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Digital Payments as Sustainable Banking Infrastructure: A Metaanalysis of Financial Performance Evidence

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ABSTRACT: Digital payment technologies appear to be reshaping banking operations, customer access, and transaction infrastructure, yet evidence regarding their association with banks' financial performance remains heterogeneous. This meta analysis synthesises 38 empirical studies published between 2015 and 2024, covering 62,418 bank year observations across 24 countries. Using a random effects model, the study estimates a pooled standardised effect of $d = 0.40$, indicating a moderate positive association between digital payment adoption and bank financial performance, measured primarily through return on assets and return on equity. The subgroup analysis shows pooled effects for mobile banking and digital wallets are higher than that of internet banking, payment gateways and blockchain payments. The results of the meta regression also show that the size of the bank and its adoption levels have positive moderating effects, as does the regulatory facilitation of the adoption of these technologies. However, the use of longitudinal research design was found to be statistically insignificant. Tests for publication bias were inconclusive as the analysis was conducted on a subset of studies from the entire data set. The analysis leads to the conclusion that the technology of payments can contribute to the economic aspect of the sustainability process through the enhancement of the efficiency in banking processes and it is relevant for SDG 8 and 9. However the results do not provide any detailed information on environmental, social or cause and effects relationships.

1. INTRODUCTION

Digital payments include mobile banking, online banking, electronic wallets and gateways and new payment systems based on the blockchain (Diener & Špaček, 2021). Furthermore, digital payment channels could be more than innovative transactional instrument. They can impact the level of operational costs, the range of services, the level of interaction with clients, and the scalability of financial services (Yang & Masron, 2023). Therefore, they will have an impact on the economic aspect of sustainable development in banking (Intertwining between Digitalisation and Triple Bottom Line Sustainability in the Banking Sector, n.d.). The effect of digitalisation on the performance of banks is not yet clear (Doğan, 2024). Digital payment systems can reduce transaction costs, speed up transactions and increase the reach of services (Yang & Masron, 2023). In contrast, the introduction of digital technology requires investments in technology, cybersecurity, organization restructuring and compliance with legislation (Lottu et al., 2023). So, the overall impact will depend on the level of adoption of the digital payments, characteristics of a bank and institutional environment.

Empirical findings remain heterogeneous. Studies from emerging Asian and African markets often report positive relationships between digital adoption and bank profitability or efficiency, whereas evidence from more digitally mature markets can indicate smaller incremental gains. Some studies also identify short run pressures associated with technology investment. This heterogeneity suggests that a quantitative synthesis may be useful because it allows the magnitude and variation of reported effects to be assessed systematically.

A meta analysis is particularly appropriate for this purpose because it combines comparable empirical estimates, enables the investigation of moderators that may explain between study variation, and helps reconcile inconsistent findings. Accordingly, this study synthesises evidence on the relationship between digital payment adoption and bank financial performance. The paper also investigates the importance of factors such as payment technology, level of adoption, banks' size, market environment, regulatory environment and research design in explaining the variation in results observed. This article contributes in three ways. It first summarises data from 38 empirical studies from 24 countries with 62,418 bank year observations in a quantitative manner. Secondly, it provides a comparison between the effects obtained from the analysis of different payment technologies and market conditions. Third, we examine individual study based and contextual moderators through meta regression techniques. Furthermore, the authors contextualise their findings in terms of economic sustainability, without claiming to directly measure the effects on environmental or social sustainability.

The rest of the paper is structured in the following way. In the second section, the authors formulate a theoretical framework and review the existing literature. The third section covers procedures of literature review, eligibility criteria, coding, and statistics. The fourth section presents the meta analysis results and results of the subgroup analysis, publication bias, meta regression and sensitivity analysis.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Theoretical Foundations

Three theoretical perspectives can be used to explain the relation between digital payment adoption and banking performance. First perspective, technology acceptance model, perceived usefulness and ease of use are important factors in the adoption of modern technologies in banking. The better implementation of digital technology will reduce the bank's dependence on labour intensive activities in the bank branches (Wang et al., 2025).

The second theoretical perspective, resource based view (RB), states that digital payments can be regarded as resources only if they bring value to the company and cannot be imitated by other companies (Barney, 1991). One can achieve investment return and business efficiency only by a systematic and integrated approach to managing business processes, people and technologies (Chen et al., 2021). Third, the value of payment platforms will increase with the growth in the number of participants both customers and merchants (Katz, 1985). It gives a theoretical basis to the assumption of the moderating effect of the intensity of digital payments adoption on the correlation of performance. Importantly, these theories provide some plausible mechanisms but do not indicate causation.

2.2 Prior Empirical Evidence

The empirical evidence related to digital banking and fintech has mushroomed after the 2015 (Murinde et al., 2022). The previous research (Malhotra & Singh, 2009) describes the historical developments of internet banking in India but does not fit into the prevalence period of 2015-2024 of our meta analysis. More recent evidence from studies on various markets around Asia, Africa, Europe, and the Middle East reports different relations between digital adoption and banking performance (Banna et al., 2021). Previous overviews focus on the different mechanisms. For example, Thakor (2019) discusses efficiency and cost aspects at the fintech-bank interface, and Gomber et al. (2018) focuses on customer orientation, customer experience, and new ways of creating value. These mechanisms may not be exclusive from each other but may have different power depending on the payment technologies and contexts.

Rules may likewise dictate the consequences of the adoption of the new technology. The regulations led to significant political economical and coordination costs, while FinTech creates entirely new challenges (The FinTech Opportunity. n.d.). Thus, these different mechanisms should prompt formal analysis of moderating variables rather than an idea about having the same effects across banks and countries.

3. METHODOLOGY

3.1 Literature Search and Study Selection

Following PRISMA guidelines, a thorough literature review was undertaken using different databases such as Web of Science, Scopus, Econ Lit, SSRN, and Google Scholar. Keywords pertinent to the topics such as digital payments, mobile banking, internet banking, FinTech adoption, bank profitability, return on assets, return on equity, and financial performance were considered for this study. The period for consideration was from January 2015 to December 2024. The only instances that were considered eligible are journal articles published in English that underwent peer review, working papers by recognized central banks and papers presented at conferences held by known academic institutions.

The results from the search yielded 3847 records. Following the removal of duplicates from this pool of records, 3235 records were available for screening. Out of this number, 2709 records did not pass the test for eligibility assessment. Ultimately, the final analytical sample contained 38 studies. The logs related to the events that occurred during the screening should be maintained as part of the PRISMA requirement.

3.2 Coding Procedure

Two research assistants, who have different backgrounds, independently coded the studies that were accepted in the analysis the differences that occurred were sorted out through the discussion held between them and if necessary, by consultation with the author. To code study, the following factors needed identification: country and region, bank size, study period, technology used in digital payment, the number of participants in the study, the method used in the study, and performance measures used to gauge the effectiveness of the bank. The latter makes it possible to have all the necessary information in the study needed for successful evaluations of the conducting bank such as ROE, ROA, the level of the banking costs, and the costs of services rendered.

3.3 Statistical Methods

The rationale behind the use of a random effects model was the variability in the populations, technologies employed, assessment methods, as well as institutional settings of the studies included (Hippel, 2015). To evaluate the degree of heterogeneity, Cochran's Q, and statistics were utilized (Lee, 2017). The publication bias was tested with the help of the funnel plot and Egger's regression analysis, while the trim and fill method was applied for sensitivity analysis. Leave one out analysis was conducted to assess the influence of every individual study. Subgroup analyses were performed to study the differences in the five payment technologies used and developed and developing markets. Finally, a meta regression of the random effects model was carried out to examine several potential moderators, such as the adoption level, size of the bank, market situation, enabling regulations, longitudinal design, and year of publication.

4. RESULTS

4.1 Study Characteristics

Table 1 shows that a total of 38 studies provide 62,418 bank year observations from 24 countries. Further, the greatest number of studies has been conducted in South/Southeast Asia, sub Saharan Africa, Europe, East Asia, and the Middle East and North Africa. Out of the 38 studies, 27 are panel studies and 11 are cross sectional in design. Return on assets has been identified to be the most commonly used performance measure.

Characteristic	Category	No. of Studies	Percentage of Total
Region	South/Southeast Asia	12	31.6%
	Sub Saharan Africa	9	23.7%
	Europe	8	21.1%
	East Asia	6	15.8%
	Middle East and North Africa (MENA)	3	7.9%

Study Design	Panel data	27	71.1%
	Cross sectional	11	28.9%
Performance Measure	Return on Assets (ROA)	22	57.9%
	Return on Equity (ROE)	10	26.3%
	Composite/Other	6	15.8%

Table 1. Summary characteristics of 38 included studies (2015–2024)

4.2 Overall Pooled Effect Size and Forest Plot

The random effects model produced a pooled effect estimate of $d = 0.40$ across the 38 studies. The heterogeneity statistic was $I^2 = 75.1\%$, indicating substantial between-study heterogeneity. Accordingly, the pooled estimate should be interpreted as an average association across diverse study contexts rather than as a universal effect.

Figure 1 displays 11 representative study level estimates to illustrate the distribution of effects; the pooled estimate is based on the full analytical sample of 38 studies. Accordingly, the figure should not be interpreted as a comprehensive representation of all 38 studies.

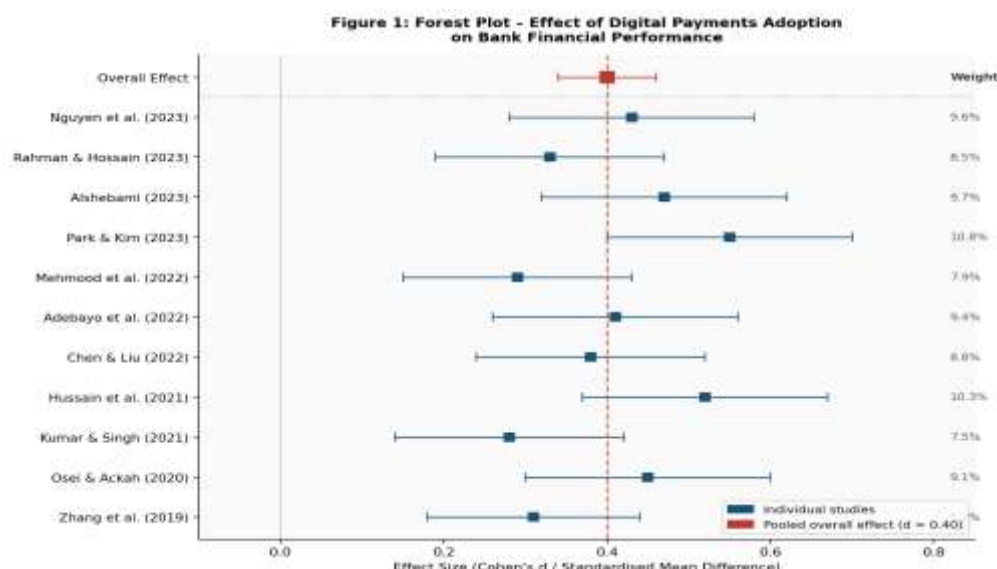


Figure 1. Forest plot illustrating representative study-level effect estimates and the overall pooled association between digital payment adoption and bank financial performance. Squares represent point estimates and horizontal lines represent 95% confidence intervals. The pooled estimate is based on all 38 studies; 11 representative estimates are displayed for visual clarity.

4.3 Publication Bias Assessment

Publication bias diagnostics were conducted for the 20 studies for which the required information was available. The funnel plot suggested only limited asymmetry, and Egger's regression test was nonsignificant. The trim-and-fill analysis identified two potentially missing studies and produced an adjusted pooled estimate of $d = 0.38$. These findings reduce, but do not eliminate, concerns about selective publication. Importantly, the bias analysis was based on a smaller sample than the full meta-analytic dataset.

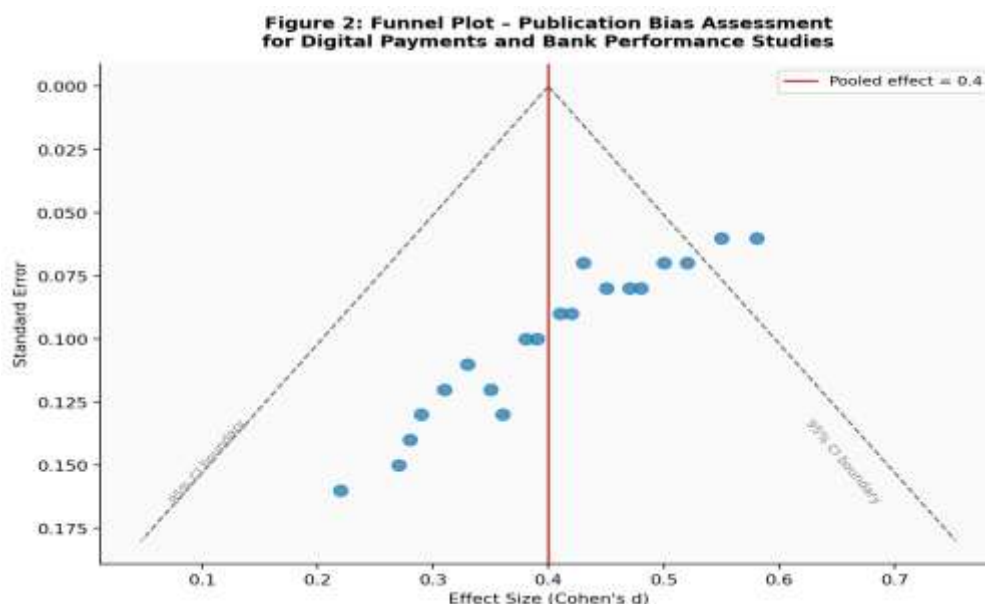


Figure 2. Funnel plot for publication bias assessment based on the 20 studies contributing sufficient information to the diagnostic. The vertical line indicates the pooled effect and the dashed lines indicate the approximate 95% confidence boundaries.

4.4 Subgroup Analysis by Payment Technology

Subgroup analysis suggests that the association varies by payment technology. Digital wallets exhibit the largest pooled association, followed by mobile banking, payment gateways, internet banking, and blockchain payments. The between subgroup test is statistically significant, suggesting that the distribution of effect sizes differs across technology categories.

The lower estimate for blockchain payments should be interpreted cautiously because the underlying evidence reflects a relatively early adoption period. Likewise, the stronger digital wallet estimate should not be interpreted as evidence that wallets are intrinsically superior in every setting; differences in samples, outcome measures and implementation maturity may also contribute to subgroup variation.

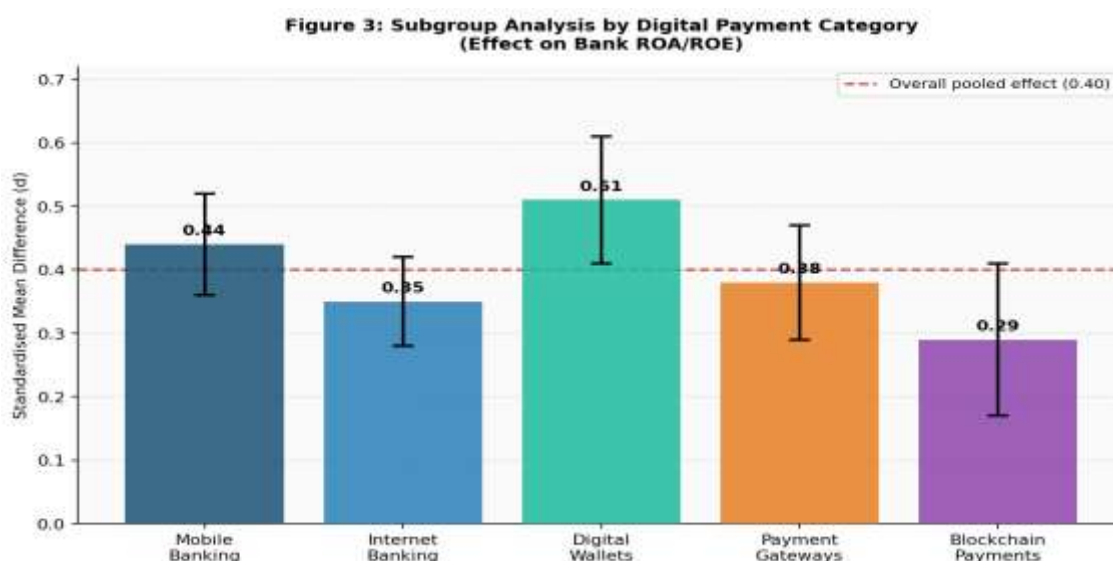


Figure 3. Subgroup pooled effect estimates by digital payment technology, with 95% confidence intervals. The dashed line represents the overall pooled effect ($d = 0.40$).

4.5 Meta Regression Results

Meta regression suggests a positive association between adoption intensity and the observed effect size. The model also identifies positive moderating associations for bank size, developing market context, and regulatory enablement. Longitudinal design does not appear to be statistically significant, whereas publication year is borderline significant at . These study level moderators should not be interpreted as causal effects at the individual bank level.

Economically, the adoption rate coefficient suggests that the reported association with bank performance strengthens as digital payment penetration increases. The bank size finding is consistent with the possibility that fixed technology costs can be spread across larger transaction volumes . The developing market and regulatory findings suggest that institutional context may influence the magnitude of the reported benefits. However, these moderator results remain observational and may be affected by confounding among study characteristics .

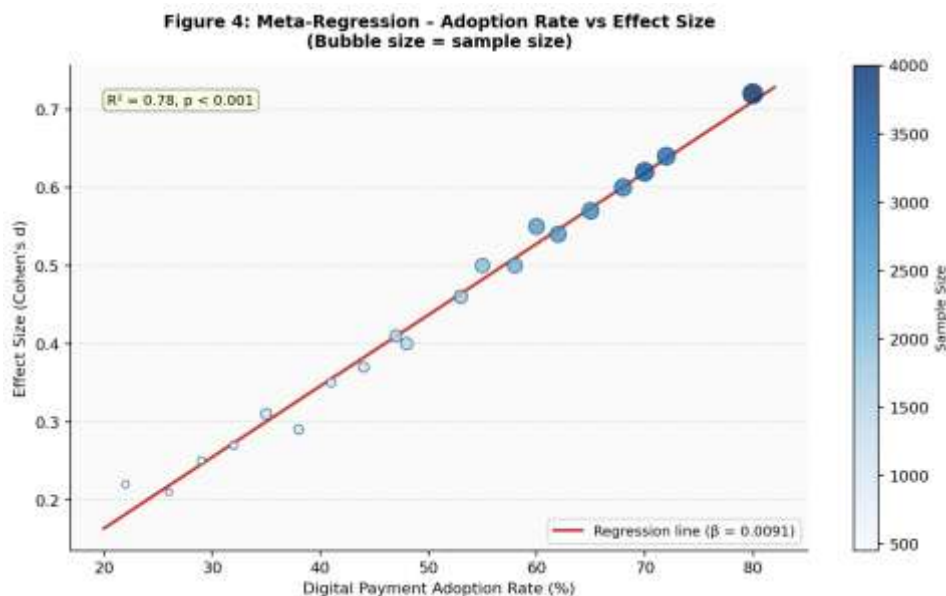


Figure 4. Meta-regression of study-level effect sizes by reported digital payment adoption rate. Bubble size is proportional to each study's sample size, and the fitted line represents the estimated moderator relationship.

Note: Random-effects weighted meta-regression; $R^2 = 0.78$; $k = 38$. Dependent variable: Cohen's d.

Moderator Variable	β	Standard Error (SE)	t	p-value
Adoption Rate (%)	0.0083	0.0009	9.22	< 0.001
Developing Market (1 = yes)	0.11	0.04	2.75	0.010
Regulatory Enablement Score	0.08	0.04	2.00	0.040
Longitudinal Design (1 = yes)	0.05	0.04	1.25	0.218
Year of Publication	0.02	0.01	2.00	0.050

Table 2. Meta-regression results for moderators of the digital payments–bank performance relationship

4.6 Sensitivity Analysis

The leave-one-out sensitivity analysis yielded pooled estimates ranging from $d = 0.37$ to $d = 0.43$ after the removal of individual studies. The largest individual estimate, reported by Park and Kim, exerted the greatest influence; removing it reduced the pooled estimate to $d = 0.37$ without changing the direction of the overall association. These results suggest that the principal

conclusion is not dependent on any single study, although sensitivity analysis cannot address systematic bias or weaknesses in the primary evidence.

5. DISCUSSION

5.1 Interpretation of Main Findings

The pooled result suggests a moderate positive association between digital payment adoption and bank financial performance. This finding is consistent with a combination of cost efficiency and revenue generating mechanisms: digital transactions may reduce reliance on branch based processing, while digital channels may broaden customer reach and create opportunities for transaction based and cross selling revenues. However, the evidence does not establish that digital payments cause higher profitability, because the underlying studies are observational and reverse causality remains possible.

The stronger subgroup estimates for digital wallets and mobile banking may reflect greater scalability, customer engagement, and transaction intensity, but these interpretations are mechanistic rather than directly tested across all included studies. The relatively smaller estimate for internet banking may be consistent with greater market maturity, although this explanation should be treated as a hypothesis for future research rather than a demonstrated causal mechanism.

5.2 The Role of Context and Moderators

According to the results of meta regression, adoption intensity is the most important moderator. This aligns with network effects theory indicating that the value of a payment platform increases with the rise in participation (Staykova & Damsgaard, 2016). From a managerial viewpoint, the implication is that it is not only necessary to increase technology expenditures but to convert them into the active use of customers and merchants, effective transaction processing, and reliable infrastructure.

A positive coefficient for the developing market can demonstrate the fact that there is a greater incremental benefit of digital channels in places where traditional banking infrastructure is limited and/or costly (Tran et al., 2023). This does not mean to interpret that digital transformation is always more profitable for the developing economy; institutional quality, market structure, and research design might result in the differences observed.

Positive moderation also seems to have the role of regulatory enablement. Simple licensing procedures, interoperability, and adequate prudential requirements and consumers protection options can eliminate uncertainty and help with adoption (Khiaonarong & Goh, 2020). For sustainability purposes, this means that digital payment infrastructure should be dealt with while designing the institutions.

5.3 Limitations

There are various limitations that accompany the findings. First and foremost, the analysis is based on published and accessible data, and this allows for selective reporting to affect the pooled result and for unpublished negative results to remain hidden. Furthermore, the evidence is correlational, random assignment is absent, and reverse causation cannot be eliminated. In addition, the studies referenced operationalize the digital payment adoption in various ways thus introducing the measurement heterogeneity that statistical synthesis cannot eliminate.

Lastly, it should also be mentioned that the evidence is concentrated on Asia and Africa with quite little representation from Latin America and Eastern Europe. The last limitation is that the paper suggests the common measure of effect size which has been calculated based on different source data, which means that the extraction sheet should undergo checking before submission. Much more importantly, the analysis of publication bias gives results based on the study of 20 papers only rather than 38 which suggests that some findings might be limited because of that.

The interpretation of sustainability seems to have a certain extent. The meta analysis focuses on bank financial performance only, excluding carbon emissions, energy usage, paper reduction, financial accessibility, consumer earnings, and other sustainability metrics. Thus, this paper implies that digital payment infrastructure could help contribute to economic sustainability, but it cannot state that the current evidence is sufficient to declare that digital payments are socially or environmentally sustainable.

This meta analysis aggregates the data from 38 empirical papers covering 62,418 bank year observations from 24 countries. The overall impact of the digital payment introduction on bank financial performance is positive and statistically proven. The impact of digital payment use seems to be stronger with digital wallet usage and mobile banking. When making decisions regarding

banking, it is proven to be necessary to approach digital payment investments as a part of general strategy aimed at gaining operational efficiency, improving client penetration, and achieving the economically viable provision of services.

The managerial question here is not only the choice of the technology but which technology actually provides measurable value depending on expenses incurred by the bank, its ability of clients to adopt the technology, and regulations in place. As for the policymakers, findings from this research indicate that regulatory arrangements can affect the economic returns produced by digital payment infrastructure, since aspects like interoperability, proportionality of regulation, and consumer protection should be combined with investment into technology.

Nevertheless, for generalized statements such as the ones regarding financial inclusion and sustainability, better information is required. With respect to research field potentials, it should be less generalized concerning that establishing causal relationships regarding digital payments practices' approaches, having clearer guidelines regarding measurement of digital payment adoption, stating complete results of analyses within studies subject to meta analysis, and discovering issues related to sustainability. Thus, future meta analyses can enhance reproducibility by publication of datasets, codes, and complete PRISMA records.

6. CONCLUSION

This meta analysis synthesised 38 empirical studies covering 62,418 bank year observations from 24 countries to examine the relationship between digital payment adoption and bank financial performance. The random effects model produced a pooled effect of $d = 0.40$, a moderate positive association that held up under leave one out testing ($d = 0.37$ to 0.43) and trim and fill adjustment ($d = 0.38$). Substantial heterogeneity ($I^2 = 75.1\%$) shows that the effect varies across contexts. Digital wallets and mobile banking showed stronger associations than internet banking, payment gateways, and blockchain payments. Meta regression identified adoption intensity, developing market context, and regulatory enablement as positive moderators, while longitudinal design was not significant. For bank managers, the findings suggest that returns depend less on technology spending than on converting that investment into active customer and merchant usage. For policymakers, interoperability, proportionate regulation, and consumer protection can strengthen the economic returns of payment infrastructure. The results support the role of digital payments in economic sustainability, particularly in relation to SDG 8 and 9. However, the evidence is observational, publication bias diagnostics covered only 20 studies, and environmental and social outcomes were not measured. Future research should pursue causal designs, standardised measures of adoption, and broader sustainability indicators.

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