SCIENTIFIC CULTURE
www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 12, No. 3.1, (2026), pp. 162-171
Open Access. Online & Print

DOI: 10.5281/zenodo. 18908126

# DIGITAL INFRASTRUCTURE THRESHOLDS IN THE FINTECH–HEALTH ACCESS NEXUS: EVIDENCE FROM EMERGING ECONOMIES

**Orhan Ozaydin[1], Hakan Yildiz[1], Erdal Harunogullari[1*]**

*[1]Istanbul Medipol University, Faculty of Business and Management Sciences, Department of Economics and Finance, Istanbul, Türkiye*

*Received: 15/02/2026*
*Accepted: 09/03/2026*

*Corresponding Author: Erdal Harunogullari (erdal.harunogullari@medipol.edu.tr)*

## ABSTRACT

***This study reviews the influential impact of fintech elevation on Universal Health Coverage (UHC) through a panel-based threshold structure. The linear fixed-effects representation does not exhibit a statistically compelling average outcome. The threshold findings further indicate the existence of a nonlinear relationship that relies on how favourable the digital infrastructure is. In countries where less people utilise internet capabilities, fintech shows to advance the scope of health. As digital infrastructure coverage improves fintech has a reduced response. This correlation suggests that, in progressive digitalisation advancements, improvements in health connections may be less reliant on the spread of fintech and more on overall structural fundamentals, including but not limited to institutional capacity, public health expenditure, and the health system overall arrangement.***

**KEYWORDS:** Fintech, Universal Health Coverage, Digital Infrastructure, Panel Threshold Model, Nonlinearity, Emerging Economies.
JEL Codes: I15, G21, C23, O33.

## 1. INTRODUCTION

As per the United Nations' 2030 Sustainable Development Goals (United Nations, 2025), all persons should have access to health care irrespective of payment capability. The current global indicators suggest that annually, nearly 100 million people become necessitous due to health care costs becoming excessive. More than half of the world's population cannot access basic health care, and a considerable public concern is the potential for drug treatment to increase. This is especially true because non-communicable diseases are becoming more common (Acharya et al., 2018). This shows that access to health services is not determined solely by individual demand or income level; it is also shaped by the service delivery capacity and infrastructural characteristics of the health system. Indeed, some findings show that deficiencies in the availability of health facilities, the level of technical equipment, and the organization of the system limit service utilization (Mesmar et al., 2025). Therefore, when sufficient physical and institutional infrastructure is lacking, ensuring access to comprehensive and sustainable health services becomes significantly more difficult.

In the search for solutions to financial access and inclusion problems, the innovative opportunities offered by fintech solutions are coming to the forefront. Studies show that financial technologies (mobile payments, blockchain, artificial intelligence, etc.) have the potential to improve access to healthcare, accessibility, and patient outcomes (Shukla et al., 2025). For example, mobile money transfer technology reduces the cost of borrowing and payment transactions by allowing monetary value to be stored on a mobile phone and transferred via SMS, and has the potential to improve risk sharing in the face of income shocks; these features are important in financing sudden and unexpected expenses (Ahmed & Cowman, 2021). In addition, digital financial innovations have the potential to support the financing of healthcare services, especially through alternative financing tools such as digital payments and crowdfunding (Cambaza, 2023). It is also noteworthy here that access to digital payments directly affects financial well-being and, therefore, health outcomes (Klein, 2021). In other words, fintech can mitigate financial risks in healthcare by expanding the ways individuals can save, make payments, and access credit when needed.

The benefits provided by fintech applications vary depending on the quality of the digital infrastructure. Investments in mobile broadband infrastructure, in particular, play a critical role in the widespread adoption of digital financial services (Niu et al., 2022). For example, China's "Broadband China" strategy has made homes less financially vulnerable by improving internet infrastructure in rural areas. Because of this, more people have been able to use digital financial services (Deng et al., 2025). These findings suggest that for fintech to achieve maximum potential strong digital infrastructure is a must.

By way of explanation, the more stringent the demands for internet access, mobile connectivity, and digital identity systems, the greater the potential for financial technologies in assisting easier payment capability and better the accessibility to healthcare providers. In this context, this study aims to investigate whether digital financial technologies affect universal healthcare coverage and whether this impact varies by the level of digital infrastructure.

The central research question is whether fintech progression has an influential capability on indicators of access to healthcare and financial protection, and whether this relationship differs above a certain threshold of digital infrastructure. In this context, the study examines the digital finance-health relationship within a heterogeneous global framework, surrounding a broad sample of countries with differing earning potentials and institutional structure levels. Analyzing countries holistically allows both observing the impact of structural differences and testing the contextual nature of digital transformation's impact on healthcare systems. Thus, the research aims to reveal not only the existence of the relationship but also the conditions under which it strengthens or weakens.

This study contributes to the literature in several ways. Firstly, it establishes an interdisciplinary bridge between the finance and health economics literatures by directly relating Fintech indicators (especially metrics of access to and use of digital financial services) to universal health coverage indicators. In this way, the macro-level impacts of financial innovations on healthcare systems are systematically analyzed. Furthermore, the study tests the assumption that the Fintech effect is not homogeneous by examining the conditioning role of the level of digital infrastructure (e.g., internet usage and related digital indicators). In this respect, the study empirically examines how the impact of digital financial technologies on health outcomes can vary across structural and technological contexts. Finally, a nonlinear perspective on the fintech–UHC relationship is provided using a threshold approach. Thus, it analyzes whether the effect is strengthened or weakened when digital infrastructure exceeds a certain threshold and offers an alternative methodological contribution to this relationship, which is mostly examined with linear models in the literature. Within this framework, the study aims to make an original contribution to the literature at both the conceptual and empirical levels by examining the interaction among digital financial development, digital infrastructure, and universal health coverage in a multidimensional, conditional framework.

## 2. LITERATURE REVIEW

Universal Health Coverage (UHC) can be considered a multidimensional policy goal that seeks to ensure that all people have access to health services that are necessary to maintain their health without suffering financial hardship. According to the World Health Organization and the World Bank, the conceptual framework of UHC comprises three dimensions: service coverage, population coverage, and financial protection (WHO & World Bank, 2017). This framework implies that universal health coverage is not only about increasing healthcare supply but also ensuring that all people have access to healthcare services.

From an empirical perspective, the most common way that UHC has been measured and estimated is through the computation of the UHC Service Coverage Index, which covers a range of important domains such as maternal and child health, communicable and non-communicable diseases, and health service infrastructure (WHO & World Bank, 2017). This index has both structural and usage components and, therefore, can be an important outcome variable for investigating the broader macro-level drivers of access.

Although income growth is important for the improvement of health outcomes, it does not guarantee access to universal health care. Wagstaff et al. (2018) demonstrated that even in growing economies, households may still experience catastrophic out-of-pocket expenditures, thus indicating that the design of the institution is critical to the determination of access to health care. Savedoff et al. (2012) highlighted that the transition to UHC is underpinned by the effectiveness of public financing systems. This discussion indicates that UHC is underpinned by the ecosystem of the institution.

In such a setting, the role of financial inclusion and digital financial technology has also emerged as an important aspect that could facilitate access to healthcare. The role of fintech, in such a context, is that it could facilitate access to financial services through digital platforms such as digital payments, mobile banking, and electronic transfer systems. Although the role of fintech is not direct in the context of healthcare, it is also important to note that it could indirectly influence healthcare access by reducing transaction costs, addressing liquidity constraints, and enhancing financial engagement, as discussed by Demirgüç-Kunt et al. (2018) and Sahay et al. (2020). The role of digital platforms is such that they could help households overcome the constraints of healthcare spending by reducing transaction costs and mobilizing resources more efficiently, especially in settings where households are expected to pay more for healthcare.

In this study, the concept of fintech is used by the share of adults who make digital payment transactions. While there are a variety of financial technologies included in the concept of fintech, digital payments are the most direct and measurable means of linking the concept of financial technology and health spending at the household level.

Although there are compelling theoretical grounds to support the positive relationship between fintech and health access, the existing literature mainly investigates this relationship from the perspective of a linear and homogeneous approach. On the contrary, the majority of the studies explore the average impact of digital finance on economic/financial outcomes, while ignoring the possibility that the impact of digital finance might differ across different structural environments (Sahay et al., 2020; Ozili, 2018). The digital infrastructure, usually captured by internet penetration, is usually incorporated as a control variable rather than a conditioning variable. This is likely to imply that the marginal impact of fintech is constant across different countries.

However, insights from the digitalization and infrastructure literature challenge this assumption. Information and communication technologies (ICT) research demonstrates that infrastructure growth presents reduced marginal returns: early-stage diffusion produces powerful economic and social effects, whereas additional expansion at high penetration levels produces smaller accumulative gains (Roller&Waverman, 2001; Qiang et al., 2009). Czernich et al. (2011) similarly show that enlargement of broadband reach encourages growth more strongly in situations where connectivity gaps are being minimised. These findings indicate that digital infrastructure functions as an enabling possibility whose marginal contribution differs across development stages.

Theoretically, this suggests that fintech and digital infrastructure are symbiotic, rather than separate, factors that drive financial inclusion. In other words, in a low-connectedness setting, increasing fintech usage can have a significant impact on alleviating financial frictions and increasing access to financial services. However, as internet penetration increases and digital access becomes widespread, the limiting factors change. When digital infrastructure becomes nearly saturated, the marginal impact of increasing fintech diffusion may diminish, and structural factors may play a more significant role in determining financial inclusion outcomes.

This complementary view, therefore, poses a critical methodological concern, especially if the impact of fintech is dependent on the level of digital infrastructure. Indeed, while the standard fixed effects models impose slope homogeneity, the linear interaction term assumes smooth adjustment across different levels of digital infrastructure. However, if the underlying relationship is subject to structural change, then a threshold model is more suitable.

A rigorous econometric approach to identify such regime shifts is given by the panel threshold framework, as proposed by Hansen (1999, 2000). In this approach, the threshold value of the conditioning variable, namely internet penetration, is endogenously estimated, allowing the slope coefficients to change discretely across regimes. This approach does not require arbitrary splitting of the sample, and the significance of the threshold is tested using a bootstrap procedure. Although the threshold approach is widely used in development economics to control for the nonlinear impact of institutions and financial development (Kremer et al., 2013), its application to the fintech-health access relationship is scarce.

This study aims to bridge the identified knowledge gap by including a specific and direct estimation of the digital infrastructure as a threshold effect on the relationship between fintech and UHC, thus directly testing the assumption of the uniformity of the marginal contribution of fintech on UHC. The theoretical assumption, following the logic of the law of diminishing returns in the process of infrastructure roll-out, suggests that the effect of fintech should be more pronounced in the lower range of digital connectivity and diminish as the digital infrastructure becomes more advanced.

Significantly, the contiguity of a weakening influence in high-infrastructure regimes does not suggest that fintech becomes meaningless. Instead, it implies that the limiting factors of UHC are reworked. In a digitally progressive environment, institutional factors, public health expenditure, insurance, and healthcare supply capacity are key determinants of UHC (Savedoff et al., 2012; Acemoglu & Robinson, 2012). Fintech acts as a complementary tool that depends on certain structural factors.

Through the integration of the UHC framework, the literature on financial inclusion, and the infrastructure saturation approach within a threshold econometric model, this study contributes to the ascent of the theoretical and conceptual understanding of the relationship between fintech and health access in emerging economies, going beyond the average effect assumptions, and offering a conditional passage to the role of fintech in bettering universal health coverage.

## 3. DATA AND METHOD

### *3.1. Data*

The sample consists of a panel of 23 emerging markets over the 2010-2024 period, harmonized according to the wave structure of the Global Findex dataset. Access to health services is measured by the Universal Health Coverage (UHC) service coverage index, which captures how effectively individuals within a population can access essential health services. Digital infrastructure is measured by the variable "Individuals Using the Internet (% of population)," which measures the share of an economy's population that uses the internet. This variable is taken as a quantitative representation of the digital infrastructure needed for fintech to support the availability of health services. In order to account for transitory dynamics and select a stable time horizon that relates to the availability of health services over the medium term, the dependent variable is constructed as a 3-period ahead moving average of UHC (using available contemporaneous and forward-looking observations).

The adoption of fintech is measured using the Global Findex variable that captures the share of individuals aged 15+ who make or receive digital payments. The intention behind this variable is to represent the degree of digital financial services within an economy, and how that economy may be indirectly enabled by those services to access health care. The macroeconomic control variable used for this analysis is real GDP per capita (in 2015 constant USD), which captures the overall ability of an economy to finance its health care infrastructure. These variables combined enable an evaluation of whether or not the relationship between fintech and health service access is rendered non-linear by the level of digital infrastructure adoption within an economy.

***Table 1: Descriptive Statistics of the Variables.***

| Variable | N | Mean | Median | SD | Min | Max |
|---|---|---|---|---|---|---|
| Universal Health Coverage Index (UHC) | 84 | 0.532 | 0.675 | 0.240 | 0.000 | 0.837 |
| Internet Usage Rate (NET) | 84 | 0.505 | 0.550 | 0.250 | 0.000 | 0.934 |
| Fintech Usage Rate (FINTECH) | 84 | 0.488 | 0.464 | 0.230 | 0.133 | 0.932 |
| GDP per Capita (current USD) | 84 | 6,287 | 4,405 | 4,900 | 691 | 18,001 |

**Note. N = number of observations; SD = standard deviation. UHC refers to the Universal Health Coverage Index. NET represents the proportion of individuals using the internet. FINTECH denotes the proportion of individuals using financial technology services. GDP per capita is reported in current U.S. dollars.**

Table 1 indicates substantial heterogeneity across countries and waves. Both the UHC index and the digital indicators- internet usage and fintech adoption- display wide dispersion within the 0–1 range, pointing to notable structural differences across countries. GDP per capita exhibits considerable variance, reflecting the gap between lower- and middle-income economies and relatively higher-income countries in the sample. These patterns underscore the importance of accounting for country-specific fixed effects in the empirical specification.

### *3.2. Method*

This research uses an unbalanced panel dataset spanning emerging markets from 2010 until 2024. The primary goal is to find evidence of nonlinearity in the effect of fintech usage on UHC service coverage conditioned on levels of digital infrastructure. To test this hypothesis, the researcher applies standard linear panel models and the panel threshold model from Hansen (1999, 2000).

The dataset sample includes observations from 23 emerging market economies. The data set construction leverages the Global Findex survey datasets (2014, 2017, 2021, 2024). The panel data structure is unbalanced because the fintech variable is only available for survey waves. Given the limited number of time periods (T = 4), no unit root or dynamic panel data tests can be carried out. Unobserved heterogeneity is accounted for with country and year fixed effects. All empirical procedures are conducted in the R language environment.

The dependent variable, $UHC_{it}$, corresponds to the Universal Health Coverage service coverage index and reflects the extent to which the population in a given country has access to essential health services. The key explanatory variables are defined as follows. $Fintech_{it}$ measures the share of individuals aged 15 and above who make or receive digital payments, capturing the level of financial digitalization. $NET_{it}$ denotes the percentage of individuals using the internet and serves as an indicator of digital infrastructure. As a control variable, $GDP_{it}$ represents real GDP per capita in constant 2015 US dollars, included to account for differences in countries' overall economic capacity.

**Phase 1: Linear and Interaction Panel Model**

In the first stage, the analysis examines whether the relationship between fintech usage and UHC can be adequately described within a linear framework. The baseline specification is defined as:

$$UHC_{it} = \alpha + \beta_1 NET_{it} + \beta_2 Fintech_{it} + \beta_3 (NET_{it} \times Fintech_{it}) + \mu_i + \tau_t + \varepsilon_{it} \quad (1)$$

Here, $\mu_i$ denotes country fixed effects, $\tau_t$ represents year fixed effects, and $\varepsilon_{it}$ is the error term. The inclusion of the interaction term allows the effect of fintech on UHC to vary with the level of digital infrastructure within a linear parametric setting. In this framework, the conditional marginal effect of fintech depends on internet penetration but remains constrained by the linear functional form.

**Phase 2: Panel Threshold Model**

Because the linear specification imposes homogeneity in slope coefficients, it may not fully capture potential regime shifts in the fintech–UHC relationship. To allow for structural differences across levels of digital infrastructure, a panel threshold model following Bruce E. Hansen (1999, 2000) is estimated.

The threshold value is determined endogenously from the data. After removing individual fixed effects through the within transformation, the threshold parameter is obtained by minimizing the concentrated sum of squared residuals:

$$\hat{c} = \arg\min_{c \in \Gamma} S_1(c) \quad (2)$$

where $\Gamma$ denotes the set of admissible threshold values defined by the trimming procedure, and $S_1(c)$ is the residual sum of squares associated with a given candidate threshold. The estimated model takes the following form:

$$UHC_{it} = \beta_L Fintech_{it} \cdot I(NET_{it} \leq c) + \beta_H Fintech_{it} \cdot I(NET_{it} > c) + \delta NET_{it} + \mu_i + \tau_t + \varepsilon_{it} \quad (3)$$

In this specification, c represents the digital infrastructure threshold, and I(·) is an indicator function that separates observations into low- and high-digital regimes. The coefficients $\beta_L$ and $\beta_H$ measure the effect of fintech on UHC in the lower and higher digital infrastructure regimes, respectively. Country and year fixed effects are again included to control for time-invariant heterogeneity and common shocks. This formulation allows the marginal effect of fintech on health service coverage to differ across regimes, thereby accommodating structural heterogeneity linked to the level of digital development.

### 3.3. Threshold Estimation and Testing Procedure

The threshold value cis selected over a grid defined on the NET variable as the value that minimizes the residual sum of squares (RSS). To prevent the formation of excessively small regimes, extreme observations are excluded through a trimming procedure. The statistical validity of the threshold effect is assessed using the bootstrap likelihood ratio (LR) test proposed by Bruce E. Hansen (2000).

The hypotheses are formulated as follows:

$$H_0: \beta_L = \beta_H \text{(the linear model is valid)}$$

$$H_1: \beta_L \neq \beta_H \text{(a threshold effect exists)}$$

Bootstrap-based p-values are used to evaluate whether the threshold specification provides a statistically superior fit relative to the linear alternative. All models are estimated using a fixed-effects (FE) framework with both country and year effects. Standard errors are clustered at the country level to account for potential heteroskedasticity and within-country serial correlation. By relaxing the assumption that the effect of fintech on health access is homogeneous and linear, this approach allows for a conditional structure in which the impact varies with the level of digital infrastructure. The use of a Hansen-type panel threshold model thus offers a methodological alternative to the predominantly linear specifications in the existing fintech–health literature.

Some diagnostic tests that are often reported are not done on purpose because of how they are set up. The Hausman test is excluded due to the expectation that the primary explanatory variables, such as internet usage and fintech adoption, will correlate with time-invariant national characteristics, including institutional capacity, regulatory frameworks, digital infrastructure, and historical development trajectories. In this context, the fundamental premise of the random-effects (RE) model—that unobserved country effects are uncorrelated with the regressors—is implausible. Consequently, the RE specification fails to present a viable alternative, diminishing the relevance of the Hausman test in this context.

In the same way, tests for panel unit roots and stationarity are not done. Because the time dimension is so short (T = 4 waves), the statistical power of these tests would be very limited, which would make their results less reliable. For the same reason, we don't report serial correlation tests made for short panels, like Wooldridge-type tests. Lastly, all models use country-clustered robust standard errors instead of doing separate tests for heteroskedasticity. This makes the inference strong against both heteroskedasticity and intra-country error correlation.

### 3.4. Findings

The results from the controlled linear panel model indicate that neither fintech usage nor internet penetration (NET), whether considered individually or through their interaction term, exerts a statistically significant effect on Universal Health Coverage (UHC). In contrast, income level (log GDP per capita) is positive and statistically significant, suggesting that macroeconomic capacity remains a primary determinant of health access. Overall, the linear specification appears to have limited explanatory power in capturing the fintech–UHC relationship within the wave-based structure of the data (Table 2).

***Table 2: Phase 1 – Controlled Linear Panel Model.***

| *Variable* | *Coefficient* | *Std. Error* | *t* | *p* |
|---|---|---|---|---|
| *Internet Usage Rate (NET)* | 0.0263 | 0.0591 | 0.44 | 0.662 |
| *Fintech Usage Rate (FINTECH)* | −0.0204 | 0.0801 | −0.25 | 0.801 |
| *Log GDP per Capita (LOG_GDP)* | 0.0864 | 0.0406 | 2.13 | 0.045* |
| *NET × FINTECH* | −0.0335 | 0.0818 | −0.41 | 0.686 |

**Note. * p < .05. NET denotes the proportion of individuals using the internet, FINTECH denotes the proportion of individuals using financial technology services, and LOG_GDP is the natural logarithm of GDP per capita (current USD).**

In the fixed-effects model with country-clustered standard errors, the coefficient on NET is 0.0263 (p = 0.662), the coefficient on FINTECH is −0.0204 (p = 0.801), and the interaction term is −0.0335 (p = 0.686), all statistically insignificant. By contrast, LOG(GDP) is positive and significant at the 5 percent level (β = 0.0864, p = 0.045).

When the nonlinear specification based on the panel threshold framework of Hansen (1999) is applied, a different picture emerges (Table 3). The non-linear relationship model threshold estimate for internet usage is 0.84. In the low-digitization regime (NET ≤ ĉ), the coefficient for fintech is 0.2658 (SE = 0.079), and is significant at the 1% level (p = 0.003). This indicates that in countries where internet usage is low, an increase in the share of the population who make or receive digital payments is associated with a large gain in UHC. In this regime, fintech seems to be able to help compensate for weaknesses in health system design that prevent access to health services.

In the high-digitization regime (NET > ĉ), the coefficient for fintech drops to 0.1414 (SE = 0.0833) and is only weakly significant (p = 0.105). The magnitude of fintech above the threshold decreases. The difference in regime effects ($\beta_{high} - \beta_{low} = -0.1244$) shows a large drop in the effect of fintech beyond the level of digital infrastructure at which the regime switch occurs. The implications are that the role of fintech in enhancing access to health services is not universal, but is conditional on the level of digitization in a country. The threshold model is estimated with 84 observations, with 72 in the low regime and 12 in the high regime. The adjusted $R^2$ is 0.976, and the within $R^2$ is 0.296, showing an increase in model fit compared to the linear model.

***Table 3: Phase 2 – Panel Threshold Model.***

| *Variable* | *Coefficient* | *Std. Error* | *t* | *p* |
|---|---|---|---|---|
| *Internet Usage Rate (NET)* | 0.0117 | 0.0429 | 0.27 | 0.788 |
| *Fintech Usage Rate (Low Regime, NET ≤ ĉ)* | 0.2658 | 0.0790 | 3.36 | 0.003** |
| *Fintech Usage Rate (High Regime, NET > ĉ)* | 0.1414 | 0.0833 | 1.70 | 0.105* |

**Estimated internet threshold (ĉ): 0.84**
**Low regime observations: 72**
**High regime observations: 12**
**Adjusted $R^2$: 0.976; Within $R^2$: 0.296**
**Note. * p < .10, ** p < .01. NET denotes the proportion of individuals using the internet. FINTECH refers to the proportion of individuals using financial technology services. The threshold variable is internet usage.**

The statistical validity of the threshold effect is supported by a bootstrap likelihood ratio (LR) test (Table 4). Given the non-standard distribution of the threshold test statistics under the null hypothesis, inference is based on a cluster bootstrap procedure with 500 replications, implemented by resampling residuals at the country level. The bootstrap LR statistics are 0.2946, with a p-value of 0.00, leading to rejection of the linear specification.

Additional trimming sensitivity analysis shows that the estimated threshold remains within the interval [0.81, 0.84], with a maximum deviation of 0.03 across alternative trimming levels. This stability indicates that the threshold estimate is not driven by extreme observations and supports the robustness of the nonlinear specification.

***Table 4: Threshold Validity and Robustness Tests.***

| *Test* | *Result* |
|---|---|
| *Bootstrap LR statistic* | 0.2946 |
| *Bootstrap p-value* | 0.00 (linear model rejected) |
| *Trim sensitivity (ĉ range)* | [0.81, 0.84] |
| *Maximum difference* | 0.03 (high threshold stability) |

**Note. The bootstrap likelihood ratio (LR) test rejects the null hypothesis of a linear model, supporting the presence of a threshold effect. The trim sensitivity interval indicates the robustness of the estimated threshold value. A small maximum difference suggests high threshold stability.**

The findings show that linear panel models fail to detect the effect of fintech on UHC, but that the nonlinear threshold model reveals a conditional effect. Conditionally, health access increases with fintech in environments that are not yet densely populated with digital infrastructure, but the return on fintech disappears as digital infrastructure begins to reach its thresholds. In environments with high levels of digital maturity, improvements in health coverage appear to depend on other structural factors rather than on additional fintech adoption.

## 4. DISCUSSION

The results of the panel threshold analysis indicate that the relationship between fintech use and access to universal healthcare is not uniform across countries but varies systematically with the level of digital infrastructure. While linear panel models fail to detect a statistically significant average effect, the threshold framework reveals a clear regime-dependent structure, with markedly different marginal impacts of fintech across digital infrastructure levels. This section discusses the potential mechanisms underlying these findings and situates the results within the broader literature on financial inclusion, digitalization, and healthcare access.

This study's findings indicate that the effect of fintech adoption on access to universal healthcare differs depending on the scope of digital infrastructure. This relationship can be better understood in terms of financial friction associated with healthcare expenditures.

In countries with underdeveloped digital infrastructure, challenges to accessing healthcare are not primarily due to low income. Rather, financial constraints such as liquidity, payment timing, and transaction costs are more the

In this context, fintech applications, especially digital payments and rapid transfer mechanisms, play a cooperative role, enabling actual access to existing services, rather than directly increasing access to healthcare. The strong and significant impact of fintech on universal healthcare access in low-internet-usage regimes indicates that these technologies facilitate short-term liquidity constraints on healthcare expenditures, thereby assisting household access to healthcare services.

Again, the deterioration of fintech's marginal impact on healthcare access as digital infrastructure reaches a certain saturation level can be explained by shifting binding constraints. In countries with elevated internet usage, since digital payment infrastructure and financial access channels are widely available, the primary limiting factor in accessing healthcare is no longer the availability of payment instruments; the institutional capacity of the healthcare system, public funding, insurance coverage, and service provision are becoming more structural factors. Under these conditions, fintech becomes a tool that largely fulfils its role within the existing system, rather than a lever that increases access to healthcare. Therefore, the decline of fintech's impact when the digital infrastructure threshold is exceeded suggests a shift in the main apparatus determining access to healthcare, rather than a technological incapability

The results align with the current literature, indicating that fintech and digital finance have a context-dependent impact on healthcare access. The health economics literature underscores that income growth alone does not determine universal healthcare coverage; access to healthcare expenditures is predominantly influenced by financing structures (Wagstaff et al., 2018; Savedoff et al., 2012). In this context, fintech's support for access to healthcare, especially in countries with limited digital infrastructure, aligns with theoretical expectations that it facilitates actual access to existing healthcare services by reducing financial friction. Conversely, the ever-shrinking sway of fintech as digital infrastructure approaches saturation corresponds with existing literature, indicating that digitalization and infrastructure investments yield decreasing marginal returns. Research in telecommunications and digital infrastructure indicates that the economic and social ramifications of digitalization are more pronounced in areas with considerable infrastructure deficits; these effects diminish as infrastructure becomes more prevalent (Roller & Waverman, 2001; Czernich et al., 2011; Qiang et al., 2009). This study, in line with these approaches, empirically demonstrates that the fintech-health access relationship is not linear and universal; it exhibits a threshold-based structure conditioned by digital infrastructure.

## 5. CONCLUSION

The aim of this study is to investigate whether the impact of financial technologies on access to universal health coverage (UHC) is structurally conditioned by the level of digital infrastructure. Moving beyond the linear panel specification of earlier studies, the analysis uses an endogenous threshold approach and shows that the relationship between fintech and health access is not universal and not necessarily monotonic in emerging economies.

These findings show a well-defined structure in the regime dependence of the results. In countries where the digital infrastructure penetration is below a certain critical level, the adoption of fintech services has a significant positive impact on the accessibility of health services. In these countries, fintech services act as a transformative enabler in the sense that they contribute to the improvement of UHC.

However, when internet penetration exceeds an estimated threshold, which is approximately 81 to 84 percent in our sample, the marginal effect of fintech on UHC diminishes and becomes statistically insignificant. This is similar to the logic of saturation, which is also seen in the diffusion of infrastructure. As digital connectivity becomes widespread, the determinants of access extend beyond payment issues to more structural issues such as public health financing, insurance, institutional factors, and service quality. In a digitally mature environment, fintech is no longer the driving force, but rather an integral part of the institutional landscape.

This evidence contradicts some of the linear and universalist assumptions that are sometimes implicitly advanced in the digital development literature. Instead, there is a clear indication that social returns from digital financial innovation do not emerge automatically. Instead, they depend on specific complementarities between the development stage and the infrastructures/institutions. In this respect, this research contributes to development economics by reinforcing a more general understanding of technological adoption, including in this case, that financial development, institutional development, and technological development do not grow in a linear fashion. Instead, they exhibit non-linear growth effects.

From a policy point of view, the results suggest that policymakers should be cautious about adopting a universal fintech-based policy to achieve universal health coverage. In a digitally constrained system, adopting a policy that supports digital payment systems and financial inclusion can lead to significant improvements in universal health coverage. In a digitally advanced system, further fintech development may not lead to significant improvements in universal health coverage.

From a methodological point of view, the present research underlines the need for threshold modelling in assessing social impacts of digital technologies. By allowing data to drive infrastructure regimes, the research reveals conditional relationships that would be lost with a more linear approach. This could be useful in other fields where there is a relationship between digitalization and institutional development.

Several limitations must be borne in mind. First, the use of fintech is measured as the use of digital payment tools, which refers to the most direct channel of financial transaction, but does not capture the entire scope of financial technology. Second, the threshold model controls for the effects of different regimes, which future studies could further explore with the inclusion of additional variables in the health financing space. Nevertheless, the main implication of the analysis holds: fintech can contribute to UHC, but in a conditional, supplementary, and structurally constrained fashion.

**Author Contributions:** All authors (O.O., H.Y., and E.H.) contributed equally to the conceptualization, design, methodology, data analysis, interpretation of results, drafting, revision, and final approval of the manuscript. All authors have read and agreed to the published version of the manuscript.

## REFERENCES

Acemoglu, D., & Robinson, J. A. (2012). *Why nations fail: The origins of power, prosperity, and poverty.* New York: Crown Business.

Acharya, S., Lin, V., & Dhingra, N. (2018). The role of health in achieving the sustainable development goals. *Bulletin of the World Health Organization*, 96(9), 591. https://doi.org/10.2471/BLT.18.221432

Ahmed, H., & Cowan, B. (2021). Mobile money and healthcare use: Evidence from East Africa. *World Development*, 141, 105392. https://doi.org/10.1016/j.worlddev.2021.105392

Cambaza, E. (2023). The role of Fintech in sustainable healthcare development in sub-Saharan Africa: a narrative review. *Fintech*, 2(3), 444-460. https://doi.org/10.3390/fintech2030025

Czernich, N., Falck, O., Kretschmer, T., & Woessmann, L. (2011). Broadband infrastructure and economic growth. *The Economic Journal*, 121(552), 505–532. https://doi.org/10.1111/j.1468-0297.2011.02420.x

Demirgüç-Kunt, A., Klapper, L., Singer, D., Ansar, S., & Hess, J. (2018). *The Global Findex Database 2017: Measuring financial inclusion and the fintech revolution*. World Bank. https://doi.org/10.1596/978-1-4648-1259-0

Deng, Y., Tao, H., Yao, B., & Shi, X. (2025). The impact of digital infrastructure on rural household financial vulnerability: A quasi-natural experiment from the broadband China strategy. *Sustainability*, 17 (5), 1-24, 1856. https://doi.org/10.3390/su17051856

Hansen, B. E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. *Journal of Econometrics*, 93(2), 345–368. https://doi.org/10.1016/S0304-4076(99)00025-1

Hansen, B. E. (2000). Sample splitting and threshold estimation. Econometrica, 68 (3), 575–603. https://doi.org/10.1111/1468-0262.00124

Klein, A. (2021). *Can fintech improve health*. Washington, DC: The Brookings Institution. https://www.brookings.edu/articles/can-fintech-improve-health/

Kremer, S., Bick, A., & Nautz, D. (2013). Inflation and growth: New evidence from a dynamic panel threshold analysis. *Empir Econ, 44: 861–878, DOI 10.1007/s00181-012-0553-9*

Mesmar, A., Mbaabu Limungi, G., Elmadani, M., Simon, K., Hamad, O., Tóth, L., Horvath, E., & Mate, O. (2025). Bridging healthcare disparities: a systematic review of healthcare access for disabled individuals in rural and urban areas. *Frontiers in Health Services,* 5, 1695320. https://doi.org/10.3389/frhs.2025.1695320

Niu, G., Jin, X., Wang, Q., & Zhou, Y. (2022). Broadband infrastructure and digital financial inclusion in rural China. *China Economic Review*, 76, 101853. https://doi.org/10.1016/j.chieco.2022.101853

Ozili, P. K. (2018). Impact of digital finance on financial inclusion and stability. *Borsa Istanbul Review*, 18 (4), 329–340. https://doi.org/10.1016/j.bir.2017.12.003

Qiang, C. Z. W., Rossotto, C. M., & Kimura, K. (2009). *Economic impacts of broadband*. In 2009 Information and Communications for Development Extending Reach and Increasing Impact, pp. 35-50, World Bank. https://documents.worldbank.org

Roller, L. H., & Waverman, L. (2001). Telecommunications infrastructure and economic development: A simultaneous approach. *American Economic Review*, 91(4), 909–923. https://doi.org/10.1257/aer.91.4.909

Sahay, R., von Allmen, U. E, Lahreche, A., Khera, P., Ogawa, S., Bazarbash, M., & Beaton, K. (2020). *The promise of fintech: Financial inclusion in the post COVID-19 era.* International Monetary Fund. Monetary and Capital Markets Department, https://www.imf.org/en/publications/departmental-papers-policy-papers/issues/2020/06/29/the-promise-of-fintech-financial-inclusion-in-the-post-COVID-19-era-48623

Savedoff, W. D., de Ferranti, D., Smith, A. L., & Fan, V. (2012). Political and economic aspects of the transition to universal health coverage. *Lancet,* 380: 924–32. https://doi.org/10.1016/S0140-6736(12)61083-6

Shukla, R., Bagotia, H., Satish, P., Kamath, H. S., Chatterjee, S., Savariah, D., Kaulgud, V., Gobburi, H.,& Acharya, S. (2025). Fintech and healthtech synergism: Pioneering a digital healthcare revolution for accessible, affordable, and effective patient-centered care. *Journal of Family Medicine and Primary Care*, 14(3), 820-824. https://doi.org/10.4103/jfmpc.jfmpc_999_24

United Nations. (2025). Goal 3 | Ensure healthy lives and promote well-being for all at all ages. United Nations. https://sdgs.un.org/goals/goal3#targets_and_indicators

Wagstaff, A., Flores, G., Hsu, J., Smitz, M. F., Chepynoga, K., Buisman, L. R., van Wilgenburg, K., & Eozenou, P. (2018). Progress on catastrophic health spending in 133 countries: a retrospective observational study. *Lancet Global Health,* e169-e179. http://dx.doi.org/10.1016/S2214-109X(17)30429-1

WHO (World Health Organization) & World Bank. (2017). *Tracking universal health coverage: 2017 global monitoring report.* World Health Organization and International Bank for Reconstruction and Development / The World Bank; 2017. Licence: CC BY-NC-SA 3.0 IGO. https://www.who.int/publications/i/item/9789241513555