

IMPACT OF TECHNOLOGICAL AND SERVICE INNOVATIONS IN BANKS: A META ANALYSIS

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ABSTRACT

With market rivalry on the rise, many banks are striving to obtain a competitive advantage through various types of innovation. Existing research, however, has not reached consistent results on the relationship between innovation and bank performance. As a result, the goal of this work is to give a quantitative analysis of the innovation-performance link based on existing research findings. A total of 24 peer-reviewed publications were reviewed and analyzed using a random effects model, a statistical technique well-suited for meta-analytic analysis, to examine the relationship between innovation and bank performance. The analysis also explored the impacts of different subgroups, focusing on both technological and service innovations. The result found that there is a significant positive association between overall innovation and different kinds of bank performance, such as profitability, income, Return on Asset (ROA), and customer satisfaction. Notably, technological innovation emerges as a key driver of bank performance, demonstrating a considerable positive impact across these performance metrics. Furthermore, specific technological innovations such as mobile banking and agent banking also show considerable positive effects on performance. Moreover, some other innovation such as product, service, has a considerable positive impact on bank performance. On the contrary, telephone banking, internet banking, Electronic Fund Transfer (EFT), etc., didn't have a significant effect on bank performance. Overall, the findings underscore the critical importance of technological innovation, particularly data or AI-driven analytics, in enhancing the customer satisfaction of banks, suggesting that banks should prioritize these advancements to achieve a greater competitive advantage.

Keywords: Meta-analysis, service innovation, artificial intelligence, bank performance, financial performance.

1. INTRODUCTION

Nowadays, business industries are very dynamic, with quick changes brought about by creativity, innovation, technical advancements, enhanced customer awareness, and customer expectations. Business industries, especially the banking industry, have seen technological advancements in connectivity and globalization, which have resulted in an increase in the number of transactions made in the banks, which has resulted in an increase in competition among these banks. Increased globalization and deregulation have resulted in a fast transition. The banking sector has become more competitive as a result of this transition. This circumstance has the potential to alter how banks arrange their business strategy, client interactions, and all specialized activities. Interest in the banking industry was both a responsibility and a requirement in terms of the quality and variety of the services supplied. The acquisition and administration of information have emerged as a critical function in banking. The most recent technological breakthroughs in the last decade of the twentieth century have compelled banks to embrace various innovations as a strategy for continued growth in an increasingly competitive market. Modern banking sectors are attempting to enhance their financial performance through innovating in areas such as products, structure, and operations, among other things, which creates significant impacts on their performance.

1.1 Innovations

The act of developing and promoting new financial products, technologies, institutions, and markets that simplify access to information, trade, and payment methods is referred to as innovation. According to (Ziemnowicz, 1942), innovation can be defined as the introduction of new technologies, the creation of new manufacturing processes, the discovery of new sources of supply, uncovering of new markets, and the development of new organizational

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structures. It is basically the quest for creative and sophisticated solutions to consumer requirements and desires that offer value. It encourages an organization to develop, thrive, and alter in response to alterations to its surroundings, both internal and external. The impact of process re-engineering and technological advancements is anticipated to be greater in banking than in other sectors. That is why banks have boosted their usage of different innovations such as ATMs, mobile banking, online banking, debit cards, credit cards, agent banking, and smart cards, customer service to remain competitive and increase profitability or, in general, the bank performance. The banking business seems to have a long tradition of innovation, stretching back to ancient civilizations' initial forms of banking. Some of them are discussed here, which create an impact on banks performance.

Information and Communications Technology is the automation and digitalization of organizational procedures, controls, and information generation through the integration of computers, telecommunications, software, and other electronic devices. This innovation enables the smooth and efficient operation of business operations. The implementation of ICT not only increased convenience for customers but also streamlined processes within bank branches, leading to reduced waiting times. This direct correlation between ICT adoption and improved customer satisfaction underscores the transformative impact of this technological advancement on the financial services industry (Murari and Tater, 2014).

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Another significant financial technological innovation is the introduction of *online banking*, also known as Internet banking, which emerged in the 1980s and 1990s. This innovation enabled customers to conveniently access their bank accounts and perform a range of financial transactions from any location with internet access. The implementation of online banking services, including balance inquiries, fund transfers, bill payments, account statement reviews, and loan or credit card applications, has streamlined banking operations and enhanced customer convenience. This has directly contributed to improved customer satisfaction and operational efficiency within bank branches.

Similarly, the widespread adoption of credit and debit cards has transformed the financial services industry. Credit cards, first introduced in the United States in the 1950s, allow users to borrow money to make purchases, while debit cards, dating back to the mid-1960s, are directly connected to the cardholder's bank account, facilitating instant payment deductions. The integration of these innovative payment technologies has optimized transaction processing, reduced administrative burdens, and enhanced the overall customer experience, ultimately contributing to enhanced bank performance (Berger, 2003).

Mobile banking, introduced in the late 1990s and early 2000s as mobile phones gained rudimentary internet access, allows customers to access their accounts and conduct transactions using smartphones and tablets. Telephone banking also enables clients to make transactions over the telephone, without needing to visit a physical bank location. These innovations in mobile and telephone banking have contributed to enhanced bank performance by optimizing transaction processing, reducing administrative burdens, and improving the overall customer experience thus improve customer loyalty and improve bank performance (Jun & Molina, 2016).

Agent banking significantly enhances bank performance through improved customer accessibility and satisfaction (Dalbah, 2020). By extending banking services to underserved areas, offering convenience and flexibility, fostering strong customer relationships, reducing transaction costs, promoting financial inclusion, and enabling real-time feedback, banks can drive growth and strengthen their market position. As the banking landscape continues to evolve, agent banking will remain a crucial strategy for financial institutions seeking to enhance their performance and meet the diverse needs of their customer *POS (Point of Sale)* systems are largely used in the banking industry to facilitate card-based payments, such as credit and debit cards at merchant sites. This innovation is changing day to day and continues to adapt and innovate with emerging technologies, including biometric authentication and

blockchain-based payments, promising to alter how we make payments and transactions. Artificial Intelligence (AI) is having a big influence on the banking sector, allowing banks to improve risk management, create better client experiences, and streamline internal processes. As artificial intelligence evolves and improves, we are expecting more and more innovations ahead in the banking sector.

Notably, advancements in Artificial Intelligence (AI) or AI driven analytics are revolutionizing the banking sector, enabling enhanced risk management, improved customer experiences, and streamlined internal processes. As AI technology continues to evolve, it promises to introduce further innovations that will shape the future of banking.

1.2 Bank performance

In this study, we have considered varieties of bank performance which are affected by various innovations. Bank performance is an important part of the financial sector since it represents a bank's capacity to make profits while maintaining operational stability. A bank's performance is often assessed using a number of measures, such as return on assets (ROA), return on equity (ROE), profitability, customer satisfaction, income etc. A well-performing bank is able to produce a healthy profit, maintain a solid capital basis, efficiently manage risks, and deliver high-quality services to its clients. A badly performing bank, on the other hand, may struggle to earn profits, incur liquidity issues, attract regulatory scrutiny, and lose client confidence. If we are going to discuss some performance indicators, the first indicator will be financial performance. Financial performance assesses how successfully a company generates value for its shareholders. It may be quantified using several financial metrics. It is defined as the extent to which financial goals are being or have been met. It is the procedure for determining the monetary value of the outcomes of a company's policies and activities. It is used to assess a company's overall financial health over the period and may also be used to compare similar enterprises in the same industry or to compare industries or sectors in aggregate (Al-Hussain and Johnson, 2009). One of the key components of financial performance is ROA, which assesses how effectively a bank's assets are used to create profits. It is computed by dividing the bank's net income by its total assets on average. A greater ROA shows that a bank is profitable in comparison to its size. Profitability, gross income, growth, stakeholder satisfaction, market share, and competitive position are some additional popular financial performance indicators (Bagorogozza and de Waal, 2010).

Customer satisfaction is a critical component of a bank's performance since it indicates the quality of services delivered to customers as well as their user satisfaction with the bank. A bank with excellent client satisfaction is much more likely to retain clients, recruit new ones, and create favorable word-of-mouth recommendations. Banks may assess customer satisfaction through a variety of methods, such as surveys, feedback forms, and customer reviews. These technologies enable banks to obtain consumer feedback on their satisfaction with the bank's offerings, services, and entire client service. Customers who are satisfied seem to be more inclined to utilize a bank's services more often and to refer others, which may lead to higher revenue and profits.

A bank's overall performance is a dynamic combination of its financial health, risk management, customers satisfaction, and market competitiveness. Banks that operate successfully often have a solid financial position, create healthy earnings, efficiently manage risks, deliver high-quality customer support, and stay market competitive. As a result, banks must constantly review and enhance their performance in order to stay on top of market competition and achieve long-term success. Understanding how different innovations impact bank performance is vital for identifying strategies that enhance financial outcomes. This meta-analysis aims to address existing inconsistencies in the literature regarding the relationship between innovation and bank performance. Despite various studies highlighting the significance of technological innovations, there is a lack of consensus on their specific effects across different banking contexts. By systematically reviewing the literature, this study seeks to clarify these relationships and provide actionable insights for banking institutions.

1.3 Objectives

With the rising usage of technology in today's society, the banking industry is also attempting to adapt to this new era. As a result, determining the impact of innovations on bank performance is critical. The overall goal of this research is to determine the influence of innovation on bank performance. The following are specific goals:

- i) To analyze the overall impact of technological innovations compared to service innovations on bank performance.

- ii) To find out the impact of innovations on bank's overall financial performance
- iii) To find out the impact of innovations on the bank's performance (profit)
- iv) To find out the impact of innovations on bank's financial performance (ROA)
- v) To find out the impact of innovations on bank's financial performance (income)
- vi) To find out the impact of innovations on the bank's performance (customer satisfaction).

1.4 Literature review

The relationship between innovation and bank performance has been a focal point of research over the past few decades, particularly as banks adapt to rapid technological advancements. Numerous studies have investigated this relationship, revealing a complex interplay between various types of innovations and performance metrics.

1.4.1 Technological Innovations

Several studies highlight the significant impact of technological innovations on bank performance. For instance, Zu et al. (2019) explored the effects of financial innovations on bank profitability in Africa. They found that while mobile banking and Internet banking have not shown as strong a correlation with profitability, traditional innovations like ATMs and bank cards positively influenced financial success. However, the study's limitation lies in its regional focus, which may not be generalizable across different contexts.

Chipeta and Muthinja (2018) conducted a similar investigation involving 42 Kenyan commercial banks and concluded that financial innovations significantly impact financial performance. Nonetheless, the study did not delve into the specific types of innovations or their comparative effectiveness, leaving a gap for further exploration into which innovations yield the most substantial benefits.

Kiplangat and Tibbs (2018) examined the influence of ICT and financial innovation in Nigeria from 2001 to 2013. They reported improvements in profitability, yet the lack of a detailed discussion on the methodological approaches raises questions about the robustness of these findings. GÜNDOĞDU and TAŞKIN (2017) focused on mobile banking and credit cards in Turkey, concluding that only credit card use positively influenced ROA. This raises a critical debate on the varied effectiveness of different technological innovations.

In contrast, Malhotra and Singh (2010) found that experience with financial innovations, particularly online banking, had minimal effects on bank performance in India. This finding underscores the importance of contextual factors and suggests that the benefits of technological innovations may not be uniformly experienced across different markets.

1.4.2. Service Innovations

Service innovations also play a pivotal role in shaping bank performance. Dehghan and Shamsi (2015) evaluated the impact of various banking services on profitability in Iran. Their findings indicated a strong relationship between Internet banking, ATM usage, and profitability, while telephone banking and electronic money showed no significant impact. This differentiation among service innovations calls for deeper investigation into which aspects of service innovations contribute to performance enhancements.

Olanrewaju (2016) emphasized that technological innovations influence not only profitability but also employee performance and customer satisfaction, suggesting a more holistic approach to evaluating innovation impacts. Similarly, Salleh et al. (2017) identified a positive correlation between technology-based strategies and financial performance, indicating that the integration of technology in service delivery can yield beneficial outcomes.

3. EMERGING PATTERNS AND CONTRADICTIONS

A recurring theme across these studies is the varying effects of different types of innovations. For example, Siddik et al. (2016) noted that electronic banking positively contributes to banks' ROE in Bangladesh, aligning with findings from studies like Kagan et al. (2005) that suggest electronic banking enhances asset quality and operational profitability. However, contrasting results emerged in studies such as Sadr (2013) and Gutu (2014), which reported

negative impacts of electronic banking on profitability in certain contexts. This contradiction highlights the need for further investigation into the contextual variables that may mediate these relationships.

Moreover, Khrawish and Al-Sa'di (2011) found no substantial influence of e-banking services on profitability in Jordan, suggesting that the benefits of electronic banking may not be universally applicable. This inconsistency prompts critical questions about the assumptions underlying the relationship between innovation and performance across different banking environments. While the literature on innovation and bank performance is extensive, there remains a need for more nuanced analysis. Future research should focus on synthesizing insights from these studies, exploring the differential impacts of technological versus service innovations, and addressing unresolved questions regarding contextual influences. This approach will enhance our understanding of how banks can leverage innovations to optimize their performance effectively.

2. METHODS

In this study, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist 2020 (Page et al., 2021) was followed in this systematic review and meta-analysis. The PRISMA framework improves the transparency and reproducibility of this study's systematic review process by requiring comprehensive reporting and evaluation of the literature, reducing bias and increasing the reliability of our results.

2.1 Search Strategies

To ensure a systematic search strategy, first identified a preliminary set of keywords based on the core concepts of "technological innovation," "service innovation," and "banks." These keywords from 2014 to 2023 were then refined through trial searches in relevant databases, following Wang and Chugh's (2014) recommendations, this study outlined search criteria based on keywords. Selected databases included peer-reviewed publications from sources like Science Direct, JSTOR, Emerald, and Scopus. The review has covered books, articles, and academic publications. "Publish or Perish 8" (PoP8) by Harzing (2007) is used, along with backward and forward searches. The literature was retrieved from several databases and publications, including Google Scholar, EMBASE, EBSCO, and JSTOR. The keywords for our searching strategy were "Bank", "Artificial Intelligence", "System innovation", "service innovation", "innovation in service", "service innovativeness", "performance", "revenue", "benefit", "outcome", "profit", "sales", "growth", "market share". Furthermore, we searched for articles in various journals using related keywords, such as financial innovation, Journal of banking & finance, Australian journal of business and management research, Research Journal of Finance and Accounting, International Journal of Economics and Finance, International Journal of Education and Research, International Journal of Bank Marketing, International Journal of Finance and Accounting, and so on. There was no language, geographical, publication, or study year barriers throughout the article search. In addition, we looked for relevant publications in the selected papers' reference lists.

2.2 Study Selection

In this study, we utilized Rayyan, an intelligent systematic review tool created by Ouzzani et al. (2016) for literature screening. This systematic review tool is used to complete the entire procedure. During the first round of screening, the title and abstract were extensively evaluated, and the entire piece was checked during the second round of screening.

2.3 Inclusion Criteria

Our analysis includes all studies that assess the influence of innovation on bank performance. This must include empirical documentation. A clear sample size and correlation coefficient between innovation and bank performance are required. Furthermore, there must be a clear definition of the types of innovation and performance. Financial innovation, technological innovation, service innovation, process innovation, product innovation, artificial intelligence, overall bank innovation, and so on are all examples of innovation. Bank performance, on the other hand, consists of financial performance (ROA), financial performance (income), financial performance (profit), overall bank performance, overall financial performance, and customer satisfaction.

2.4 Exclusion Criteria

Our investigation excludes studies with insufficient information or a clear conclusion on the association and sample size. Furthermore, studies reporting cases described in any other original articles by the same author, as well as the entire overlap of reporting, are removed. We also omitted any preprint papers since these papers are not peer reviewed, verified or result status was preliminary level. Also, these articles do not clarify the information regarding the type of performance, and category of innovation is likewise omitted from our analysis. Furthermore, conference papers, letters, and editorials were not included in our analysis. Furthermore, articles written in any language other than English are omitted from this study.

2.5 Data Extraction

The acquired data was saved using a predefined excel sheet. The following information is extracted: author information, publication year, geographic location, data type, male/female ratio (if available), innovation kind, performance type, correlation, and sample size. Any unavailable data from a given study was double-checked.

2.6 Statistical Analysis

We utilized the inverse variance approach to get the pooled correlation and the 95% confidence interval for the result of interest. The Z statistic is used to evaluate the hypothesis (level of significance $p < 0.05$). Between study, heterogeneity is estimated by Cochran's Q and I^2 indices. Chi-square test is used as test statistic to test the statistical heterogeneity (I^2). I^2 identifies the percentage of variability due to heterogeneity rather than sampling error. Values of I^2 indices 25%, 50%, and 75% indicate low, medium, and high heterogeneity, respectively (Higgins et al., 2003). Random-effects model meta-analysis is performed under the appearance of statistical heterogeneity. Between study variance (τ^2) in the random effects model was estimated using the Sidik-Jonkman estimator. Fisher's z transformation of correlations. Different subgroup analyses are also carried out based on the type of innovation and the type of performance. The meta-analysis findings are shown in forest plots. The statistical study was carried out using the programming language R (Allaire, 2012).

2.7 Publication Bias and Sensitivity Analysis

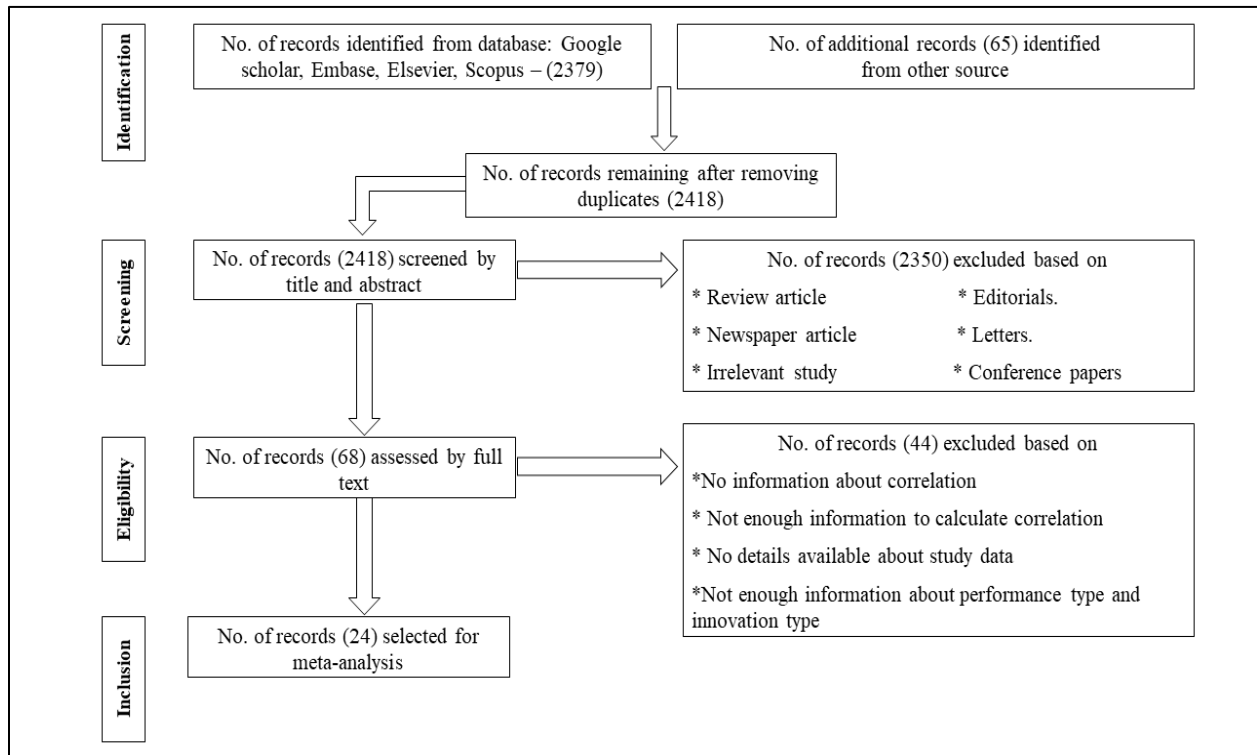
The chosen studies' publication bias is investigated using both qualitative and quantitative methodologies. The funnel plot is used as a qualitative tool to check for publication bias through visual examination. It contains two axes, with the y-axis reflecting each study's standard error and the x-axis denoting the effect magnitude. There is no publishing bias based on assumptions if that research lies symmetrically inside our pooling effect size inside the shape of a funnel. To assess publication bias, we used Egger's test, another quantitative method (Figure 7). Egger's test of the intercept is used to assess and statistically test the funnel plot test's asymmetry (Egger et al., 1997). The funnel plot and Egger's test were both used to assess the effect of small studies.

3. RESULTS

3.1 Study Selection

Our initial search yielded 2418 results, including 2379 from Google Scholar, EMBASE, Elsevier, and Scopus and 65 from other sources. There were 2418 articles remaining after removing duplicates. After carefully evaluating and reading the title and abstract of the remaining 2418 research articles, we rejected about 2350 publications based on our exclusion criteria. The remaining 68 papers were then read in full. Finally, 44 items were removed since they did not meet our inclusion requirements. Following the final round of screening, 24 publications were chosen for our systematic review and meta-analysis based on our inclusion criteria. Figure 1 displays more details of our selection procedure.

Figure 1: PRISMA flow Diagram of Literature Review



3.2 Study Characteristics

As previously indicated, 24 publications were ultimately chosen for our systematic review and meta-analysis. Among these 24 studies are six from Kenya, three from Lebanon, three from Nigeria, two from different developed and developing countries, one from Bahrain, one from Cameroon, one from Europe, one from Iraq, one from Malaysia, one from the Middle East, one from Nepal, one from Sudan, one from Tanzania, and one from Zambia. From 2007 through 2023, selected papers were published. Overall bank performance, overall financial performance, bank performance (profit), financial performance (income), financial performance (ROA), and customer satisfaction are examples of performance types. Agent banking, artificial intelligence, ATM, credit card and debit card, electronic fund transfer (EFT), financial innovation, financial technology, internet banking, mobile banking, Point of Sale (POS), process innovation, product innovation, service innovation, and so on are examples of innovation types. Twelve research utilized secondary data, ten used survey data, and two used combined survey and secondary data. Table 1 shows further features of chosen research.

3.3 Statistical Heterogeneity

The results of the meta-analysis indicate a high level of variation ($I^2 = 99.4\%$ for overall innovation and $I^2 = 99.0\%$ for individual innovations) in the correlation between innovation and bank performance. This suggests that differences in how studies were conducted, as well as regional factors, are affecting the results. For example, studies from developed markets with better technological infrastructure might show stronger positive effects of innovation compared to regions where adopting innovation is more challenging. In short, the maturity of the market and regional differences can significantly influence the impact of innovation on bank performance.

Result also found that in the first phase of this analysis, where innovation and performance were considered in general, the high heterogeneity ($I^2 = 99.4\%$) implies that pooling all types of innovation together might difficult to understand important patterns, that means ‘mixing effects biasness’ makes it difficult to identify how each type

specifically impacts bank performance. For instance, studies might be mixing technological innovations with process innovations, each having different impacts on bank performance. To address this, we conducted a subgroup analysis based on different bank performance measures, such as ROA, income, and customer satisfaction.

In the second phase, when individual innovations (e.g., technological innovation, service innovation) were analyzed in relation to bank performance, heterogeneity ($I^2 = 99.0\%$) was high. This could be due to the complexity of innovation typologies, which affect bank performance in a variety of ways. For example, product innovations may primarily drive customer satisfaction, whereas process innovations may improve operational efficiency. Furthermore, technological innovation, such as AI-driven analytics, can have a positive impact on bank performance by improving decision-making and operational processes, which can increase stakeholder trust. These distinct impacts highlight the difficulty of understanding the relationship between innovation typologies and bank performance. The results of the meta-analysis reveal that the random effects model effectively captures the variations across different studies, which often differ by region, type of innovation, or performance measures. Rather than assuming a uniform effect of innovation on bank performance, this model highlights the differences observed in the data. For example, it shows that technological innovations, such as AI-driven analytics, may yield strong results in certain regions while having weaker impacts in others. These findings provide banks with a clearer understanding of which innovations are most effective in specific contexts. As a result, banks can tailor their strategies to focus on the innovations that are most likely to enhance their performance based on their unique environments.

Table 1: Summary of Studies Examining the Relationship Between Innovation Types and Performance Outcomes

Study	Survey Region	Data Type	Study Period	Participants	Sample size	Innovation Type	Performance Type	Correlation
Agbolade et al. 2011	Nigeria	Survey Data		3 banks	90	ICT Innovation	Bank Performance (Profit)	0.70
Akhisar et al. 2015	23 developed and developing country	Secondary data	2005-2013		184	Credit and Debit card	Financial Performance (ROA)	0.00
						POS (Point of Sale)	Financial Performance (ROA)	0.09
						ATM (Automated Teller Machine)	Financial Performance (ROA)	-0.03
						Internet Banking	Financial Performance (ROA)	-0.48
Al-Baag et al. 2021	Iraq	Survey data	2016-2019	19 banks	339	Technology Innovation	Overall Financial Performance	0.98
Alzaidi et al. 2018	Middle east	Survey data		Bank employee	200	Artificial Intelligence	Overall Bank Performance	0.98
							Customer Satisfaction	0.19
Ashiru et al. 2023	Nigeria	Secondary data	2012-2021	24 banks	216	ATM (Automated Teller Machine)	Financial Performance (ROA)	0.42
						POS (Point of Sale)	Financial Performance (ROA)	0.24
						Internet Banking	Financial Performance (ROA)	0.25
Beccalli et al. 2007	Europe	Secondary data	1993-2000	737 banks	4414	Technology Innovation	Financial Performance (ROA)	0.20
Chai et al. 2016	Malaysia	Secondary data		Bank employee	319	Service Quality	Overall Bank Performance	0.96
						Technology Innovation	Overall Bank Performance	0.97
						Innovation	Overall Bank Performance	0.96
Haabazoka et al.	Zambia	Secondary data	2011-	19 banks	48	Technology Innovation	Financial Performance (ROA)	0.98

Study	Survey Region	Data Type	Study Period	Participants	Sample size	Innovation Type	Performance Type	Correlation
2019			2014			Internet Banking	Financial Performance (ROA)	0.25
						Mobile Banking	Financial Performance (ROA)	0.96
						ATM (Automated Teller Machine)	Financial Performance (ROA)	0.75
Hannoon et al. 2021	Bahrain	Secondary data	2019	12 banks	12	Financial Technology	Overall Financial Performance	0.92
Joseph et al. 2014;	Nigeria	Survey data	2008-2013	Customer	1634	Technology Innovation	Customer Satisfaction	0.79
Mahboub et al. 2018	Lebanon	Secondary data	2009-2016	50 banks	400	Technology Innovation	Overall Financial Performance	0.38
						ATM (Automated Teller Machine)	Overall Financial Performance	-0.09
						Mobile Banking	Overall Financial Performance	0.29
						Internet Banking	Overall Financial Performance	0.16
						Telephone Banking	Overall Financial Performance	0.06
						Credit and Debit card	Overall Financial Performance	0.09
						POS (Point of Sale)	Overall Financial Performance	0.09
Makur et al. 2014	Sudan	Secondary data	2009-2013	16 banks	16	Overall Financial Innovation	Financial Performance (ROA)	0.69
						ATM (Automated Teller Machine)	Financial Performance (ROA)	0.58
						Mobile Banking	Financial Performance (ROA)	0.01
Mugane et al. 2016)	Kenya	Survey data	December, 2014	43 banks	43	Financial Innovation	Financial Performance (ROA)	0.58
						Product Innovation	Financial Performance (ROA)	-0.20
						Service Innovation	Financial Performance (ROA)	0.34

Study	Survey Region	Data Type	Study Period	Participants	Sample size	Innovation Type	Performance Type	Correlation
Ngari et al. 2014	Kenya	Secondary data	2008-2012	16 banks	43	Financial Innovation	Overall Financial Performance	0.786
						Credit and Debit card	Overall Financial Performance	0.45
						Internet Banking	Overall Financial Performance	0.06
						Mobile Banking	Overall Financial Performance	0.24
						Agent Banking	Overall Financial Performance	0.28
Mwawasaa et al. 2020	Kenya	Survey data	2017	42 banks	71	Financial Innovation	Overall Financial Performance	0.71
						Financial Institution	Overall Financial Performance	0.02
						Product Innovation	Overall Financial Performance	0.66
						Process Innovation	Overall Financial Performance	0.41
Ndunga et al. 2016	Kenya	Survey data		20 banks	60	Technology Innovation	Overall Bank Performance	0.70
Ngando et al. 2017	Tanzania	Survey data	2015	56 banks	384	Technology Innovation	Overall Bank Performance	0.61
						Mobile Banking	Overall Bank Performance	0.03
						Internet Banking	Overall Bank Performance	-0.59
Ngumi et al. 2014	Kenya	Survey data and secondary data	2012	20 banks	325	Technology Innovation	Financial Performance (Income)	0.70
						ATM (Automated Teller Machine)	Financial Performance (Income)	0.08
						Credit and Debit card	Financial Performance (Income)	-0.14
						POS (Point of Sale)	Financial Performance (Income)	0.19
						Mobile Banking	Financial Performance (Income)	0.02
						Internet Banking	Financial Performance (Income)	0.24

Study	Survey Region	Data Type	Study Period	Participants	Sample size	Innovation Type	Performance Type	Correlation
Ngumi et al. 2014						Electronic Fund Transfer (EFT)	Financial Performance (Income)	-0.01
						Technology Innovation	Financial Performance (ROA)	0.97
						ATM (Automated Teller Machine)	Financial Performance (ROA)	-0.07
						Credit and Debit card	Financial Performance (ROA)	0.22
						POS (Point of Sale)	Financial Performance (ROA)	-0.08
						Mobile Banking	Financial Performance (ROA)	-0.09
						Internet Banking	Financial Performance (ROA)	-0.04
						Electronic Fund Transfer (EFT)	Financial Performance (ROA)	-0.10
						Technology Innovation	Bank Performance (Profit)	0.69
						ATM (Automated Teller Machine)	Bank Performance (Profit)	-0.08
						Credit and Debit card	Bank Performance (Profit)	0.00
						POS (Point of Sale)	Bank Performance (Profit)	-0.12
						Mobile Banking	Bank Performance (Profit)	0.08
						Internet Banking	Bank Performance (Profit)	0.09
Electronic Fund Transfer (EFT)	Bank Performance (Profit)	0.22						
Ngwa et al. 2020	Cameroon	Secondary data	2006-2018	4 banks	28	Service Innovation	Financial Performance (ROA)	0.98

Study	Survey Region	Data Type	Study Period	Participants	Sample size	Innovation Type	Performance Type	Correlation
Setiawan et al. 2021	Lebanon	primary and secondary data			191	Artificial Intelligence	Financial Performance (ROA)	0.40
Shrestha et al. 2022	Nepal	Survey data	2020	27 banks	355	Service Concept	Customer Satisfaction	0.70
						Service Process	Customer Satisfaction	0.68
						Technology Innovation	Customer Satisfaction	0.69
Sujud et al. 2017	Lebanon	Survey data			200	Overall Bank Innovations	Bank Performance (Profit)	0.77
						ATM (Automated Teller Machine)	Bank Performance (Profit)	-0.07
						Credit and Debit card	Bank Performance (Profit)	0.00
						POS (Point of Sale)	Bank Performance (Profit)	-0.12
						Mobile Banking	Bank Performance (Profit)	0.08
						Internet Banking	Bank Performance (Profit)	0.09
						Electronic Fund Transfer (EFT)	Bank Performance (Profit)	0.23
						Overall Bank innovations	Financial Performance (ROA)	0.99
						ATM (Automated Teller Machine)	Financial Performance (ROA)	-0.07
						Credit and Debit card	Financial Performance (ROA)	0.23
POS (Point of Sale)	Financial Performance (ROA)	-0.08						

Study	Survey Region	Data Type	Study Period	Participants	Sample size	Innovation Type	Performance Type	Correlation
						Mobile Banking	Financial Performance (ROA)	-0.09
						Internet Banking	Financial Performance (ROA)	-0.03
						Electronic Fund Transfer (EFT)	Financial Performance (ROA)	-0.11
Suleymanov et al. 2019	23 developed and developing country	Secondary data	2008-2018		184	Credit and Debit card	Financial Performance (ROA)	0.00
						POS (Point of Sale)	Financial Performance (ROA)	0.09
						ATM	Financial Performance (ROA)	0.03
						Internet Banking	Financial Performance (ROA)	0.48

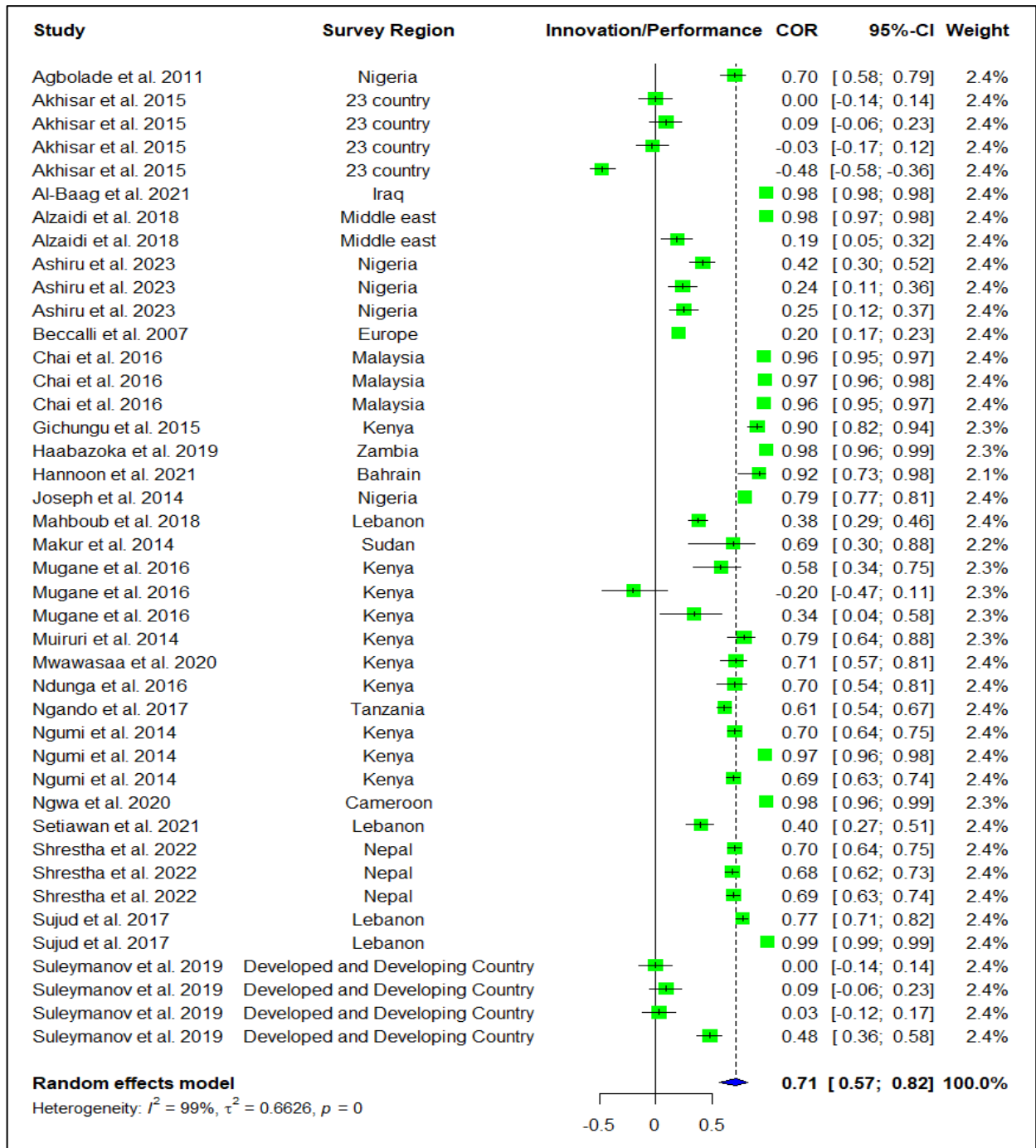
Source : Author's Own Compilation

3.4 Impact of innovations on bank performances

In the case of the first part, is the impact of the overall innovation (ignore the subsection or individual innovations) and overall performance, summary effect size [COR: 0.71; 95%CI: 0.57-0.82, Zval: 7.06, P < 0.0001] which is provided in figure 2. In case of subgroup analysis based on bank performance effect size for bank performance (profit) [COR: 0.72; 95%CI: 0.66-0.77], financial performance (ROA) [COR: 0.57; 95%CI: 0.26-0.77], overall financial performance [COR: 0.84; 95%CI: 0.53-0.95], overall bank performance [COR: 0.93; 95%CI: 0.80-0.98], customer satisfaction [COR: 0.64; 95%CI: 0.44-0.78], financial performance (income) [COR: 0.70; 95%CI: 0.64-0.75]. All these results are presented in figure 3.

In the second part, we have considered the impact of all individual innovations on bank performance and it gives us a summary effect size [COR: 0.36; 95%CI: 0.23-0.47, Zval: 5.10, P < 0.0001] which is presented in figure 4. In addition, subgroup analysis based on bank performance, the effect size for bank performance (profit) [COR: 0.09; 95% CI: -0.04 - 0.22], financial performance (ROA) [COR: 0.26; 95%CI: 0.08-0.43], financial performance [COR: 0.41; 95% CI: 0.11-0.65], bank performance [COR: 0.84; 95%CI: 0.34-0.97], customer satisfaction [COR: 0.64; 95% CI: 0.44-0.78], financial performance (income) [COR: 0.06; 95%CI: -0.05 - 0.17]. All these results are presented in figure 5.

In figure 6, the subgroup analysis based on different types of innovation estimated the effect sizes as follows: For technological innovation, the correlation coefficient (COR) was 0.79 with a 95% confidence interval (CI) of 0.52 to 0.92, indicating a strong positive effect on bank performance. Innovation in credit and debit cards showed a weaker correlation with a COR of 0.08 and a 95% CI of -0.03 to 0.19, suggesting a minimal impact. Point-of-Sale (POS) innovations had a COR of 0.03 (95% CI: -0.06 to 0.12), and ATMs had a COR of 0.13 (95% CI: -0.07 to 0.32), both showing low positive associations. Internet banking demonstrated a COR of 0.03 (95% CI: -0.16 to 0.21), also indicating a negligible effect. On the other hand, innovations involving artificial intelligence (AI) showed a more substantial, though variable, impact with a COR of 0.74 (95% CI: -0.32 to 0.98). Mobile banking had a moderate effect with a COR of 0.24 (95% CI: -0.12 to 0.55), while product innovation showed a COR of 0.29 (95% CI: -0.58 to 0.85). Service innovation, with a COR of 0.86 (95% CI: -0.51 to 0.99), and process innovation, with a COR of 0.57 (95% CI: 0.27 to 0.77), indicated stronger positive effects on bank performance. Other innovation types like Electronic Fund Transfer (EFT) had a weak correlation (COR: 0.05, 95% CI: -0.1 to 0.19), while innovations in service quality (COR: 0.96, 95% CI: 0.95 to 0.97) and overall innovation (COR: 0.96, 95% CI: 0.95 to 0.97) showed very strong positive effects. Financial technology innovations had a COR of 0.92 (95% CI: 0.73 to 0.98), also indicating a significant impact. Conversely, telephone banking (COR: 0.06, 95% CI: -0.04 to 0.16) and agent banking (COR: 0.28, 95% CI: -0.02 to 0.54) had less noticeable impacts. Lastly, innovations in the service concept had a positive correlation with a COR of 0.7 (95% CI: 0.64 to 0.75). These results are visually represented in a forest plot (Figure 6). However, when comparing it to other innovation types, "service quality" and "overall innovation" show even higher correlations, both having a COR of 0.96 (95% CI: 0.95 to 0.97). This implies that while service innovation is impactful, "overall innovation" and "service quality" have an even greater influence on bank performance.



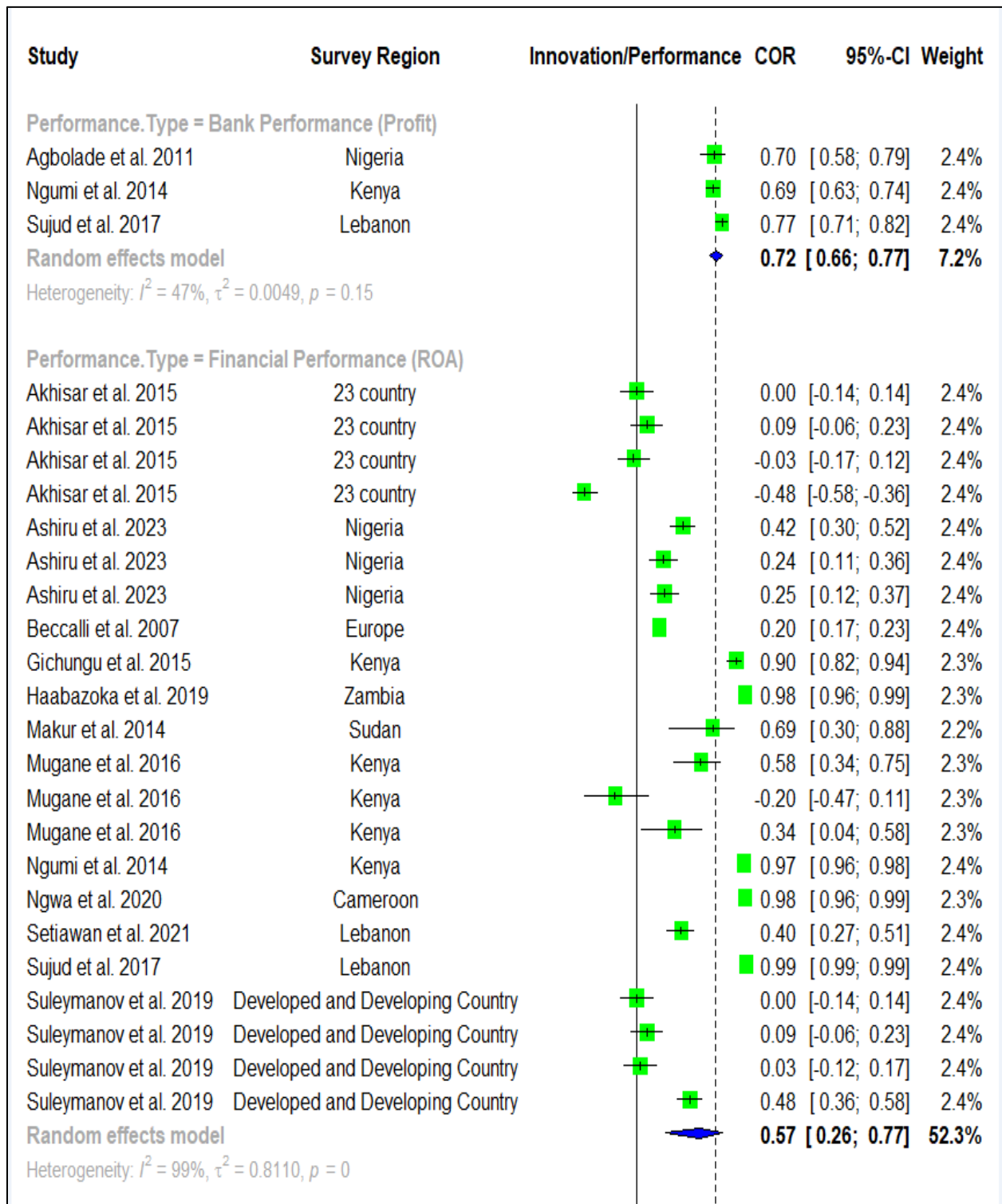


Figure 2: Impact of overall innovation on banks performance

Figure 3: Impact of overall innovation on banks performance (Subgroup analysis based on performance type)
(Cont...)

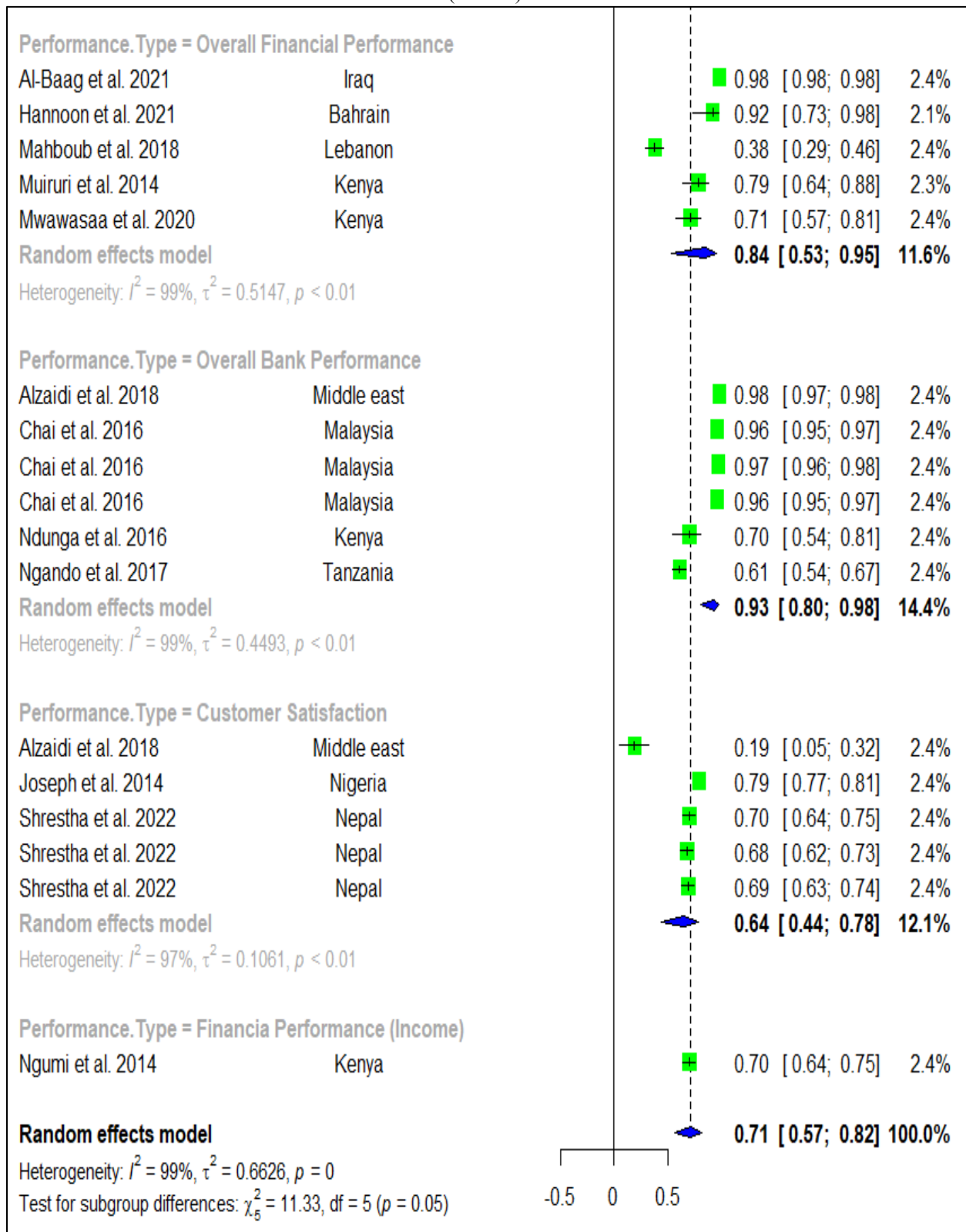


Figure 3: Impact of overall innovation on banks performance
(Subgroup analysis based on performance type)

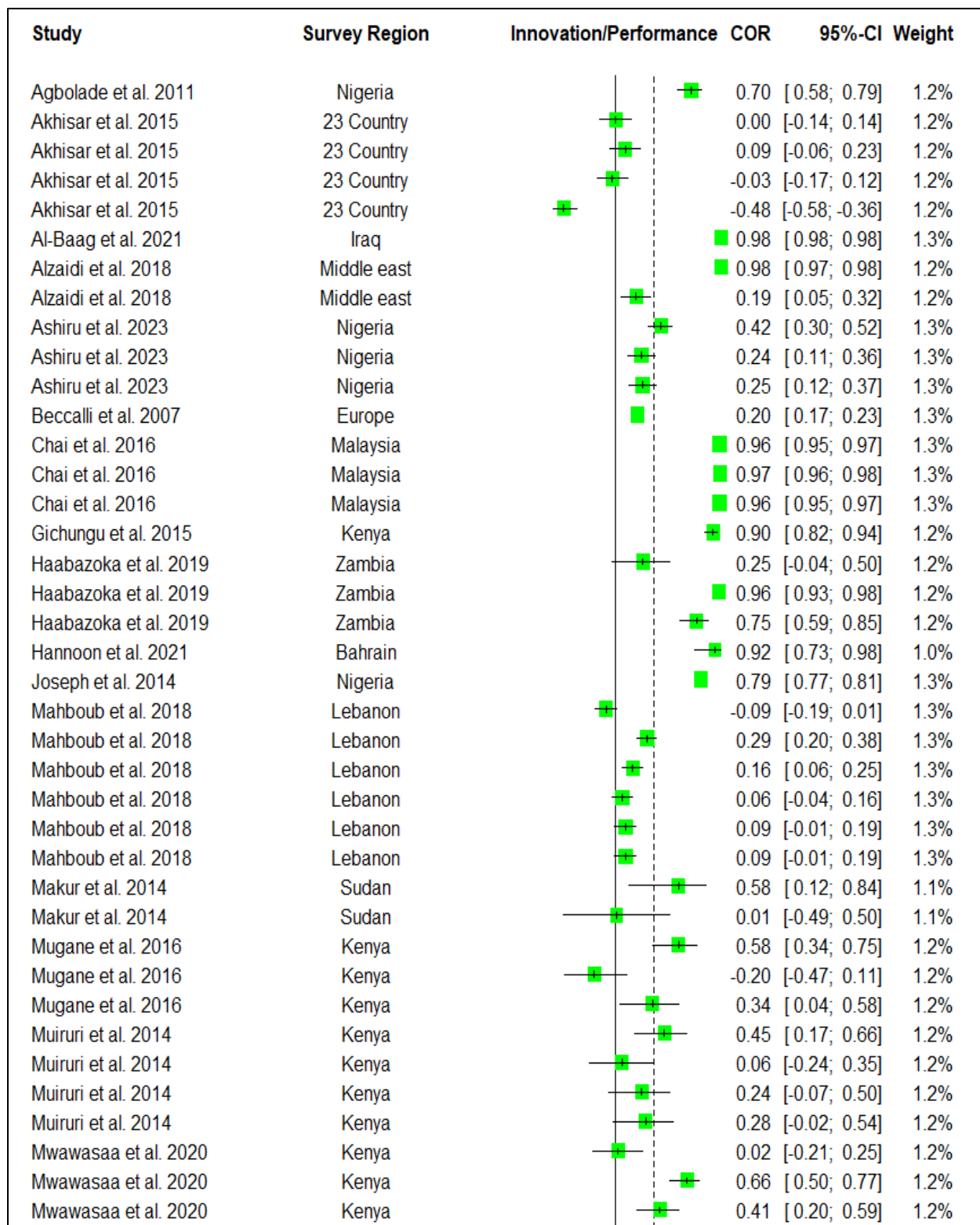


Figure 4: Impact of individual innovations on bank performance (Cont...)

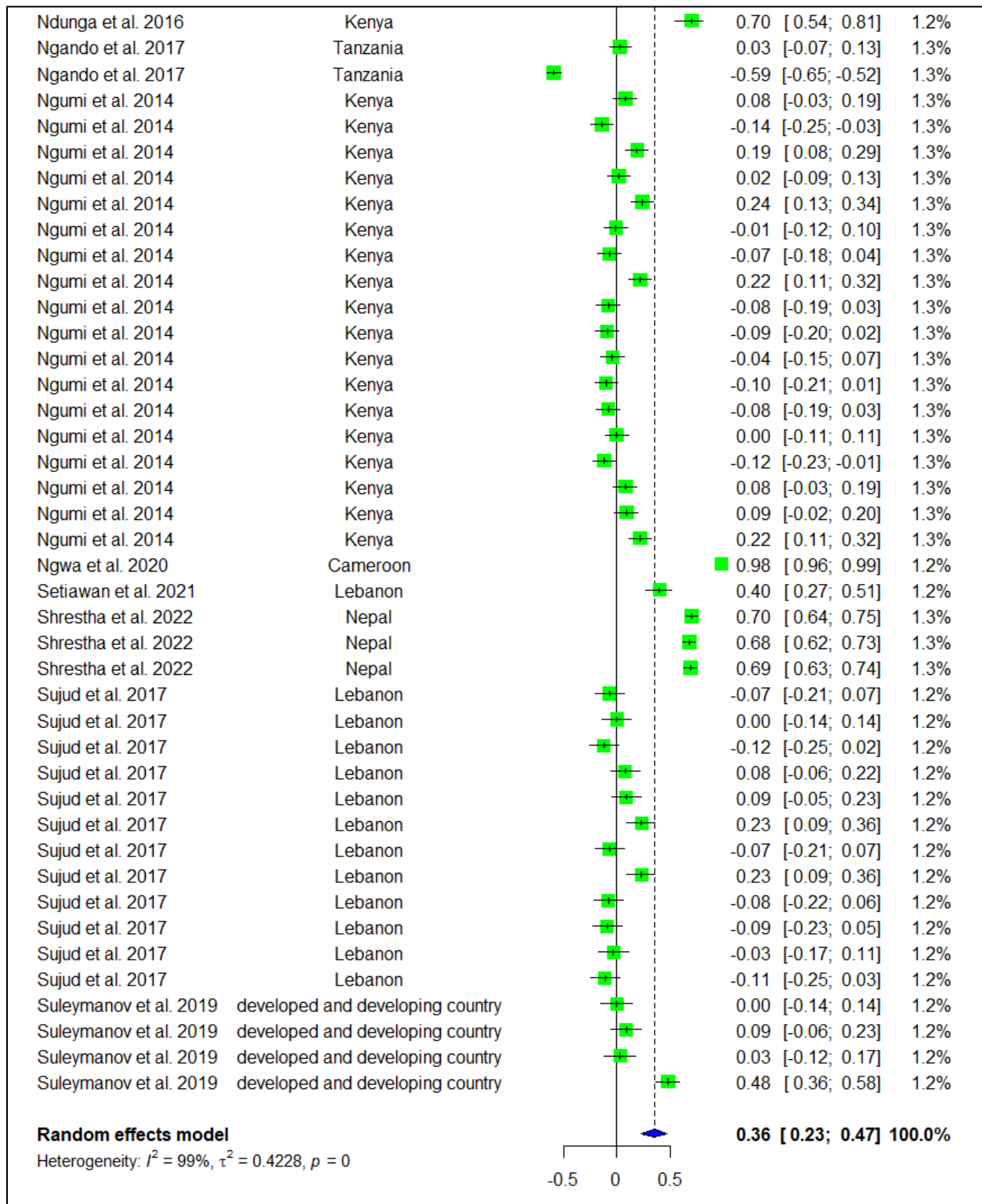


Figure 4: Impact of individual innovations on bank performance

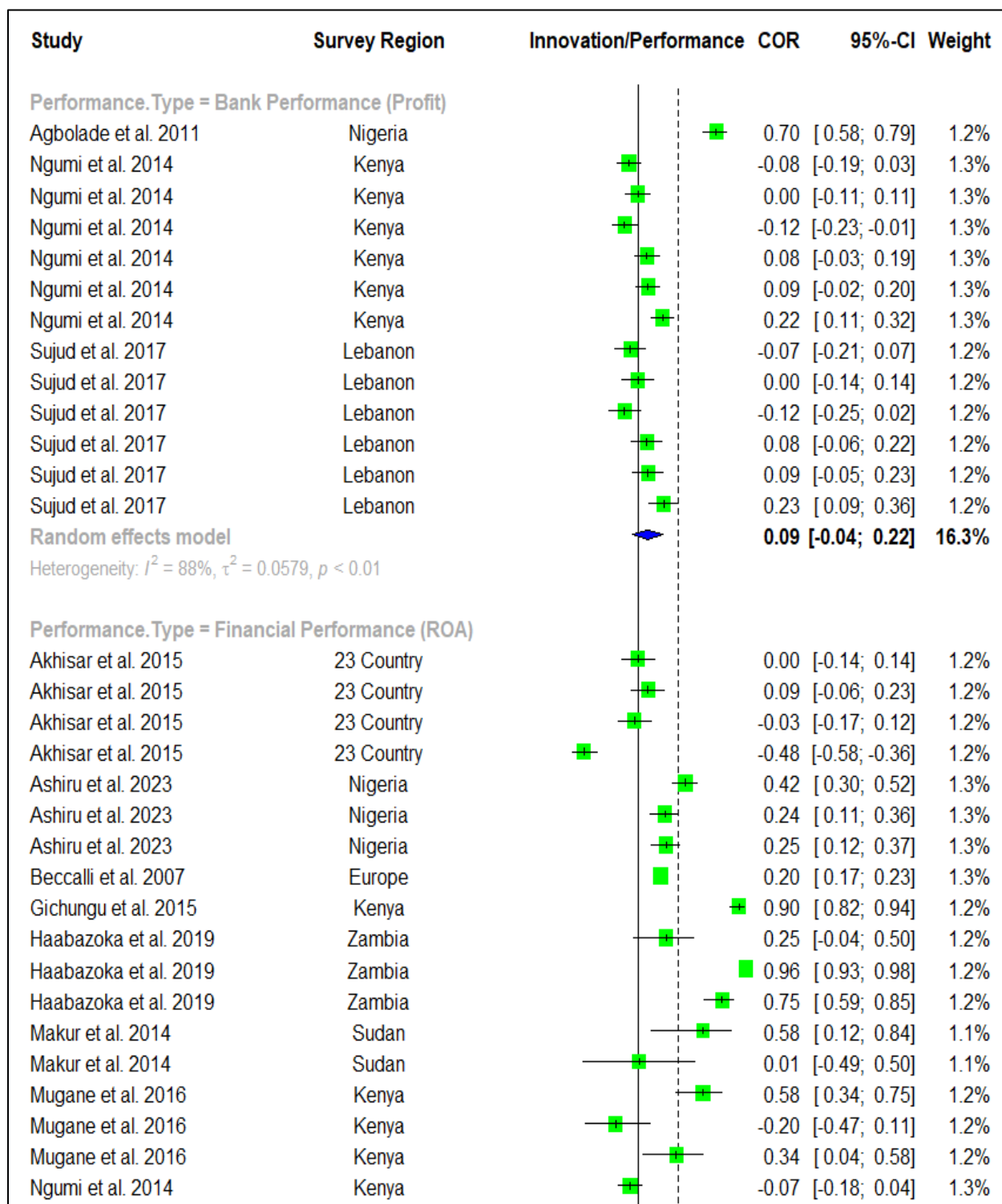


Figure 5: Impact of individual innovations on banks performance (Subgroup analysis based on performance type)
(Cont...)

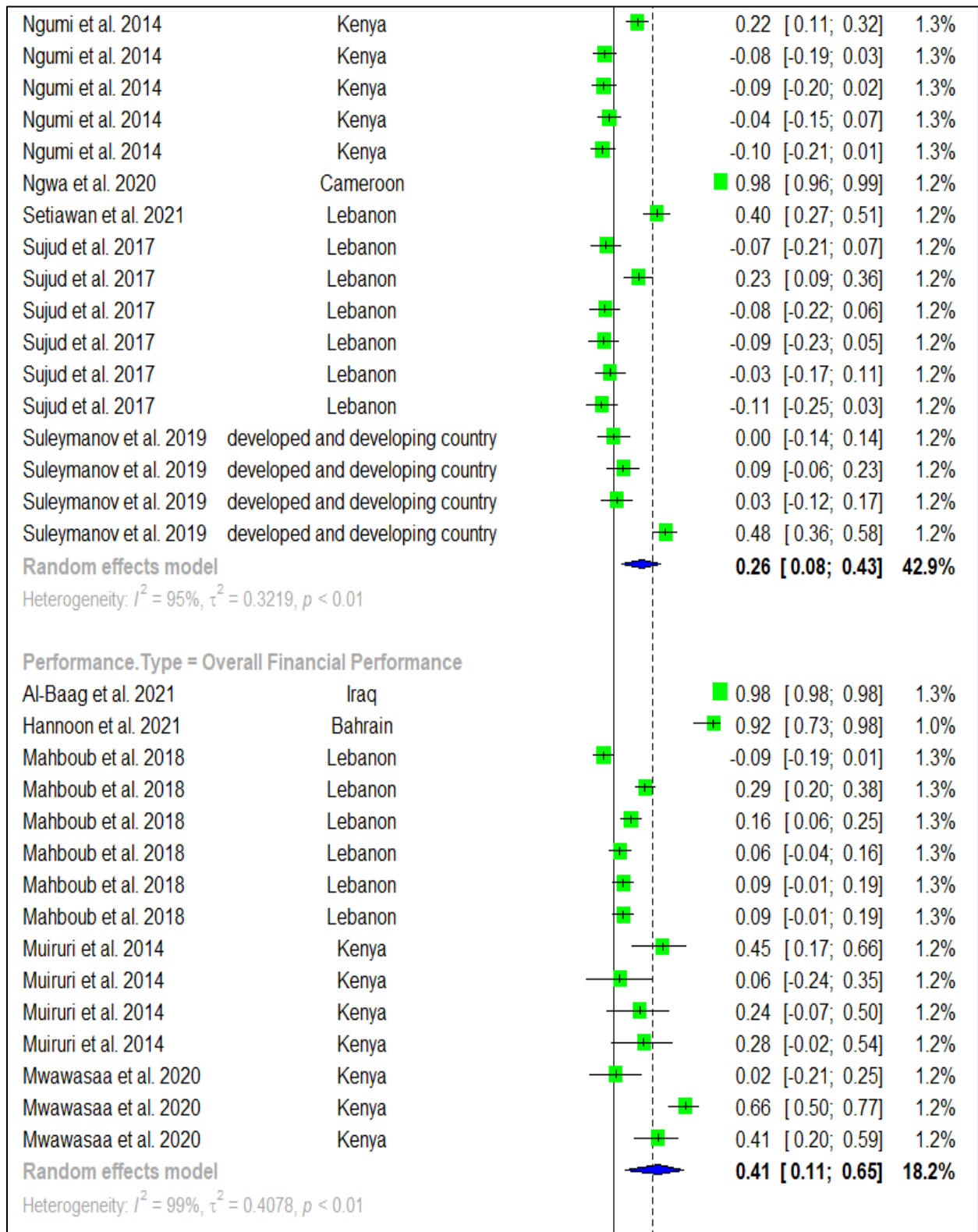


Figure 5: Impact of individual innovations on banks performance
Subgroup analysis based on performance type (Cont...)

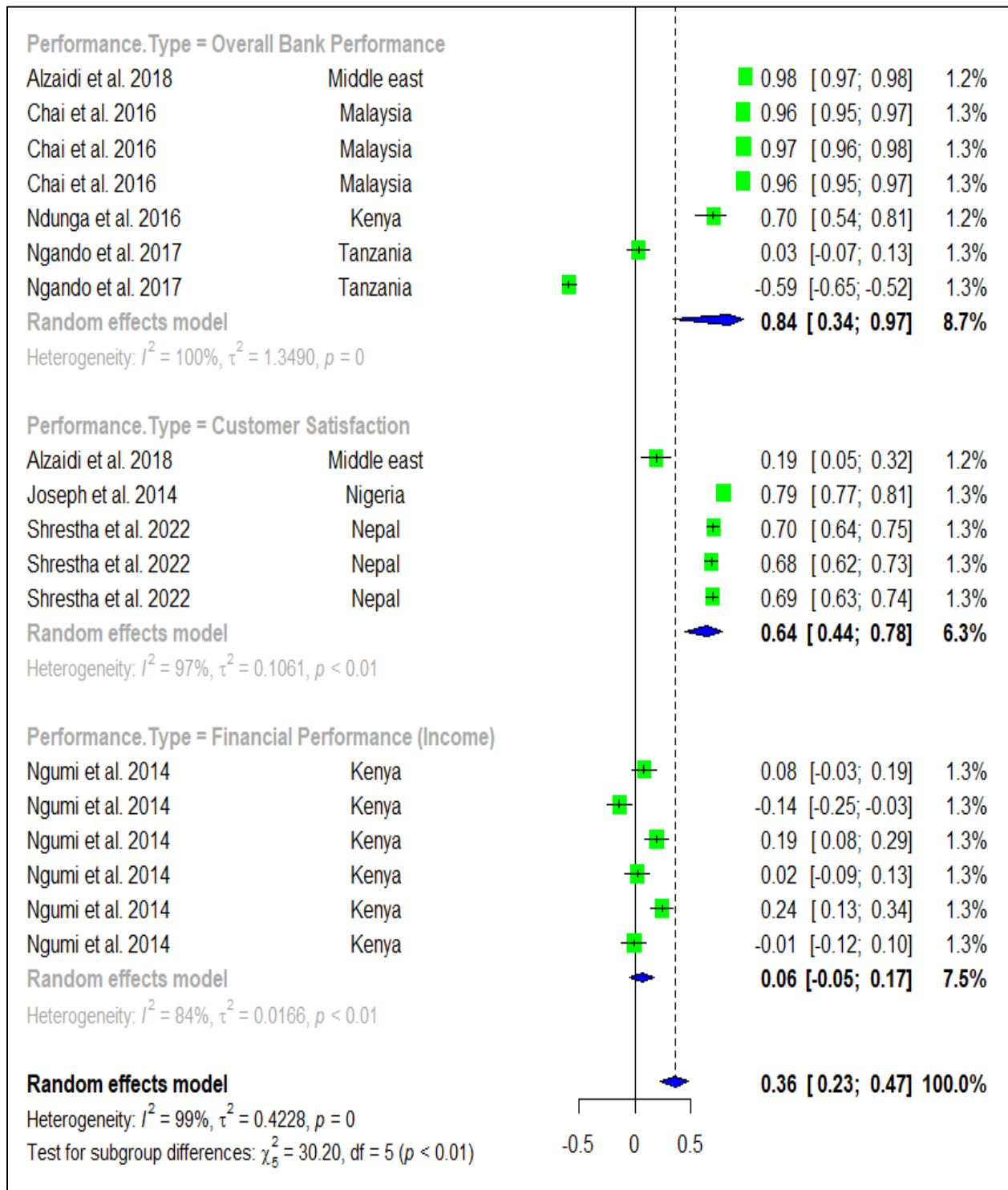


Figure 5: Impact of individual innovations on banks performance (Subgroup analysis based on performance type)

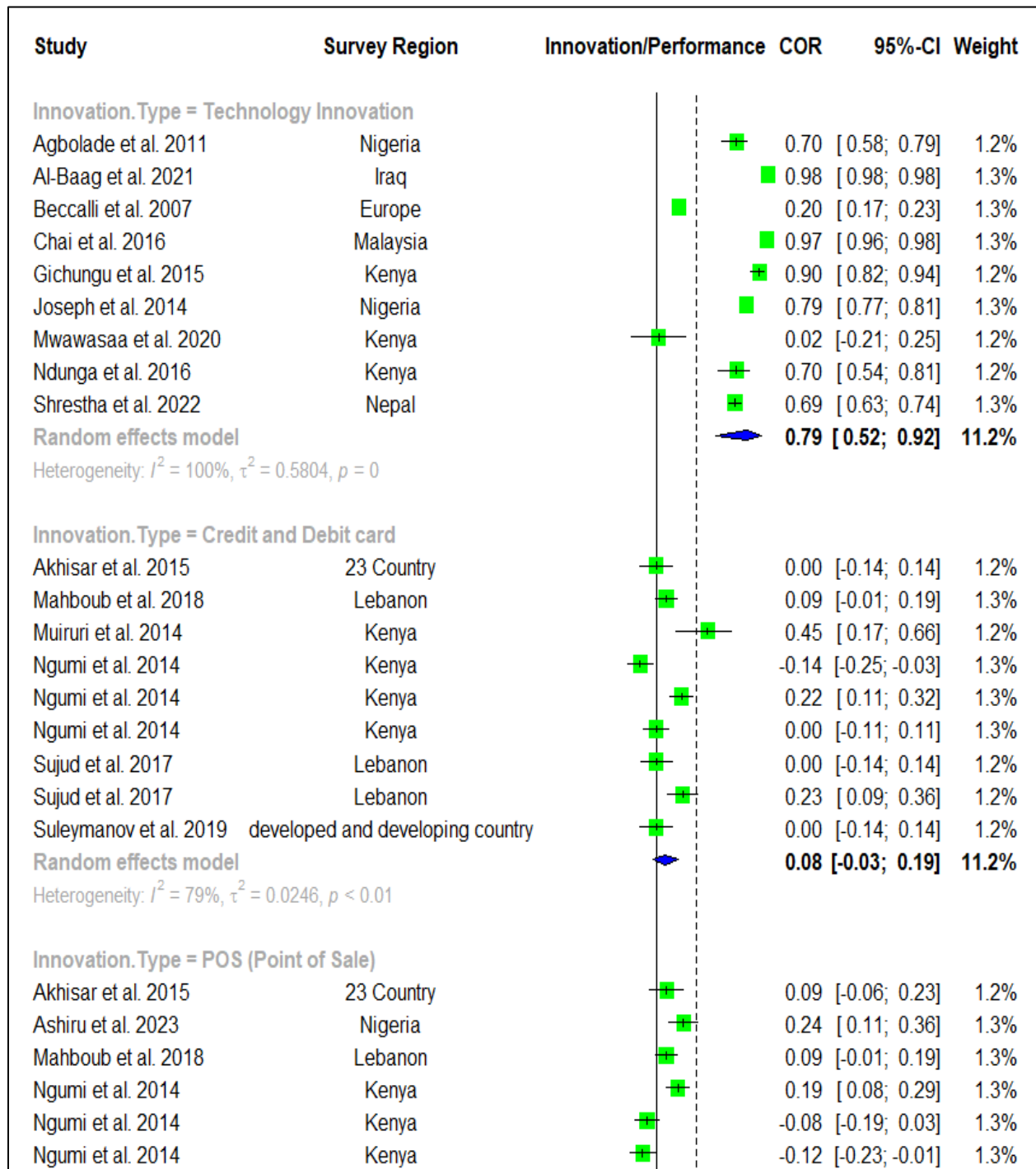


Figure 6: Impact of individual innovations on banks performance
Subgroup analysis based on innovation type (Cont...)

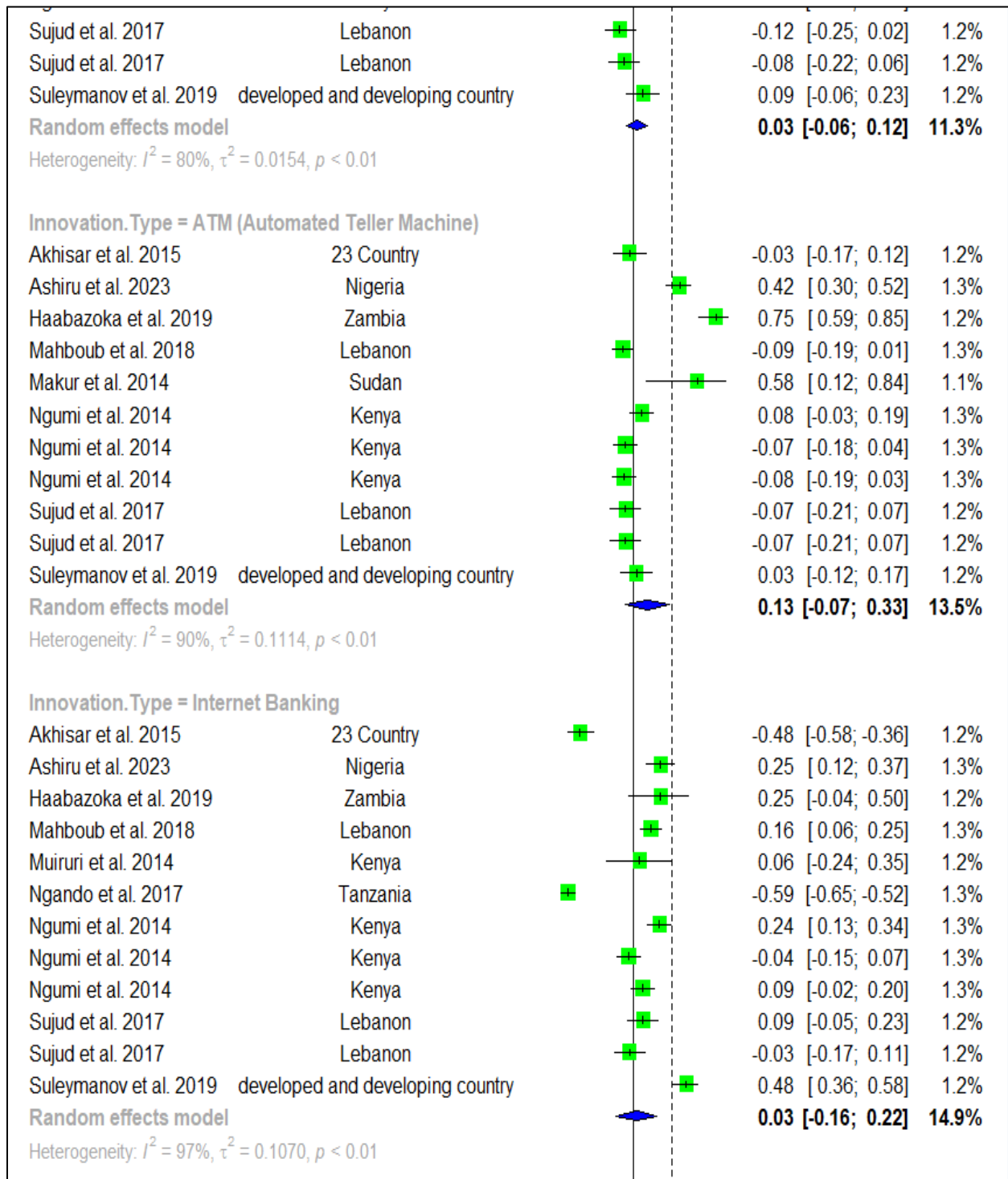


Figure 6: Impact of individual innovations on banks performance
Subgroup analysis based on innovation type (Cont...)

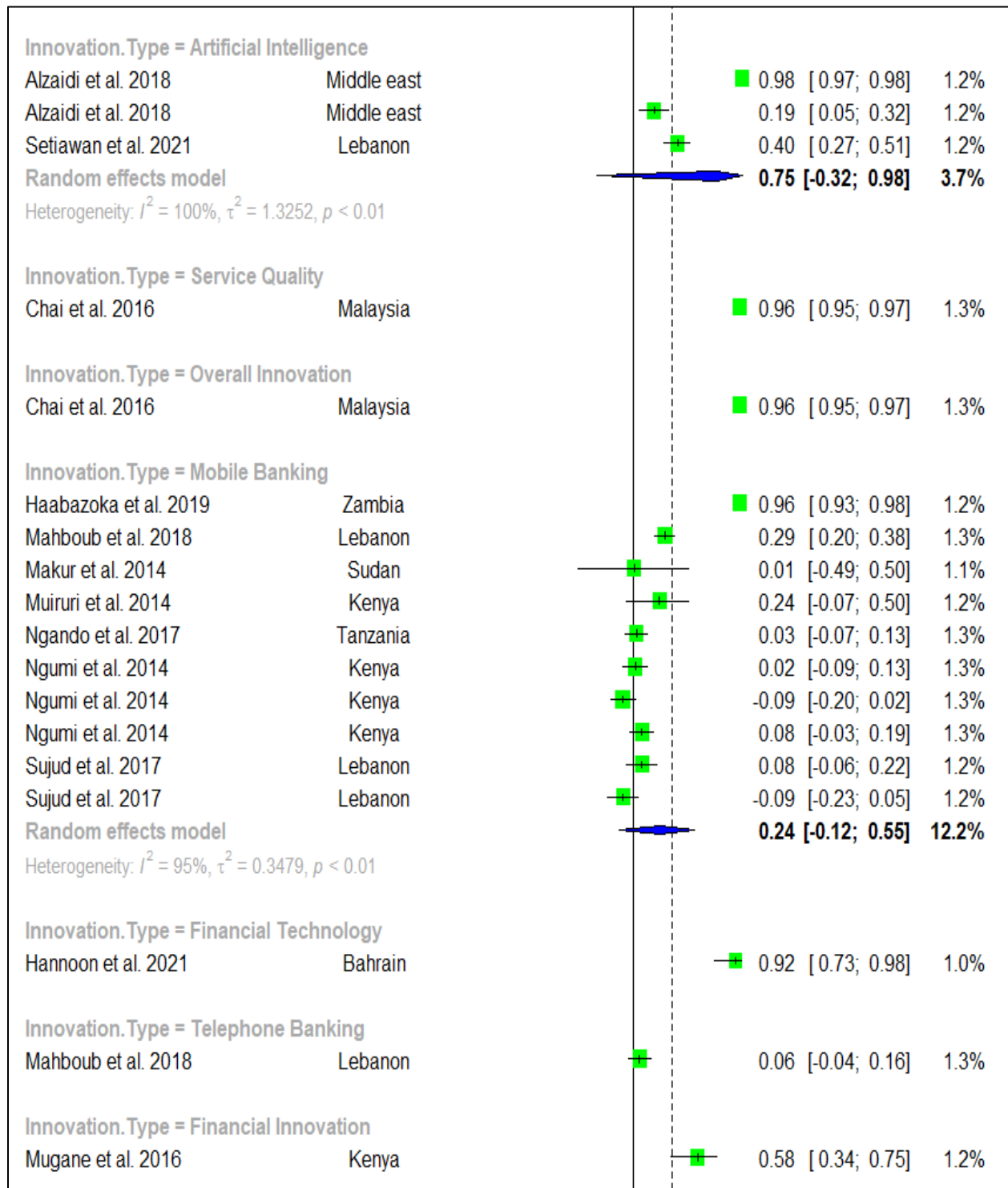


Figure 6: Impact of individual innovations on banks performance
Subgroup analysis based on innovation type (Cont...)

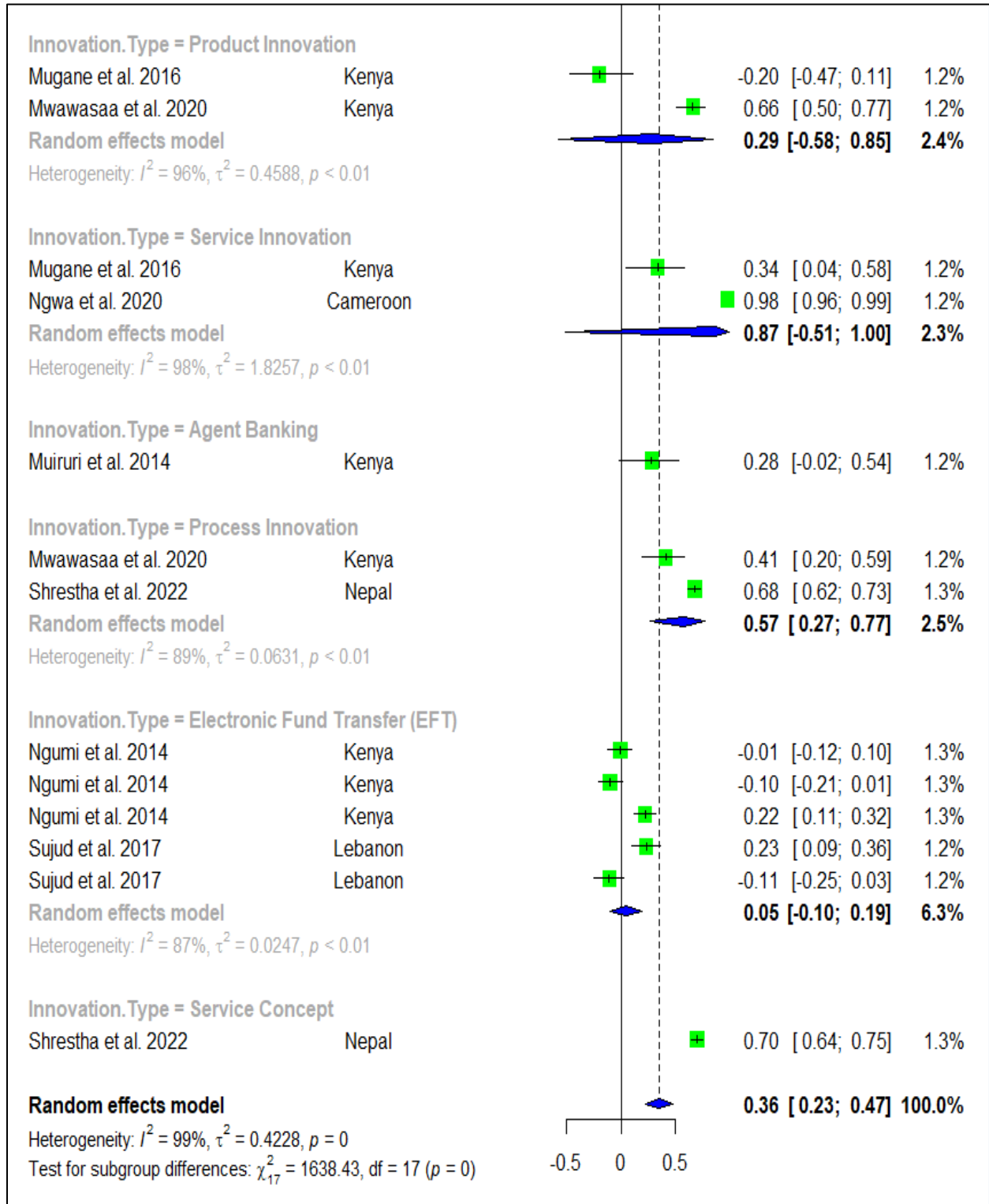


Figure 6: Impact of individual innovations on banks performance (Subgroup analysis based on innovation type)

3.5 Publication Bias

Results of publication bias using funnel plot shown in figure 7 for the selected studies. Funnel plot does not show an evidence of publication bias. The plot is symmetrical. To quantify the result of funnel plot Egger’s test is also conducted which is shown in table 3.

Figure 7: Funnel plot

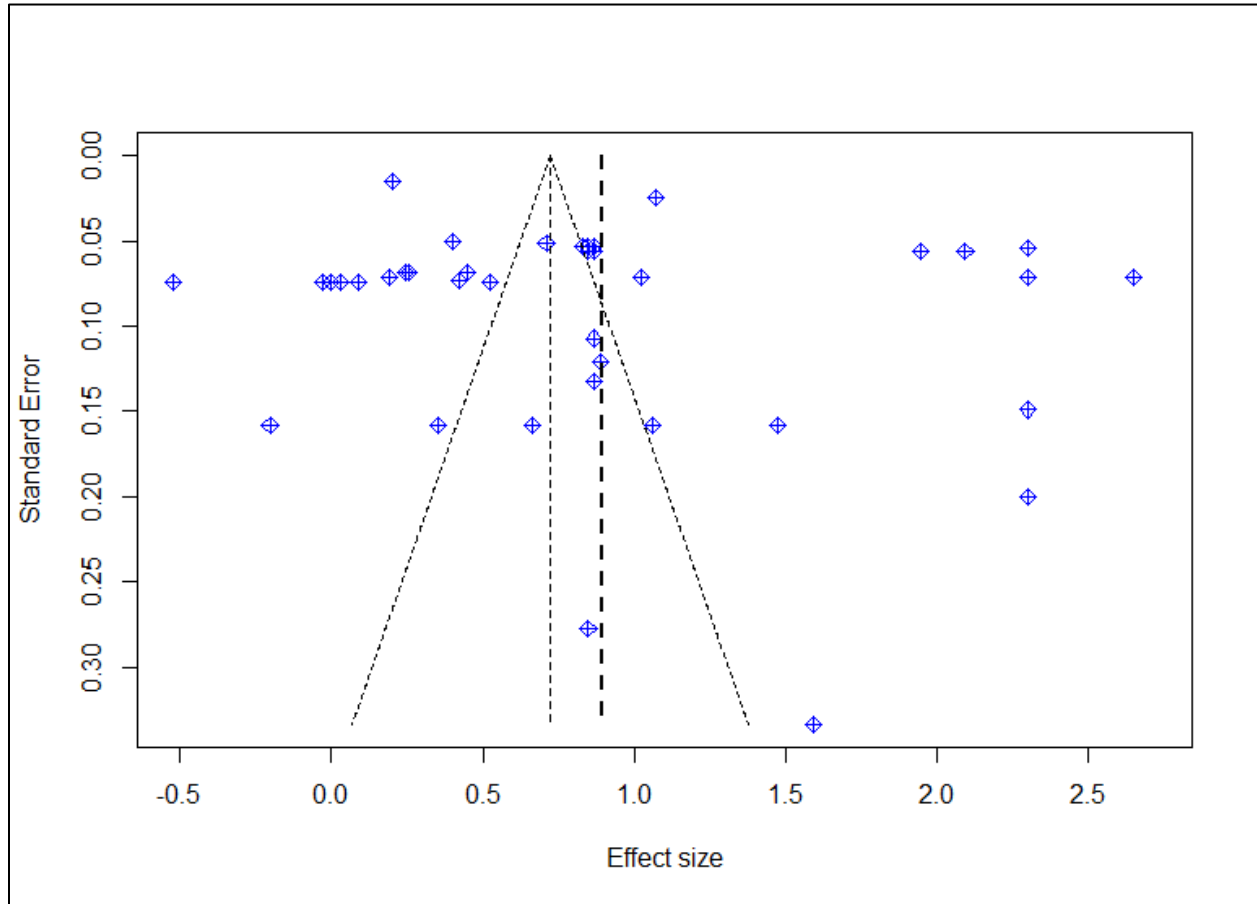


Table 3: Egger’s test result

Intercept	95% confidence Interval		P value
5.808	-0.96	12.58	0.1006 (>0.05)

It is also evident from the Egger’s test result that there is no substantial asymmetry in the funnel plot (P- value > 0.05).

4. DISCUSSION

In recent years, there has been a great deal of attention and study into the influence of innovations on bank performance. The purpose of this meta-analysis was to conduct a systematic evaluation of the current literature and integrate the findings in order to gain a greater insight into the overall impact of innovations on bank performance. Our review comprised a wide range of study findings that looked at different kinds of innovations, such as technological innovations, process innovations, product/service innovations, and organizational innovations, and the

effects they have on various aspects of bank performance, such as financial performance, operational performance, and customer performance.

As a whole, our meta-analysis indicated a positive link between innovations and bank performance (correlation (r): 0.71). When we consider subgroup analysis based on bank performance, the result also provided us with the same conclusion. Innovation impact on bank performance: profit (correlation (r): 0.72), innovation impact on financial performance: ROA (correlation (r): 0.57), innovation impact on overall financial performance (correlation (r): 0.84), innovation impact on the overall bank performance (correlation (r): 0.93), innovation impact on bank performance: customer satisfaction (correlation (r): 0.64), innovation impact on financial performance: income (correlation (r): 0.70). The included studies' findings consistently showed that innovations had a significant and beneficial influence on bank performance, with an average effect size indicating a medium to large benefit. These results are consistent with the findings of Mahmoud et al. (2018), Aayale (2017), Ngigi (2012), Patrick (2011). This shows that innovations are important drivers of success in the banking sector and play a critical role in enhancing bank performance.

This meta-analysis revealed an important finding - technical advancements such as digitalization, automation, and data analytics have emerged as especially powerful predictors of bank success (correlation (r): 0.79). The findings obtained by John (1999), SALEEM and Mathew (2022) is in line with our findings. Rapid technological improvement has resulted in substantial changes in the banking industry, resulting in the development of new products, services, and delivery methods. Banks that invest in and implement technology advances have a greater opportunity to improve financial performance, operational efficiency, and consumer experiences. This highlights the significance of technology-driven innovations in defining bank performance in the digital era. It enables banks to analyze vast amounts of data quickly, allowing for more informed decision-making. For example, predictive analytics can identify trends and customer behaviors, helping banks modify their services to meet specific needs, thus improving bank performance (customer satisfaction). Second, AI automates routine tasks, such as processing transactions and managing customer inquiries, which streamlines operations and reduces costs. Additionally, this paper identifies several types of innovations such as product innovations, service innovations, and technological innovation that have a positive correlation with bank performance. For instance, product innovations (correlation, $r = 0.29$) and service innovations (correlation, $r = 0.86$) show significant positive effects, aligning with findings from Maina and Ndwiga (2018). Furthermore, innovations in financial technologies, such as mobile banking (correlation, $r = 0.24$) and agent banking (correlation, $r = 0.28$), also demonstrate a beneficial impact on performance. These results are consistent with previous studies by Mutua (2013), Kithaka (2014), and Kathuo et al. (2015), although they contradict the findings of Vekya (2017) and Jenevive and Anyanwaokoro (2017).

These innovations not only attract new customers but also enhance customer retention and create additional revenue streams to improved bank performance. By relating these innovations back to technological advancements, we see that both technological innovations and these specific categories of innovation play a crucial role in shaping the future of banking. Together, they provide banks with the tools needed to adapt to changing market demands and improve operational efficiency, reinforcing the overall findings of this meta-analysis on the importance of innovation in driving success in the banking sector.

Furthermore, credit and debit card (correlation, $r = 0.08$), POS (correlation, $r = 0.03$), ATM (0.13), internet banking (correlation, $r = 0.03$), EFT (correlation, $r = 0.05$), telephone banking (correlation, $r = 0.06$) did not enhance banking performance significantly. Our findings about the impact of internet banking are consistent with the findings of (Sadr, 2013; Sathye, 2005; Khrawish and Al-Sa'di, 2011) but conflict with the findings from (Monyoncho, 2015, Mateka et al., 2016; Barasa et al., 2017). The result of telephone banking is in line with the results obtained from (Al-Hawari, 2006, Al-Hawari and Ward, 2006) but contradicts with Kihara (2015), who found a significant relationship between telephone banking and bank performance. Similarly, the correlation result of POS and bank performance is consistent with the result obtained by Dehghan and Shamsi (2015), Alber (2011), Abebe (2016). Opposite results found by Meihami et al. (2013) and Vekya (2017). The inclusion of these product or service innovations under the broader category of banking technologies highlights their role in modern banking; however, their limited effect suggests that merely implementing these technologies may not be enough to enhance performance.

In general, when this paper analyzes the entire impact of innovation on bank performance, found a strongly favorable relationship. However, if the innovations are considered separately, the results are mixed. This conclusion

is explained by the fact that numerous different types of innovation either service or technological influence the use of total innovation. As a result, it is feasible that one invention is so potent that it can offset the negative impact of another. Individual innovation performance, on the other hand, is affected by various factors that vary by region such as innovations in developed country (North America) might yield significantly higher returns due to advanced technological infrastructure and consumer readiness compared to developing country regions like Sub-Saharan Africa, where such technologies may face challenges like lower digital penetration and infrastructure deficits. This, we believe, is why the finding we obtained from individual innovation effect is consistent with certain research while contradicting many others.

4.1 Limitation and Future Research Direction

Our meta-analysis, however, has certain limitations. Our meta-analysis was limited to published papers, which may have been influenced by publication bias and may not have included all relevant studies on the issue. Furthermore, it only takes into account research written in English that provide direct correlation or information that may be utilized to determine correlation. Aside from that, many research is dismissed. There is a possibility of data loss. This coverage issue might be the cause for the disparity between our results and those of previous research in the case of individual innovation. Bank performance is impacted by a variety of contextual factors, including the regulatory environment, economic conditions, and cultural variations, which may vary between studies included in the meta-analysis. These contextual considerations may complicate the link between innovation and bank performance, limiting the generalizability of findings across diverse contexts. We can achieve a more robust outcome and a clearer judgment if we can acquire and examine all of this information. While these limitations affect the findings, analytics and artificial intelligence as forms of innovation hold significant potential for improving performance across various sectors, particularly in driving sustainability efforts. Future research should explore how AI-driven analytics can enhance not only banking performance but also address sustainability challenges in industries like manufacturing and telecommunications, offering a broader impact on business practices and environmental goals.

5. CONCLUSION

The meta-analysis provides substantial proof that innovations improve bank performance. Technological, process, product/service, and organizational innovations are all significant factors of bank performance. Banks that develop and implement new technologies are more likely to increase their financial performance, client satisfaction, profitability, and so on. This meta-analysis also concludes that further study is required to fully comprehend the complicated link between innovation and bank success. The meta-analysis' shortcomings, such as variability in innovation metrics and potential publication bias, may need more rigorous study designs and methodology in future investigations. Furthermore, the need for additional studies in various locations and situations might be highlighted in order to improve the external validity and generalizability of findings. To summarize, while a meta-analysis of the impact of innovation on bank performance may give helpful insights into the current research, it is critical to acknowledge the limitations and contextual variables that may influence the findings. More study is likely to be required to better understand the link between innovation and bank performance, as well as to discover the processes and boundary conditions that drive this relationship.

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