected to influence numerous factors related to the supply and demand for loans and deposits.

Furthermore, there is scant literature which describes possible idiosyncratic factors which might have a tendency to explain the relationship between these

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factors and duration gaps for ICBs. One fact established from the discussion presented above is that there are some studies which have adopted duration gap as the dependent variable for measuring the impact of IRR for CCBs. In fact, to the best of our knowledge, it is hard to pinpoint even a single study from ICBs' perspective which provides reasonable analysis. However, using the existing studies from CCBs' perspective, this study adds significant contribution to the literature. Our approach and analysis can offer deeper insight into the issue and give guidance to ICBs on managing the duration gaps within their unique integrated regulatory system.

Therefore, as for the choice of variables, after reviewing the literature, the study finds seven idiosyncratic variables: *Liquidity Ratio*, *Liquidity Gap*, *Total Financing to Total Assets*, *Number of Maturity Buckets*, *Bank Size*, *GDP Growth*, and *Central Bank Policy Rate*, which are important in identifying and explaining the dependent variable in this research through Panel GMM model. The descriptions of these variables and expected significant signs are presented in Section 4, along with the regression models and the specifications of the models.

Methods

Data Used for the Estimation of Duration Gap for ICBs

We selected a sample of 50 ICBs from 13 countries, namely, Bahrain, Bangladesh, Indonesia, Jordan, Kuwait, Malaysia, Pakistan, Qatar, Saudi Arabia, Turkey, UAE, and Yemen, for the period 2007-2015. The main reasons and criteria for choosing this sample and period are: (a) balanced panel, (b) latest data of full-fledged ICBs globally (instead of including Islamic windows or Islamic units or branches of the CCBs), and (c) full-fledged ICBs operating in dual banking systems (thus excluding Sudan and Iran). The accessibility of long-horizon data for the ICBs covering 2007-2015, with relevant information on the undiscounted contractual maturity breakdown of the assets and liabilities, was a critical concern that posed a serious challenge. It is worth mentioning that the sample countries hosting these 50 ICBs are leading Islamic finance jurisdictions, where almost 90% of the total Islamic banking assets reside within the dual banking system. The size of these 50 ICBs amounted to US$ 558 billion in 2015, including the top 5 systemically important ICBs in terms of asset size, holding more than 70% shares of Global Islamic Banking Assets.

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Figure 2: Data used for the estimation of Duration Gap for ICBs

Assets side	Liabilities Side
Financing, net	Deposits
Financing (or financing assets or sales receivables) using any debt-based contract such as *Murābahah*, CMT, *Ijārah*, *Istisnā*, *Salam*, etc.	All kinds of deposits backed by various *Sharī'ah*-compliant contracts, for savings account, current account, fixed maturity.
The study did not include *Mushārakah* and *Mudārabah* investment due to ex-post pricing mechanism.	
Due from banks and financial institutions	PSIA or unrestricted investment account
	CMT-based deposits (also known as *Murābahah* payables or *Wakālah* payables)
	Due to banks and financial institutions

Note: For comparison, in the case of PSIA, we considered it as a deposit, instead of its legal status with respect to its contract.

In order to calculate the duration gaps of ICBs, the data for the maturity breakdown of banks' assets and liabilities is manually and individually extracted from the banks' annual financial reports, required under the IFRS, for the sample period. This ensured that the extracted data is reliable. A very stringent validation process was carried out to ensure that the extraction process was clean and accurate. Figure 2 indicates the key considerations based on which the data was extracted for the ICBs. For the duration gap on the assets side, in order to determine the amount of financing, the study uses total financing (Chattha and Bacha, 2010; Chattha and Alhabshi, 2017, 2018; Chattha et al. (2019); Ruprecht et al. 2013) as the case may be, from one-month to long-term financing (all maturity buckets). Unlike CCBs, the data for the ICBs is complex due to the nature of the ICBs' balance sheet, as Islamic banks can participate or provide financing to their customers' projects or assets acquisition in numerous ways as per the principles of *Sharī'ah*. Thus, financing, from the ICBs' perspective, is taken from five common debt-based contracts/instruments used by the ICBs across the various countries (Figure 2).[10] Moreover, in our study, our estimation

[10] According to IFSB (2017), the data on "financing by type of the Shariah-compliant contracts" reveals that these five major financing contracts used by the ICBs as of 2017Q1 cover almost 85% of total financing extended by the ICBs. http://www.ifsb.org/preess_full.php?id=400&submit=more.

of duration gap only included 'On-Balance Sheet' items listed as financing (short-term to long-term) on the asset side, and customer's deposits (short-term to long term) on the liability side.

Panel Data for ICBs in GMM Estimation

With respect to the Panel GMM, the sample of the study consists of 50 ICBs with 450 observations reflecting a **balanced panel** (Table 1). Annual time series data for independent and dependents variables is extracted individually from the banks' annual audited financial statements for the period 2007-2015. While other key relevant data such as GDP growth is obtained from the World Bank, central bank policy rates are obtained from the IMF. The size was converted to log value and all remaining data was held as a percentage.

Research Methodology

The research methodology comprises two-stages. Stage one uses Duration Gap model to calculate the duration gaps of ICBs; stage two uses Panel GMM.

Stage 1: Determination of Duration Gaps of the ICBs

Building on the conceptual understanding of duration gap (Section 3), the duration gap of a bank is demonstrated by comparing the weighted average D_A (Equation 1) with the weighted average D_L (Equation 2). In terms of a model, the study determines the duration gap with a four-step process, consistent with Koch and MacDonald (2009), Chattha and Bacha (2010), Chattha and Alhabshi (2017, 2018); Chattha et al. (2019):

(a) Determining the D_A and D_L for each asset and liability item of the balance sheet (in this study, financing and deposit);
(b) Finding the weight (proportion) of each item within its category;
(c) Calculating the weighted duration of D_A and D_L using (a) and (b); and
(d) Calculating the duration gap (DGAP) by deducting D_A from D_L.

Weighted Average Duration of Bank Assets (D_A)

$$D_A = \sum_{i}^{n} w_i Da_i \qquad (1)$$

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Where,

w_i = Market value of asset i divided by the market value of all bank assets

Da_i = Macaulay's duration of asset i (Equation 3)

n = number of different bank assets

Weighted Average Duration of Bank Liabilities (D_L)

$$D_L = \sum_{j}^{m} z_j Dl_j \qquad (2)$$

Where,

z_j = Market value of liability j divided by the market value of all bank liabilities

Dl_j = Macaulay's duration of liability j

m = number of different bank liabilities

The traditional Macaulay's duration (D) calculation:

$$D = \frac{\sum_{t=1}^{k} \mathrm{CF_t(t)}/(1+y)^{\mathrm{t}}}{\sum_{t=1}^{k} \mathrm{CF_t}/(1+y)^{\mathrm{t}}} = \frac{\sum_{t=1}^{n} \mathrm{CF_t(t)}/(1+y)^{\mathrm{t}}}{PV\ of\ the\ Security} \qquad (3)$$

Where:

D = Duration

CF_t = Cash Flow at t time

Y = Yield to maturity or rate of discount

T = Time at which cash flow is received

PV = Present value of the security

n = Number of years to maturity

Stage 2: Econometric Model and Specifications

Conceptual Framework of the Model and Specifications

In order to determine the idiosyncratic factors influencing the duration gaps of ICBs, the study develops Panel GMM supported by *Fixed Effects* (FE) and *Random Effects* (RE) regressions. The choice of the model, and reasons for the same, are explained below. The model consists of one dependent variable and seven bank-specific independent variables as reflected in the following Equation 4. It is worth mentioning that Equation 4 includes a lagged dependent variable (as regressor) in the Panel GMM to increase the reliability of the estimation.

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Out of these seven independent variables, five are bank-specific and two are macroeconomic-specific.

$$DGAP_{it} = b_0 + b_1\, DGAP_{it-1} + b_2\, LIQR_{it} + b_3\, LIQG_{it} + b_4\, FINA_{it} + b_5\, BUCK_{it} + b_6\, SIZE_{it} + b_7\, GDPG_{it} + b_8\, RATE_{it} + u_{it} \quad (4)$$

Where,

i = 1, …, N; and t = 1, …, T_i; u_{it} is the error term

Figure 3 summarises of the variables' descriptions, expected signs, their source, and some references to previous papers in the literature that have also used these variables. Moreover, in addition to the aforementioned seven variables, one dummy variable is included to account for the crisis, specifically the GFC reflecting structural breaks. The expected purpose of using the GFC as a variable is to determine whether the crisis had any impact on the duration gaps of the ICBs. To serve this purpose, the crisis years of 2008 and 2009 are included in the model. The GFC takes a value of 1 for crisis and zero for no crisis.

Figure 3: Variables: Definitions, Expected Signs and Literature Review

Variable Name	Description, Computation and Supporting Literature	Expected Signs
DGAP	Duration Gap model. It is the difference between the D_A and D_L. It is the weighted average time in terms of years, as defined in Section 3. (Ballester et al., 2009; BCBS, 2004; Bierwag and Kaufman, 1985; Bierwag and Fooladi, 2006; Chattha and Bacha, 2010; Entrop et al., 2009, 2012; Esposito et al., 2013; Ruprecht et al., 2013; Van and Styger, 2006)	
LIQR	Liquid assets ÷ Total Assets. The LIQR is the buffer of liquid assets as a share of balance sheet total assets, which may influence the duration gap. More liquid assets means the duration of assets will be lower. In general, according to the IFSB, core liquid assets ((i) currencies and (ii) deposits and other financial assets available on demand or within at most three months) comprise assets that are readily available to meet any demand for cash. They usually consist of assets maturing within one year held either in cash or near-cash equivalents. The study model utilised the core liquid asset ratio for LIQR. (Ruprecht et al., 2013)	?*

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Variable Name	Description, Computation and Supporting Literature	Expected Signs
LIQG	The LIQG is the difference between the maturity mismatch of total assets and total liabilities in different maturity buckets. The mismatch can influence the duration gap both positively and negatively, depending on the direction of the maturity mismatch. The study modelled the LIQG as the gap difference between the short-term maturity (up to one-year) mismatch of total assets and liabilities in different maturity buckets. The difference is converted to a percentage of total assets for each year and for each ICB for the study's observation. $CLGAP_{i,t}$ = (Risk Sensitive Assets one-year) – (Risk Sensitive Liabilities one-year) i (banks) = 1, … , N; and t (time in year) = 1,…,Ti (Elijah, 1985; Esposito et al., 2013; Khan and Syed, 2013; Laurine, 2013; Salman, 2013; Saporoschenko, 2002; Sun et al., 2014)	+/-
FINA	Total Net Financing ÷ Total Assets. The FINA shows a positive impact on the performance of the ICBs. A higher ratio of financing will indicate higher concern and vulnerability to duration gap. In risk-sensitive financing (RSF), the financing has a tendency to be influenced when the benchmark rates are moving upward or downward. More RSF means the D_A will be higher than the D_L. The FINA is modelled as net financing after loss provisions and adjustments. (Ballester et al., 2009; Ehrmann and Worms, 2004; Rajha and Alslehat, 2014; Racic et al., 2014; Ruprecht et al., 2013)	+
BUCK	Total number of maturity buckets available in the respective bank. The empirical logic behind BUCK suggests that more assets maturing in longer time bands (buckets) should render duration of assets positive. (Elijah, 1985; Entrop et al., 2012; Ruprecht et al., 2013; Salman, 2013)	+
SIZEL	Log (Total Assets). The assets of each ICB were converted into US$ for the study's observation (2007-2015). (Ballester et al., 2009; Esposito et al., 2013; Racic et al., 2014; Ruprecht et al., 2013; Saporoschenko, 2002)	+
GDPG	Annual growth of respective country GDP in percentage. The data on GDPG for each sample country is retrieved from the World Bank database. (Entrop et al., 2012; Ruprecht et al., 2013)	+
RATE	The RATE is extracted from the IMF IFS database. (Entrop et al., 2012)	?*

*This symbol specifies that the predicted sign is indeterminate.

Having outlined the variables, and before discussing the choice of Panel GMM, it is important to emphasise that the above-mentioned studies reflect three important observations: first, there are no available direct empirical studies or evidence focusing on the determinants of the duration gaps across the ICBs and over time; second, the available empirical studies — where the DGAP has been used as a dependent variable — have measured the impact of IRR or the determinants of IRR in a conventional sense using DGAP as a proxy[11]; third, most of these studies have used panel data regression with *Random Effects* or *Fixed Effects*, but none have used the Panel GMM (Difference or System) in their models. In this study, we considered the two impacts of holding the DGAP as the dependent variable: first, determining the factors influencing the duration of ICBs; and second, determining the on-balance sheet factors for the ROR impact on ICBs. First, the determination of the factors influencing the duration of ICBs; and second, the determination of the on-balance sheet factors for the ROR impact on ICBs. Consequently, the signs of the relationship between potential variables from the ICBs' perspective are theoretically ambiguous, and so it becomes an empirical question, which is addressed in this study.

With the above in mind, we employ the following Panel GMM technique using **STATA 13** software to estimate the relationship between the dependent variable and independent variables, and to increase the efficiency of estimation procedures. A brief literature on the GMM estimation and justification for its use, and a few issues pertaining to the GMM are presented below.

Panel GMM - Estimation and Specifications

The ordinary least squares (OLS), a classical estimation technique in a linear regression model, tends to provide a partial view of the relationship and does not describe the relationship for panel data, in particular for short-term data. On the other hand, combining time-series and cross-section observations, panel data regression gives more informative data with more variability but less collinearity among the variables (Fauziah et al., 2009). This method provides more advantages, for instance: controlling for individual heterogeneity, reducing problems of multicollinearity, eliminating estimation bias, and capturing the dynamic relationship between independent variables and dependent variables (Ballester et al., 2009).

[11] Within these studies, for instance, Ballester et al. (2009) considered DGAP with absolute values. In addition, Entrop at el. (2012) used DGAP as a proxy for IRR.

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Besides the widespread usage of GMM in conventional banking for years, GMM has also been used in Islamic finance by many authors, including El Alaoui et al. (2016), Othman and Masih (2015), and Abdul Wahab et al. (2017). Therefore, in the context of this study, given the data structure, the use of the Panel GMM framework is deemed appropriate. The choice of using the GMM in this study is driven by the data limitations of ICBs, composition of the data (i.e. heterogeneity across the banks), number of banks and observations, the sample period under observation, and dual banking systems (Table 1). The literature review primarily suggests dynamic models like GMM for bank-related analysis for cross-section and time-series panel data.

Table 1: Complete sample of banks and observations

#	Country	Number of ICBs	Observations
1	Bahrain	7	63
2	Bangladesh	3	27
3	Indonesia	2	18
4	Jordan	2	18
5	Kuwait	4	36
6	Malaysia	11	99
7	Pakistan	4	36
8	Qatar	4	36
9	Saudi Arabia	3	27
10	South Africa	1	9
11	Turkey	4	36
12	UAE	4	36
13	Yemen	1	9
	Total	50	450

Note: The sample observations are for the study period 2007–2015.

To tackle the OLS complications, studies in the literature have recommended using of the GMM for dynamic panel data, as was proposed by Arellano and Bond (1991). This method uses a certain number of moment conditions specified for the model, where the moment conditions are functions of the model parameters and

the data. Therefore, panel GMM provides a remedy for the endogeneity problem suffered by OLS, by replacing the biased variables with the instrumental variables. In this respect, Arellano and Bond (1991) offered the practice of first difference lag levels for each variable as instrumental variables. The use of Difference estimators in the dynamic panel GMM model should eliminate bias potentially sourced from omitted variables in cross-sectional estimates (Masih and Masih, 1996). Due to some practical problems with the Difference GMM, Arellano and Bover (1995) and Blundell and Bond (1998) suggested the System GMM, which can offer greater flexibility to the variance-covariance structure.

If we look at the finance literature, several studies demonstrate the advantages and disadvantages of both Difference and System GMM (Blundell and Bond, 1998; Bun and Windmeijer, 2010; and Abdul Wahab et al., 2017). For instance, Blundell and Bond (1998) argue that the 'System GMM' performs better than the 'Difference GMM' as it improves efficiency and may reduce the finite sample bias. In addition, Blundell and Bond (1998) and Wu and Bowe (2012) further discuss that the 'System GMM' is not necessarily superior to the 'Difference GMM' in cases where the autoregressive parameter is below 0.80. In our results, the choice of using the Difference GMM or System GMM is determined based on the coefficient of the lagged dependent variable. We use Difference and System GMM under 'two-step robust' estimations as it is more efficient and reliable.

Robustness Checks

To check the consistency of the GMM estimators on the soundness of the instruments, there is a need to employ specification tests, as suggested by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). The **Arellano and Bond tests** (AR1) and (AR2), examine the absence of first and second order serial correlation in the differenced residuals. For AR (1), the null hypothesis should be rejected, and the failure to reject the null hypothesis for AR (2) test indicates that model is robust. However, the **Sargan-Hansen test** indicates robustness for overriding restrictions of the instruments' variables. In addition to Arellano-Bond Dynamic Panel GMM robustness tests, RE and FE are performed before applying the Hausman specification test through STATA, to strengthen the results.

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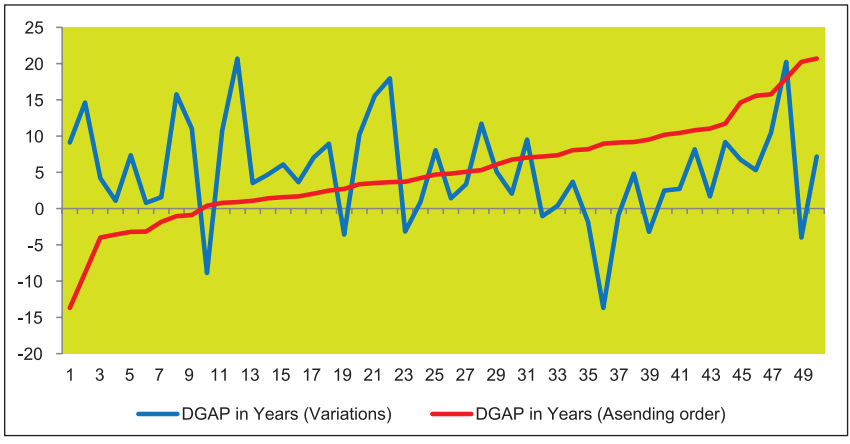
Results and Discussions

Duration Gap in ICBs

Among the 50 ICBs, the results reveal the important findings for the years 2007-2015. In aggregate, the study results show a general excess of short-term liabilities and long-term financing (Figure 4). The results indicate that: (a) 82% of the ICBs (41 ICBs) have positive and higher duration gap; (b) only 18% (9 ICBs) tend to have negative duration gap; (c) positive duration gaps have more cross-sectional and time-series variations; and (d) 11 ICBs have duration gaps in double digit figures in terms of years (Table A.1). In addition, we also found that only three ICBs (Boubyan Islamic Bank, Al Barakah Bank Pakistan and Islamic International Arab Bank) have mean duration gaps close to zero. A close examination of these ICBs' balance sheets reflects that they are managing their duration of assets and duration of liabilities more effectively through long-term liabilities and reduced concentration of financing for longer-term maturities. This implies that these ICBs would not be affected should their respective supervisory authorities increase the benchmark rate. However, the problem is much more severe in most other which have positive duration gaps, suggesting the need for crucial reviews of their business models.

Figure 4: Variation of ICBs' Duration Gap (2007-2015)

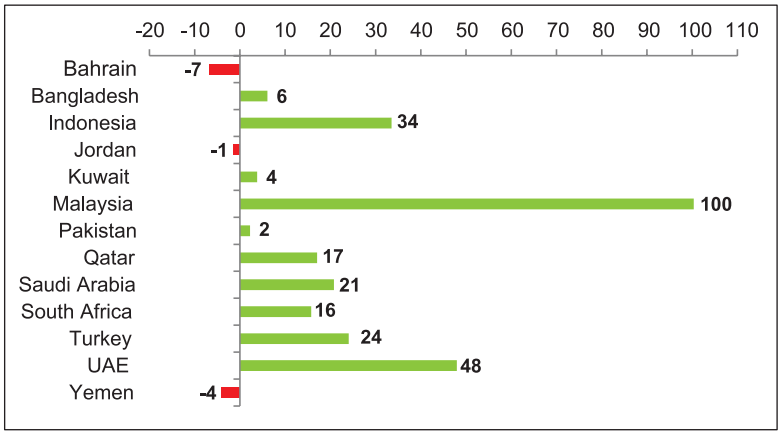


Note: The Duration Gap is measured in years for each bank.

The highest among the ICBs, with a duration gap of 20.69 years, is AmIslamic Bank from Malaysia, and the lowest among the ICBs, with a duration gap of -13.71 years, is KFH Bahrain. The top-five ICBs (in terms of positive duration

gap) accounting for almost one-third of the duration gap for the period 2007-2015 are as follows: AmIslamic Bank Berhad (20.69), Sharjah Islamic Bank (20.22), Bank Syariah Muamalat Indonesia (17.96), Al Barkah South Africa (15.77), and Bank Syariah Mandiri (15.56). Higher and positive duration gaps highlight the rationale for closely examining the business models of these ICBs to identify what is causing these ICBs to have higher duration gaps, which can consequently expose them to benchmark rate risk or ROR risk. Furthermore, despite higher duration gaps among the majority of the ICBs, there is evidence suggesting that nine ICBs have mean duration gaps less than zero (negative). In this respect, the bottom-five ICBs (in terms of negative duration gap) are as follows: Khaleeji Commercial Bank (-3.21), Bank Islami Pakistan (-3.59), Tadhamon International Islamic Bank (-3.98), Al Salam Bank (-8.90), and KFH Bahrain (-13.71). This negative duration gap is an indication that a few ICBs have been managing the ALM more effectively.

Figure 5: Trend of ICBs' Duration Gap (2007-2015)



Note: The Duration Gap is measured in years for each country.

Besides the trend, it is also vital to establish which jurisdiction contributes towards much of the duration gap for the ICBs. In terms of countrywide findings (Figure 5), the results revealed two important observations for the study sample: (a) 10 countries (76%) tend to host positive and significant duration gap, and only three countries (Jordan, Yemen, and Bahrain) have negative duration gap for the sample period; and (b) five countries account for almost 85% of duration gap; Malaysia stands out as the highest with a duration gap of 100.34 years for 11 ICBs, UAE with a duration gap of 47.97 years for 4 ICBs, Indonesia with a

duration gap of 33.53 years for 2 ICBs, Turkey with a duration gap of 24.05 years for 4 ICBs, and Saudi Arabia with a duration gap of 20.78 for 3 ICBS. It is worth noting that within the sample, Malaysia is the dominant jurisdiction representing significantly higher duration gaps indicating the vulnerability of the ICBs operating in this region. Thus, regional distribution of duration gap is skewed towards South East Asia followed by the ICBs in the GCC region (Table A.2).

In order to add more import to the existing literature with regards to ICBs with higher duration gaps, we examined the business models of these ICBs thoroughly by investigating their respective financial reports. This led to an appraisal of the key balance sheet indicators that could possibly explain the reasons behind their high duration gaps. These indicators included, among others: Average Financing to Total Assets Ratio (FINA); maturity bucket; and Average Cumulative Liquidity Gap to Total Assets (LIQG). The balance sheets of the ICBs suggest that *Murābahah* financing is the most dominant form of financing extended by the ICBs to customers to meet their different needs. Furthermore, the results reveal that there in a correlation between the FINA and the duration gap in some cases. However, this needs to be empirically tested to ascertain whether this factor, or any other factor significantly influences the duration gap with a larger sample size over a long period of time. We report these results in Section 5.2.

The significantly higher duration gap can be attributed to the inspiration and business models of these ICBs, which have more long-term financing with short-term deposits, demonstrating the inability to raise the long-term deposits, consequently creating a severe mismatch in the assets and liabilities. This suggests that the size of the duration gap is correlated with lengthy asset duration but not with short (not long) liability duration (Chattha and Bacha, 2010). The finance theory and academic literature suggest, as pointed out in earlier, that when the duration gap is positive and higher, an increase in the benchmark rates by any basis points from the central bank would bring severe consequences to the net worth (NW) risk or economic value of equity (EVE) and the capital base of the banks (Chattha and Alhabshi, 2017, 2018). This suggests that the ICBs would have to keep more capital against ROR risk under ICAAP Pillar 2 of the Basel Accords. Our results are consistent with (Chattha and Alhabshi, 2017, 2018) and Chattha et al. (2019).

We also infer from the results that ICBs tend to have higher duration gaps since they cannot avail of certain risk management tools and techniques due to certain *Sharia* limitations. These include: (a) lack of *Sharia*-compliant hedging instruments (e.g. swaps and options); (b) lack of financing or assets' tradability (i.e. factoring of financing); (c) lack of adjusting the price of assets due to sale

contracts; and (d) lack of floating-rate assets and fixed rate liabilities. Having examined the business models of the ICBs across the 13 jurisdictions of the sample under observation, this study confirms that all of the above factors influence the duration gaps of the ICBs, positively and negatively.

In addition, we also attribute the ICBs' variations in duration gap to the different reporting standards (e.g. AAOIFI), in particular the disclosure of the maturity of assets and liabilities in different maturity buckets. There was little evidence available to suggest that the ICBs have implemented the AAOIFI accounting standards. We found that the majority of the ICBs keep financing in the long-term maturity bucket, and rely very scarcely on long-term funding liabilities such as PSIA or savings deposits. This reflects that ICBs should not hold financing in long-term maturity buckets, and should have more reliance on long-term funding liabilities, including PSIA or *Sukūk* financing through *Sharia* -compliant securitisation.[12] This observation is included in our study panel data to determine whether this has any influence on the duration gaps of the ICBs. The empirical results using GMM are explained in Section 5.2.

Robustness Analysis of Duration Gap of ICBs – Comparison with CCBs

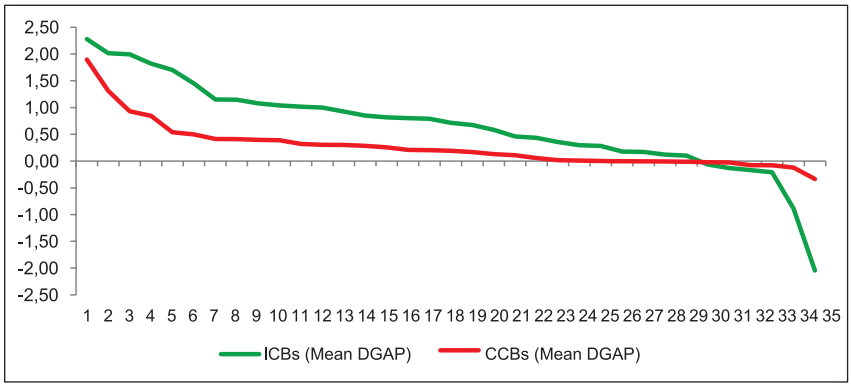
As a detailed comparative analysis of ICBs and CCBs is beyond the scope of this paper,[13] nonetheless, to ensure that our results are robust and significant with respect to duration gap, we undertook a comparative approach to show the implications from both sides of the banking system. We selected the top 35 ICBs (70% of the sample ICBs) in terms of their asset size, and compared them with CCBs with similar asset size across 11 countries within the sample for the period 2009-2015.[14] This ensured that the comparison made is reliable and consistent. By plotting the duration gaps for both ICBs and CCBs among the 35 paired samples used, we find that the variance is much larger for the ICBs than the CCBs for the sample period 2009-2015 **(Figure 6)**.

[12] There is also some evidence of the same from a few ICBs which have issued Sukūk to raise long-term funding. While this has not been a common phenomenon due to the underlying *Sharī'ah* and regulatory requirements, it can help in managing the duration gaps of ICBs.

[13] We present in a separate study the detailed analysis of 100 banks in dual banking systems, which reflect the implications for CCBs and ICBs, for 13 countries on a comparative basis.

[14] These top 35 ICBs accounted for 95% of the total sample asset size for Islamic banks. The size of the 35 ICBs was almost equal to 90% of the CCBs. We also ensured that the comparison period excluded the crisis years. The pairing is consistent with research of Chattha and Alhabshi, 2017, 2018) and Chattha et al. (2019) on duration gaps comparison in dual banking systems.

Figure 6: Comparative Analysis of Mean Duration Gap of Banks (2009-2015)



Note: The Mean Duration Gap is measured in years for each bank. In order to obtain the Mean Duration Gap, the Duration Gap of each bank for 2009-2015 is estimated for both ICBs and CCBs. The list comparing the 35 CCBs with similar sized ICBs is in **Table A.3.**

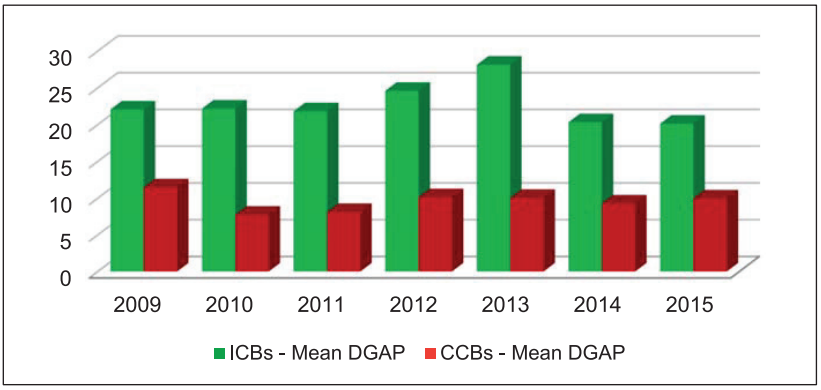
In addition, the results also revealed that ICBs have a tendency to have a higher (more) duration gap, specifically 159.12 years (with a mean duration gap of 22.73 years), in comparison to their conventional counterparts, CCBs, which recorded a duration gap of 66.54 years (with a mean duration gap of 9.11 years). This shows that the ICBs have 2.39 times more mean duration gap compared to the CCBs, reflecting serious implications for risk management and risk culture among the sample banks. Our results are consistent with Chattha and Bacha (2010).

From the results we establish that, overall, the duration gap of all banks under observation increased; however, ICBs have a general tendency of maintaining a higher duration gap compared to their conventional counterparts, the CCBs. For instance, for the ICBs, the duration gap remained in the range of 20-28 years, compared to the CCBs' range of 7-11 years **(Figure 7)**. In order to further statistically validate our findings of ICBs having a larger duration gap compared to their conventional counterparts, CCBs, we run the parametric t-test for paired samples (35), for both one-tail and two-tail tests (i.e. *t-Test: Paired Two Sample for Means*). The results supported our argument, as the sample statistics (2.27) fulfil the critical value of 5% confidence level (2.03) to reject the null hypothesis, with the probability of the one-tail test ($p = 0.01$) and two-tail test ($p = 0.02$) both being significant.[15] The results confirm a significant difference in the duration gaps

[15] Generally, the following rules are applied for the hypothesis: (a) If the absolute t Stat value > 2 or t Stat value is larger than the t-critical value, then the ratio is significant, and (b) If the

of ICBs compared to CCBs, and ICBs have a higher mean duration than CCBs. This shows that ICBs are more vulnerable to ROR risk, and suffer significant implications for their balance sheet adjustment in the light of changing benchmark rate risk.[16]

Figure 7: Magnitude of Duration Gap of Banks (2009-2015)



Note: The Duration Gap is measured in years for banks.

Determinants of ICBs' duration gap

This section, through an empirical model, establishes that there are factors which can explain the duration gaps. The results of the study are discussed below.

Correlation Matrix

The correlation matrix between the variables is presented in Table 2, for comprehending any multicollinearity in the data. The results obtained provide confirmation of the variables — that there is no multicollinearity in the sample data. In only one case, the correlation between DGAP and LIQG is above 0.50. Thus, there are no variables which are significantly correlated with each other, which could have caused estimation problems. Consequently, including all of these variables as regressors simultaneously should not cause the estimated coefficients to be unstable and unreliable (Ballester et al., 2009). Thus, we use these variables in the GMM.

p-value is less than alpha (level of significance), then it is significant.

[16] In light of these results, we show in a separate study the quantification of the impact on the ICBs and CCBs under stress scenarios of various basis points in line with the IFSB and the BCBS.

Table 2: Pearson Correlation Matrix

	DGAP	LIQG	LIQR	FINA	BUCK	SIZEL	GDPG
DGAP	1						
LIQG	**-0.5676***	1					
LIQR	-0.0273	0.2892*	1				
FINA	0.4194*	-0.2610*	-0.4602*	1			
BUCK	0.0647	-0.1247*	-0.0047	-0.1922*	1		
SIZEL	0.1232*	-0.1869*	-0.2598*	0.1777*	-0.3818*	1	
GDPG	0.0215	-0.0074	0.0542	-0.0408	0.0216	0.0131	1
RATE	-0.0647	0.1379*	0.037	-0.1289*	0.3159*	-0.3551*	-0.0981*

Note: The table shows the correlation matrix between the variables.
Note: Bold numbers represent correlations above 0.5.
Note: The descriptive statistics using STATA (minimum, maximum, mean, standard deviation, N=450, n= 50, T=9) of the panel data estimation using Difference and System GMM are available upon request.

Normality and Heterogeneity Conditions

Although normality[17] is not a condition for Panel GMM, it is advisable to check for extreme weights and outliers before starting any analysis. The study, in Figure 8, plots the data and indicates the normality of the data observation for clarity and understanding. The red-dotted line clearly indicates that the data is normally distributed, and there is no abnormality nor outliers in the balanced panel data under observation. An important reflection is that the effect of the GFC cannot be seen to be suggesting that crises have no significant impact on the ICBs' variables. Therefore, the expected results from the GMM output should reflect no significance of the GFC dummy variable included in panel GMM for Difference and System estimations.

[17] As explained in Section 4, GMM does not assume normality and it allows for heteroscedasticity in the data (El Alaoui et al., 2016).

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Figure 8: Plotting Normal Distribution Using STATA

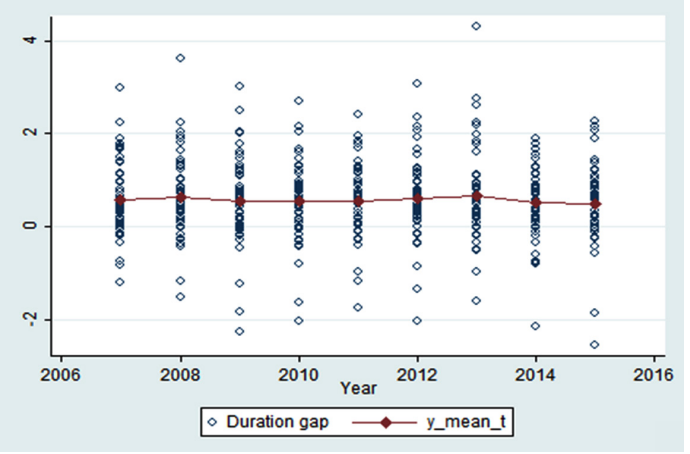
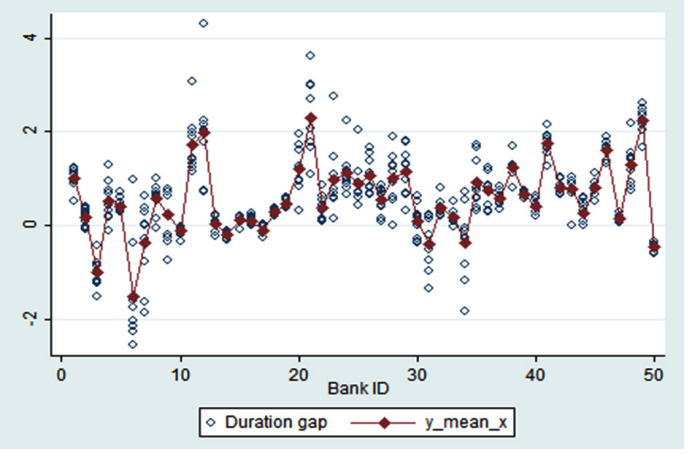


Figure 9 plots the study's sample observation data and indicates that the data has Heterogeneity features, reflecting that each sample country has its own characteristics and, thus, it is expected that some differences would exist for the ICBs under study. This Heterogeneity is handled easily by the GMM technique, instead of using the OLS classic regression. Therefore, in the context of this study, the use of Panel GMM framework, to control simultaneously for country and ICBs' characteristic effects, while taking into account heterogeneity across banks, validates the use of this model and is appropriate given the study's data structure.

Figure 9: Plotting Heterogeneity across ICBs Using STATA



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Difference and System GMM Estimation Results and Discussion

In this subsection, we present the relationship between seven idiosyncratic variables and duration gap, which is analysed by using both Difference and System GMM.

First, after running Panel GMM (Difference) two-step vce (robust), with number of observations 350, number of groups 50, and number of instruments 37, the Arellano-Bond dynamic panel-data estimation indicated that DGAP L1 (lagged dependent variable) is significant, with a p-value of 0.04, and its coefficient is positive, at 0.140. In respect to regressors, four out of five bank-specific variables such as LIQG, FINA, BUCK, and SIZEL are found to be significant with p-values of 0.05, 0.07, 0.07, and 0.002 respectively. However, LIQR and both macroeconomic variables, GDPG and RATE, are not found to be statistically significant (Table 3). These results confirmed the results of 'one-step' and 'one-step vce (robust)'.[18]

Second, after running Panel GMM (Difference), the study also ran Panel GMM (System) two-step vce (robust), with number of observations 400, number of groups 50, and number of instruments 44. The System dynamic estimation showed that DGAP L1 is significant, with a p-value of 0.02, and its coefficient is positive, at 0.236. This demonstrates that the value of the lagged dependent variable has increased under Panel GMM (System). With regards to regressors, three out of the five bank-specific regressors (LIQG, FINA, and SIZEL) are significant, with p-values of 0.05, 0.04, and 0.017 respectively. Under GMM (System), BUCK became insignificant and LIQR is found significant at p-value 0.105. In addition, both macroeconomic variables, GDPG and RATE, are found to be insignificant (Table 3).

Referring to Table 3, the choice of using the Difference GMM or System GMM is determined based on the coefficient of the lagged dependent variable, and in our case, Panel GMM (Difference) would be applicable as the autoregressive parameter 0.22 is below 0.80. Therefore, using Panel GMM (Difference), it can be concluded that there is strong evidence suggesting that except one variable (the LIQR) in the estimation, all the remaining four bank-specific variables, FINA, BUCK, SIZE, and LIQG, are found to be significant, and proven to be effective in explaining and determining the ICBs' duration gap as per the sign of their coefficients. This means that these variables can play an important role in

[18] It is worth mentioning that prior to performing a two-step vce (robust), we performed 'one-step' and 'one-step vce (robust)'. The empirical results of 'one-step' and 'one-step vce (robust)' for Difference and System GMM are available upon request.

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influencing the duration gap positively or negatively. Consequently, the results also indicate the ROR risk applicable to the ICBs.

Table 3: Two-Step Robust - DIFF GMM and SYS GMM Estimations

	(DIFF) DGAP	**(SYS) DGAP**
L.DGAP	0.140**	0.236**
	(1.98)	(2.23)
LIQG	-0.499*	-0.482*
	(-1.95)	(-1.89)
LIQR	0.500	1.217
	(1.00)	(1.62)
FINA	0.978*	1.522**
	(1.81)	(2.04)
BUCK	0.323*	0.108
	(1.79)	(1.18)
SIZEL	-0.799***	-0.804**
	(-3.17)	(-2.38)
GDPG	-0.230	-0.623
	(-0.79)	(-0.91)
RATE	1.569	-1.932
	(1.30)	(-0.95)
GFC	-0.0607	-0.0476
	(-0.98)	(-0.62)
_cons	5.623**	6.512*
	(2.03)	(1.78)
N	350	400
AR(1)p	0.0065	0.0069
AR(2)p	0.3070	0.2262
Hansenp	0.291	0.165

Z statistics in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

HO: no autocorrelation

Note: This table presents the results of two-step robust Difference GMM and System GMM estimations for a sample of 50 ICBs in 13 countries for the period 2007–2015.

Note: It is worth mentioning that we had to run xtabond2 to get the Hansen test robustness as no Sargan test is available for vce (robust) estimation.

Furthermore, it is also essential to highlight that the macroeconomic variables (GDPG and RATE) are not found to be significant, indicating no relation to the determination of the ICBs' duration gap. In the case of the crisis dummy variable, the GFC was also found to be insignificant in all cases, suggesting no impact on ICBs' duration gaps. This was expected since there was no abnormality in the data for the crisis years 2008 and 2009. Under Panel GMM estimation, both standard robustness AR tests, as discussed below, are found to be significant, thereby increasing the reliability of the Panel GMM estimation.[19] In respect to the study results, it should be noted that our results are in line with the findings of Saporoschenko (2002), Ballester et al. (2009), Entrop et al. (2012), Ruprecht et al. (2013), and Esposito et al. (2013).

In particular, after having discussed the significance results, we examine the direction of the regressors' coefficients and their implications. For instance, in the case of FINA, it seems natural to expect a positive association between this ratio and the ICBs' duration gap and ROR risk. This finding is consistent with the results obtained by Ballester et al. (2009), Entrop et al. (2012), and Ruprecht et al. (2013) using a different methodology. It also suggests that ICBs that hold a larger percentage of assets in the form of *Sharia*-compliant financing have a larger degree of ROR risk and duration gap. One possible clarification for this finding is that the larger relative weight of *Sharia* -compliant financing in the ICBs' balance sheet causes an increase in the traditional maturity mismatch between the bank's assets and liabilities. The mismatch can influence the duration gap both positively and negatively, depending on the direction of the maturity mismatch. This is also the case in the LIQG, which is also significant with a negative coefficient, similar to Esposito et al. (2013). This finding suggests a significant correlation between liquidity risk and ROR risk and duration gaps; the ICBs facing higher liquidity risk may decrease their on-balance-sheet duration gap more suddenly.

[19] In addition to the independent variables identified in Equation 4, the study also included two additional variables to examine their impact on duration gap. These two variables included DEPO (Total deposits to Total Assets) and FDR (Total Financing to Deposit Ratio). While the FDR is similar to FINA, the DEPO indicates the degree of dependability of deposits with respect to duration gap (Racic et al., 2014; Ruprecht et al., 2013; Saporoschenko, 2002). However, when FDR was included in the model, the significance of the FINA decreased considerably. The DEPO was found to be insignificant.

Robustness Checks with Arellano–Bond Tests in Panel GMM Estimation

To check the robustness of results, the study performed the Arellano-Bond test for zero autocorrelation in first-differenced errors, and second-order serial correlation induced by the difference estimators under the dynamic Difference and System GMM. As indicated in Section 4, Estat abond reports the Arellano–Bond tests for serial correlation in the first-differenced errors at order m. In this case, HO: no autocorrelation should be rejected at order 1 (i.e. **AR (1)**). However, rejecting the null hypothesis of no serial correlation in the first-differenced errors at an order greater than one (**AR (2)**) implies model misspecification (Yalta and Yalata, 2010).

In terms of diagnostics for the validity of the instruments, as indicated in Section 4, the results of robustness are reported in Table 3. Both standard AR tests are found to be significant, where the study rejects the **AR (1)** (p-value = 0.0065 for Difference GMM and p-value = 0.0069 for System GMM), and similarly the study failed to reject the **AR (2)** (p-value = 0.3070 for Difference GMM and p-value = 0.2262 for System GMM). This fulfils the standard requirement for validating the GMM estimation. In addition, the results of the Hansen test (p-value = 0.291 for Difference GMM and p-value = 0.165 for System GMM) of overriding restrictions indicate that the instruments are valid (Table 3). Hence, the Hansen test of overidentifying restrictions indicates that the instruments are valid instruments, i.e., uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. These robustness results indicate the reliability of the GMM test and the validity of the instruments with respect to the study.

Fixed Effect and Random Effect Estimation: Robustness Check

In order to further check the robustness, FE (within) Regression and RE GLS Regression was also performed. The summary results of FE and RE presented in Table 4 confirmed the results of the GMM. In fact, all five bank-specific variables (LIQG, LIQR, FINA, and SIZEL BUCK) were found to be significant under FE Regression, with p-values of 0.000, 0.000, 0.001, 0.006, and 0.05 respectively.

In addition, similar to Panel GMM, both macroeconomic variables are found to be not significant. However, when RE GLS Regression was run, only one of the five regressors, SIZEL, was found to be insignificant. After running the Hausman test to choose between FE and RE, the study ran FE Regression and found that SIZEL remained insignificant.

Table 4: FE and RE and Hausman test

	(FE)	**(RE)**
	DGAP	**DGAP**
LIQG	-1.111***	-1.272***
	(-6.51)	(-8.08)
LIQR	1.396***	1.830***
	(4.59)	(6.17)
FINA	0.911***	1.334***
	(3.44)	(5.45)
BUCK	0.135***	0.0710**
	(2.77)	(2.15)
SIZEL	-0.244*	-0.0550
	(-1.96)	(-0.55)
GDPG	-0.136	0.316
	(-0.23)	(0.54)
RATE	-0.112	-0.210
	(-0.09)	(-0.20)
GFC	0.0322	0.0670
	(0.61)	(1.26)
_cons	1.187	-0.687
	(0.93)	(-0.65)
N	450	450
Hausman test: Prob>chi2 = 0.0000		

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Based on the empirical analysis results, the study established the following: first, in our case, duration gaps are significantly affected by changes in endogenous variables rather than exogenous factors; second, due to substantial heterogeneity within the system, overall, ICBs show a considerable degree of exposure to duration gap and ROR risk; third, the FINA, BUCK, LIQG and SIZEL appear to be the most important determinants of ICBs' duration gap and ROR risk; fourth, macroeconomic variables do not display a significant relationship with the duration gap; fifth, the crisis did not have any significant impact upon ICBs in terms of explaining the duration gap; and finally, liquidity did not cast any impact on the duration gap under both Difference and System GMM. One

possible explanation for the lack of impact of the LIQR could be that it was not included in the estimation of DGAP, as liquid assets tend to have shorter maturity and hence their duration would be extremely small, if at all applicable. This was the reason the study excluded from the calculation of the duration gap any assets with one-month maturity.

In the context of our results, the major apprehension is the regressor coefficient sign related to SIZEL, where it is found to be statistically significant but its coefficient is found to be negative, indicating that the ICBs' are inefficient at intermediation. Although the correlation coefficient between SIZEL and DGAP is found to be positive, it is important to highlight that in most cases it is expected to have a positive relationship. However, literature has found both positive and negative signs associated with SIZEL, with different explanations (Au Yong et al., 2009; Fraser et al., 2002; Faff et al., 2005; Reichert and Shyu, 2003; Saporoschenko, 2002).

In light of the above findings, and taking into account results of the robustness tests, specifically the Arellano-Bond test for zero autocorrelation in first-differenced errors and second-order serial correlation, the study infers that there is strong evidence suggesting significant difference in the estimated coefficients' idiosyncratic factors influencing the duration gaps of the ICBs in the study, and subsequently, the null hypothesis could be rejected with reliable estimates and validity of the instruments.

Conclusions

The study provides empirical evidence regarding the estimation of the duration gap of 50 ICBs from 13 countries. Using the Duration Gap model, the study established that among the 50 ICBs, most banks showed more cross-sectional and time-series variations in duration gap. This revealed that the ICBs are exposed to increasing ROR risk due to their larger duration gaps and severe liquidity mismatches. As per finance theory, the higher the duration gap, the higher would be the profit rate sensitivity of a financial instrument, and vice-versa. There is also evidence that some ICBs had lower gaps over the last few years, reflecting effective ALM practices. It was also established that ICBs tend to maintain a higher (more) duration gap than conventional counterparts, the CCBs. The higher duration gap in the ICBs is attributed to the inspiration and business model of these ICBs. Without a stable and long-term funding base, and the HQLA on the assets side, ICBs are rendered less resilient to exogenous liquidity shocks. Within the study

sample it was also observed that in terms of duration gap there exist regional differences between the ICBs.

By adopting Panel GMM estimation (Difference), the findings of the study indicate that duration gaps are significantly affected by changes in endogenous variables rather than by exogenous factors. We found a significant difference in the estimated coefficients of the idiosyncratic factors influencing the duration gaps of ICBs. The results reflect the ROR risk to the ICBs through balance sheet indicators. In this respect, the ICBs have a considerable degree of exposure to duration gap and ROR risk, and the FINA, BUCK, LIQG, and SIZEL appear to be the most important determinants of the same. However, there is not enough evidence to suggest the significance of GDPG and RATE's macroeconomic variables on the duration gap. To ensure more rigorous results of the model, both the FE and RE regressions were also performed, which consequently confirmed the results of Panel GMM. Both standard robustness Arellano Bond (AR) tests for autocorrelation and Sargan-Hansen tests of overidentifying restrictions are found to be significant, increasing the reliability of the Panel GMM estimation and the validity of the instruments. In the context of the GMM findings, the study provides an empirical basis for the ICBs to address bank-specific variables that are significant. The understanding of the underlying factors explaining ICBs' ROR risk and duration gap is essential for different economic agents and stakeholders — such as ICBs' senior management, who want to adequately manage their duration gap and ROR risk exposure, and ICBs' regulators, who are primarily concerned with the assessment of ROR in the banking book of the ICBs and the stability and soundness of the banking system.

The variations in ICBs' duration gaps could be attributed to the different reporting standards, in particular the disclosure of the maturity of assets and liabilities in different maturity buckets. On the other hand, the ICBs' business model of having more long-term financing with short-term deposits demonstrates their inability to raise long-term deposits, consequently creating a severe mismatch in the assets and liabilities. To reduce the duration gap, on the asset side, ICBs should engage in the diversification of their financing into medium-term maturities and liquid assets (e.g., HQLA). The ICBs should also continuously monitor and control the gaps between maturing assets and liabilities in various time buckets. In this respect, the ICBs should have in place the approved limits set by their respective BOD for the maximum duration gap. The ALCO should implement these limits.

Given that global benchmark rates are currently low, having fallen steadily over the last several years after the GFC, the study implies that larger duration gaps

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will pose a serious challenge to ICBs as the benchmark rate cycle turns. For the ICBs to fully deflect this risk, while being part of a dual banking system, it would require them to undertake significant improvements in their risk management tools (such as *stress testing*) and applying innovative new techniques including PLS, to reduce the asset-liability mismatches.

Limitations and Future Direction

While the results are consistent with some existing studies, it is important to note that this study reported findings with the use of Panel GMM, which no previous study has done with respect to the ICBs. In addition, due to different accounting definitions and formulations of the regressors in this study, the results are expected to be, to some extent, different compared to the previous studies. As to our knowledge, no prior studies have explained the determinants, along with the precise estimation, of the duration gaps of the ICBs, as done in this study using the Panel GMM.

Given that this is a pioneer study in Islamic finance to measure the factors of duration gap, it would be desirable to undertake more studies with long-term data, additional variables, and a larger sample in order to establish stronger correlations for the ICBs. It would also be useful to apply the same factors in the conventional setting (i.e. for CCBs), with a similar model, to establish the robustness of the estimation. Finally, in addition to Panel GMM estimation, a qualitative approach (in the form of a survey) for factors determining DGAP and DGAP management practices across more than 100 ICBs can be undertaken, to see whether there is any significant difference and relationship in results when using primary data and secondary data.

Appendix A: Duration Gaps of ICBs

Table A.1: Details of ICBs' Duration Gap at ICBs' Level

No.	ICB Bank Name	Country	DGAP in Years (2007-2015)	DGAP Direction
1	AmIslamic Bank Berhad	Malaysia	20.69	Positive
2	Sharjah Islamic Bank	UAE	20.22	Positive
3	Bank Syariah Muamalat Indonesia	Indonesia	17.96	Positive
4	Al Barkah South Africa	South Africa	15.77	Positive
5	Bank Syariah Mandiri	Indonesia	15.56	Positive
6	Abu Dhabi Islamic Bank	UAE	14.61	Positive

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No.	ICB Bank Name	Country	DGAP in Years (2007-2015)	DGAP Direction
7	Emirates Islamic Bank	UAE	11.71	Positive
8	Al Rajhi	Saudi Arabia	11.04	Positive
9	AlRajhi Malaysia Berhad	Malaysia	10.80	Positive
10	RHB Islamic Bank Berhad	Malaysia	10.41	Positive
11	Bank Muamalat Malaysia Berhad	Malaysia	10.19	Positive
12	Hong Leong Islamic Bank Berhad	Malaysia	9.51	Positive
13	Public Islamic Bank Berhad	Malaysia	9.18	Positive
14	ABC Islamic Bank	Bahrain	9.11	Positive
15	Bank Islam Malaysia Berhad	Malaysia	8.94	Positive
16	Masraf Al Rayan	Qatar	8.19	Positive
17	CIMB Islamic Bank Berhad	Malaysia	8.05	Positive
18	Al Barakah Turkish Finance House	Turkey	7.37	Positive
19	Turkiye Finans Participation Bank	Turkey	7.18	Positive
20	Bank Asya	Turkey	7.02	Positive
21	Qatar International Islamic Bank	Qatar	6.76	Positive
22	Bank Al Bilad	Saudi Arabia	6.09	Positive
23	Qatar Islamic Bank	Qatar	5.30	Positive
24	Exim Bank Ltd	Bangladesh	5.08	Positive
25	KFH Malaysia Berhad	Malaysia	4.83	Positive
26	Bahrain Islamic Bank	Bahrain	4.70	Positive
27	Affin Islamic Bank Berhad	Malaysia	4.21	Positive
28	Ithmaar Bank	Bahrain	3.71	Positive
29	Bank Al Jazira	Saudi Arabia	3.65	Positive
30	Asian Finance Bank Berhad	Malaysia	3.52	Positive
31	Dubai Islamic Bank Pakistan	Pakistan	3.36	Positive
32	Kuwait International Bank	Kuwait	2.72	Positive
33	Kuvet Turk Participation Bank	Turkey	2.48	Positive
34	First Security Islamic Bank	Bangladesh	2.06	Positive
35	Meezan Islamic Bank	Pakistan	1.69	Positive
36	AL Barka Bank Bahrain	Bahrain	1.57	Positive
37	Dubai Islamic Bank	UAE	1.42	Positive
38	Ahli United Bank	Kuwait	1.08	Positive
39	Boubyan Islamic Bank	Kuwait	0.90	Positive
40	Al Barakah Bank Pakistan	Pakistan	0.80	Positive

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No.	ICB Bank Name	Country	DGAP in Years (2007-2015)	DGAP Direction
41	Islamic International Arab Bank	Jordan	0.39	Positive
42	KFH Kuwait	Kuwait	-0.87	Negative
43	Islamic Bank Bangladesh Ltd	Bangladesh	-1.05	Negative
44	Jordan Islamic Bank	Jordan	-1.84	Negative
45	Barwa Bank	Qatar	-3.18	Negative
46	Khaleeji Commercial Bank	Bahrain	-3.21	Negative
47	Bank Islami Pakistan	Pakistan	-3.59	Negative
48	Tadhamon International Islamic Bank	Yemen	-3.98	Negative
49	Al Salam Bank	Bahrain	-8.90	Negative
50	KFH Bahrain	Bahrain	-13.71	Negative

Note: The list of ICBs is presented in order of the size of duration gap. The details of the ICBs' duration gap estimations for 2007-2015 are available upon request.

Table A.2: Details of ICBs' Duration Gap at Country Level

No.	ICB Bank Name	Number of ICBs	DGAP in Years (2007-2015)	DGAP Direction
1	Malaysia	**11**	**100.34**	Positive
2	UAE	**4**	**47.97**	Positive
3	Indonesia	**2**	**33.53**	Positive
4	Turkey	**4**	**24.05**	Positive
5	Saudi Arabia	**3**	**20.78**	Positive
6	Qatar	**4**	**17.06**	Positive
7	South Africa	**1**	**15.77**	Positive
8	Bangladesh	**3**	**6.08**	Positive
9	Kuwait	**4**	**3.82**	Positive
10	Pakistan	**4**	**2.26**	Positive
11	Jordan	**2**	**-1.46**	Negative
12	Yemen	**1**	**-3.98**	Negative
13	Bahrain	**7**	**-6.73**	Negative

Note: The list of countries is presented in order of the size of duration gap.

Table A.3: Details of CCBs' Duration Gap

No.	CCB Bank Name	Grand Total	Mean DGAP	No.	CCB Bank Name	Grand Total	Mean DGAP
1	ABC Bank (Bahrain)	**1.79**	**0.26**	18	Capitecbank (South Africa)	**0.39**	**0.06**
2	Affin Bank (Malaysia)	**3.49**	**0.50**	19	CBK Bank (Kuwait)	**0.01**	**0.00**
3	Al Khaleeji Commercial (Qatar)	**2.10**	**0.30**	20	Commercial Bank of Dubai (UAE)	**-0.04**	**-0.01**
4	Alliance Bank (Malaysia)	**1.34**	**0.19**	21	Faysal Bank (Pakistan)	**-0.15**	**-0.02**
5	AmBank (Malaysia)	**13.28**	**1.90**	22	Gulf Bank (Kuwait)	**6.52**	**0.93**
6	Anadolubank A.Ş. (Turkey)	**3.77**	**0.54**	23	Habib Metro Bank (Pakistan)	**-0.53**	**-0.08**
7	Bank Al Etihad (Jordan)	**-0.05**	**-0.01**	24	HBL Bank (Pakistan)	**-2.34**	**-0.33**
8	Bank Al Falah (Pakistan)	**1.42**	**0.20**	25	Hong Leong Bank (Malaysia)	**2.12**	**0.30**
9	Bank AlHabib (Pakistan)	**-0.19**	**-0.03**	26	Mashreq Bank (UAE)	**2.71**	**0.39**
10	Bank BJB (Indonesia)	**2.78**	**0.40**	27	MCB Bank (Pakistan)	**0.12**	**0.02**
11	Bank BNI (Indonesia)	**-0.08**	**-0.01**	28	National Bank of Bahrain (Bahrain)	**2.87**	**0.41**
12	Bank of Punjab (Pakistan)	**-0.86**	**-0.12**	29	NBK Bank (Kuwait)	**0.92**	**0.13**
13	Bank of Sharjah (UAE)	**-0.54**	**-0.08**	30	NBP Bank (Pakistan)	**2.25**	**0.32**
14	Bank Panin (Indonesia)	**0.76**	**0.11**	31	RAK Bank (UAE)	**9.20**	**1.31**
15	Burgan Bank (Kuwait)	**1.18**	**0.17**	32	RHB Bank (Malaysia)	**2.89**	**0.41**
16	Burgan Bank A.Ş. (Turkey)	**1.47**	**0.21**	33	Saudi France Bank (Saudi Arabia)	**2.00**	**0.29**
17	Cairo Amman Bank (Jordan)	**0.06**	**0.01**	34	UBL Bank (Pakistan)	**-0.02**	**0.00**
				35	United Arab Bank (UAE)	**5.91**	**0.84**

Note: The Mean Duration Gap (i.e. summation of duration gap for 2009-2015 divided by number of years, which is seven years) is measured in years for each bank. In order to obtain the Mean Duration Gap of one CCB, the Duration Gap of each bank for 2009-2015 is estimated. The details of the CCBs' duration gap estimations for 2009-2015 are available upon request.

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