# Explaining Variation in Adoption of FinTech Products and Services Among Citizens: A Multilevel Model

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**Abstract.** Despite the several advantages, adoption of the FinTech services vary across individuals in different countries. This study proposes a model to examine how the country level ICT competitiveness, demographic and socio-economic factors influence the FinTech services diffusion in a country. In this study, we use Generalized Linear Mixed Model to analyze both the individual-level and country-level variables to explain the variation in the probability of individuals adopting FinTech services while accounting for the variance at each level. National ICT competitiveness especially political and regulatory environment, Infrastructure, ICT usage by firms demonstrated a stronger influence on the adoption of FinTech services. In addition, demographic variables and socio-economic status also demonstrated stronger evidence in explaining the variation in the adoption of FinTech services.

**Keywords:** FinTech, ICT, Diffusion

## 1 Introduction and background

In 2020, half of the world will be using at least one FinTech product or service [9]. Major reason for this trend is the recent proliferation of financial technologies, such as payment service providers, aggregators and robo advisors, peer-to-peer lenders, and innovative trading platforms along with increased smartphone usage [52]. Consumers are using FinTech products to access financial services in a much cheaper and efficient way [5]. In 2015, Jim Yong Kim (World Bank Group President) announced World Bank has set an ambitious goal of universal financial access by 2020. With the continued digitalization of financial sector, both the banks and other financial institutions had made efforts to increase the consumer's adoption of FinTech products and services, capitalizing on high mobile and smartphone usage [28].

Although, more consumers worldwide are accepting FinTech applications, adoption and frequency of usage vary across countries. The 2018 National Financial Capability Study reports that 84% of the banked US respondents engage in online banking and 65% in mobile banking at least sometimes [38]. However, only nearly half of the banked US respondents use FinTech services frequently, rest presumably using other payment methods like cash, credit or checks. In contrast, in some economies, there has been a large demand for FinTech services. Countries like China, India have high rate

(87%) of FinTech adoption and countries like Japan (34%) and France (35%) have low rate of adoption [17]. Even though the customer awareness of FinTech services remains high at 96% globally, average adoption rate is only 64%. Industry experts [17] point out two major reason for these variations in adoption rates (i) Lack of infrastructure and restriction or regulation of certain FinTech services (ii) Financial behaviors exhibited by consumers because of demographic and socio-economic characteristics. This is further supported by the academic literature. FinTech usage is influenced or constrained by Information communication and Technology (ICT) infrastructure, adoption in financial sector and political or regulatory environment [4,34]. In developing economies, a gender gap of 6 percentage points exists, 43 % of men have both mobile phone and internet access, while only 37 % of women have the same. In some economies like Bangladesh, Ethiopia, and India, men have access to mobile and internet twice as likely as women do. However, in China, Colombia, and South Africa, both men and women have equal access [18]. Adoption of FinTech is also driven by various factors like age, gender and social status [36, 40, 60]. Given these variations and complexities, it is important to understand what all factors could explain the variations in adoption of FinTech products and services across countries.

Because of the strong linkages between financial development and economic growth, determinants of adoption of financial technologies has been largely studied [27]. Our brief review of existing literature indicate that there are two main streams of research evident in the adoption of financial technologies literature [26]. First stream concerns with identifying determinants related to adoption of FinTech among organizations [8]. Second stream of research concerns with identifying determinants related to adoption of FinTech by end consumers [55]. In the second stream of research, most studies utilized technology adoption literature to explain the adoption of FinTech products and services. Few studies have addressed whether the national ICT level will influence adoption of FinTech [1,20]. Several other studies focus on individual factors such as demographic variables, trust, and subjective norm to understand the diffusion of financial technologies [56,47]. However, these studies confine within a country [51,53] or few countries [2] . The current study aimed to fill this gap in prior research by conducting a cross-country (127 countries) analysis, including both country level (national ICT competitiveness) and individual level (demographic and socio-economic) variables in the same model to explain variation in adoption of financial technologies. To increase the understanding of the FinTech usage behavior, following research question motivated our study:

RQ: *What are the macroeconomic (ICT competitiveness related) and individual level factors that could explain the variation in adoption of FinTech products and services among citizens across countries?*

## 2 Theoretical Background and Hypotheses

### 2.1 Individual level difference and FinTech adoption

Previous studies conceptualized financial technologies as technological innovation and analyzed adoption of FinTech products using various technology adoption theories

[34]. Further, the speed of diffusion of financial technologies depends on the characteristics of the technology as well as characteristics of the users to whom it is directed [14]. Various theories include UTAUT theory [62], Diffusion of Innovation theory, TAM [45] and SDT [59]. User differences plays a key role in adoption and using innovation and same goes with financial technologies as these differences result in variety of needs and expectation [47]. To increase the likelihood of the success of FinTech, FinTech firms and financial institutions should target the early and late adopters of innovation, as late adopters are potential consumers of next generation services [30]. Accordingly, grouping of the consumers based on their demographic and socio-economic status is critical to understanding the willingness to adopt Fintech. Diffusion paradigm helps to capture the distinction between different users based on their innovativeness.

Diffusion, according to Rogers [46] is a "process in which an innovation is communicated through certain channels over time among the members of a social system". Rate of adoption of innovation is determined by its characteristics. Rate of adoption is determined by the 1) perceived attributes of innovation (relative advantage, compatibility, complexity, trialability and observability). These characteristics are perceived differently based on demographic features and social-economic status [46]. Gender plays an important role in moderating the relationship between perceived ease of use and behavioral intention to use the system; as men will rate the perceived ease of use highly [36]. Previous studies found younger people are more likely to adopt innovation quickly [6]. Further, the older generation are more skeptical about digital payments or remittance as older people are more prone to financial exploitation [40]. In addition, the adoption of FinTech applications also depend on the education level and income level of the individual in the country [34]. Higher education is assumed to be improving one's knowledge, productivity, and thus speeds up the adoption of innovation-decision process [37,46]. Further, it was found out that higher-income families use more technology than low-income families [60]. Thus, more the income of the household can increase the probability of usage of FinTech services. This is also driven by an inherent motivation inside the individual to gain social status [16]. Thus, we hypothesized that

*Hypothesis 1: Gender influence FinTech usage among individuals in a country where males adopt FinTech services more than females.*

*Hypothesis 2: Age influence FinTech usage among individuals in a country where younger adults adopt FinTech services more than older adults.*

*Hypothesis 3: Education influence the FinTech usage among individuals in a country where more educated to adopt FinTech services more than less educated.*

*Hypothesis 4: Income influence the FinTech usage among individuals in a country where high net worth individuals adopt FinTech services more than low net worth.*

### 2.2 ICT Competitiveness and FinTech adoption

National ICT development assist financial sector in the form of services offered to the citizens and aid support to firms to produce FinTech products [17-19,33]. Innovative services and digitalization of the financial market is a symbol of a well-developed economy and capital market which promotes entrepreneurship especially FinTech innova-

tors [20]. Business innovation environment is categorized by the availability of the latest technologies, local competition, government procurement of latest technology, and more [19]. Technologies like nearfield communication (NFC), QR codes, and bluetooth enabled mobile wallet transactions helped the firms for the faster payment systems, reduced transaction costs, and improved information symmetry. Political environment plays a crucial role in implementing the favorable regulatory policies, communication channels, and business environments. Recently, scholars have identified the impact of such laws on various technology adoption of various currencies like bitcoin [4], blockchain [61], robo advisors [15], social trading platforms [13] and e-wallet and mobile payment services [35]. Venture capital investment in the FinTech start-ups is mainly determined by the differential treatment of enforcement of political laws [12]. To summarize, overall network readiness of a country indicates the modernization of society, including financial system, which will improve the adoption of FinTech products and services among citizens. Thus, we hypothesized that

*Hypothesis 5: Adoption of FinTech services among individuals occur more in countries with a political and regulatory environment that facilitate ICT penetration.*

*Hypothesis 6: Adoption of FinTech services among individuals occurs more in countries with a well-developed business innovation environment that facilitate innovation.*

*Hypothesis 7: Adoption of FinTech services among individuals occur more in countries with higher Business usage of ICT.*

Another driver of FinTech usage is the extent to which the ICT infrastructure support latest FinTech applications and services. One such example is the shift in the withdrawal of money from banks to Automatic teller machine (ATM) to mobile banking [49,44]. Previous studies have indicated a positive correlation between mobile or internet services and financial development in a country [48,7]. It was identified that a 1% increase in the fixed broadband number led to a 2.13% increase in financial development and a 1% increase on internet lead to a 0.097% increase in financial development [1]. In Sub-Saharan African countries, mobile phone account payments or remittance through text-based mobile services (m-pesa) has revolutionized the financial inclusion [20,29]. Thus, we hypothesized that

*Hypothesis 8: Adoption of FinTech services among individuals occur more in countries with well-developed infrastructure for ICT.*

## 3 Methodology

### 3.1 Data sources and data definition

The data sources for this research include the Global information technology report (GITR) 2016 [19] by the World Economic Forum and Global financial inclusion index (GFI) 2017 [18], and world bank datasets. After excluding the missing data and data cleaning, final sample includes 127 countries common to both data sources which include a total of 78,529 cases. GITR publishes the Networked Readiness Index (NRI), which assess the various factors that enable a country to leverage the ICT for increased competitiveness in all sectors. Global Findex database is one of the global comprehensive datasets on explains the financial inclusion of adults which include their account

holding pattern, how individuals save, borrow, make payments, or send money. To ensure validity and reliability of the data, global data collection agencies like the World Economic Forum and World Bank followed various processes. For instance, to ensure reliability, GFI was created using three-level of sampling which include stratified sampling at higher, clustering at the middle and random at the bottom level to choose household. Data weighting was done to ensure database consists of national representatives from each economy and to ensure nonresponse error. To ensure the validity, questionnaires were prepared with the help of leading academic practitioners and policymakers.

**Variables.** This study uses ICT competitiveness (country level) and individual level variables. Country-level predictor variables include political and regulatory score, business environment score, infrastructure score, and business usage taken from GITR. The rationale for choosing these variables, as they represent the ICT competitiveness of the country. Individual-level predictor variable includes gender, age group, education, and household income taken from GFI. Individual-level control variable includes individual is a member of workforce (employed or not) and country-level variable includes income groups and logarithm of GDP.

*FinTech adoption.* FinTech refers to the technology-enabled or digitalization process of finance solutions [56]. To improve validity, we burrow the concept of "bucket" from Global FinTech Adoption Index published by EY [17]. This study introduces the concept of "buckets" or "categories" and grouped similar services together. Therefore, a FinTech adopter is someone who uses two or more categories of services. This study used five categories: 1) basic access of financial services (access account through internet or mobile), 2) money transfer and payments, 3) e-commerce trade/utility bill, 4) budgeting and financial planning, 5) borrowing and insurance

*Age, Household income, Education, and Gender.* Age is a nominal variable with six different age groups ranging from below 18 to 65 and above. Gender is a dichotomous variable with male coded as 1 and female as 0. Household income is a nominal variable with five different groups ranging from the poorest 20% to the richest 20%. Education is also a nominal variable with three levels ranging from primary to tertiary and more.

*National level predictors.* The political and regulatory environment consists of nine indicators that assess the environment favorable for penetration of ICT. The business and innovation environment consists of nine indicators that measure the environment favorable for entrepreneurship in terms of innovation-friendly. Infrastructure consists of four indicators that capture the country's ICT infrastructure. Business usage consists of six indicators that capture ICT usage in business.

*Control variables.* Employed is a dichotomous variable, where "1" represents the individual is a member of the workforce. Income level classification is based on the World Bank classification by income. GDP indicates the country's standard of living.

**Generalized Linear Mixed Model (GLMM).** In the current study, we use GLMM, which is a multilevel modeling technique. GLMM examine dependent variables that is categorical in nature and predictor variables are nested within groups [44]. In this study, all the demographic and socio-economic variables are nested within a larger group (countries), thus GLMM were employed to analyze both the individual (level 1) and

country-level (level 2) variables to explain the variation in the probability of individuals' adopting FinTech services while accounting for the variance at each level [24]. GLMM incorporates the necessary transformation and appropriate error distribution directly into the statistical model to mitigate violation and approximate the model to near linear [25, 32]. Further, we used robust estimation to handle violation of assumptions. GLMM was analyzed using IBM SPSS [22]. The two-level GLMM model using the logistic link function is as follows:

$$\text{Level 1: } \text{Fintechadoption}_{ij} = a_{0j} + a_{1j} * \text{edu}_{ij} + a_{2j} * \text{gender}_{ij} + a_{3j} * \text{income}_{ij} + a_{4j} * \text{age\_group}_{ij} + a_{5j} * \text{employed} + r_{ij} \quad (1)$$

$$\text{Level 2: } a_{0j} = b_{00} + b_{01} * \text{PR}_j + b_{02} * \text{BI}_j + b_{03} * \text{BU}_j + b_{04} * \text{INF}_j + b_{06} * \text{Inclvl}_j + b_{07} * \text{logGDP}_j + u_{0j} \quad (2)$$

*$a_{1j} = b_{1j}$, $a_{2j} = b_{2j}$, $a_{3j} = b_{3j}$, $a_{4j} = b_{4j}$, $a_{5j} = b_{5j;}$ $\text{Fintechadoption}_{ij}$ is the adoption of FinTech services by the individual i in country j; $b_{00}$ is the mean adoption of FinTech services for all of the countries in the sample; $b_{1j}$ is the slope of education for individual in country j; $b_{2j}$ is the slope of gender for individual in country j; $b_{3j}$ is the slope of income for individual in country j; $b_{4j}$ is the slope of age group for individual in country j; $b_{5j}$ is the slope of employed for individual in country j; $b_{6j}$ is the slope of the cross level interaction term; $r_{ij}$ is a unique error associated with the individual i in country j, ; $b_{01}$ is the slope of political and regulatory environment value for each country; $b_{02}$ is the slope of Business and innovation environment value for each country; $b_{03}$ is the slope of business usage for each country; $b_{04}$ is the slope of infrastructure level for each country; $b_{06}$ is the slope of income group level for each country; $b_{07}$ is the slope of logGDP for each country; and $u_{0j}$ is a unique error to the intercept associated with country j.*

## 4 Results and Discussion

**Null Model (model 1).** The variance of the intercept has a coefficient greater than 1(1.280) which indicates there is significant variation between countries in terms of the proportion of individuals identified as FinTech adopters. This essentially indicates that there might be other level 1 and level 2 (country) predictors that can be added to the model which can explain random variation. Thus justifies the multilevel model. The Intraclass correlation (ICC) describes the proportion of variance that lies between countries relative to the total variance (i.e., between and within countries). The estimated ICC suggests that 33.24% of the variability in FinTech adoption exist between countries.

**Table 1.** The intraclass correlation for the null model

| **Fixed effect** | Coefficient (t) | Odds ratio | 95% CI |
|---|---|---|---|
| Intercept | -0.855(8.492)*** | 0.425 | [0.349 0.518] |
| **Random effects** | | | |
| Countrylevel effect($\mathbf{u_{0j}}$) | 1.280 (Z=7.793)*** | | [0.995 0.518] |
| ICC | 33.24% | | |

*: p<0.05, **: p<0.01, ***: p<0.001.

**Random intercept model with level 1 and level 2 predictors (model 2).** The estimates of the level 1 variables (Table 2) suggest that they are significant variations in the adoption of FinTech services within the both levels. The odds of adopting FinTech services are about 1.179 times higher for males than females, holding other factors constant. Regarding the age group, higher age groups (above 45) are less likely to adopt FinTech services as compared to lower age groups. For an individual, whose income household income is on the higher side have higher probability of adopting FinTech services. Finally, the probability of an individual who has tertiary or more education adopting FinTech service is 30.39% and the probability of an individual who has secondary education adopting FinTech service is 17.07% as compared with the individual having primary education.

**Table 2.** Random intercept model with Level 1 and Level 2 predictors

| | Without control variables | With control variables |
|---|---|---|
| **Fixed effect** | Coefficient(t ) | Coefficient(t) |
| Intercept | -6.184 (-9.616)*** | -4.014 (-3.468)*** |
| Gender | 0.211 (7.599)*** | 0.165 (5.734)*** |
| AgeGroup 65&above | -1.799 (-13.546)*** | -1.691 (-12.336)*** |
| 55-64 | -0.781 (-5.735)*** | -.851 (-6.169)*** |
| 45-54 | -0.209 (-1.707) | -0.352 (-2.883)** |
| 35-44 | 0.227 (1.990)* | 0.076 (0.658) |
| 25-34 | 0.319 (2.755)** | 0.177 (1.506) |
| 18-24 | 0.326 (3.104)** | 0.241 (2.235)* |
| Income Richest 20% | 0.896 (16.387)*** | 0.867 (16.095)*** |
| Fourth 20% | 0.578 (11.570)*** | 0.557 (11.262)*** |
| Middle 20% | 0.392 (8.241)*** | 0.379 (8.001)*** |
| Second 20% | 0.233 (5.361)*** | 0.225 (5.194)*** |
| Education- Tertiary or more | 1.497 (26.174)*** | 1.474 (25.7)*** |
| Secondary | 0.729 (15.149)*** | 0.722 (14.836)*** |
| PR_value | 0.558 (2.895)** | 0.430 (2.444)* |
| Infra_value | 0.231 (2.767)** | -0.106 (-0.992) |
| Bus_usage | 0.670 (13.608)*** | 0.652 (3.078)** |
| **Random effects** | | |
| Country level effect($\mathbf{u_{0j}}$) | 0.769 (Z=7.524)*** | 0.615 (Z=7.323)*** |

*: p<0.05, **: p<0.01, ***: p<0.001. Note: Income classification based on within economy household income quin-tile and base is poorest 20%. Education base is Primary education. Age group base is below 18(15,16,17). Non-significant values and control variable values were omitted in table.

Between countries, political regulatory environment and business usage are positively related to the probability of adopting FinTech services by citizens (0.401, p <.05 and 0.601, p<0.01). This suggests that improving political and regulatory environment

score (e.g., liberalizing the ICT laws) and business usage score (e.g., firm-level technology absorption) increase the probability of adopting FinTech services. An estimate of the other level 2 predictors suggest that they are insignificant in predicting the probability of adoption of FinTech service. Thus, this full model draws support for Hypotheses 1, 2, 3, 4, 5 and 7.

We run two set of sensitivity tests to improve the stability of our results. We replace one of the country-level control variable 'income group' by 'country group'. This helps to group the adoption of FinTech services based on IMF classification of various economies based on their region (e.g. Eurasia). Second, we run a regression on sub-samples where countries were randomly selected. Results show that the effect of individual-level effects on the probability of adoption of FinTech services are more robust and country-level variables show slight deviation.

**Influence of national ICT competitiveness on FinTech services adoption.** The positive effect of level 2 variables on the adoption of FinTech services by individuals suggests that individuals who are in countries with favorable political and regulatory environment for ICT development, favorable ICT infrastructure and higher adoption of ICT by business entities are more likely to have a higher probability of adoption of FinTech products and services. The findings in this study are consistent with the assessment of the world bank. According to the framework developed by the World Bank as a part of universal financial access by 2020 initiative [54], financial and ICT infrastructures, legal and regulatory frameworks, and public and private commitment as the potential critical enablers of the universal access to and frequent usage of transaction accounts. Further, the impact of business usage is significantly positive. Given that the business usage sub-index is an aggregate of various several indicators like firm-level technology absorption, business to consumer internet use, it is not appropriate to compare the direct influences of each indicator on the adoption of FinTech services. However, the nature of the dependent variable (see section 3.1), ensures that this study did more to highlight a convincing influential pattern of several indicators of business usage on adoption of FinTech. ICT Infrastructure of a country also shows a positive influence, which shows that the probability of citizens adopting FinTech services is higher for the citizens in countries having a better ICT infrastructure environment. This can be explained based on the shortage of capital investment in ICT structure in middle income and low-income countries and they could not catch up with the pace in which high-income countries invest in ICT structures [20]. To summarize, national ICT competitiveness demonstrated a stronger influence on the adoption of FinTech services, which highlights the additional evidence for the existence of third-order digital divide (related to ICT outcome) [23, 50,57].

**Influence of individual-level variables on FinTech services adoption.** The overall findings suggest a linkage between level 1 predictor variables and FinTech adoption. Males have higher probability than female to adopt FinTech services. This is consistent with the earlier findings where gender differences impact the adoption and use of ICT [11]. Further, this finding also highlights the growing recognition of a digital divide

based on gender differences [57]. The findings regarding age groups suggest that older adults have lower probabilities of adopting FinTech services with respect to the younger generation. Previous research on the relation between different age groups and internet use was found to be piecewise linear, with younger people tend to more internet enthusiasts than older people [3]. A possible explanation for this digital divide is that the younger generation receives quite a lot of exposure and benefits from the ICT competitiveness of the country [49]. Regarding the socio-economic status variables education and household income level, findings indicate that individuals' having higher education and belongs to higher income levels have a higher probability for the adoption of FinTech services. Previous literature indicates that education undoubtedly has been very significant in influencing technology use [41]. Households' emphasis on better education has fostered awareness and ICT skills which invariably help individuals to adopt and use ICT for their development [39,21]. Yang [58] have identified that income level in a household is one of the crucial determinants on internet penetration and income per capita [10] as a determinant of ICT (mobile or computer) product ownership. To summarize, demographic variables and socio-economic status demonstrated a stronger influence on the adoption of FinTech services. In addition, this study also highlights the additional evidence for the existence of the level 2 variables on the adoption of FinTech services.

## 5 Conclusion

By presenting a multilevel model including both the network readiness variables which represents the national ICT competitiveness and individual-level variables which represent their demography and socio-economic status, this study sheds light on the complex influences of ICT competitiveness on the probability of adoption of FinTech services by a citizen. This study synthesize literature related to diffusion paradigm, the impact of ICT on development of the financial sector and makes following contribution; First, this study adds to the literature by exploring the variation in the adoption of FinTech services using the ICT competitiveness of the country, which was not explored in the previous studies. Such findings would be very helpful in a better understanding of what will be the effect of ICT competitiveness, in this case, role of the political and regulatory environment of a country and assimilation of ICT in business within a country in predicting the adoption tendencies. Second, by employing, a new way to examine the two widely recognized indices to assess the FinTech services adoption, this study encompasses a broad spectrum of subjects across countries. Third, we used GLMM to analyze both the individual-level and country-level variables to explain the adoption of FinTech services while accounting for the variance at each level (nested model). In terms of practical implication, the study points out a direction for national policymakers in providing a favorable political and regulatory environment as well for the FinTech firms to channel their innovation. Moreover, demographic and socio-economic status have a major influence in explaining the variation in the probability of FinTech service adoption. As a result, the findings are of particular importance for FinTech firms and national level policymakers.

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