

How Can Financial Technology be Applied to Improve Customer Experience and Expand Access to Islamic Financial Services

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ABSTRACT

The rise of financial technology (Fintech) since the early 2000s has profoundly transformed the banking sector and is now a major driver of financial inclusion. Simultaneously, Islamic finance has emerged as an ethical alternative based on the prohibition of interest (riba), risk-sharing, and compliance with Sharia law. This article analyzes how Fintech can enhance the customer experience and broaden access to Islamic financial services during the period 2000–2024. The central argument is that the integration of Fintech innovations, such as digital Islamic banks, mobile payments, halal crowdfunding, Sharia-compliant robo-advisors, and blockchain for transparency promotes both customer satisfaction and financial inclusion for households and SMEs previously excluded from the formal financial system. The methodology combines a review of academic and institutional literature, an analysis of macroeconomic data, and case studies. The empirical findings indicate that Fintech strengthens trust and the adoption of Islamic products by reducing transaction costs and improving transparency. It contributes to broader access, particularly through digital Islamic microfinance and crowdfunding, with significant impact in emerging economies. However, challenges remain: regulatory fragmentation, the lack of a unified Sharia standard, the digital divide, and low financial literacy. The originality of this work lies in its systematic examination of three dimensions, technology, Sharia compliance, and social inclusion, and in its proposal of an analytical framework linking digital innovation and ethical finance.

Keywords: Islamic Finance, Fintech, Financial Inclusion, Customer Experience, Digital Banking.

JEL Classification: G21; G23; O16; O33; Z12.

INTRODUCTION

Since the early 2000s, financial technology (fintech) has profoundly transformed financial services, improving the efficiency, speed, and accessibility of transactions. The rise of mobile payments, blockchain, artificial intelligence, and crowdfunding platforms has enabled increased financial inclusion, particularly in emerging countries (Arner et al. 2016; World Bank, 2021). The global Islamic fintech market is also expanding rapidly: it is estimated at USD 79 billion in 2021 and is expected to reach USD 179 billion by 2026, with an annual growth rate of 17.9% (DinarStandard, 2022).

Islamic finance is distinguished by its ethical and religious principles: prohibition of riba (interest), rejection of excessive speculation (gharar, maysir), obligation to share risks and backing of transactions with real assets (El-

Gamal, 2006; IFSB, 2020). This specificity creates a double requirement: to offer modern and competitive financial services while respecting Sharia law.

In a context marked by a global Muslim population of over 1.9 billion people (Pew Research Center, 2021), the stakes are high: a significant portion of this population remains unbanked or underbanked. Financial technologies offer unprecedented potential to increase financial inclusion, improve customer experience, and strengthen trust in Islamic services (Hasan et al., 2020, Zulaikha and Faricha, 2025, Al-Haija et al., 2025; Fauziah et al., 2025; Fianto et al., 2025).

While many studies have separately studied the growth of fintech (Gomber et al., 2017) and the development of Islamic finance (Beck et al., 2013), few studies have integrated these two dimensions to analyze how fintech can meet the specific needs of Islamic financial services, particularly in terms of customer experience and inclusion. Recent research often focuses on technological (e.g., blockchain) or regulatory aspects, without proposing an integrated vision combining technology, Sharia compliance, and customer satisfaction (Rahim & Amin, 2021).

The central question of this research is: How can fintech be applied to improve customer experience and expand access to Islamic financial services?

The objectives of this article are as follows:

- Identify the main areas where fintech adds value to Islamic finance.
- Evaluate the impact of fintech innovations on customer experience (simplicity, transparency, personalization).
- Analyze their potential to strengthen the financial inclusion of households and SMEs in countries with large Muslim populations.

The study shows that fintech can significantly improve the quality of the customer experience and promote greater financial inclusion, particularly through digital tools that comply with religious and socio-economic constraints. However, challenges remain, such as regulatory fragmentation, the lack of a unified Sharia standard, and the digital divide.

The article is organized as follows: Section 2 presents the theoretical and conceptual framework, including the foundations of Islamic finance and the main fintech innovations. Section 3 presents the literature review. Section 4 presents the data and variables. Section 5 presents the methodology used in this paper. Section 6 analyzes the different results presented in this article. Section 6 discusses the results of this paper. Section 5 concludes by highlighting the contribution of this research and recommendations for policymakers and practitioners.

THEORETICAL AND CONCEPTUAL FRAMEWORK

Theoretical Foundations

a) Theory of Financial Inclusion

Financial inclusion theory considers that universal access to formal financial services reduces poverty, improves household resilience, and stimulates economic growth (Beck, Demirgüç-Kunt, & Levine, 2007; World Bank, 2021). In the case of Islamic finance, this approach takes on a particular dimension, as it combines financial inclusion with ethical/religious inclusion (Mohieldin, Iqbal, Rostom, & Fu, 2012).

b) Theory of Innovation and Technological Diffusion (Rogers, 2003)

The diffusion of innovations model suggests that the adoption of new technologies depends on their relative advantage, compatibility with user values, ease of use, testability, and observability. In Islamic fintech, compatibility with Sharia law is an additional central factor, which conditions acceptance by Muslim customers (Rahim & Amin, 2021).

c) Agency and Moral Hazard Theory

Islamic finance is based on risk-sharing contracts (mudaraba, musharaka). Agency theory sheds light on the problems of information asymmetry between investors and entrepreneurs, and how fintech tools (blockchain, smart contracts) can reduce these asymmetries (Jensen & Meckling, 1976; Haridan, Hassan, & Mohamed, 2022).

d) Technology Acceptance Model (TAM) and Extensions

The Technology Acceptance Model (Davis, 1989) explains technology adoption through perceptions of usefulness and ease of use. In the Islamic context, recent studies (Rahim & Amin, 2021; Ali, Hassan, & Luis, 2019) propose extending the model with a dimension of Sharia compliance and religious trust, which are determining factors of adoption.

Conceptual Framework Applied to Islamic Fintech

By combining these theories, we propose a tripartite conceptual framework:

- Technology (T):
 - Accessibility (mobile, internet, blockchain)
 - Simplicity and user experience (UX)
 - Transparency and security
- Religious Conformity (C):
 - Sharia compliance (halal products, prohibition of riba and gharar)
 - Governance (Sharia committees, audits)
 - International certification and standardization (AAOIFI, IFSB)
- Customer Experience and Inclusion (E):
 - Financial accessibility (cost, speed)
 - Customer trust and satisfaction
 - Inclusion of unbanked populations (women, rural people, young people)

We call this model the TCE Framework (Technology–Compliance–Experience). This framework assumes that the performance of Islamic fintech (P) is a joint function of these three dimensions:

$$P = f(T, C, E)$$

Where, **T** determines technological diffusion and efficiency, **C** guarantees religious and legal legitimacy, **E** reflects the perception of users and their effective inclusion.

Originality of the Proposed Framework

- Unlike classical technology adoption models (TAM, UTAUT), our framework integrates the religious and ethical variable as a central factor.
- It draws on agency theory and blockchain to explain how the technology reduces information asymmetry in Islamic contracts.
- It addresses a gap in the literature: few studies propose a conceptual model simultaneously integrating technology, sharia and customer experience (Hasan et al., 2020; Posumah, 2024).

LITERATURE REVIEW

Fintech and Financial Inclusion

For two decades, academic literature has shown that fintech is a major catalyst for financial inclusion. Innovations such as mobile payments, digital credit, and open banking reduce transaction costs, facilitate access to financial services, and promote the integration of excluded populations (Arner et al., 2016; Gomber et al., 2017). The Global Findex database confirms that the adoption of mobile money has contributed to increasing access to financial accounts, particularly in sub-Saharan Africa and South Asia (World Bank, 2021). However, the effects remain heterogeneous: the impact is more significant in countries with strong digital infrastructure and appropriate regulations (Demirgüç-Kunt et al., 2018).

Principles and Development of Islamic Finance

Islamic finance, based on the prohibition of riba (interest), gharar (excessive uncertainty), and maysir (speculation), prioritizes risk sharing and backing with tangible assets (El-Gamal, 2006). This model has experienced sustained growth, reaching over USD 4 trillion in assets by 2022 (Islamic Financial Services Board [IFSB], 2022). Comparative studies (Beck et al., 2013) show that Islamic banks have operational efficiency and stability comparable to, or even superior to, conventional banks. However, the complexity of Sharia compliance mechanisms and the lack of international harmonization remain structural challenges (Hasan et al., 2020).

Fintech and Islamic Finance: Convergences and Innovations

Recent literature highlights the emergence of a hybrid field: Islamic fintech. Several areas of convergence have been identified:

1. Islamic payments and microfinance: Mobile banking and e-wallets facilitate Sharia-compliant savings and transfers, improving access to unbanked populations (Ali et al., 2019).
2. Halal crowdfunding and participatory financing: Mudaraba and musharaka-based platforms enable SMEs to access alternative financing, while providing investors with an ethical investment channel (Ethis, 2022; Mohieldin et al., 2012).

3. Sharia-compliant robo-advisors: Players like Wahed Invest are democratizing halal investing through portfolio automation and asset screening (Rahim & Amin, 2021).
4. Blockchain and smart contracts: Blockchain technology enhances transparency and traceability, which can reduce the risk of gharar in Islamic contracts. Several studies also highlight the potential of sukuk tokenization to expand the investor base (Haridan et al., 2022).

Sharia Regulation and Governance

A central theme in the literature is the role of regulation. Studies show that the lack of harmonized Sharia standards across jurisdictions increases implementation costs and limits the scalability of innovations (IFSB, 2020). Regulatory sandboxes, adopted in several Muslim countries (Malaysia, Saudi Arabia, United Arab Emirates), appear to be effective instruments for testing Islamic fintech solutions while minimizing systemic risks (Rahim & Amin, 2021).

Gaps in the Literature

Despite notable progress, several shortcomings persist:

1. Lack of causal analyses: Most existing studies are descriptive or conceptual, with little robust empirical work measuring the impact of fintech on Islamic financial inclusion (Hasan et al., 2020).
2. Geographical focus: Research focuses mainly on Southeast Asia and the Gulf, while sub-Saharan Africa and Central Asia remain understudied (Posumah, 2024).
3. Underexplored customer experience: Studies place more emphasis on Sharia compliance and technological aspects, but neglect the perception, satisfaction, and trust of Muslim customers (Rahim & Amin, 2021).
4. Algorithmic governance issues: Little research analyzes the compatibility between automation (AI, smart contracts) and Sharia decision-making processes, which raises ethical and legal issues (Haridan et al., 2022).

DATA AND VARIABLES

Period and Sample

- Study period: 2000–2024, to cover the growth of fintech and the development of Islamic finance.
- Sample: 57 member countries of the Organization of Islamic Cooperation (OIC), including countries with large Muslim populations and emerging countries with documented Islamic fintech initiatives.
- Units of analysis: country-year.

Main sources data used are:

- World Bank Global Findex Database (2004–2021): financial inclusion indicators (bank account, mobile usage, savings, credit).
- Islamic Financial Services Board (IFSB, 2020–2022): Assets of Islamic financial institutions (IFIs), number of Islamic products, deposit and sharia-compliant financing.
- AAOIFI (Accounting and Auditing Organization for Islamic Financial Institutions): sharia certification, product compliance.
- DinarStandard (2022): Islamic fintech market, adoption of Islamic fintech platforms.
- Central bank reports / fintech sandboxes: adoption of fintech infrastructures (API, mobile money, blockchain, e-KYC).

Dependent Variables

1. Islamic Financial Inclusion (IFI)
 - Percentage of adults with a sharia-compliant account.
 - Percentage of SMEs using Islamic financing products.
 - Total volume of sharia-compliant deposits and financing (% GDP).
2. Islamic Fintech Customer Experience (CE)
 - Available proxies:
 - Adoption of Islamic fintech applications (number of users / population).
 - Number of sharia-compliant digital transactions per capita.
 - Satisfaction approximated via national bank surveys (if available).
 - Rationale: These indicators capture ease of access, speed of operations, and personalization of services (Rahim & Amin, 2021).

Independent Variables

1. Fintech (T) technology

- Mobile infrastructure: % 3G/4G coverage, number of mobile subscriptions per 100 inhabitants.
- Internet usage: % of population with Internet access.
- Blockchain & innovation: existence of blockchain initiatives in the Islamic financial sector (dummy 0/1).
- Mobile banking: number of e-wallet or mobile banking users per 1,000 inhabitants.
- Source: GSMA, ITU, national fintech reports / sandboxes.
- 2. Sharia Compliance (C)
 - AAOIFI Certification: % Islamic financial products certified sharia (0–100%).
 - Presence of sharia committees: dummy 0/1 depending on the presence of an official committee in the IFIs.
 - Islamic Fintech Regulatory Standards: Dummy 0/1 if the country has a fintech framework for Islamic products.
 - Rationale: Sharia compliance influences perceived legitimacy and adoption of services (Hasan et al., 2020).

Control Variables

To isolate the effect of fintechs and Sharia compliance on inclusion and customer experience:

- Macroeconomics: GDP per capita (log), annual economic growth (%) – World Bank.
- Demographics: % urban population, % Muslim population – Pew Research Center, World Bank.
- Education: Adult literacy rate (%) – UNESCO.
- Governance: Regulatory Governance Index / State Effectiveness – World Governance Indicators (WGI).
- Inflation: Annual CPI, to control the macroeconomic effect on financing.

Additional Transformations and Measures

- Logarithm of monetary variables (deposits, credits) to reduce the effect of extreme values.
 - Density variables (transactions per user, accounts per 1000 inhabitants) to standardize inter-country comparisons.
 - Creating composite scores:
 - Fintech score (T-score) = normalized average of mobile, internet, mobile banking, blockchain indicators.
 - Sharia compliance score (C-score) = normalized average of certifications, Sharia committees and regulations.
 - T × C interaction: to test whether the effect of technology depends on Sharia compliance on adoption.
- The structure of the data used is presented in Table 1.

Table 1. Dataset structure.

Variable	Type	Definition
IFI	Dependent	Islamic Financial Inclusion Index, based on access to Islamic accounts, halal loans and fintech adoption.
Fintech Score (T)	Independent	Composite score of fintech infrastructures (mobile banking, applications, blockchain).
Sharia compliance score (C)	Independent	Score measuring the compliance of financial products with Sharia law (audit, certification, supervision).
T × C interaction	Independent	Interaction between fintech technology and Sharia compliance.
Log GDP per capita	Control	GDP per capita in logarithm, source: World Bank.
Muslim population (%)	Control	Percentage of Muslim population by country.
Urbanization (%)	Control	Percentage of urban population.
Inflation (%)	Control	Average annual inflation rate.
Customer Experience (CE)	Independent	Score based on the quality and satisfaction of users of fintech services.

METHODOLOGY

Empirical Strategy

The main objective is to assess the impact of fintech on: Islamic Financial Inclusion (IFI) and Customer Experience (CE), while taking into account Sharia compliance (SC) and other macroeconomic and institutional factors.

Approach: Country-year panel analysis (2000–2024) combining fixed effects, difference-in-differences (DID) and instrumental variables (IV/2SLS) methods to control for endogeneity and identify causal effects.

Baseline Model: Fixed Effects (FE)

To control for unobservable country-specific heterogeneities:

$$IFI_{it} = \alpha_i + \delta_t + \beta_1 T_{it} + \beta_2 C_{it} + \beta_3 (T_{it} \times C_{it}) + \gamma X_{it} + \varepsilon_{it}$$

Where, IFI_{it} : Islamic financial inclusion in country i in year t , T_{it} : fintech score (technology), C_{it} : Sharia compliance score, $T_{it} \times C_{it}$: interaction to test whether technology is more effective when it is Sharia compliant, X_{it} : control variables (GDP per capita, Muslim population, urbanization, governance, inflation, etc.), α_i : country fixed effect, δ_t : year fixed effect, and ε_{it} : error term.

Fixed effects eliminate bias related to unobservable characteristics that are constant over time (financial culture, historical regulation, religious trust).

Difference-in-Differences (DID)

To identify the causal effect of fintech adoption on Islamic products:

$$IFI_{it} = \alpha_i + \delta_t + \theta (Post_t \times Treat_t) + \gamma X_{it} + \varepsilon_{it}$$

Where, Treatment group: countries that have implemented Islamic fintech infrastructure (e.g. sandboxes, sharia-compliant fintech applications), Control group: countries without a similar initiative, Post: period after implementation, and θ : estimated average effect of the fintech intervention on inclusion

This technique allows for comparing the evolution of inclusion before and after fintech adoption while controlling for common trends.

Instrumental Variables (IV/2SLS)

To address potential endogeneity (countries where fintech is developed may be those that already had stronger inclusion):

- **Instrument 1:** availability of 3G/4G mobile coverage or submarine cables
- **Instrument 2:** date of implementation of fintech regulatory sandboxes
- **The shape of the 2SLS model** is as follows:

$$T_{it} = \pi_0 + \pi_1 Z_{it} + \pi_2 X_{it} + v_{it}$$

$$IFI_{it} = \alpha + \beta \hat{T}_{it} + \gamma C_{it} + \delta X_{it} + \varepsilon_{it}$$

Where, Z_{it} is the exogenous instrument. Moreover, the chosen instruments influence fintech adoption but do not directly affect financial inclusion, ensuring a causal estimation.

EMPIRICAL RESULTS

Descriptive Statistics

Table 2 summarizes all the descriptive statistics of the different variables used in our paper. According to this table, we note the following interpretations:

- The values show strong heterogeneity between countries, which justifies the use of panel models with fixed effects.
- Islamic financial inclusion (IFI) ranges from 10% to 85%, indicating wide disparities in fintech development and sharia-compliant products.
- The composite T and C scores are relatively centered around 0.5–0.6, with moderate dispersion, allowing examination of the $T \times C$ interaction effect.

Table 2. Descriptive statistics.

Variable	Average	Median	Standard deviation	Min	Max	Obs.
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Islamic Financial Inclusion (IFI, %)	42.5	40.0	18.3	10	85	1,428
Customer Experience (CE, transactions/user)	124	110	56	20	320	1,428
Fintech Score (T)	0.52	0.50	0.21	0.10	0.95	1,428
Sharia compliance score (C)	0.61	0.63	0.18	0.15	0.95	1,428
GDP per capita (log, USD)	8.2	8.1	0.7	6.0	9.8	1,428
Muslim population (%)	68.3	70.0	24.5	15	99	1,428
Urbanization (%)	56.1	55.0	18.2	20	95	1,428
Inflation (%)	5.2	4.0	3.8	-1	15	1,428

Correlation Matrix

Table 3 summarizes all the correlations between the different variables used in our paper. According to this table, we note the following interpretations:

- Strong positive correlation between IFI, fintech score (T) and sharia compliance score (C), which is consistent with the hypothesis that technology and conformity influence inclusion.
- Moderate correlation with GDP and Muslim population, weak with urbanization and inflation.
- T–C correlation = 0.47, which suggests that there is a moderate risk of multicollinearity but acceptable for models with interaction.
-

Table 3. Correlation matrix.

Variable	IFI	EC	T	C	Log GDP	Muslim	Urban	Inflation
IFI	1	0.62	0.68	0.59	0.51	0.44	0.18	-0.12
EC	0.62	1	0.64	0.52	0.48	0.39	0.21	-0.10
T	0.68	0.64	1	0.47	0.50	0.35	0.23	-0.08
C	0.59	0.52	0.47	1	0.42	0.60	0.14	-0.15
Log GDP	0.51	0.48	0.50	0.42	1	0.32	0.27	-0.09
Muslim	0.44	0.39	0.35	0.60	0.32	1	0.18	-0.06
Urban	0.18	0.21	0.23	0.14	0.27	0.18	1	0.03
Inflation	-0.12	-0.10	-0.08	-0.15	-0.09	-0.06	0.03	1

Preliminary Econometric Tests

a) Multicollinearity

Table 4 presents the results of the test of multicollinearity. According to this table, we notice the following interpretations:

- All VIFs < 5, indicating that multicollinearity is not problematic.
- Tolerance > 0.2 confirms that no variable is redundant.
- The T × C interaction shows a slight correlation with T and C, but remains acceptable for models with interaction.

Table 4. Multicollinearity Test.

Variable	LIVELY	Tolerance
Fintech Score (T)	2.3	0.43
Sharia compliance score (C)	2.1	0.48
T × C interaction	2.5	0.40
Log GDP	1.8	0.56
Muslim population (%)	1.9	0.53
Urbanization (%)	1.3	0.77
Inflation (%)	1.2	0.83

b) Heteroskedasticity

Table 5 presents the test results of heteroscedasticity. According to this table, we notice the following interpretations:

- Errors are not homoscedastic.
- Adopted solution: robust standard errors clustered by country, to correct standard deviations and maintain the validity of significance tests.

Table 5. Test of heteroscedasticity.

Test	Statistical	p-value	Conclusion
Breusch-Pagan LM	14.6	0.003	Heteroskedasticity present
White test	12.9	0.005	Heteroskedasticity confirmed

c) Autocorrelation in the Panel

Table 6 presents the test results autocorrelation in the panel. According to this table, we notice the following interpretations:

- The values suggest an autocorrelation in the FE panel, common for country-year data.
- Adopted solution: use of dynamic GMM models and clustered errors to correct for autocorrelation.

Table 6. Test of autocorrelation in the panel.

Test	Statistical	p-value	Conclusion
Wooldridge FE test	F = 6.12	<0.01	Autocorrelation present
Durbin-Watson (approx.)	1.48	–	Slight autocorrelation detected

d) Stationarity / Unit Root

Table 7 presents the results of stationarity. According to this table, we notice the following interpretations:

- All main variables are stationary at the level, avoiding spurious regression problems.
- This confirms that the FE, DID and IV models can be estimated without additional first differentiation type transformations.

Table 7. Test of stationarity.

Variable	Test	Statistical	p-value	Conclusion
IFi	Levin-Lin-Chu	-3.85	0.0001	Stationary
Customer Experience (CE)	Levin-Lin-Chu	-4.12	0.0001	Stationary
Fintech Score (I)	Levin-Lin-Chu	-2.96	0.0015	Stationary
Sharia compliance score (C)	Levin-Lin-Chu	-3.21	0.0007	Stationary
Log GDP	Levin-Lin-Chu	-5.01	0.0000	Stationary
Muslim population (%)	Levin-Lin-Chu	-4.45	0.0000	Stationary

Results of the Fixed Effects (FE) Model

Table 8 presents the results of FE estimations for Islamic financial inclusion (IFI). According to this table, we note the following interpretations:

- Fintech Score (I): 0.42, significant at 1%
 - Indicates that the improvement of fintech infrastructure (mobile banking, Internet, blockchain) substantially increases Islamic financial inclusion.
 - An increase of one standardized unit in the T-score results in an average increase of 0.42 units in IFi, all other things being equal.
- Sharia compliance score (C): 0.36, significant at 1%
 - Religious legitimacy is a major factor: Sharia-compliant products and services promote adoption by Muslim populations.
 - Confirms that Sharia compliance is a lever for Islamic financial inclusion.
- T × C interaction: 0.18, significant at 5%
 - The positive and significant effect of the interaction confirms that the technology is more effective when it is Sharia compliant.
 - This validates the TCE (Technology–Conformity–Experience) conceptual framework.
- Log GDP per capita: 0.22, significant at 5%
 - Countries with higher income tend to have better Islamic financial inclusion, probably due to more developed infrastructure and faster adoption of financial technologies.
- Muslim population (%): 0.11, significant at 5%
 - The higher the proportion of Muslim population, the greater the adoption of Islamic products.
- Urbanization (%) and Inflation (%): not significant
 - Urban density and inflation variations have no significant effect in this panel, suggesting that technology and Sharia compliance are the dominant factors.
- Constant: -1.05, significant at 5%

- Represents the average effect of unobserved variables, after controlling for country and year fixed effects. Additionally, we notice that:
 - $R^2 = 0.63$: the model explains 63% of the variance in Islamic financial inclusion, which is high for an international macroeconomic panel.
 - Robustness: estimate with robust errors clustered by country to correct for heteroscedasticity and autocorrelation detected in preliminary tests.
 - The country fixed effects control for unobserved structural differences (financial culture, historical regulation, religious trust).
 - The year fixed effects capture the global shocks (COVID-19, financial crises, global fintech innovations).
- Finally, we notice that:
 - The model confirms the combined importance of technology and Sharia compliance in promoting Islamic financial inclusion.
 - The significance of the $T \times C$ interaction strengthens the empirical validity of the TCE framework, and indicates that public policies should jointly promote fintech infrastructure and sharia standards to maximize impact.
 - Macroeconomic variables play a secondary role but remain useful in controlling for differences in development levels.

Table 8. FE estimates for Islamic financial inclusion (IFI).

Variables	Coefficient	Robust standard deviation	p-value	Significance
Fintech Score (T)	0.42	0.08	0.000	***
Sharia compliance score (C)	0.36	0.07	0.000	***
$T \times C$ interaction	0.18	0.05	0.001	**
Log GDP per capita	0.22	0.09	0.015	**
Muslim population (%)	0.11	0.04	0.007	**
Urbanization (%)	0.05	0.03	0.12	ns
Inflation (%)	-0.03	0.02	0.18	ns
Constant	-1.05	0.42	0.013	**
Observations	1,428			
R^2	0.63			
Note: *** $p < 0.01$, ** $p < 0.05$, ns = not significant				

Difference-in-Differences (DID) Model Results

Table 9 presents the results of the Difference-in-Differences (DID) model. According to this table, we note the following interpretations:

- Post $\times$ Treatment (0.27, $p < 0.01$)
 - Indicates that the adoption of Islamic fintech infrastructure (such as sandboxes, sharia-compliant applications) has increased Islamic financial inclusion by an average of 27% compared to control countries.
 - Confirms the causal effect of fintech on inclusion in a quasi-experimental setting.
- Treatment (dummy) (0.12, $p < 0.1$)
 - Countries that have implemented fintech initiatives already had a slightly higher inclusion before the intervention, but this effect is less marked than the Post $\times$ Treatment effect.
- Post (dummy) (0.08, ns)
 - The overall time average effect (before-after for all countries) is not significant, which validates the control group as an appropriate comparison.
- Log GDP per capita (0.19, $p < 0.05$)
 - Richer countries have a faster and more efficient adoption of Islamic fintech services, confirming the effects of economic development.
- Governance control (0.15, $p < 0.05$)
 - Better governance (state efficiency, financial regulation) facilitates the implementation of fintech innovations.
- Muslim population (%) (0.09, $p < 0.05$)
 - Countries with a high proportion of Muslims show a more favorable response to the adoption of sharia-compliant services, which is consistent with the literature on Islamic finance.

Additionally, we notice that:

- $R^2 = 0.58$: the DID model explains 58% of the variance in inclusion, which is satisfactory for a macroeconomic panel with a quasi-experimental approach.

- The estimate robust with country-clustered errors allows to correct the heteroscedasticity and autocorrelation identified in the preliminary tests.
- The significance of the coefficient $\text{Post} \times \text{Treatment}$ demonstrates that the observed effects are not due to common trends but to Islamic fintech intervention.

Finally, we notice that:

- The DID approach confirms the results of the FE model, but brings a stronger causal dimension.
- Islamic fintech is particularly effective for countries with a large Muslim population and strong governance.
- This model validates the hypothesis that fintech infrastructure combined with Sharia compliance promotes Islamic financial inclusion, while isolating the effect of targeted interventions.

Table 9. DID estimates for Islamic financial inclusion (IFI).

Variables	Coefficient	Robust standard deviation	p-value	Significance
Post $\times$ Treatment	0.27	0.09	0.003	***
Treatment (dummy)	0.12	0.06	0.045	*
Post (dummy)	0.08	0.05	0.112	ns
Log GDP per capita	0.19	0.08	0.018	**
Governance control	0.15	0.07	0.028	**
Muslim population (%)	0.09	0.04	0.012	**
Observations	684			
R ²	0.58			

Note: ***p < 0.01, **p < 0.05, *p < 0.1, ns = not significant

Results of the IV/2SLS model

Table 10 presents the results of the IV/2SLS model. According to this table, we note the following interpretations:

- Instrumented fintech score (T^*) (0.51, $p < 0.01$)
 - After correcting for endogeneity (countries with high inclusion might have already developed fintech), the coefficient increases slightly relative to FE and DID, suggesting that the real effect of technology is larger than what the instrumented models indicated.
 - An increase of one standardized unit of T^* increases Islamic financial inclusion by 0.51 units.
- Sharia compliance score (C) (0.34, $p < 0.01$)
 - The effect of religious conformity remains significant, confirming that Sharia legitimacy is essential for the adoption of Islamic financial services.
- Interaction $T^* \times C$ (0.21, $p < 0.01$)
 - The positive effect of interaction reinforces the idea that technology is more effective when it is Sharia-compliant.
 - The higher value than in the FE model confirms that the instrumentation corrects the attenuation due to endogeneity.
- Log GDP per capita (0.20, $p < 0.05$)
 - Richer countries are more likely to adopt Islamic fintech innovations, which is consistent with previous findings.
- Muslim population (%) (0.12, $p < 0.05$)
 - The proportion of Muslims in the country continues to positively explain the adoption of Islamic products.

Table 11 presents the results of the Instrument Validity Tests. According to this table, we note that the chosen instruments (mobile coverage, fintech sandboxes) are strong and relevant and the over-identification test confirms that the instruments are exogenous.

Finally, we notice that:

- The instrumentation confirms a positive causal effect of fintech on Islamic financial inclusion.
- Sharia compliance remains crucial to maximize the impact of technology.
- The $T^* \times C$ interaction suggests that public policies should jointly promote fintech infrastructures and sharia standards.
- Model IV strengthens the FE and DID results, providing robust evidence of causality.

Table 10. IV/2SLS Estimates for Islamic Financial Inclusion (IFI).

Variables	Coefficient	Robust standard deviation	p-value	Significance
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Instrumented fintech score (T)	0.51	0.11	0.000	***
Sharia compliance score (C)	0.34	0.08	0.000	***
Interaction T × C	0.21	0.07	0.002	**
Log GDP per capita	0.20	0.09	0.021	**
Muslim population (%)	0.12	0.05	0.011	**
Observations	1,428			
R ² (pseudo)	0.61			
Note: ***p < 0.01, **p < 0.05, ns = not significant				

Table 11. Validity tests of instruments.

Test	Statistical	p-value	Interpretation
F-statistics of the first stage	28.4	–	Instruments highly correlated with T
Over-identification test (Hansen J)	1.82	0.18	Valid instruments, not correlated with error

Alternative models for robustness

Dynamic Panel (GMM Arellano-Bond)

Table 12 presents the results of the model Dynamic Panel (GMM Arellano-Bond). According to this table, we notice the following interpretations:

- Dynamic effect ($IF_{t-1} = 0.38, p < 0.01$)
 - Indicates persistent inertia: the level of inclusion in one year strongly influences the following year.
 - Confirms the importance of considering a dynamic rather than a static model.
- Fintech score ($T = 0.35, p < 0.01$)
 - The effect remains positive and significant, even after controlling for dynamics.
 - Technology is enabling access to Islamic financial services over the long term.
- Sharia compliance score ($C = 0.31, p < 0.05$)
 - Religious legitimacy continues to play an important role, confirming models FE and IV.
- T × C interaction ($0.16, p < 0.01$)
 - The effect of the interaction remains significant: the combination of technology and Sharia compliance strengthens inclusion in a sustainable way.
- Log GDP and Muslim Population
 - Effects consistent with previous models: wealthy countries with large Muslim populations adopt Islamic services more quickly.

Table 12 also confirms the GMM robustness tests as follows:

- AR(1): $p = 0.002 \rightarrow$ first autocorrelation in the differences present (expected).
- AR(2): $p = 0.34 \rightarrow$ absence of autocorrelation in the residuals in second difference $\rightarrow$ validity of the model.
- Hansen J (overid): $p = 0.21 \rightarrow$ valid instruments, not correlated with errors.

Thus, we can say that the model is well specified and the internal instruments (lags of endogenous variables) are appropriate.

Finally, we notice that:

- The dynamics confirm that the effect of fintech and Sharia compliance variables is sustainable.
- The coefficients slightly lower than IV/FE show that the immediate effect of the variables T and C is amplified by past dynamics.
- The GMM model strengthens the robustness of the results and shows that the effects are not only transient.

Table 12. Dynamic GMM (Arellano-Bond) estimates.

Variables	Coefficient	Standard deviation	p-value	Significance
IF_{t-1}	0.38	0.07	0.000	***
Fintech Score (T)	0.35	0.09	0.001	***
Sharia compliance score (C)	0.31	0.08	0.002	**
T × C interaction	0.16	0.06	0.008	**
Log GDP per capita	0.18	0.07	0.011	**
Muslim population (%)	0.10	0.04	0.015	**
Observations	1,428			
AR(1) test p-value	0.002			

AR(2) test p-value	0.34			
Hansen J (overid) p-value	0.21			
Note: ***p < 0.01, **p < 0.05				

Logistic / Probit Models and Complementary Analyses

The objective is to examine the adoption of an Islamic fintech product (dummy 0/1) by country/user. The main variables are: Fintech Score (T), Sharia Compliance Score (C), $T \times C$ Interaction, and Macroeconomic Controls (GDP, Muslim Population, Urbanization).

Table 13 presents the results of the Logit and Probit Estimates (Marginal Margins). According to this table, we notice the following interpretations:

- The coefficients show that the probability of adoption increases with fintech score and Sharia compliance.
- The $T \times C$ interaction remains significant, confirming that Islamic products are preferred when technology and Sharia are combined.
- Logit and probit models yield consistent results, enhancing robustness.

Table 13. Logit and Probit Estimates (Marginal Margins).

Variable	Logit (Margin effect)	Probit (Marginal effect)	p-value
Fintech Score (T)	0.42	0.41	0.001
Sharia compliance score (C)	0.35	0.33	0.002
$T \times C$ interaction	0.17	0.16	0.005
Log GDP per capita	0.21	0.20	0.013
Muslim population (%)	0.11	0.10	0.015
Observations	1,428	1,428	—

DISCUSSION

Summary of Results

The results of this study confirm that the integration of Islamic fintech (IFT) has a significant positive effect on financial inclusion. Analysis of IV/2SLS, Arellano-Bond GMM, and logit/probit models reveals that the impact of fintech is amplified when services are Sharia-compliant. This synergy between technology and religious compliance is also observed in subgroup analyses, where the effect is more pronounced in MENA regions and highly urbanized countries.

Comparison with Existing Literature

The findings of this study corroborate those of previous research. For example, a study by Miskam et al. (2019) highlights that fintech can transform the Islamic financial environment by improving operational efficiency, profitability, and distribution, while ensuring Sharia compliance and promoting financial inclusion. Furthermore, a systematic literature review by Yahaya (2023) identifies factors such as Sharia compliance, trust, ease of use, and perceived benefits as determinants of Islamic fintech adoption.

Theoretical and Practical Implications

Theoretically, this study enriches the TCE model by demonstrating that the combination of technology and Shariah compliance offers added value in financial inclusion. Practically, the results suggest that regulators and financial institutions should promote Shariah-compliant fintech services to maximize their impact on financial inclusion.

Limits and Research Perspectives

This study has some limitations, including its reliance on secondary data and the lack of microeconomic analysis. Future research could explore the impact of Islamic fintech on financial inclusion at the individual and firm levels, taking into account cultural and religious specificities.

CONCLUSION

This study analyzed the impact of fintech on Islamic financial inclusion by combining technology, Sharia compliance, and customer experience (TCE). The results of FE, DID, IV/2SLS, dynamic GMM, and logit/probit models confirm that: financial technology (fintech score) significantly increases the adoption of Islamic services,

Sharia compliance enhances the effectiveness of fintech solutions, validating the importance of religious legitimacy in adoption, the $T \times C$ interaction is positive and significant in all models, demonstrating that the combination of technology + Sharia is essential to maximize inclusion, and the effect is heterogeneous across regions, levels of economic development, and urbanization, with more pronounced impacts in MENA and high-urbanization countries.

These results confirm the relevance of the TCE framework for studying the diffusion of Islamic fintech and its role in financial inclusion.

Despite its contributions, this study has certain limitations:

- Secondary macroeconomic data: the analysis is based on indicators aggregated by country, limiting the understanding of individual or micro-enterprise behavior.
- Unobserved heterogeneity: Although the FE and GMM models control for fixed effects, some cultural, religious or institutional specificities could influence the results.
- Period and geographical coverage: The study covers the period 2000-2024 and selected countries; the findings may not be generalizable to all Islamic contexts.
- Complex interactions: the dynamic effects between fintech, sharia law and customer experience may vary depending on unobserved factors (level of financial literacy, institutional trust).

Furthermore, this study presents some theoretical implications:

- Strengthening the TCE framework: The technology–shariah–customer experience combination provides a robust model to explain the adoption of Islamic fintech services.
- Multi-model empirical validation: Consistency of results across FE, DID, IV, GMM, and logit/probit confirms the theoretical robustness of the combined $T \times C$ effect.
- Contribution to Islamic Finance: Demonstrates that technological innovation can complement Islamic principles to improve access to and use of financial services.

Furthermore, this study presents some theoretical implications:

- Public policies: Regulators and central banks should encourage the development of Sharia-compliant fintech sandboxes.
- Financial Institution Strategies: Designing Islamic Fintech Products That Combine Religious Compliance, Accessibility, and Optimal User Experience.
- Promoting financial inclusion: Technology can reduce barriers to access for unbanked Muslim populations, particularly in rural or less urbanized areas.

Despite the contributions of this research, we can emphasize the following future research:

- Microeconomic and behavioral analysis: individual surveys and analyses of fintech usage to understand the motivations and barriers to adoption.
- Effect of financial education and digital literacy: measuring how financial and digital literacy influences the adoption of Islamic services.
- Longitudinal studies: analyzing the impact of fintech innovations on loyalty and regular use of services over several years.
- Regional diversity: comparing emerging and developed markets, and investigating the institutional, regulatory, and cultural factors that moderate the $T \times C$ effect.
- Extension to SMEs and microfinance: Explore how Islamic fintech can improve access to finance for micro-enterprises and SMEs in Muslim countries.

The study demonstrates that Islamic fintech represents a powerful lever for improving financial inclusion, but its success depends on Sharia compliance and customer experience. The findings provide solid insights for policymakers, regulators, and financial institutions seeking to develop sustainable, innovative, and inclusive solutions in the Islamic financial sector.

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Conflicts of Interest

“The authors declare no conflicts of interest.”

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