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Digital Finance, Labor Market Integration, and Gender Inequality: Evidence from Brazil

Mesbah Fathy Sharaf [1,*] and Abdelhalem Mahmoud Shahen [2]

[1] Department of Economics, Faculty of Arts, University of Alberta, Edmonton, AB T6G 2H4, Canada
[2] Department of Economics, College of Business, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh 11432, Saudi Arabia; amshahen@imamu.edu.sa
* Correspondence: sharaf@ualberta.ca

Abstract

Digital financial services have expanded rapidly across emerging economies and are often presented as tools for advancing women's economic inclusion. However, the extent to which digital finance is associated with lower gender inequality depends on the broader structural conditions in which women live and work. This study examines the relationship between digital financial participation, labor market integration, and gender inequality in Brazil using nationally representative microdata from the 2025 Global Findex survey. Three outcomes are examined: digital account ownership, use of any digital payment, and engagement in merchant digital payments. Multivariate logit models show moderate gender gaps at early stages of digital financial participation. However, these gaps are not uniform across the population. The interaction results show that gender differences are concentrated mainly among individuals outside employment and among those without internet access. Among employed and digitally connected individuals, the gender gap becomes small and statistically insignificant across the three outcomes. A nonlinear decomposition shows that observable socioeconomic characteristics explain only a small share of the aggregate gender gap, especially for account ownership and any digital payment use. Additional robustness checks using probit and complementary log-log models support the main pattern of results. This suggests that the gender gap cannot be explained only by differences in education, income, employment, or internet access, and may also reflect unobserved household, institutional, or social constraints. The findings suggest that digital finance alone does not equalize participation. Rather, women's digital financial participation is closely associated with their position in the labor market and their access to digital infrastructure. Because the analysis is based on cross-sectional data, the results should be interpreted as conditional associations rather than causal effects. Digital financial expansion is therefore more likely to support gender inclusion when it is linked to broader policies that strengthen women's labor force attachment, digital connectivity, and economic autonomy.

Keywords: gender inequality; digital financial participation; labor market integration; women's economic empowerment; Brazil

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1. Introduction

Digital financial services are frequently presented as inherently empowering for women. By lowering transaction costs, reducing mobility barriers, and enabling more private control over financial resources, digital platforms are expected to strengthen women's economic agency. International development institutions increasingly frame digital finance

as a pathway to narrowing gender gaps in financial inclusion and enhancing women's autonomy (Demirgüç-Kunt et al., 2022; World Bank, 2022). Yet feminist economics has long cautioned that access to economic tools does not automatically translate into empowerment. Technology operates within existing power structures; it does not stand outside them.

Foundational work in feminist economics emphasizes that agency depends on control over resources, bargaining power within households, and position within labor markets (Agarwal, 1997; Kabeer, 1999). Within intra-household bargaining models, participation in paid work strengthens fallback options and reshapes decision-making authority (Lundberg & Pollak, 1993; Duflo, 2012). Financial inclusion, from this perspective, is not merely about account ownership but about the capacity to exercise meaningful economic choice. A woman may hold a digital account yet lack control over income flows. She may have access to digital tools but remain constrained by weak labor market attachment or limited bargaining power.

These concerns are particularly salient in Latin America. The region has experienced rapid financial and digital expansion over the past decade, yet gender inequalities in labor market participation, income stability, and informality remain persistent. Women in Latin America are disproportionately concentrated in informal employment and unpaid care work, limiting their access to stable income streams and formal financial systems (Gasparini & Marchionni, 2015; OECD et al., 2020). Although the region has seen important progress in educational attainment among women, labor force participation gaps remain significant, especially among lower-income groups (Ñopo, 2012).

Research on financial inclusion in Latin America shows that gender disparities often reflect labor market segmentation and informality rather than purely cultural barriers (Bruhn & Love, 2014; Cámara & Tuesta, 2014). In Brazil specifically, while digital payment systems have expanded rapidly—particularly following the introduction of instant payment platforms—gender differences in employment rates and earnings continue to shape economic opportunities (OECD, 2023). This creates a critical tension where digital infrastructure is relatively advanced, yet structural gender inequalities persist.

The literature on digital inequality further reinforces this concern. Access to internet infrastructure and digital skills strongly conditions who benefits from technological expansion (van Dijk, 2005; Helsper, 2012). In Latin America, gaps in connectivity and quality of access often mirror broader socioeconomic divides (Galperin & Arcidiacono, 2021). Women, especially those outside formal employment, are more likely to experience unstable connectivity or limited digital engagement. If digital financial services require reliable internet access and technological confidence, then structural inequalities in digital access may translate into financial participation gaps.

Brazil is an important case for examining digital finance and gender inequality. The country has experienced significant growth in financial inclusion over the past decade. Currently, about 84 percent of the population own financial accounts, while in 2011 this number was about 56 percent (World Bank, 2025).

The adoption of digital financial instruments has also increased since the launch of the Pix system in 2020. Pix is an instant payment system that has become one of the most widely used financial instruments in Brazil. According to recent statistics, more than 160 million people are registered with Pix, and the system processes more than 3 billion transactions every month (Banco Central do Brasil, 2025). Meanwhile, internet penetration is about 84 percent of the population (The Global Economy, 2025).

Against this background, an important question emerges: how are gender differences in digital financial participation in Brazil related to labor market integration and digital connectivity? This study does not claim to identify causal effects. Instead, it examines whether gender gaps differ across employment status, education, and internet access, and

whether observable socioeconomic characteristics account for the aggregate gender gap in digital financial participation.

Using nationally representative microdata from the 2025 Global Findex survey, this study examines gender differences across three dimensions of digital financial participation: digital account ownership, use of any digital payment, and engagement in merchant digital payments. Rather than treating financial inclusion as a single binary outcome, the analysis distinguishes between formal access, general digital payment use, and market-facing transactional use. In the Brazilian context, especially after the rapid diffusion of Pix, merchant payments should not be read as a strictly superior or more difficult stage of participation. They are better understood as a distinct form of routine participation in market transactions through digital finance.

The empirical findings reveal a clear pattern. Moderate gender gaps exist at the entry stage, but these differences narrow at more active forms of digital engagement. More importantly, the gap is concentrated among women who are not employed and among those without internet access. Among employed individuals and among those with internet connectivity, gender differences largely disappear. Education also plays an important role in narrowing the gap. These results suggest that digital financial inequality in Brazil is closely associated with structural conditions in labor market integration and digital access. Because the data are cross-sectional, these patterns should be interpreted as conditional associations rather than evidence of causal mechanisms.

The contribution of this study is threefold. First, it extends the literature on gender and financial inclusion in Latin America by distinguishing between access and active digital engagement, rather than focusing solely on account ownership (Cámara & Tuesta, 2014; Demirgüç-Kunt et al., 2022). Second, it integrates feminist economic theory by linking digital financial participation to labor market attachment and bargaining power (Agarwal, 1997; Duflo, 2012). Third, it contributes to digital divide literature by showing that connectivity is closely associated with the narrowing of gender gaps when other structural barriers are less binding (van Dijk, 2005; Galperin & Arcidiacono, 2021).

The evidence suggests that digital finance in Brazil does not automatically generate gender equality. Its equalizing potential appears to depend on whether women are integrated into paid work and connected to digital infrastructure. Technology may help narrow disparities, but only when underlying structural inequalities are also addressed.

The remainder of the paper proceeds as follows. Section 2 reviews the literature on gender, labor markets, and digital financial inclusion. Section 3 describes the data and empirical strategy. Section 4 presents descriptive patterns, baseline multivariate estimates, interaction analyses, and decomposition results. Section 5 discusses the findings, and Section 6 concludes.

2. Literature Review

In the past two decades, the economic literature has highlighted the growing role of digital financial services in facilitating financial inclusion and expanding access to financial services (Gallego-Losada et al., 2023). The development of financial technology, mobile banking, and digital payments has changed the nature of financial systems in many economies. These changes can help integrate individuals who were previously outside the traditional financial system by reducing transaction costs, improving convenience, and overcoming geographic and institutional barriers to traditional banking (Klapper & Dutt, 2015; Sahay et al., 2020). Recent systematic evidence also shows that digital payment technologies can support financial inclusion by lowering transaction costs and expanding access to formal financial services. However, these benefits depend on the

wider institutional, digital, and socioeconomic environment in which people use these tools (Shahen & Sharaf, 2025).

This is important for the present study because digital finance is not only a technical innovation. It is used within existing social and economic structures. For this reason, the benefits of digital finance depend not only on whether services are available, but also on whether people have the income, connectivity, skills, trust, and autonomy needed to use them in daily life.

A growing number of studies show that the expansion of digital financial services does not necessarily remove gender gaps in financial inclusion. Many studies document persistent differences between men and women in access to financial services and in actual use, even in settings where digital infrastructure has expanded quickly. Systematic reviews suggest that women remain less likely than men to own financial accounts or use digital financial services because of several interacting economic, social, and institutional constraints (Roy & Patro, 2022; Gupta & Kiran, 2023; Kowsick & Ramasamy, 2024; Guzmán & Paoloni, 2025). This point is also supported by recent work showing that digital financial inclusion is shaped not only by access to technology, but also by socioeconomic position, institutional trust, infrastructure quality, and the ability to convert access into meaningful participation (Sharaf et al., 2026b).

Comparative literature also confirms that the gender gap in digital financial inclusion is a global phenomenon, although its size and sources differ across countries. Studies based on international data show that women tend to use digital financial services less than men in many developing and emerging economies, especially digital payments and mobile banking services (Gallego-Losada et al., 2023; Khan et al., 2026). Some studies further suggest that the gender gap may continue even when the gap in account ownership becomes smaller. This reflects deeper constraints related to women's economic and social position (Kulkarni & Ghosh, 2021). Recent evidence from Nigeria reaches a similar conclusion. Shahen and Sharaf (2026a) show that gender gaps in digital financial participation are closely linked to structural differences in internet access, employment, education, and broader socioeconomic resources. This supports the view that gender inequality in digital finance should not be understood only as a matter of account ownership, but also as a problem of unequal capacity to use digital financial tools in daily economic life.

The COVID-19 period also increased attention to the role of digital payments in financial inclusion. Recent review evidence argues that the pandemic accelerated the shift toward digital payments and made digital financial tools more central to everyday economic participation (Shahen & Sharaf, 2026b). Evidence from Saudi Arabia also shows that COVID-19 encouraged stronger digital payment adoption, although the benefits of this shift were not evenly distributed across all social groups (Sharaf et al., 2026a).

The financial inclusion literature therefore points to an important distinction between formal access and active use. Account ownership may show that a person has entered the formal financial system, but it does not show whether the person uses the account regularly, controls the account independently, or benefits from digital payment services. This distinction is especially important for gender analysis because women may be formally included while still facing constraints that limit actual participation.

Feminist economics helps explain why this distinction matters. This literature emphasizes that women's economic agency depends on access to resources, control over those resources, bargaining power inside the household, and position in the labor market. Participation in paid work can be associated with more stable income, stronger fallback options, and greater involvement in financial decision-making (Duflo, 2012; Kochhar et al., 2017). Employment may also increase contact with formal financial systems through wage payments, savings, transfers, and regular transactions. Comparative evidence shows that employed

women are more likely to use bank accounts and digital financial services than women who are not employed (Guruprasad et al., 2025; Kumari et al., 2025; Peter et al., 2025).

Some studies also indicate that digital financial services may strengthen women's economic empowerment when they are linked to actual control over financial resources. Empirical evidence shows that the use of digital payments or electronic wallets can increase women's ability to manage financial resources and make economic decisions within the household, especially when this is accompanied by greater financial independence (Heath & Riley, 2024). Other studies suggest that financial technology may help reduce some institutional constraints that historically limited women's access to traditional financial services by providing more flexible and independent financial channels (Chen et al., 2023).

However, feminist economics also cautions against assuming that digital finance automatically empowers women. A woman may have a digital account but may not control the income entering that account. She may have access to a payment platform but may still depend on household decisions, unstable work, or informal income. From this perspective, labor market integration is not simply another control variable. It is part of the wider economic setting that may shape whether women can turn access into meaningful participation.

In addition to labor market and income factors, the literature points to the importance of digital infrastructure in explaining gender gaps in digital financial inclusion. Despite the global expansion of internet access, a gender digital divide remains in access to and use of digital technologies. Women are often less likely to own digital devices or have stable access to the internet, especially in developing contexts (Hilbert, 2011; Singh et al., 2025). Access to the internet is a necessary condition for using many digital financial services, including electronic payments and mobile banking. For this reason, several studies indicate that the digital gap contributes to the gender gap in digital financial service use (Gupta & Kiran, 2024; Sikakebieke & Kuanova, 2025). The literature also emphasizes that digital skills influence participation in the digital economy. Weak digital skills may remain a barrier even when internet access is available (van Deursen et al., 2014; Grohmann et al., 2018).

The digital divide theory therefore adds a second layer to the argument. Digital financial inclusion depends not only on financial access, but also on digital access. Connectivity, device ownership, digital skills, and confidence in using online systems shape who can benefit from digital finance. This means that gender gaps in digital finance may reflect both economic exclusion and infrastructural exclusion.

The literature has also examined gender gaps in digital financial inclusion through several explanatory frameworks. Some studies focus on differences in socioeconomic characteristics between men and women, such as education, income, and employment. Analytical studies based on international data show that part of the gender gap in financial inclusion can be explained by differences in the distribution of these resources between men and women (Özşuca, 2019; Khera et al., 2022; Morrar et al., 2024). Similarly, Sharaf et al. (2026b) show that digital financial inclusion is shaped by socioeconomic position, digital access, and policy conditions, reinforcing the argument that digital finance must be studied as part of a wider inclusion and inequality framework.

In contrast, other studies suggest that part of the gender gap remains unexplained even after controlling for socioeconomic characteristics. This indicates that institutional, behavioral, or household-level factors may influence patterns of digital financial service use. Some studies document that the design of digital financial markets and credit scoring models may reproduce forms of gender bias within financial markets (Johnen & Mußhoff, 2023; Oluoch & Alhassan, 2026). Other studies suggest that regulatory structures and the design of fintech platforms may contribute to the persistence of gender gaps in digital financial services (Filipovska et al., 2024).

A related strand of research also shows that financial inclusion depends not only on individual adoption, but also on the reliability, reach, and governance of the wider payment ecosystem. Studies on central bank digital currencies and alternative payment networks show that payment infrastructure can shape the inclusiveness, resilience, and trustworthiness of digital financial systems (Sharaf et al., 2026c, 2026d).

Although most of the literature on digital financial inclusion and gender is based on global evidence or multi-country comparative studies, these findings do not necessarily apply in the same way across all regional contexts. In many developing economies in Asia and Africa, the gender gap in digital financial services is closely related to differences in education, income, and access to digital infrastructure, which leads to substantial disparities in account ownership and use of digital services between men and women (Mpofu, 2023; Singh et al., 2025).

In Latin America, the nature of the gender gap may be different. The region has experienced significant expansion in access to financial services and digital infrastructure during the last two decades. This expansion has helped reduce gaps in financial account ownership in several countries. However, differences in the use of digital financial services still remain in some contexts, especially in relation to digital payments and mobile banking. The literature suggests that these gaps may be linked more strongly to labor market factors and economic empowerment than to purely technological constraints (Gallego-Losada et al., 2023; Galindo-Manrique & Rojas-Vargas, 2025).

Overall, these studies show that digital financial inclusion is not only a question of access. Feminist economics helps explain why formal access may remain limited if women do not control income or have a strong position in the household and labor market. Digital divide theory shows that connectivity, skills, and confidence shape whether people can actually use digital tools. Financial inclusion research also shows that owning an account, making a digital payment, and using digital finance in market transactions are related but not identical. This study brings these ideas together in the Brazilian context by asking whether gender gaps differ by employment status, education, and internet access.

This gap matters because much of the existing work still treats digital financial inclusion as a single outcome, often account ownership. Yet in practice, participation is broader than account access. It includes using digital payments and relying on digital finance in everyday transactions. The present study therefore examines several forms of digital financial participation and asks whether women's participation is associated with labor market integration and digital connectivity. The analysis does not treat employment or internet access as proven causal mechanisms. Instead, it examines whether they are important conditions under which gender gaps become smaller or disappear.

Despite progress in the literature, there is still a clear research gap concerning the conditions that link digital financial inclusion with gender inequality in emerging economies, especially in Latin America. Much of the existing literature focuses either on measuring the gender gap in financial inclusion or on analyzing the role of financial technology in expanding inclusion. Less attention has been given to how labor market integration and digital connectivity are associated with gender differences across different forms of digital financial participation.

Moreover, much of the existing literature treats digital financial inclusion as a binary concept, usually measured by whether a person has a financial account. However, digital financial participation can be understood more broadly. It begins with access to accounts, but it also includes actual use of digital payments and participation in everyday market transactions through digital finance. Distinguishing between these dimensions allows for a more accurate understanding of where gender gaps appear and under what conditions they narrow.

Building on this literature, the present study contributes to the discussion by analyzing digital financial participation in Brazil, with a particular focus on employment status and internet access. The study does not treat these factors as proven causal mechanisms. Rather, it examines whether they are important conditioning factors associated with the size and structure of the gender gap in digital financial participation. By combining multivariate models, gender-specific estimates, interaction models, and a nonlinear decomposition, the paper provides a more detailed picture of how gender, labor market integration, and digital connectivity are related in one of Latin America's largest economies.

3. Materials and Methods

3.1. Data Source and Sample

This study uses individual-level microdata from the 2025 Global Findex survey for Brazil. The Global Findex is one of the main international data sources for studying financial inclusion, digital payments, account ownership, saving, borrowing, and related financial behaviors. It is especially useful for this study because it provides comparable individual-level information on financial access, digital payment use, socioeconomic characteristics, labor market status, and access to digital infrastructure.

The analysis focuses on adults in Brazil and uses the survey weights provided in the dataset to improve national representativeness. The full country sample includes 1000 respondents. After excluding observations with missing values on the outcome or control variables used in the econometric models, the final regression sample includes 976 individuals. All descriptive statistics are weighted, while the regression models are estimated using robust standard errors.

The sample size should be considered when interpreting the results. Although the Global Findex sample for Brazil is nationally representative, it remains modest for detailed subgroup analysis. This is important because several parts of the analysis divide the sample by gender, employment status, education, and internet access. As a result, some subgroup estimates are based on smaller numbers of observations and may be less precise than the full-sample estimates. For this reason, the interaction results are interpreted as conditional patterns rather than precise estimates for every subgroup. Statistically insignificant subgroup results should also be read with caution, as some comparisons may have limited statistical power.

Brazil provides a useful setting for this study for two main reasons. First, the country has experienced a rapid expansion of digital financial services, especially after the introduction and widespread adoption of digital payment platforms such as Pix. Second, despite this digital expansion, gender differences remain visible in labor market participation, income stability, and access to economic resources. This makes Brazil a valuable case for examining whether gender gaps in digital financial participation are associated with broader structural inequalities.

3.2. Outcome Variables

The empirical analysis examines three measures of digital financial participation. These outcomes are designed to capture different dimensions of engagement with digital finance, moving from access to active use.

The first outcome is digital account ownership, which equals one if the respondent reports having access to a financial account that can support digital financial participation, and zero otherwise. This variable captures entry into the formal financial system.

The second outcome is use of any digital payment, which equals one if the respondent reports using at least one form of digital payment, and zero otherwise. This

measure captures actual participation in digital financial transactions rather than simple account ownership.

The third outcome is merchant digital payment use, which equals one if the respondent reports making digital payments to merchants, stores, or service providers, and zero otherwise. This measure captures market-facing digital payment activity. In Brazil, where Pix has become widely used, merchant digital payments should not be interpreted as necessarily more demanding than general digital payment use. Instead, the variable captures a distinct form of routine digital financial participation in everyday market transactions.

Using these three outcomes allows the study to avoid treating digital financial inclusion as a single binary concept. Instead, the analysis distinguishes between access, general use, and market-facing transactional engagement.

3.3. Main Explanatory Variables

The main variable of interest is gender, measured by a binary indicator equal to one for women and zero for men. The coefficient on this variable captures the gender difference in digital financial participation after controlling for other individual characteristics.

The second key variable is employment status, measured by an indicator equal to one if the respondent is employed and zero otherwise. Employment is central to the study because labor market participation may be associated with exposure to formal financial systems, regular income flows, wage payments, and day-to-day transaction needs. From a feminist economics perspective, employment may also be related to women's control over resources and their ability to make independent financial decisions. However, employment is not treated as an identified causal mechanism in this study. Because the data are cross-sectional, employment and digital financial participation may be jointly determined.

The third key variable is internet access, measured by an indicator equal to one if the respondent has access to the internet and zero otherwise. Internet access is included because digital financial services require basic digital connectivity. Without reliable connectivity, individuals may be formally included in the financial system but still unable to use digital financial tools effectively.

The models also control for several individual characteristics that may influence digital financial participation. These include age, education, income, urban residence, and phone ownership. Education is measured using categorical indicators for secondary and tertiary education, with primary education or less serving as the reference group. Income is measured using income quintiles, with the lowest quintile used as the reference category. Urban residence and phone ownership are included because both may shape access to financial and digital infrastructure.

3.4. Empirical Strategy

The empirical analysis proceeds in four steps. First, the paper presents weighted descriptive statistics by gender. This provides a first view of whether men and women differ in digital account ownership, digital payment use, merchant payment use, and the main socioeconomic characteristics. The descriptive analysis is important because it shows whether raw gender gaps are large or moderate and whether these gaps may be linked to differences in employment, education, income, or digital access.

Second, the study estimates baseline logit models for each of the three binary outcomes. The general model can be written as in Equation (1).

$$\Pr(Y_i = 1) = F\left(\alpha + \beta \text{Female}_i + X_i'\gamma + \varepsilon_i\right) \quad (1)$$

where the dependent variable, Y_i, represents one of the three digital financial participation outcomes for individual i. The main explanatory variable is the gender indicator, and the

vector of controls, X_i', includes age, education, income quintile, employment status, urban residence, phone ownership, and internet access. The logistic cumulative distribution function is used to estimate the probability of each outcome.

The results are reported as average marginal effects (AMEs) rather than log-odds coefficients. This makes the interpretation more direct. For example, a marginal effect of -0.05 for women means that women are five percentage points less likely than men to report the outcome, holding other variables constant.

Third, the study estimates gender-specific models separately for men and women. This step examines whether the correlates of digital financial participation operate in the same way for both groups. This is important because the same characteristic may have different associations for men and women. For example, employment may be more strongly associated with digital financial participation among women if paid work is linked to financial autonomy and exposure to formal payment systems.

Fourth, the study estimates interaction models to examine whether the gender gap differs across employment status, education level, and internet access. The interaction models take the general form in Equation (2).

$$\Pr(Y_i = 1) = F\left(\alpha + \beta \text{Female}_i + \delta Z_i + \theta(\text{Female}_i \times Z_i) + X_i'\gamma + \varepsilon_i\right) \quad (2)$$

where the moderating variable, Z_i, represents employment status, education level, or internet access. The interaction term $(\text{Female}_i \times Z_i)$ shows whether the gender gap differs across these conditions. Instead of focusing only on the interaction coefficient, the analysis reports conditional marginal effects. This allows the paper to show, for example, whether the gender gap appears among non-employed individuals but becomes smaller among employed individuals.

Because the data are cross-sectional, the estimated models identify associations rather than causal effects. Employment and digital financial participation may be jointly determined. Employment may increase exposure to wage payments, formal accounts, and regular transactions, but individuals who already use digital financial tools may also be better positioned to participate in the labor market. Unobserved factors, such as household bargaining power, income control, financial confidence, care responsibilities, or local labor market conditions, may also shape both employment and digital financial participation. The empirical results are therefore interpreted as conditional associations, not as evidence that employment causes digital financial inclusion.

3.5. Decomposition Analysis

To further examine the sources of the gender gap, the study applies the Fairlie decomposition method. This method is appropriate because the outcomes are binary and the models are nonlinear. The Fairlie decomposition separates the raw difference between men and women into two components: an explained component and an unexplained component.

The explained component measures how much of the gender gap is due to differences in observable characteristics such as age, education, income, employment, urban residence, phone ownership, and internet access. The unexplained component captures the remaining gap that cannot be accounted for by these observed characteristics. This unexplained portion may reflect differences in unobserved factors, social norms, household financial decision-making, institutional barriers, preferences, or other constraints not directly measured in the data.

Formally, the gender gap in the average probability of the outcome can be expressed as in Equation (3).

$$\overline{Y}_M - \overline{Y}_F \quad (3)$$

where the expression compares the predicted outcome for men, $\overline{Y}_M$, and the predicted outcome for women, $\overline{Y}_F$. The Fairlie method estimates how much of this difference would change if women had the same distribution of observable characteristics as men.

This decomposition is useful for the present study because it helps distinguish between two possible explanations. The first is that women participate less in digital finance because they differ from men in employment, income, education, or digital access. The second is that the gender gap remains even after accounting for these observable characteristics, suggesting that deeper institutional, behavioral, or household-level constraints may be involved.

The decomposition should not be interpreted as a causal explanation of the gender gap. It shows how much of the observed difference is statistically associated with measured characteristics. Any remaining unexplained component should be interpreted carefully, because it may reflect unobserved constraints, measurement limits, differences in returns to characteristics, or other factors not captured by the Global Findex survey.

3.6. Model Diagnostics and Robustness Checks

Several diagnostic checks are conducted to assess the reliability of the logit models. First, variance inflation factors are calculated to examine whether multicollinearity is a concern among the explanatory variables. Second, Hosmer–Lemeshow goodness-of-fit tests are used to assess whether the predicted probabilities are consistent with the observed outcomes. Third, link tests are used to examine potential model specification problems.

Because the link test indicated a possible functional-form concern for the any digital payment model, additional robustness checks were conducted. The models were re-estimated using alternative binary-response specifications, including probit and complementary log-log models. These checks are important because any digital payment use is one of the three main outcomes of the study. They also help assess whether the main results remain stable when a different binary-response model is used.

The empirical analysis is further strengthened by estimating separate models for men and women and by using interaction terms for employment, education, and internet access. These models help examine whether the baseline gender gap is similar across the population or concentrated among specific groups. This is central to the paper's argument because the study is not only interested in whether a gender gap exists, but also in where and under what conditions it appears.

The sample size should also be considered when interpreting the interaction models. Although the Global Findex sample for Brazil is nationally representative, some subgroup comparisons become smaller once the sample is divided by gender, employment status, education, and internet access. For this reason, the interaction results are interpreted as conditional patterns rather than precise estimates for every subgroup.

Overall, the empirical strategy is designed to provide a comprehensive analysis of gender inequality in digital financial participation. The baseline models estimate average gender differences. The gender-specific models show whether correlates differ between men and women. The interaction models identify the conditions under which gender gaps narrow or disappear. The decomposition analysis then examines whether observable characteristics explain the aggregate gender gap. Together, these methods provide a more complete understanding of how digital finance, labor market integration, and digital connectivity are associated with gender inequality in Brazil.

4. Results

4.1. Descriptive Patterns of Digital Financial Participation by Gender

Table 1 reports weighted participation rates for the three digital financial outcomes by gender. The full sample contains 1000 observations; 976 observations remain in the regression sample.

Table 1. Digital Financial Participation by Gender (Weighted Column Percentages).

Outcome	Male (%)	Female (%)	Gap (Male − Female)
Digital account ownership	75.2	66.8	8.4
Any digital payment	82.3	72.8	9.5
Merchant digital payment	63.8	56.8	7.0
N	403	597	

Notes: Weighted means. Source: Authors' calculations.

The descriptive statistics show that digital financial participation in Brazil is high for both genders. More than two-thirds of women report owning a digital account, and over 70 percent report using digital payments. Even merchant digital payments exceed 50 percent among women. A gender gap is present across all outcomes. The largest gap appears in any digital payment use, followed by account ownership and merchant payments. Importantly, the gap does not widen across the three outcomes. It narrows slightly for merchant digital payments.

This pattern supports the decision to treat the three outcomes as different dimensions of digital financial participation rather than as a strict hierarchy from simple to advanced use. In the Brazilian context, where Pix is widely used, merchant digital payments are best understood as market-facing digital transactions, not necessarily as a more demanding stage of participation. This clarification is important because Pix has become a routine payment instrument in Brazil, so merchant payment use should not be interpreted as automatically more selective than general digital payment use.

Table 2 presents weighted descriptive statistics for the main covariates.

Table 2. Weighted Descriptive Statistics by Gender.

Variable	Male	Female
Age	42.88	42.69
Secondary education	0.503	0.508
Tertiary education	0.147	0.181
Employed	0.712	0.533
Urban residence	0.568	0.579
Phone ownership	0.922	0.919
Internet access	0.881	0.870

Notes: Weighted means; standard deviations in parentheses. Source: Authors' calculations.

Age and education are nearly identical across genders. Women are slightly more represented in tertiary education. Digital access indicators also show minimal gender differences.

The most pronounced disparity concerns employment. Seventy-one percent of men are employed compared to 53 percent of women—an 18-point gap. This difference exceeds the raw digital financial gap.

The descriptive evidence therefore suggests that labor market status may be closely related to gender differences in digital financial participation. However, this pattern should

be interpreted as descriptive rather than causal. Employment and digital financial participation may influence each other, and both may also reflect wider household, institutional, and labor market conditions.

The next subsection turns to multivariate analysis to examine whether the gender gap persists after controlling for these compositional differences.

4.2. Baseline Multivariate Estimates

Table 3 reports average marginal effects (AMEs) from logit models for the three outcomes.

Table 3. Logit Average Marginal Effects (AMEs).

Variables	Digital Account	Any Digital Payment	Merchant Digital Payment
Female	−0.057 **	−0.046 *	−0.024
	(0.027)	(0.026)	(0.028)
Age	−0.0038 ***	−0.0021 **	−0.0048 ***
	(0.0009)	(0.0009)	(0.0009)
Secondary	0.155 ***	0.148 ***	0.159 ***
	(0.036)	(0.035)	(0.035)
Tertiary	0.225 ***	0.244 ***	0.235 ***
	(0.051)	(0.049)	(0.052)
Income Q2	0.025	0.006	0.059
	(0.045)	(0.043)	(0.044)
Income Q3	0.102 **	0.014	0.104 **
	(0.043)	(0.043)	(0.044)
Income Q4	0.123 ***	0.080 **	0.160 ***
	(0.041)	(0.039)	(0.042)
Income Q5	0.199 ***	0.166 ***	0.226 ***
	(0.046)	(0.044)	(0.047)
Employed	0.083 ***	0.085 ***	0.097 ***
	(0.026)	(0.026)	(0.027)
Urban	0.062 **	−0.020	0.022
	(0.025)	(0.025)	(0.026)
Phone own	0.126 **	0.057	0.207 **
	(0.053)	(0.044)	(0.083)
Internet	0.200 ***	0.188 ***	0.284 ***
	(0.038)	(0.035)	(0.054)
N	976	976	976

Notes: *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively. Robust standard errors in parentheses. Source: Authors' calculations.

After controlling for socioeconomic and digital characteristics, women are 5.7 percentage points less likely to own a digital account. The gender gap declines for any digital payment use and becomes statistically insignificant for merchant digital payments. The pattern indicates that inequality is more visible for account ownership and weaker for market-facing digital payment use.

Education and income display strong gradients. Tertiary education is associated with a higher probability of digital participation across all three outcomes. Higher income

is also positively associated with digital financial participation, especially in the upper income quintiles.

Employment is consistently positive and statistically significant across all outcomes. Being employed is associated with a higher probability of account ownership, any digital payment use, and merchant digital payment use.

These estimates show that employment status is an important correlate of digital financial participation. They do not show that employment causes digital financial participation. Because the data are cross-sectional, the relationship may be bidirectional: employment may increase exposure to wage payments and formal transactions, while digital financial participation may also make it easier to receive income, manage payments, or engage in work-related transactions.

Internet access emerges as one of the strongest predictors. Individuals with internet access are much more likely to own a digital account and to use merchant digital payments.

The size of the internet-access association is especially important. It suggests that digital connectivity is not only a background condition, but a major factor linked to participation in digital finance. This finding also deserves attention because internet access appears to narrow the gender gap in a way that is similar to employment, as shown later in the interaction results.

Urban residence and phone ownership play more limited roles, though phone ownership significantly predicts having a digital account and merchant digital payment use.

Several diagnostic tests were conducted to assess the validity and stability of the logit specifications. Table 4 presents the results of these diagnostic tests. First, multicollinearity does not appear to be a concern. The mean variance inflation factor (VIF) across all models is 1.58, and the maximum VIF is 2.14, well below conventional thresholds of concern. This indicates that the explanatory variables are not highly correlated and that coefficient estimates are unlikely to be distorted by collinearity.

Table 4. Diagnostic Tests for Logit Models.

Diagnostic Test	Digital Account	Any Digital Payment	Merchant Digital Payment
Mean VIF	1.58	1.58	1.58
Maximum VIF	2.14	2.14	2.14
Hosmer–Lemeshow χ^2 (8)	7.61	8.48	10.30
Hosmer–Lemeshow *p*-value	0.472	0.388	0.245
Link Test: _hat (*p*-value)	<0.001	<0.001	<0.001
Link Test: _hatsq (*p*-value)	0.058	0.040	0.105
Pseudo R^2	0.292	0.247	0.287
N	976	976	976

Source: Authors' calculations.

Second, the Hosmer–Lemeshow goodness-of-fit tests fail to reject the null hypothesis of adequate model fit in all three cases. The *p*-values suggest that predicted probabilities are consistent with observed outcomes across risk deciles. The models therefore provide an acceptable fit to the data.

Third, the link test shows that the predicted value (_hat) is highly significant in all models, as expected. The squared predicted value (_hatsq) is statistically insignificant in the digital account and merchant payment models, indicating no major specification problem for these two outcomes. For the any digital payment model, however, _hatsq is statistically significant at the 5 percent level. Since any digital payment use is one of the three central

outcomes of the paper, this result should not be dismissed. It suggests that the baseline logit specification for this outcome requires an additional robustness check.

To address this concern, all three-outcome models were re-estimated using probit and complementary log-log specifications. These results are reported in Table A2 in Appendix A, while the baseline logit average marginal effects are reported in Table 3. The alternative specifications produce the same substantive pattern as the main logit models. Employment, internet access, education, and higher income remain positively associated with digital financial participation across the three outcomes. The female marginal effect remains negative across all specifications, although its statistical significance varies by outcome and model. This is especially relevant for the any digital payment model, where the link test suggested a possible functional-form concern. Overall, the robustness checks indicate that the main findings are not driven by the choice of logit specification.

The next subsection examines whether these correlates operate symmetrically across men and women by estimating gender-specific regressions.

4.3. Gender-Specific Determinants of Digital Financial Inclusion

To assess whether the observed gender gap reflects differences in characteristics or differences in returns to those characteristics, we estimate logit models separately for men and women. Average marginal effects are reported in Table 5.

Table 5. Gender-Specific Average Marginal Effects.

Variables	Digital Account		Any Digital Payment		Merchant Digital Payment	
	Men	Women	Men	Women	Men	Women
Age	−0.004 **	−0.003 **	−0.003 *	−0.002	−0.005 ***	−0.005 ***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Secondary	0.145 **	0.160 ***	0.149 **	0.147 ***	0.144 **	0.171 ***
	(0.060)	(0.044)	(0.057)	(0.043)	(0.057)	(0.045)
Tertiary	0.302 ***	0.195 **	0.240 ***	0.242 ***	0.290 ***	0.209 **
	(0.077)	(0.062)	(0.074)	(0.063)	(0.090)	(0.066)
Income Q2	0.168 **	−0.049	0.163 **	−0.076	0.134 *	0.022
	(0.076)	(0.054)	(0.075)	(0.051)	(0.076)	(0.054)
Income Q3	0.202 ***	0.038	0.109	−0.049	0.181 **	0.051
	(0.070)	(0.054)	(0.070)	(0.055)	(0.071)	(0.056)
Income Q4	0.242 ***	0.039	0.182 **	0.013	0.219 ***	0.122 **
	(0.066)	(0.050)	(0.065)	(0.048)	(0.069)	(0.054)
Income Q5	0.295 ***	0.144 **	0.227 ***	0.142 **	0.280 ***	0.199 ***
	(0.070)	(0.059)	(0.069)	(0.056)	(0.072)	(0.063)
Employed	−0.001	0.145 ***	0.003	0.149 ***	0.036	0.138 ***
	(0.044)	(0.031)	(0.042)	(0.033)	(0.046)	(0.033)
Urban	0.075 *	0.054 *	0.005	−0.038	0.025	0.020
	(0.038)	(0.032)	(0.038)	(0.034)	(0.041)	(0.034)
Phone ownership	0.102	0.147 *	0.073	0.028	0.191 *	0.218
	(0.070)	(0.079)	(0.058)	(0.065)	(0.105)	(0.135)
Internet	0.140 **	0.262 ***	0.156 ***	0.219 ***	0.214 ***	0.369 ***
	(0.059)	(0.052)	(0.052)	(0.049)	(0.075)	(0.089)

Notes: *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively. Robust standard errors in parentheses. Source: Authors' calculations.

The gender-specific regressions reveal several important asymmetries. First, age is negatively associated with digital participation for both men and women across all outcomes. The magnitude is broadly comparable across genders, suggesting that age-related patterns operate in similar ways for men and women.

Second, education is strongly associated with digital participation for both groups. However, tertiary education yields particularly large associations for men in digital account ownership and merchant payments, compared to women. The returns to secondary education are more similar across genders. These results suggest that while education is an important correlate of participation for both men and women, its association with digital financial participation may differ across gender and outcome.

Third, income gradients differ noticeably. For men, income displays a clear relationship with digital participation across all outcomes. For women, the income gradient is weaker and becomes statistically significant mainly at the highest quintile. This suggests that income stratification is more clearly reflected in men's digital participation than in women's.

The most striking asymmetry concerns employment. Employment has no statistically significant association with digital participation for men across any outcome. The estimated marginal effects are near zero. In contrast, employment is strongly and positively associated with women's digital account ownership, any digital payment use, and merchant payments. These associations are large, economically meaningful, and statistically significant.

This asymmetry suggests that employment is more strongly associated with digital financial participation among women than among men. For men, digital financial participation appears less sensitive to employment status. For women, employment is associated with substantially higher probabilities of account ownership, digital payment use, and merchant payment use. This pattern is consistent with the idea that labor market attachment may be linked to income flows, financial autonomy, exposure to formal payment systems, and regular transaction needs. However, because the data are cross-sectional, this should be interpreted as an association rather than a causal mechanism.

Internet access also yields stronger marginal effects for women, particularly for merchant payments. Connectivity appears to be more strongly associated with women's digital participation than men's.

The gender-specific regressions suggest that the gender gap in Brazil does not arise because women receive uniformly weaker returns from education or connectivity. Rather, certain enabling conditions—especially employment and internet access—are more strongly associated with women's digital financial participation.

4.4. Employment Status and the Gender Gap: Gender × Employment Interaction

The gender-specific regressions indicate that employment plays a central role for women. To formally test whether employment moderates the gender gap, interaction terms between female and employed are introduced. Conditional marginal effects are reported in Table 6.

The interaction results provide clear evidence of heterogeneity in the gender gap by employment status. Among individuals who are not employed, women are 14.5 percentage points less likely to own a digital account, 11.2 percentage points less likely to use any digital payment, and 9.7 percentage points less likely to engage in merchant payments. These are large differences, both statistically and economically.

However, among employed individuals, the gender gap becomes small and statistically insignificant across all three outcomes. The conditional marginal effects are close to zero.

This finding substantially refines the interpretation of the baseline results. The gender gap is not uniform across the population; it differs by labor market status. The results

show that gender differences are concentrated among individuals outside employment, while they are small and statistically insignificant among employed individuals. This does not prove that employment causes digital financial participation. Rather, it shows that employment status marks an important point of difference in how gender and digital finance are associated in Brazil. Employment may increase exposure to formal payment systems, but digital financial participation may also support labor market engagement, and both may be shaped by unobserved household or institutional factors.

Table 6. Conditional Gender Effects by Employment Status.

Outcome	Gender Effect (Unemployed)	Gender Effect (Employed)
Digital Account Ownership	−0.145 ***	0.015
	(0.040)	(0.034)
Any Digital Payment	−0.112 ***	0.014
	(0.038)	(0.034)
Merchant Digital Payment	−0.097 **	0.022
	(0.049)	(0.034)

Notes: **, and *** denote significance at 5%, and 1% levels, respectively. Robust standard errors in parentheses. Source: Authors' calculations.

To assess whether the employment interaction for the any digital payment outcome is sensitive to the choice of binary-response model, the same interaction was re-estimated using probit and complementary log-log specifications. These results are reported in Table A3 in Appendix A. The pattern remains stable. In both alternative models, the gender gap in any digital payment use remains large and statistically significant among non-employed individuals, but becomes small and statistically insignificant among employed individuals. This supports the interpretation that the employment-related pattern is not driven by the baseline logit specification.

The interaction results should also be interpreted with the sample size in mind. Although the Brazilian Global Findex sample is nationally representative, the number of observations becomes smaller when the sample is divided by gender and employment status. Table A1 in the Appendix A reports the unweighted number of observations in the main interaction groups. For the employment interaction, the sample includes 306 non-employed women, 129 non-employed men, 278 employed women, and 263 employed men. These numbers allow for meaningful comparison, but the subgroup results should still be interpreted cautiously.

4.5. Human Capital and the Gender Gap: Gender × Education Interaction

To examine whether education narrows gender disparities, interaction terms between female and education levels were introduced. Conditional marginal effects are reported in Table 7.

The results reveal a clear gradient. Among individuals with primary education or less, women are less likely to own a digital account and less likely to use digital payments. These differences are statistically significant.

At the secondary level, the gender gap shrinks substantially and becomes statistically insignificant. At the tertiary level, the gap effectively disappears.

Education therefore appears to be an equalizing condition. The disadvantage is concentrated among lower-educated women. Once women attain secondary or tertiary education, their digital financial participation converges toward that of men.

Table 7. Conditional Gender Effects by Education Level.

Outcome	Primary or Less	Secondary	Tertiary
Digital Account Ownership	−0.112 ***	−0.041	−0.018
	(0.036)	(0.031)	(0.034)
Any Digital Payment	−0.095 **	−0.038	−0.012
	(0.034)	(0.029)	(0.032)
Merchant Digital Payment	−0.084 **	−0.029	−0.006
	(0.041)	(0.033)	(0.036)

Notes: **, and *** denote significance at 5%, and 1% levels, respectively. Robust standard errors in parentheses. AMEs represent the discrete change in predicted probability associated with being female at each education level. Source: Authors' calculations.

Importantly, this pattern suggests that education is not only associated with higher participation on average; it is also associated with smaller gender differences. However, the education interaction should be interpreted with more caution than the employment interaction because the tertiary education subgroup is relatively small. As shown in Table A1, the tertiary group includes 68 women and 41 men. This does not invalidate the result, but it means that the tertiary-level conditional estimates should not be overstated.

Additional robustness checks for the any digital payment outcome are reported in Table A3. In the probit and complementary log-log models, the conditional gender effects by education remain negative but statistically insignificant across education levels. This supports a cautious interpretation: education is associated with a narrowing of the gender gap, but the evidence should be read as a conditional pattern rather than a precise causal estimate for each education subgroup.

4.6. Digital Connectivity and Gender Disparities

Table 8 reports conditional gender effects by internet access.

Table 8. Conditional Gender Effects by Internet Access.

Outcome	No Internet	Has Internet
Digital Account Ownership	−0.138 ***	−0.021
	(0.041)	(0.029)
Any Digital Payment	−0.119 ***	−0.018
	(0.038)	(0.027)
Merchant Digital Payment	−0.104 **	−0.009
	(0.045)	(0.030)

Notes: Entries are predictive margins from logit models with gender–internet interactions. **, and *** denote significance at 5%, and 1% levels, respectively. Robust standard errors in parentheses. Source: Authors' calculations.

Among individuals without internet access, women are substantially less likely than men to participate in digital finance. The magnitude of the gap is large across all outcomes, reaching 13.8 percentage points for digital account ownership and remaining above 10 percentage points for payment usage.

However, among individuals who have internet access, the gender gap becomes statistically insignificant and economically small across all three outcomes.

This pattern suggests that digital connectivity is an important equalizing condition in Brazil's financial ecosystem. Once individuals have internet access, women's likelihood of engaging in digital finance becomes statistically similar to that of men. In other words, the gender gap is concentrated among the digitally disconnected population.

This finding complements the employment interaction results. Both results show a striking symmetry between two conditions: employment and internet access. Employment represents economic integration, while internet access represents infrastructural integration. Both are associated with the disappearance of the gender gap in the interaction models. This symmetry deserves emphasis because it suggests that women's digital financial participation is shaped not only by financial services themselves, but also by the economic and digital conditions that allow women to use those services.

Table A1 also helps assess the precision of the internet-access interaction. The internet-access group is relatively large, with 485 women and 324 men. The no-internet group is smaller, with 99 women and 68 men. This means that the estimates for those without internet access should be interpreted more cautiously than the estimates for those with internet access.

The robustness checks in Table A3 show that, for the any digital payment outcome, the conditional gender effects by internet access remain negative but statistically insignificant in the probit and complementary log-log specifications. The direction of the estimates remains consistent with the baseline pattern, but the wider standard errors for the no-internet group confirm the need for caution when interpreting smaller subgroup estimates.

From a broader perspective, this evidence suggests that Brazil's digital financial system does not appear to disadvantage women once key access conditions are present. Rather, inequality is concentrated among groups facing economic or infrastructural exclusion.

4.7. Decomposing the Gender Gap: Fairlie Decomposition Results

The Fairlie decomposition allows the total gender gap to be decomposed into explained and unexplained components.

4.7.1. Aggregate Decomposition Results

The first step is to assess the magnitude of the raw gap and the share explained by observable characteristics.

Table 9 reports the aggregate decomposition results. For digital account ownership, the raw gender gap is 7.39 percentage points. However, only 0.003 of this gap—just over 4 percent—is explained by differences in age, education, income, employment, urban residence, phone ownership, and internet access. More than 95 percent of the gap remains unexplained.

Table 9. Aggregate Fairlie Decomposition.

Outcome	Men Mean	Women Mean	Raw Gap	Explained	Unexplained	% Explained
Digital Account	0.709	0.635	0.0739	0.0030	0.0709	4.1%
Any Digital Payment	0.770	0.705	0.0649	0.00035	0.0646	0.5%
Merchant Digital Payment	0.577	0.526	0.0508	0.0175	0.0333	34.4%

Source: Authors' calculations.

For any digital payment use, the explained share is even smaller. Of the 6.49 percentage-point gap, only 0.00035 is explained. This means that observable characteristics account for less than 1 percent of the disparity.

For merchant digital payments, the explained share is larger but still partial. Of the 5.08 percentage-point gap, 0.0175 (about one-third) is explained by observed characteristics, leaving two-thirds unexplained.

These results indicate that while observable characteristics strongly predict digital participation in the regression models, differences in the distribution of those characteristics between men and women explain only a limited portion of the gender gap.

4.7.2. Variable-Level Contributions

We now examine which characteristics contribute to the explained component of the gender gap, which are quantified in Table 10.

Table 10. Fairlie Decomposition Contributions by Outcome.

Variable	Digital Account	Any Digital Payment	Merchant Digital Payment
Age	−0.0038 **	−0.0038 *	−0.0015
	(0.0019)	(0.0021)	(0.0019)
Secondary	−0.0001	0.0012	−0.0006
	(0.0013)	(0.0016)	(0.0013)
Tertiary	−0.0020	−0.0025	−0.0086 ***
	(0.0018)	(0.0017)	(0.0032)
Income Q2	0.0022	0.0004	−0.0003
	(0.0025)	(0.0028)	(0.0014)
Income Q3	0.0074 **	0.0035	0.0049 *
	(0.0034)	(0.0028)	(0.0026)
Income Q4	0.0036	0.0012	0.0063 *
	(0.0027)	(0.0022)	(0.0035)
Income Q5	0.0034	0.0042	0.0107 ***
	(0.0035)	(0.0033)	(0.0034)
Employed	−0.0002	0.0005	0.0073
	(0.0089)	(0.0075)	(0.0094)
Urban	−0.0051 *	−0.0001	−0.0009
	(0.0028)	(0.0011)	(0.0017)
Phone	−0.0009	−0.0014	−0.0012
	(0.0011)	(0.0014)	(0.0009)
Internet	−0.0009	−0.0040 **	0.0018
	(0.0013)	(0.0018)	(0.0013)

Notes: *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively. Robust standard errors in parentheses. Source: Authors' calculations.

As for the contribution of the demographic and socioeconomic characteristics, the results show that age contributes modestly to widening the gap in account ownership and payment usage. Income differences contribute positively to explaining the gap in digital account ownership and merchant digital payments, particularly at higher income quintiles. For merchant payments, the top quintile alone explains 1.07 percentage points of the gap.

Tertiary education contributes negatively and significantly in the merchant payment decomposition. This indicates that differences in tertiary attainment slightly widen the merchant payment gap.

Most importantly, employment and internet access contribute very little to explaining the overall gap—even though earlier interaction models showed that the gender gap becomes small and statistically insignificant among employed individuals and among those with internet access.

This contrast between the interaction results and the Fairlie decomposition is one of the most important findings of the paper. The interaction models show that the gender gap becomes small and statistically insignificant among employed individuals and among those with internet access. The decomposition, however, shows that differences in observable characteristics explain only a small share of the aggregate gender gap, especially for any

digital payment use and digital account ownership. These results are not necessarily contradictory. They answer two different empirical questions. The interaction models ask whether the gender gap differs within subgroups defined by employment or internet access. The decomposition asks whether men and women differ enough in the distribution of observed characteristics to explain the overall gap.

In Brazil, employment and internet access appear to be important conditioning factors at the individual level, but their distributional differences between men and women are not large enough to explain most of the aggregate gap. For example, the descriptive statistics show a clear employment difference between men and women, but the decomposition indicates that this difference does not explain most of the raw gender gap in digital payment use. This may reflect nonlinear relationships, threshold effects, or unobserved constraints that are not captured by the Global Findex variables.

The unexplained component may reflect factors that the data cannot measure directly. These include who controls income inside the household, whether women can use accounts independently, the quality and affordability of internet access, trust in digital platforms, exposure to informal work, unpaid care responsibilities, and social norms around financial decision-making. The decomposition therefore suggests that observable endowments matter, but they do not fully capture the gendered constraints that shape digital financial participation.

The Fairlie decomposition results provide a clear conclusion that, in Brazil, the gender gap in digital financial participation is only partly explained by observable socioeconomic and digital resource characteristics.

While education, income, employment, and internet access are strongly associated with participation probabilities, differences in these characteristics between men and women explain only a small fraction of the raw participation gap.

This suggests that structural, behavioral, institutional, or household-level factors not captured by standard covariates may play an important role. These may include intra-household financial decision-making patterns, risk preferences, social norms, informal financial practices, trust in digital platforms, or institutional barriers that affect women disproportionately.

The decomposition therefore reinforces a more cautious interpretation of the paper's main argument. Resource access matters, but measured resources do not fully explain Brazil's gender gap in digital finance. The findings point to the need for more detailed data on household control over money, quality of connectivity, digital skills, trust, and informal work conditions. They also show why digital finance should not be treated as a stand-alone solution to gender inequality. Its relationship with inclusion depends on the broader economic and infrastructural conditions in which women participate.

5. Discussion

The findings from Brazil indicate that gender differences in digital financial participation cannot be understood in isolation from women's position in the labor market and their access to digital infrastructure. Gender gaps in digital financial participation are present, but they are not evenly distributed across the population. They are most visible among women who are outside labor market and among those without reliable internet access. Among employed and digitally connected individuals, the gap becomes small and statistically insignificant. This pattern is important, but it should be interpreted with care. The data are cross-sectional, so the results show conditional associations rather than causal effects.

The role of labor market integration stands out. Across all three outcomes, employment status is closely associated with the structure of the gender gap. Among individuals who are

not working, women are less likely to participate in digital finance. Among those who are employed, men and women look much more similar. This finding speaks to long-standing arguments in feminist economics that agency is closely connected to economic position. Labor market participation may be associated with income security, bargaining power, and control over resources (Agarwal, 1997; Duflo, 2012). Within collective household models, labor market attachment can be linked to fallback options and financial decision-making authority (Lundberg & Pollak, 1993). However, the evidence in this paper does not show that employment causes digital financial participation. Employment and digital finance may influence each other. Employment may increase exposure to wage payments, accounts, and regular transactions, while digital financial tools may also help people receive income, manage payments, and participate in work-related activities. Both may also be shaped by unobserved factors such as household bargaining power, care responsibilities, informality, local labor market conditions, and confidence in financial institutions.

It is also notable that employment is more strongly associated with digital participation among women than among men. For men, digital engagement appears less sensitive to labor market status. For women, employment is associated with much higher participation. This does not mean that employment is a proven "transformative mechanism." A more careful interpretation is that employment marks a condition under which women's digital financial participation becomes much closer to men's. This distinction matters because the study does not use panel data or an identification strategy that can establish causality.

This gender difference in the association with employment also helps explain the small explained component in the Fairlie decomposition. The decomposition result does not mean that employment is unimportant. Rather, it suggests that the role of employment is not mainly about the difference in employment rates between men and women. It is also about how employment is associated with digital financial participation within each gender group. Table 5 shows that employment has little and no statistically significant association with digital participation among men, but a large and statistically significant association among women across all three outcomes. This asymmetry helps explain why the decomposition assigns little explanatory power to employment endowments, even though employment is strongly associated with women's digital participation. The same employment status does not appear to carry the same meaning for men and women. For women, employment may be more closely linked to income flows, account use, payment needs, and financial autonomy. For men, digital financial participation appears less dependent on employment status. This interpretation fits the feminist economics framing of the paper because it points to differences in how economic resources are converted into financial participation, not only to differences in who has those resources.

The income results in Table 5 point in the same direction. Among men, income is strongly and consistently associated with digital financial participation across the three outcomes. Among women, the income gradient is weaker and becomes statistically significant mainly at the highest income quintile. This pattern suggests that income access may not translate into digital financial participation in the same way for women and men. From a feminist economics perspective, this may reflect the difference between household income and individual control over income. A woman may live in a higher-income household without having the same control over financial decisions, account use, or payment behavior. The stronger association at the highest income quintile may indicate that only at higher levels of economic security does income become more clearly linked to women's digital financial participation. This reinforces the paper's main argument that digital financial inclusion depends not only on formal access or household resources, but also on women's ability to use and control those resources in practice.

Internet access functions in a similar way. The gender gap is concentrated among those without digital connectivity. Among individuals who have internet access, participation converges. This is consistent with the broader literature on digital inequality, which emphasizes that technology only produces returns when individuals can actually use it effectively (van Dijk, 2005; Helsper, 2012). Access to infrastructure reduces transaction costs and facilitates engagement, but uneven connectivity can reproduce existing disadvantages. In this sense, digital financial inclusion depends as much on connectivity as on financial services themselves.

One of the strongest findings of the paper is the symmetry between employment and internet access. Employment represents economic integration, while internet access represents infrastructural integration. Both are associated with the disappearance of the gender gap in the interaction models. This means that women's digital financial participation is not shaped only by the availability of financial products. It also depends on whether women have the economic and digital conditions needed to use these products in daily life. This point is especially important for policy because expanding digital payments alone may not be enough if women remain outside labor market or lack reliable connectivity.

Education also compresses the gap. Higher levels of schooling are associated with convergence between men and women, especially in more active forms of digital financial participation. This is in line with evidence linking education to financial literacy and digital competence (Lusardi & Mitchell, 2014). At the same time, the education interaction should be interpreted cautiously because the tertiary education subgroup is relatively small, as shown in Table A1 in the Appendix A. The subgroup results are still useful, but they should be read as conditional patterns rather than precise estimates for every education group.

The decomposition results add an important layer to the analysis. They show that observable characteristics explain only a small portion of the aggregate gender gap, especially for account ownership and any digital payment use. This may seem puzzling because the interaction models show that the gender gap becomes small among employed individuals and among those with internet access. The two findings are not contradictory. They answer different questions. The interaction models ask whether the gender gap differs within groups defined by employment or internet access. The Fairlie decomposition asks whether men and women differ enough in the distribution of observed characteristics to explain the aggregate gender gap. Employment and internet access may be strongly associated with convergence within subgroups, but differences in their distribution between men and women may still explain only a small part of the overall gap.

This tension is one of the most theoretically interesting findings of the paper. It suggests that observable resources matter, but they do not fully capture the constraints shaping women's digital financial participation. The unexplained component may reflect household control over money, informal financial practices, unpaid care responsibilities, trust in digital platforms, quality and affordability of internet access, or social norms around women's financial autonomy. These factors are not measured directly in the Global Findex data. The decomposition therefore points to the limits of standard socioeconomic controls and supports the need for richer data on household decision-making and the quality of digital access.

These results caution against assuming that digital finance automatically empowers women. Expanding access to accounts and payment tools can help, but it does not remove gender inequality on its own. Previous research shows that new technologies often work through existing social and economic structures rather than replacing them (Norris, 2003; Toyama, 2017). The Brazilian case shows this clearly. Digital finance is most equalizing when women are already connected to paid work and digital infrastructure. Where these barriers remain, digital tools alone are not enough to close the gap.

From a gender perspective, the distinction between formal access and substantive empowerment matters. Having a digital account or the ability to transact does not necessarily imply control over financial decisions or autonomy in resource allocation (Galperin & Arcidiacono, 2021). Employment and connectivity may act as enabling conditions that allow women to convert access into meaningful participation. Without employment and reliable connectivity, digital inclusion may remain limited in practice.

The interpretation of merchant digital payments also needs to be placed in the Brazilian context. The paper examines merchant digital payments as a distinct form of market-facing digital participation, not as a strictly higher or more demanding stage of digital finance. This is important because Pix is widely used in Brazil, and merchant payments may be part of ordinary daily transactions. The results therefore should not be read as showing a simple ladder from basic to advanced use. Instead, they show that gender gaps vary across different forms of digital financial participation.

The policy implications follow from this interpretation. Expanding digital payment systems or increasing account ownership remains important, but it is unlikely to eliminate gender disparities if women remain excluded from stable employment or lack reliable internet access. Policies should therefore connect digital finance with broader economic inclusion. This includes supporting women's access to formal and stable work, reducing barriers linked to unpaid care responsibilities, improving access to childcare and safe transportation, encouraging employers to use low-cost digital wage payments, and linking social transfers to accounts that women can control directly. At the same time, digital inclusion policies should expand affordable internet access, improve digital and financial literacy, strengthen consumer protection, and ensure that digital payment platforms are simple, safe, and trusted by women in both formal and informal work.

Several limitations should be noted. First, the study uses cross-sectional data, so the results should be interpreted as associations rather than causal effects. Second, employment and digital financial participation may be bidirectionally related. Third, although the Global Findex survey is nationally representative, the Brazilian sample is relatively small for detailed subgroup analysis. The full sample includes 1000 respondents, and the final regression sample includes 976 individuals. Splitting the sample by gender, employment, education, and internet access reduces the size of some conditional cells. Table A1 reports these cell sizes to make this limitation transparent. Fourth, the data do not measure several factors that may matter for women's digital financial participation, including intra-household control over money, quality of internet access, digital confidence, trust in payment systems, unpaid care responsibilities, and exposure to informal work.

Future research could examine these relationships more closely. Qualitative work could show how women experience digital financial tools in relation to household dynamics, income control, and trust in digital platforms. Longitudinal data would help clarify whether entry into employment leads to sustained changes in digital financial participation, whether digital financial participation supports labor market engagement, or whether both are shaped by deeper social and institutional conditions. Understanding these pathways would move the analysis beyond access and toward agency.

Overall, the Brazilian evidence shows that digital finance does not automatically reduce gender inequality. Its benefits are strongest when women have access to both economic opportunities and reliable digital infrastructure. Digital tools can help narrow gaps, but they cannot fully overcome barriers rooted in labor markets, households, and infrastructure.

6. Conclusions

Digital transformation alone does not remove gender inequality. The Brazilian evidence shows that gaps in digital financial participation are not fixed features of women's behavior. They are closely linked to structural conditions, especially paid work and digital connectivity. Gender gaps are larger among women outside employment and among those without internet access, but they become much smaller when these conditions are present.

Using nationally representative data from the 2025 Global Findex survey, this study shows that moderate gender gaps exist in digital account ownership and digital payment use. However, these differences are not uniform across the population. They are concentrated among individuals outside the labor market and among those without internet access. Among employed individuals, women's digital financial participation is statistically similar to that of men. Similarly, among those with internet access, gender disparities become small and statistically insignificant. Higher levels of education are also associated with narrower differences.

These results should be read as conditional associations, not causal effects. The study does not show that employment or internet access causes women's digital financial participation to increase. Employment, connectivity, and digital finance may influence each other, and they may also reflect deeper household, institutional, and labor market conditions. This caution is important because the analysis is based on cross-sectional data.

Importantly, differences in observable socioeconomic characteristics explain only a limited portion of the aggregate gender gap. This suggests that inequality in digital financial participation cannot be fully explained by measured differences in education, income, employment, or internet access. Unmeasured factors such as control over income, household financial decision-making, unpaid care responsibilities, trust, informality, and the quality of digital connectivity may also matter. Digital technologies operate within existing economic and social structures. Where women's economic agency is constrained, digital finance may reflect those constraints. Where women are economically integrated and digitally connected, gender differences are much smaller.

The results therefore caution against viewing digital financial expansion as a standalone solution to gender inequality. Expanding digital accounts or payment platforms is unlikely to produce deep inclusion if structural barriers in employment and connectivity remain unaddressed. Policy should move on two tracks at the same time: strengthening women's access to stable work and improving the affordability, reliability, and usability of digital infrastructure. Digital wage payments, social transfers linked to accounts women can control, digital skills training, consumer protection, and affordable internet access can help make digital finance more useful in practice.

Future research should move beyond measuring access and examine how digital financial participation interacts with women's bargaining power, decision-making authority, and income control within households. Longitudinal and qualitative evidence would be especially useful for understanding whether employment leads to more digital financial participation, whether digital finance supports labor market engagement, or whether both are shaped by deeper structural conditions. The broader challenge is not simply increasing women's presence in digital financial systems, but ensuring that digital transformation enhances women's economic agency rather than reproducing existing patterns of gender inequality.

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Appendix A

Table A1. Unweighted Number of Observations in the Main Gender Interaction Groups.

Group	Women	Men	Total
Not employed	306	129	435
Employed	278	263	541
No internet access	99	68	167
Has internet access	485	324	809
Primary education or less	224	167	391
Secondary education	292	184	476
Tertiary education	68	41	109
Total	584	392	976

Notes: The table reports the number of observations in each subgroup using the final regression sample. The final regression sample includes 976 individuals.

Table A2. Robustness Checks Using Alternative Binary-Response Models.

	Digital Account		Any Digital Payment		Merchant Digital Payment	
Variable	**Probit Model**	**Complementary Log-Log**	**Probit Model**	**Complementary Log-Log Model**	**Probit Model**	**Complementary Log-Log Model**
Female	−0.058 ** (0.026)	−0.044 * (0.025)	−0.044 * (0.025)	−0.039 (0.024)	−0.026 (0.028)	−0.013 (0.026)
Age	−0.0037 *** (0.0009)	−0.0035 *** (0.0008)	−0.0022 ** (0.0009)	−0.0021 *** (0.0008)	−0.0048 *** (0.0009)	−0.0045 *** (0.0008)
Secondary	0.162 *** (0.036)	0.167 *** (0.034)	0.152 *** (0.034)	0.157 *** (0.033)	0.161 *** (0.035)	0.174 *** (0.035)
Tertiary	0.235 *** (0.049)	0.234 *** (0.044)	0.244 *** (0.046)	0.240 *** (0.042)	0.244 *** (0.052)	0.260 *** (0.048)
Income Q2	0.034 (0.044)	0.029 (0.042)	0.014 (0.043)	0.012 (0.041)	0.066 (0.044)	0.064 (0.044)

Table A2. *Cont.*

	Digital Account		Any Digital Payment		Merchant Digital Payment	
Variable	**Probit Model**	**Complementary Log-Log**	**Probit Model**	**Complementary Log-Log Model**	**Probit Model**	**Complementary Log-Log Model**
Income Q3	0.104 ** (0.043)	0.097 ** (0.041)	0.019 (0.043)	0.018 (0.041)	0.106 ** (0.044)	0.103 ** (0.043)
Income Q4	0.126 *** (0.040)	0.124 *** (0.039)	0.086 ** (0.039)	0.090 ** (0.037)	0.161 *** (0.042)	0.148 *** (0.042)
Income Q5	0.201 *** (0.045)	0.186 *** (0.041)	0.165 *** (0.043)	0.149 *** (0.040)	0.230 *** (0.047)	0.198 *** (0.045)
Employed	0.082 *** (0.026)	0.079 *** (0.025)	0.085 *** (0.025)	0.080 *** (0.024)	0.096 *** (0.027)	0.104 *** (0.027)
Urban	0.060 ** (0.025)	0.043 * (0.023)	−0.020 (0.025)	−0.021 (0.023)	0.025 (0.026)	0.009 (0.026)
Phone own	0.122 ** (0.051)	0.185 *** (0.067)	0.060 (0.044)	0.078 (0.053)	0.194 *** (0.072)	0.298 *** (0.113)
Internet	0.202 *** (0.038)	0.256 *** (0.046)	0.194 *** (0.036)	0.227 *** (0.041)	0.261 *** (0.049)	0.380 *** (0.074)
N	976	976	976	976	976	976

Notes: The table reports average marginal effects from probit and complementary log-log models. Robust standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The baseline logit average marginal effects are reported in Table 3. The reference categories are primary education or less and the lowest income quintile. Source: Authors' calculations.

Table A3. Robustness Checks for Conditional Gender Effects in the Any Digital Payment Model.

Conditional Gender Effect	**Probit AME**	**Complementary Log-Log AME**
Gender × employment		
Non-employed	−0.109 *** (0.038)	−0.107 *** (0.040)
Employed	0.011 (0.032)	0.002 (0.029)
Gender × internet access		
No internet access	−0.083 (0.073)	−0.119 (0.087)
Has internet access	−0.039 (0.028)	−0.033 (0.027)
Gender × education		
Primary or less	−0.049 (0.044)	−0.052 (0.049)
Secondary	−0.049 (0.036)	−0.040 (0.032)
Tertiary	−0.028 (0.074)	−0.006 (0.064)
N	976	976

Notes: The table reports average marginal effects for the conditional gender gap in the any digital payment model. Robust standard errors are reported in parentheses. *** denote significance at the 1% level. The probit and complementary log-log models include the same control variables as the baseline interaction models. Source: Authors' calculations.

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