Questioning the Efficiency of Fintech and Financial inclusion in Reducing the Gender Gap: an International Quantile Analysis

# Abstract

***Purpose***

This study investigates whether Fintech reduces gender inequality through active financial inclusion activities, such as i) Borrowing and ii) Saving; or whether pre-existing social constraints limit financial inclusion to only Access activity, iii) such as opening an Account.

***Design/methodology***

This study utilizes Quartile OLS regression analysis for a sample of 147 countries in 2011- 2021.

***Results***

Empirical results show that Fintech enhances the propensity of females to be financially included through Account ownership, Savings and Borrowing. However, a reduction in gender inequality is only realized to an Access form of financial inclusion (Account ownership), not Active forms which can enhance social mobility (Borrowing and Saving). Results are consistent when the sample is partitioned by time and country-level income, development stage, and when machine learning approaches are applied.

***Contribution***

To the best of our knowledge, this is the first study to identify that pre-existing social constraints associated with access to equity mitigate Fintech’s effect in reducing gender inequality. The result speak to the action that is required to normalize Active financial inclusion opportunities amongst females to reduce the gender gap. As a result, the study contributes to international policymaking debates and extends the finance and sustainability literatures.

**Keywords**: Gender inequality; Financial Inclusion; Fintech; Policymaking; Sustainability

# Introduction

Many argue that new technologies such as Fintech have the potential to reduce gender inequality. Song et al. (2024) argue that Fintech algorithms remove gender biases from the decision-making process of financial institutions. Loco & Yang (2022) assert that Fintech can reduce gender inequality, because it has the potential to remove some restrictions embedded in traditional financial services. In support of this view, Yeyouomo et al. (2023) note that Fintech may narrow the gender gap, by reducing disparities in both access and usage of financial services. On the other hand, critics argue that Fintech technology’s effect in reducing gender inequality may be limited. Kömürcüoğlu & Kömürcüoğlu (2025) provide evidence that Fintech does not reduce gender inequality. Sparks & Eckenrode (2020) surmise that Fintech has the potential to narrow the class and rural divide, but has no significant impact on the gender gap. Taken together, different perspectives exist in the literature pertaining as to whether, or not, Fintech may reduce gender inequality. To address this academic tension, this study’s primary research objective is to answer the following question. *Does Fintech reduce gender inequality, through financial inclusion (access/usage)?*

We have several motivations to conduct this study. First, Demir et al. (2022) argue that increasing financial inclusion/participation (Account access, Borrowing and Saving), has the potential to lead to lower levels of income inequality. Moreover, Kanga et al. (2021) argue that Fintech has the potential to enhance financial inclusion through technology diffusion (Kanga et al., 2021). However, many argue that there is no guarantee that financial inclusion will reduce income inequality (Kling et al. [2021](https://www.tandfonline.com/doi/full/10.1080/1351847X.2021.1981418); Lashitew et al., 2019; Tian & Kling, 2021). Carlsen (2022) asserts that income inequality stems from unobservable constraints. Expanding on this idea, Chen et al. (2023) and Cheah et al. (2021) explain that women are comparatively less likely to adopt Fintech services. The literature can therefore be interpreted as follows. Fintech has the potential to reduce income inequality. However, there is the potential that pre-existing social constraints associated with female financial inclusion, may limit the effect of Fintech in reducing gender inequality. Disentangling which situation is more likely can contribute to knowledge, by extending sustainability debates.

Second, the World Bank stipulates that opening an i) Account is the first step to use other financial services1. Opening an Account is recognized as an Access (passive) form of financial inclusion. The next step in achieving social mobility is ii) Borrowing, and the final step is recognized as iii) Saving. Both are Active forms of financial inclusion, that require increasing amounts of equity. Previous studies infer that Fintech technology increases the propensity of firms to open an Account, due to the ease of access to financial services through internet banking (Arner et al., 2018; Ansar et al., 2018 ; Demir et al., 2022). However, whether Fintech has the potential to increase financial inclusion through Active opportunities that require increasing levels of equity, is a question left unanswered. Evidence that Fintech’s effect in promoting financial inclusion is lower for activities that require increasing levels of equity, contributes to knowledge by providing nuanced interpretations. More specifically, by introducing the supposition that access to equity can be the pre-existing social constraint, which limits Fintech’s effect in reducing gender inequality.

Third, gender inequality is more prevalent in developing, low-income countries, compared to developed economies (Jain-Chandra et al., 2017; Demirgüç-Kunt et al., 2015). Tang (2022) acknowledges that in developing countries, gender inequality may stem from financial exclusion. Kara et al. (2021) provide evidence that females are more likely to be rejected from financial services, deprived from formal credit, and pay higher cost. In this regard we are motivated to investigate whether the impact of Fintech on gender inequality through financial inclusion is different across countries with differing levels of gender inequality. Whether countries with differing gender inequality levels would be impacted differently or similarly, by Fintech and financial inclusion, based on the gender inequality at country-level is a question left unanswered. To contribute to knowledge, we partition our sample based on gender inequality levels (10th, 25th, 75th, 90th percentiles), to capture the effect of Fintech and financial inclusion on gender inequality. Evidence that the impact of Fintech and financial inclusion on gender inequality is similar/dissimilar across regions with different gender inequality, would contribute to knowledge, by indicating the extent to which the phenomenon is isolated to high gender inequality regions, or a universal problem.

Fourth , we are motivated to contribute to policy debates. Gender equality is considered one of the most important objectives of the United Nations (UN). The G20 High-Level Principles for Digital Financial Inclusion (G20-HLP-DFI) is considered as a policy to enact the UN’s gender equality objectives, by promoting the financial inclusion of females (Fu and Ghurani, 2025). G20-HLP-DFI identifies Fintech as a driver to meet these joint objectives. Evidence that Fintech’s effect in reducing gender inequality is constrained by pre-existing social constraints, can speak to policy debates. More specifically, if barriers associated with equity acquisition limit the participation of females in Active financial inclusion activities, that promote social mobility (Saving and Borrowing), Fintech may not be the solution that policymakers hope. This view is consistent with Kaplinsky and Kraemer-Mbula (2022), who argue that a pivot in techno-economic paradigms, equally require complementary societal-level changes. Fifth, in an instance where empirical results imply that Fintech’s effect in reducing gender inequality is limited by financial inclusion, we are motivated to provide a normative perspective about how education can be a policy/action to reduce the gender gap.

Using data for a sample of 147 countries over the 2011-2021 period, the results of machine learning techniques and quartile OLS regression provide evidence that Fintech promotes financial inclusion. More specifically, through the availability of a phone banking app, more females are able to open an Account (Access) and engage in Borrowing and Saving (Active). However, when we investigate Fintech’s effect in reducing gender inequality, through financial inclusion, empirical findings show that results are only significant in terms of opening and Account. For Active inclusion activities such as Borrowing and Saving, results remain inconsistent. The results suggest that pre-existing social constraints associated with access to equity mitigate the effect of Fintech in reducing gender inequality. When the sample is divided by time, income level, region, and development stage, the results remain indifferent. In summary (1) Fintech increases gender inequality, (2) gender inequality is only reduced through Access (Account ownership) and not through usage (Saving and Borrowing). Results are consistent when the sample is partitioned into quartiles based on country-level gender inequality. Taken together, the results suggest that Fintech may not be the solution perceived by legislators in reducing the gender gap. To avoid unnecessary repetition, the contributions associated with these findings are discussed in detail in section 6.

The remainder of the paper proceeds as follows. In section 2, relevant literature is reviewed, and hypotheses are introduced. In section 3 we introduce the research methodology. In section 4, descriptive statistics and empirical results are presented. Additional analysis is presented in section 5. Finally, contributions are introduced in section 6. Moreover, areas of future research, policy suggestions, and limitations are discussed.

# Literature review

*Fintech and financial inclusion*

In Honohan’s (2005) seminal study, two core dimensions of inclusive finance are introduced, based on demand and supply. In the 2010s, these dimensions are extended into three categories, specifically (i) Penetration, (ii) Access or Availability, and (ii) Usage (Kumar, 2013; Mukhopadhyay, 2016; Sarm, 2016). More recently, financial inclusion measurement has been conceptualized in terms of Access to financial services (Accounts Ownership), and Active usage (Borrowings and Savings). Demir et al. (2022) provide empirical evidence that Fintech increases Access and Active financial inclusion. Similarly, Ansar et al. (2018) emphasizes this view, stating that Fintech enables underbanked populations to access the financial system. However, as is indicated by the world bank, the next step in financial inclusion is participating in Active usage, which includes services such as Savings and Borrowing1. As discussed in numerous studies, Active financial inclusion refers to the use of financial products such as savings, credit and deposits, which promote social mobility (Ambarkhane et al., 2016; Beck et al., 2007b; Honohan, 2008; Kim, 2016).

The effect of Fintech on financial inclusion is perceived from two perspectives in the extant literature. Firstly, proponents assert that Fintech innovations serve as an important driver of financial inclusion (Ghosh, 2016; Ha et al., 2021; Jack and Suri, 2011; Mbiti and Weil, 2015; Pal et al., 2021; Tchamyou et al., 2019; Tchidi et al., 2025). Fintech is shown to reduce homosexuality bias in Africa (Kabengele & Hahn, 2025). Empirical studies show that households adopting Fintech solutions, for example mobile money services, are more likely to own bank accounts, engage in sending and receiving remittances, and accumulate savings (Jack & Suri, 2011; Mbiti & Weil, 2015; Morawczynski, 2009; Ouma et al., 2017). Moreover, it is recognized that Fintech innovations offer new opportunities to mitigate these inequalities by facilitating financial inclusion by expanding financial access to financial services, facilitating entrepreneurship, and lowering the barriers of entry into labor markets (Bayrakcı & Köse, 2019; Demir et al., 2022; Guo et al., 2021). Digital credit platforms enhance female participation in financial services by enabling women entrepreneurs to access credit independently from traditional banking systems. Similarly, mobile payment systems provide non–bank individuals entry points into the formal financial system (Komürcüoğlu & Komürcüoğlu, 2025). Similarly, as explained by Philippon (2019), Big Data tools utilized by Fintech are reported to provide access to the credit market on a non-biased basis. Bartlett et al. (2018) report that Fintech reduces negative prejudices, with algorithms discriminating 40% less than face-to-face lenders. Moreover, according to Berg et al. (2020, 2019), Fintech algorithms have more predictive power that matches or exceeds traditional face-to-face lenders or credit bureau scores. Taken together, evidence exists to argue that Fintech enhances financial inclusion.

On the other hand, some critics argue that Fintech does not have a positive effect on financial inclusion. Whilst Fintech lenders could serve more creditworthy borrowers, it is reported that they charge higher interest rates, typically in the region of 14-16 basis points (Buchak et al., 2018). It is argued that this outcome has two consequences: (1) Potential borrowers are deterred by the high interest rate and, hence, would be financially excluded; (2) Borrowers who accept higher rates would enter a vicious cycle of over-indebtedness. In a similar fashion Bartlett et al. (2018) reports that Fintech is found to be no different, compared to traditional lenders, in charging minorities a higher rate for mortgages and refinancing. Furthermore, Ediagbonya & Tioluwani (2023) surmise that despite the increasing use of Fintech in digital platforms by government, regulators and financial institutions, there is still a noticeable increase in the financial inclusion gap. Taken together, it can be argued that whilst Fintech has potential to enhance financial inclusion, this view is not accepted in the extant literature.

*Financial inclusion and Gender inequality*

Many argue that providing females access to the financial system can reduce poverty, hence reduce the gender gap (El Zoghbi et al., 2019; Klapper et al., 2016). However, Kara et al. (2021) reports that in emerging countries, females face a higher likelihood of being excluded from Active

financial institution inclusion activities, such as Borrowing. It is also recognized that females are often required to pay higher interest rates. Morsy (2020) explains that to an education gap is a potential why females face a less favorable borrowing situation in developing countries. This view is reiterated by Rao (2015), who surmises that a lack of educational attainment coupled with lower financial literacy, could lead women to being less confident in filling loan applications, hence, more vulnerable to resorting to unfavorable and exploitative lending practices. Ghosh and Vinod (2015) envision that a solution to the gender inequality problem, can be the development of opportunities for educational attainment to enhance financial literacy, hence financial inclusion. The literature therefore infers that education may be a social constraint which can be a barrier to gender equality.

It is established that because financial institutions are profitmaking, groups perceived to be of higher risk are financially excluded, or are required to pay higher interest rates (Aitken, 2014; 2010; Guérin et al. 2014; Mader, 2013). Giron et al. (2014) report that gender affects the financial inclusion opportunities that are available to male/females. More specifically, they find that females are excluded from formal Saving opportunities that are available to males. Dang and Nguyen (2021) provide a reason to explain why females have lower access to financial inclusion opportunities. More specifically, they report that females are more likely to permanently lose their jobs, compared to men, and have their income fall by 50% more than men. This study speaks to the unobservable social constraints that may exist in society, which reduce the potential to access equity to engage in Active financial inclusion. Taken together, the literature can be interpreted as follows. Financial inclusion may benefit society by reducing gender inequality. However, whether such benefits can be enacted through Fintech remains a question left unanswered.

*Fintech and Gender Inequality*

Fintech’s role in promoting gender equality is interpreted from two perspectives in the extant literature. Firstly, Tripathi and Rajeev (2023) find that Fintech is a significant technological development which allows females access to financial services, conveniently on mobile phones. The use of Fintech credit algorithms are also shown to significantly increase loan approvals, hence reduce gender inequality in bank loans. For example, Song et al. (2024) report that female loan approval rates improved by 8% when Fintech algorithms were adopted by banks. The same study shows that the effect is more substantial for banks with higher baseline gender bias in credit decisions. Fintech, with its utilization of algorithms and big data, is also shows to have the potential to reduce gender bias in credit decisions, and hence promote financial inclusion (Makina, 2019; Ozili, 2021; Purda & Ying, 2022). By relying on algorithms and machine learning, Fintech companies can be perceived to avoid human biases in traditional credit decision-making processes (Johnson et al., 2019; Lui & Lamb, 2018; Packin & Lev-Aretz, 2018). In particular, many argue that algorithms can be designed to use a broader range of data sources, including non-traditional ones such as social media and online shopping patterns, which can capture a more comprehensive picture of an individual’s creditworthiness (Hurley & Adebayo, 2016; Makina, 2019; Peng & Zhu, 2021; Purda & Ying, 2022; Sadok et al., 2022). In summary, an argument exists in the literature which infers that Fintech can has the potential to reduce gender inequality.

Second, Kömürcüoğlu & Kömürcüoğlu (2025) provide evidence that whilst Fintech reduces male and female unemployment rates, it does not offer sufficient opportunities to reduce gender inequality. Sparks & Eckenrode (2020) claim that whilst Fintech is revolutionizing finance, there is no consideration of the significant gender imbalance that exists in society. Fintech is also argued to be having a narrowing impact on the class and rural divide, but no impact on the gender divide (Tok & Heng, 2022).Within the Fintech industry, the few studies on gender inequalities that exist provide evidence of striking disparities. In the UK, women account for 28% of the Fintech workforce (Kimber, 2023), with 17% of senior Fintech roles taken up by females (Fox-Robertson & Wojcik, 2024). Sparks & Eckenrode (2020) reported that only 12.2% of the 3,017 Fintech startups in 2019 had at least one-woman (co-)founders. The challenge to gender inclusion for borrowers and within the Fintech industry is identified by Demir et al. (2022), who argues that a collective challenge exists that holds the Fintech ecosystem accountable, to make it a more inclusive, equitable, and attractive environment for females.

Taken together, the literature can be summarized as follows. Fintech technology is likely to promote females’ financial inclusion. More specifically, the establishment of mobile banking apps are likely to allow a greater number of females open an Account at a financial institution. We also envision that Fintech technology will allow females the opportunity to participate in Active forms of financial inclusion (Borrowing and Saving). However, due to preexisting inequalities that exist in society, we only expect that Fintech technology will reduce gender inequality through Access forms of financial inclusion. More specifically, there can be an expectation that when females are able to access online banking, numerous benefits can be enjoyed. On the other hand, we do not expect that Fintech will have a negative impact on gender inequality through Active financial inclusion. More specifically, due to (perceived) education and employment constraints, females are less likely to have access to equity. As a result, females are less likely to be able to participate in financial inclusion activities that promote social mobility, such as Borrowing and Savings. Based on the above, the following hypotheses are introduced:

* 1. *Fintech will reduce gender inequality through financial inclusion in terms of Access (Account ownership)*

*H.2. Due to societal constraints, Fintech may not reduce gender inequality in terms of Active usage (Borrowing and Saving).*

# Research Methodology

*Model*

We borrow from the model introduced by Demir et al. (2022), which is adapted from Altunbas & Thornton (2019). The former investigates the potential income inequality reducing effect of financial inclusion. The latter focuses on the impact of financial development on income inequality. Model (1) is different, as it focuses specifically on the impact of i) Female Fintech adoption can have on reducing ii) Gender inequality (within-country), through iii) Financial Inclusion. A visual representation of the study’s main regression Model (1) is illustrated below:

*GIi,t* = *α*0 + *α*1*Fintechi,t* + *α*2*FinancialInclusioni.t* + Σ*K ρk Xk,i,t* + *Ui,t* (1)

*k*=1

*<*Insert Table 1 here*>*

A list of variable definitions is listed in Table 1. As shown in Panel A, the dependent variable, *GII*, refers to values presented in the Gender Inequality Index. As defined in the Human Development report[[1]](#footnote-1), *GII* is a composite metric of gender inequality using three dimensions, i) reproductive health, ii) empowerment and iii) the labor market. A low GII value indicates lower inequality between women and men, and vice-versa. *GII* is an established measure to indicate gender inequality in the extant literature (Ohiomu & Ogbeide-Osaretin, 2019; Seth, 2009). Borrowing from Demir et al. (2022), *Fintech* is an empirical representation of the percentage of females that are over 15, which have used their phone to pay bills (% age 15+). A negative association between *Fintech* and *GII*, infers that female Fintech adoption reduces gender inequality. A positive association would infer that Fintech increases the gender gap.

To recognize the effect female *Fintech* adoption can have on *GII*, through financial inclusion, Model (2) is introduced to capture the mediating impact of *FinTech* on *Financial Inclusion*. *Financial˙Inclusion* metrics are listed in Panel B. Utilizing Allen et al’s. (2016) approach, *Financial˙Inclusion* is captured empirically as the percentage of females aged 15 and more who have an i) *Account,* have ii) *Saving(s)* iii) and *Borrowing(s)* at a financial institution. If the association between *Financial˙Inclusion* and *Fintech* is positive in Model (2), and the association between *Fintech* and *GII* is negative in equation (1), it would infer that financial inclusion is not a factor which mitigates the effect of Fintech on GII. If *Financial˙Inclusion* does mitigate the effect of *Fintech* technology on *GII*, the association between *Fintech* and *GII* would be positive in equation (1). As explained above, we expect the former association with access financial inclusion opportunities such as opening an *Account* (H.1.), and the latter association with active saving opportunities such as *Borrowing* and *Saving*, *H.2.* All Financial Inclusion data is obtained from The Global Financial Inclusion index (Global Findex).

*Financial˙Inclusion i,t* = *α*0 + *α*1*Fintechi,t* + Σ*K ρk Xk,i,t* + *Ui,t* (2)

*Control variables*

The following independent variables are added as controls in models (1) and (2) (*Education,* *Redistributive Policies, Trade, Population Growth, GDP Growth, GDP, and Institutional Quality see Table 1)*. *Education* is a critical determinant of financial inclusion and a mitigator of inequality. Education can improve income levels of women (Pahlevan Sharif et al., 2023; Riddell & Song, 2011), increase financial access (Lotto, 2018; Morgan &Trinh, 2019), reduce poverty levels and, by extension, reduce financial inequalities ([Neaime & Gaysset,](#_bookmark56) [2024; Neaime & Gaysset, 2018).](#_bookmark56) *Education* is expected to have a negative association with *GII*, and a positive relationship with *Financial Inclusion*. Similarly, *Redistributive policies* such as taxes and transfer systems (Guillaud et al., 2020; Zucman, 2019), social welfare programs (Demirgüç-Kunt et al., 2020; Acemoglu & Robinson, 2013), and subsidies (Bazzi et al., 2021; Piketty, 2014) have been associated with gender inequality and financial inclusion. Properly targeted (and implemented) *redistributive policies* could lead to increased financial access and thus reduce financial inequalities (Bazzi et al., 2021; Auclert, 2019). *Redistributive Policies* are therefore predicted to have a negative association with *GII,* and a positive relationship with *Financial Inclusion*.

Another key control variable, *Trade,* is associated with financial inclusion and gender inequality through its effects on labor markets and economic integration (Autor et al., 2016; Porto & Conti, 2020). While trade openness may widen inequality by favoring skilled labor (Chinoda & Mashamba, 2021; Jaumotte et al., 2013), it can also stimulate job creation and financial access. *Trade* is expected to have a negative association with *GII*, and a positive relationship with *Financial Inclusion*. In contrast, *Population Growth* can increase income disparities, by straining resources [(Ashraf et al., 2021; Neaime & Gaysset,](#_bookmark56) 2024). Therefore, *Population growth* is expected to have a positive association with *GII*, and a negative relationship with *Financial Inclusion*.

There is evidence that GDP growth is associated with reductions in inequality and financial inclusion [(Beck et al.,](#_bookmark10) [2008).](#_bookmark10) However, this relationship is not unidirectional indicating that financial development may initially worsen inequality before long-term improvements (Greenwood & Jovanovic, 1990). *GDP growth* is therefore expected to have a positive association with *GII*, and a negative relationship with *Financial Inclusion*. On the other hand, GDP per capita directly improves financial inclusion (Demirgüç-Kunt & Klapper, 2012). However, equitable growth policies are critical for reducing inequality (Cuesta & Agostino, 2021; Dabla-Norris et al., 2015). *GDP* *per capita* is predicted to have a negative association with *GII*, and a positive relationship with *Financial Inclusion*. Finally, investments in financial markets are shown to play an instrumental role in redistributing economic resources and promoting long-term productivity [([Beck et al.,](#_bookmark10) 2008; Merton & Bodie,](#_bookmark50) [1995)](#_bookmark50). Thus, there is an expectation that *Institutional Quality* can have a negative relationship with *GII*, and a positive relationship with *Financial Inclusion.*

*Sample Selection*

While the control variables are available on a yearly basis, GII data is only available on a three year ‘wave’ basis (2011, 2014, 2017, 2021). Therefore, the analysis consists of data observations included in these waves. Based on data availability, the sample consists of 147 countries.

# Empirical results

*Descriptive Statistics*

Table 2 provides summary statistics (after data cleaning). For the sample of 145 countries, there are a total of 580 observations, across the 4 waves. Total countries after cleaning the data for missing values for each wave are (2011 (104), 2014 (89), 2017 (80), 2021 (47)) 318 observations. Because the number of observations is large, we report untabulated results for country specific determinants. Denmark is recognized as having the lowest level of gender inequality (2021), as well as the highest level of female Fintech adopters. With regards to Financial Inclusion, the country where females have the highest level of Account ownership is Canada. Females in Sweden are shown to have the highest levels of Saving and Borrowing. Panama is recognized as possessing the highest level of gender inequality. The lowest in terms of female Fintech adoption, Borrowing, Savings and Account ownership, are Turkmenistan, Algeria, Yemen and Turkmenistan respectively.

*<*Insert Table 2 here*>*

We report untabluated results that the Max-Min range levels for female Fintech adoption; all three Financial Inclusion measures; and GII are different based on country’s income status. The association between gender inequality and income is delineated is delineated in Figure 1. Figure 1 reports that as a country’s income group decreases, gender inequality increases. Figure 2 provides details about the association between county level income, i) % of females that have adopted Fintech, and those who have ii) an Account, ii) Saving(s), or iii) Borrowing from a formal financial institution at a specific country.

*<*Insert Figure 1 here*>*

*<*Insert Figure 2 here*>*

Figures 2, a-d indicate that lower income countries suffer lower female Fintech adoption, and that females face lower access to Accounts, Savings and Borrowing. On the other hand, countries classified in higher income groups enjoy higher Fintech adoption, and higher levels of Accounts, Savings and Borrowing. Both Figure 1 and 2 highlight how low-income economies suffer from higher gender inequality. These descriptive statistics raise an important question. More specifically, what can be the differential effect of Fintech, on gender inequality, through financial inclusion, based on a country’s gender inequality status. This constitutes the substance of the quantile analysis conducted in Table 8, formally assessing whether the impact of Fintech and financial inclusion on gender inequality is equal/different, based on country partitioning.

*Correlation test*

Table 3 provides the results of Pearson correlations. As expected, there is a strong negative association between *Gender Inequality* (GII), *Fintech* (-0.176\*\*) and *Account* (-0.597\*\*\*), *Savings* (-0.446\*\*\*), *Borrowing* (-0.368\*\*\*). *Fintech* is an empirical representation of the percentage of females that are over 15, which have used their phone to pay bills (% age 15+). *Financial˙Inclusion* is captured empirically as the percentage of females aged 15 and more who have an i) Account, have ii) Savings iii) and Borrowing at a financial institution, using mobile technology. Therefore, there is the potential for a multicollinearity problem to influence the results.

To exclude the potential of a multicollinearity problem, we conduct Variance Inflation Factor tests for the model and each variable. We report untabulated results that for all variables in the model, VIF scores are lower than 2. This result suggests that multilinearity is not a concern for the model.

*<*Insert Table 3 here*>*

*Economic Strategy*

This study investigates if financial inclusion is mediating the effect of Fintech on gender inequality. We also use different measures of financial inclusion and test how they affect gender inequality. The empirical strategy proceeds as follows: (1) Run *t* test to evaluate the presence of gender inequality, gender gap in Fintech adoption, financial access (Account ownership) and financial use (Saving and Borrowing) (2) Test how Fintech affects financial inclusion using pooled OLS regression (model 2); (3) Examine the effect of Fintech on gender inequality in Model (1). We then include in the model control variables that have been found to affect gender inequality, and check if the coefficient on Fintech changes significantly. Finally, we add financial inclusion proxies into the model and examine how this measure affects gender inequality. (4) Next, we run quantile regressions to examine the potentially differential effects of Fintech and financial inclusion can have on gender inequality across countries with different levels of gender inequality.  
(5) We run three robustness checks including : (a) an endogeneity test, (b) panel year, income, and development stage’ fixed effects models, and (c) machine learning algorithms to evaluate the importance of the variables in affecting gender inequality.

*Main results*

Table 4 provides mean levels of male/female Fintech adoption, and t-tests, comparing the usage of financial services. The adoption of Fintech for males and females is not different. However, there is a statistically significant difference between males and females in terms of Financial Inclusion proxies (Account, 0.003\*\*\*, Saving, 0.001\*\*\* and Borrowing, 0.000\*\*\*). In Table 5, it is recognized that a male-female gender gap exists (GII 0.000\*\*\*). Taken together, descriptive statistics provide evidence consistent with pervious studies that acknowledge the existence of gender inequality in society.

*<*Insert Table 4 and 5 here*>*

In Table 6, we report the results from model (2), which captures the effect of female Fintech adoption on Financial Inclusion measures. Empirical results show that female Fintech adoption increases financial inclusion via three measures: Account (0.134\*\*\*) , Saving (0.270\*\*\* ) and Borrowing (0.428\*\*\*). These results are consistent with previous research which argue that Fintech has a positive impact on both Access and Active forms of financial inclusion (Bartlett et al., 2018; Berg et al., 2020; Buchak et al., 2018; Jack &Suri, 2011; Ghosh, 2016; Gosavi, 2018; Mbiti &Weil, 2015; Morawczynski, 2009; Ouma et al., 2017; Tchamyou et al., 2019).

*<*Insert Table 6 here*>*

Table 7 presents the results of the main regression analysis, model (1), which investigates the impact of Fintech and Financial Inclusion, on GII. In the first column, GII, is regressed on Fintech only. In the second column, control variables are added to the regression. The results show that in the first column, Fintech significantly reduces GII (-0.035 \*\*\*). However, Fintech starts to increase gender inequality once the control variables have been added. This indicates that other control variables (institutional quality, Education, trade, GDP ) have higher predictive validity and are more influential in reducing gender inequality, as compared to Fintech adoption.

*<*Insert Table 7 here*>*

In the third, fourth, and fifth columns, financial Inclusion proxies are added. For all models, empirical results imply that that Fintech adoption increases gender inequality, rather than reducing it. However, Account ownership significantly decreases gender inequality (-0.067\*\*\*). Interestingly, there is no significant impact on *Borrowing* and *Savings* on *GII*. We interpret the results as follows. Opening an Account is the financial inclusion measure that requires the lowest level of equity for participation. Active forms of financial inclusion, such as Borrowing and Savings require higher levels of equity. The results therefore infer that Fintech provides females an opportunity to open an Account, consistent with H.1. However, due to pre-existing social constraints, Fintech technology alone may not be sufficient to enhance the social mobility of females through Borrowing or Savings, consistent with H.2.

Next, we examine whether the impact stated above varies across countries, with different gender inequality levels, based on the 10th , 25th , 50th , 75th and 90th percent quantiles. The 10th quartile indicates the lowest levels of gender inequality. The 90th quartile represent the highest level of gender inequality. To the best of our knowledge, whether through *Fintech*, *Financial Inclusion* reduces *GII*, regardless of the country-level gender inequality, is a question left unanswered. The result from this analysis is presented in Table 8.

*<*Insert Table 8 here*>*

The first five columns report the regression results for the propensity of females to open an Account. The signs of the quantile regression are consistent with the results in Table 7, indicating that an increase in the proportion of the population with an account at a formal financial institution is associated with a reduction in gender inequality, at all quantiles of the gender inequality partitioning. We also note that the Account ownership effect in reducing GII diminishes in countries with high gender inequality. The results also show how Fintech becomes more significant in increasing gender inequality, especially in countries with higher gender inequality (75th and 90th quantile).

The second five columns (6-10) and third five columns (11-15), provide results regarding the impact of Saving and Borrowing on GII across the 5 quartiles of gender inequality. The results show an insignificant impact of both metrics on gender inequality. This is in conformity of the aggregate results obtained in Table 7. The results also reiterate the role of Fintech in increasing gender inequality, especially in countries with higher gender inequality (75th and 90th quantile). From this quartile analysis and the aggregate results in Table 7, it is apparent that Financial Inclusion can reduce gender inequality is terms of access to Account ownership, but not in terms of active usage through Saving and Borrowing, consistent with H.1. and H.2. The results also reiterate that the gender inequality increasing effect of Fintech is more significant in countries with higher gender inequality.

1. *Robustness Checks*

The fifth step is to run three robustness checks. More specifically: (a) endogeneity testing, (b) year, country-level income, and development stage fixed effects models, and (c) machine learning algorithms.

*Endogeneity test*

To ensure that Fintech and the financial inclusion metrics are free from endogeneity, we follow the model of Demir et al. (2022) which includes (a) Fixed Broadband Penetration’ and (b) Mobile phone subscription as instrumental variables. The Wu-Hausman test seeks to identify if there is a significant difference between the coefficients from the OLS estimate and the two stage least squares estimates (2SLS) which uses the instrumental variables. For the main explanatory variables not to be endogenous, the Wu-Hausman test p-value needs to be greater than the critical value of 5%. A test value that of *<*5% would indicate a significant difference between the two types of regression. A value that of *>*5% would indicate that there is no significant difference between the two regressions and hence the OLS regression provides consistent estimates. The results in line one from Table 9 indicate that Fintech is not an endogenous variable in impacting gender inequality, when included along the financial inclusion variables: Account ownership, Saving and Borrowing. Similarly, row 2 indicates that the Financial Inclusion variables: Account ownership, Saving and Borrowing are not endogenous variables in impacting gender inequality when included alongside the Fintech variable. The above provide evidence that the model is free from endogeneity concerns.

*<*Insert Table 9 here*>*

*Fixed effects: Time, Income group, Development stage*

Next, we investigate whether results are consistent after controlling for i) a countries’ income level, ii) time-period, and iii) country development stage. In the first analysis, years in waves relating to 2011, 2014, 2017 and 2021, are allocated a dummy variable for each year (1), 0 otherwise. In the second analysis, developing countries are assigned a value of 1. Developed countries are assigned a value of 0. In the third analysis, dummy variables are assigned a 1/0 dummy variable based on lower, lower-middle, and higher-middle income, and high income status. When we introduce these additional dummy variable controls into model, untabulated results remain qualitatively indifferent, adding additional robustness to our analysis.

*Machine learning*

Machine learning (ML) analysis investigates the impact of Fintech’s effect on GII through Financial Inclusion. Table 10 compares 10 ML models, and identifies the best model for each regression, based on their R2. In our initial analysis, the Extra Trees Regressor (ET) model is found to be superior in accuracy, compared to the remainder of the ML modules.

*<*Insert Table 10 here*>*

Figure 3 shows the results of the variables importance, followed by the features selection. The purpose of the variable importance approach is to rank variables in terms of their significance, while the feature selection help isolate non-significant factors. The results in Figure 3 are consistent with the results obtained in Table 7 and 8. Namely, variables importance figures show that Account ownership is higher, compared to Saving and Borrowing in terms of impacting gender inequality. This is further confirmed by the features selection graphs. Account ownership is ranked as feature 2, while the features selection stops at 8. On the other hand, Saving is ranked 5th, while the features selection stops at the fourth variable. Similarly, Borrowing is ranked 7th, while the features selection stops at the sixth variable. These results provide additional support to previous results, that Account ownership is the only financial inclusion metric to impact gender (in)equality. Again, these results add support to H.1. and H.2.

*<*Insert Figure 3 here*>*

# Conclusion

This study makes numerous important contributions to knowledge. First, there are disagreements regarding the impact of Fintech in promoting financial inclusion. Proponents argue that Fintech promotes financial inclusion, through enabling customers to have greater to access to financial services, and by extension usage (Ansar et al. 2018; Arner et al., 2018; Demir et al., 2022; Ghosh, 2016; Jack & Suri, 2011; Mbiti & Weil, 2015; Tchamyou et al., 2019). On the other hand, critics argue that Fintech’s effect in promoting financial inclusion is limited (Bartlett et al., 2018; Komürcüoğlu & Komürcüoğlu, 2025; Philippon, 2019). Consistent with former assertion, we extend the literature with evidence that on an international basis, Fintech promotes financial inclusion for females in terms of Access (opening and Account), and Active services (Borrowing and Saving).

Second, Carlsen (2022) argues that Fintech’s effect in reducing inequality is now well-understood in the extant literature. Many argue that Fintech has the potential to reduce gender inequality, through the use of algorithms, which reduce inherent biases that prevent access to financial services (Johnson et al., 2019; Lui & Lamb, 2018; Packin & Lev-Aretz, 2018; Song et al., 2024; Loco & Yang, 2022). On the other hand, it is argued that Fintech may not be instrumental in reducing gender inequality, due to social constraints (Kömürcüoğlu & Kömürcüoğlu 2025; Sparks & Eckenrode, 2020). Our empirical results offer nuance to extend these interpretations. More specifically, we provide empirical evidence that in an instance where females open an Account, Fintech can reduce gender inequality. However, Fintech is shown to not enact a reduction gender inequality through active forms of financial inclusion that enhance social mobility (Borrowing and Saving). We interpret the results as follows. There is the potential for the algorithms used in Fintech may reduce biases. However, the social inequality that females are likely to face as a result of restricted access to equity, may not be overcome by Fintech adoption alone. In summary, we surmise that social inequality is an inherent limitation to Fintech technology’s effect in reducing the gender gap.

Third, prior to this study, the incremental effect of financial inclusion and female Fintech adoption on gender inequality, regardless of the country-level gender inequality, remained a question left unanswered. We report that regardless of gender inequality partitioning, Account opening is the only financial inclusion activity which reduces gender inequality. Interestingly, for those countries classified as possessing lower levels of gender inequality, female Fintech adoption is shown to not have an incremental effect on gender (in)equality. On the other hand, in high gender inequality countries, female Fintech adoption is shown to increase gender inequality. This finding adds further support to our assertion that equity unavailability is the social constraints that mitigates the effect of Fintech in reducing gender inequality. The study also contributes to knowledge by inferring that in countries with higher gender inequality, Fintech technology may exacerbate the gender gap.

As explained in the introduction, a key goal of the UN2030 Agenda for Sustainable Development (UN-2030-ASD) is the promotion of gender inequality. An associated policy is the G20 High-Level Principles for Digital Financial Inclusion (G20-HLP-DFI), which aims to increase financial inclusion through innovative technologies such as Fintech. There is an expectation that UN-2030-ASD’s gender inequality objectives will be enacted by G20-HLP-DFI’s vision that financial inclusion through Fintech technology will reduce the gender gap. However, our results suggest that at this time, Fintech’s effect will have a limited effect in achieving this objective, due to aforementioned constraints.

Fourth, a normative perspective is introduced, to explain how interventions may be adopted to enhance Fintech’s effect in reducing gender inequality, through financial inclusion. Lotto (2018) argues that education is a key factor for equitable access to finance. Neaime & Gaysset (2024, 2018) suggest that access to education will reduce poverty levels, and by extension, financial inequalities. Many argue that educated individuals are more likely to secure higher-paying jobs, save surplus income, and qualify for financial products such as credit (Spath & Schmid, 2018; Riddell & Song, 2011). Thus, we posit that for Fintech to reduce the gender gap, barriers that constrain female’s access to equity would need to be removed in the first instance. If such an aspiration was successfully enacted, Fintech’s positive effect in reducing the gender gap may be manifested.

Finally, we introduce a limitation. We approach this study from the theoretical perspective that male and females are equal in every sense. The study ignores that females may prefer to adopt paternal roles as mothers, and therefore simply may not have an inclination for Active financial inclusion opportunities such as Saving and Borrowing. A different interpretation of our results can therefore be, females may have less of an inclination to engage in active financial inclusion, due to roles as primary care givers. Future studies may investigate i) whether the results are a representation of the perceptions/acceptance of some females to allocate active financial duties (Borrowing and Saving) to partners, or on the other hand ii) the extent to which the results indicate social injustice. To disentangle which situation is more likely, studies that conduct interviews and collect questionnaire data may highlight the different attitudes of females towards Fintech adoption in terms of Active and Access opportunities.

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1. https://hdr.undp.org/data-center/thematic-composite-indices/gender-inequality-index#/indicies/GII [↑](#footnote-ref-1)