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Fintech, Female Employment, and Gender Inequality

Boileau Loko and Yuanchen Yang

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Fintech, Female Employment, and Gender Inequality
Prepared by Boileau Loko and Yuanchen Yang

Authorized for distribution by Boileau Loko

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ABSTRACT: Fintech, which delivers financial services digitally, promises to promote financial inclusion and close the gender gap. Using a novel fintech dataset for 114 economies worldwide, this paper shows that fintech adoption significantly improves female employment and reduces gender inequality, the effect being more pronounced in firms without traditional financial access. Fintech not only increases the number and ratio of female employees in the workforce, but also mitigates financial constraints of female-headed firms. Digital divide and poor institutions weaken such benefits. Endogeneity is accounted for by a fixed effects identification strategy. We conclude by providing policy recommendations and outlining avenues for future research.

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WORKING PAPER

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Prepared by Boileau Loko and Yuanchen Yang¹

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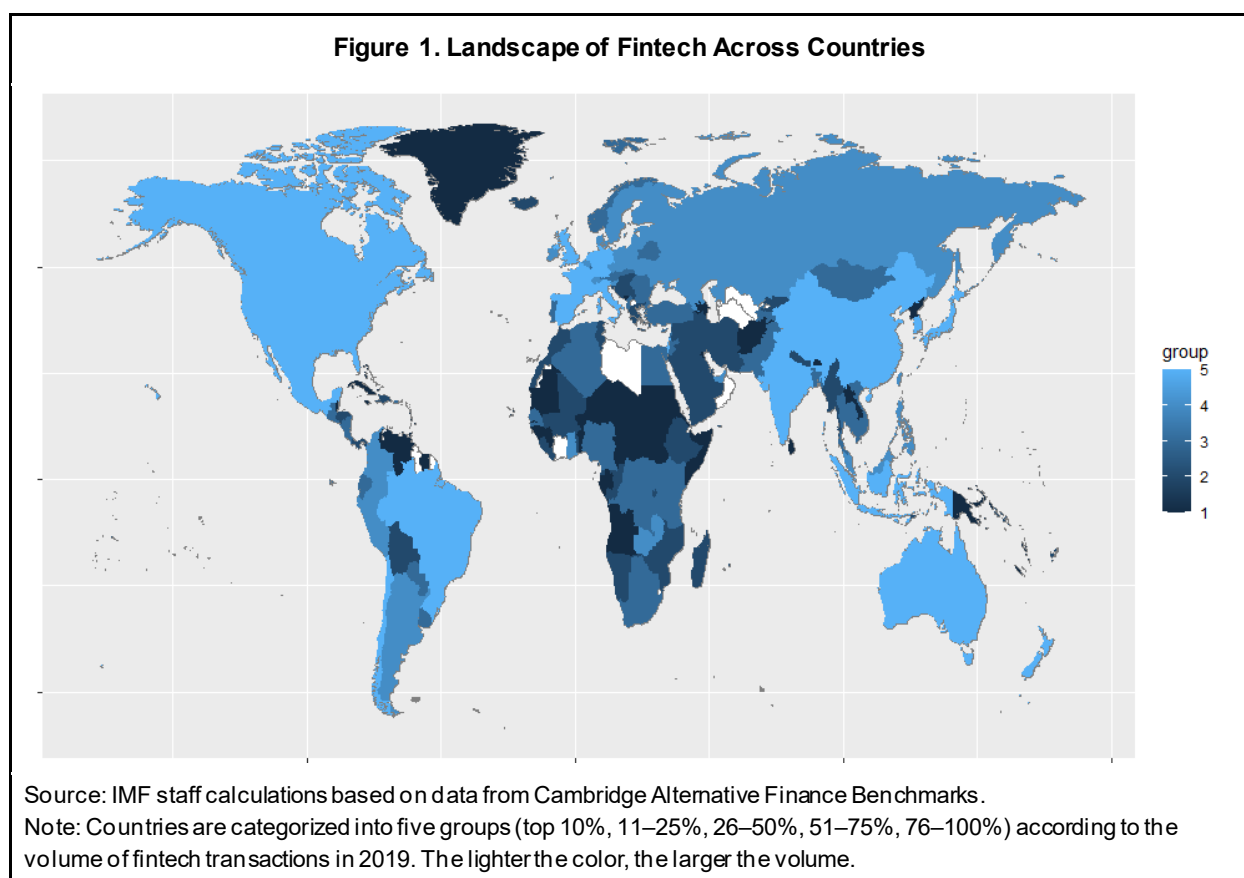
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Introduction

Gender equality lays the foundation for a peaceful, prosperous, and sustainable world (United Nations, 2015). Despite remarkable progress made over the last decades, many challenges remain: women experience higher levels of poverty, unemployment, and other economic hardships (IMF, 2021). Particularly in the global financial system, women continue to be under-represented at all levels, from depositors and borrowers to managers and regulators (Sahay and Cihak, 2018).

Can fintech, which refers to newly developed digital technologies to support or enable financial services and processes (Schüffel, 2016), reduce gender inequality? While there seems to be much hope that new technology in finance, which quickly spreads across the world (Figure 1), will unlock great potential for economic growth and social welfare like any other form of innovation, the distributional consequences of digital finance are not yet well understood or researched.



A limited number of studies has investigated the relationship between fintech and inequality. Most studies found that fintech could affect income inequality by helping create new job and income-generating opportunities for the poor as well as by promoting financial inclusion. Scholars have provided the empirical evidence based on cross-country aggregate data or single-country cases, with the latter focusing on developing economies. Suri and Jack (2016) showed that mobile money lifted 2 percent of Kenyan households out of poverty and increased per capita consumption levels. Zhang et al. (2020) link the index of digital financial inclusion with

China Family Panel Studies (CFPS) data. Their findings show that fintech development is positively correlated with household income, and the positive effect is larger for rural households than the urban counterpart, suggesting a benign distributive impact. As regards cross-country studies, Asongu and Nwachukwu (2018), using a sample of 93 countries, concluded that the use of mobile phones to pay bills or to send/receive money is significantly and negatively associated with income inequality but only in upper-middle income countries. More recently, Demir et al. (2020) found that while fintech significantly reduces inequality at all quantiles of the inequality distribution, these effects are primarily associated with higher-income countries. Finally, Chinoda et al. (2021), analyzing the interaction between financial technology, financial inclusion, and income inequality in a panel of 25 African countries over the periods 2011, 2014, and 2017, found that financial inclusion mediates the financial technology-income inequality relationship thus playing a fundamental role in reducing income inequality in Africa.

Most of the studies analyzing the nexus between fintech and inequality have focused on income inequality. Building on the existing literature, our paper sheds light on the link between fintech and gender inequality, particularly female employment. Taking the form of digital platforms, fintech could easily cross physical barriers and expand financial services to geographically marginalized communities. With big data made available by these digital platforms, fintech firms can process borrower information more efficiently and overcome information asymmetry. Unlike their traditional counterparts that have heavier compliance and capital requirements, fintech firms are subject to lighter regulations, which enables them to operate nimbly in certain market segments, to lend with few collaterals, and to better support the economy. When viewed from a gender lens, the benefits from fintech could be larger.

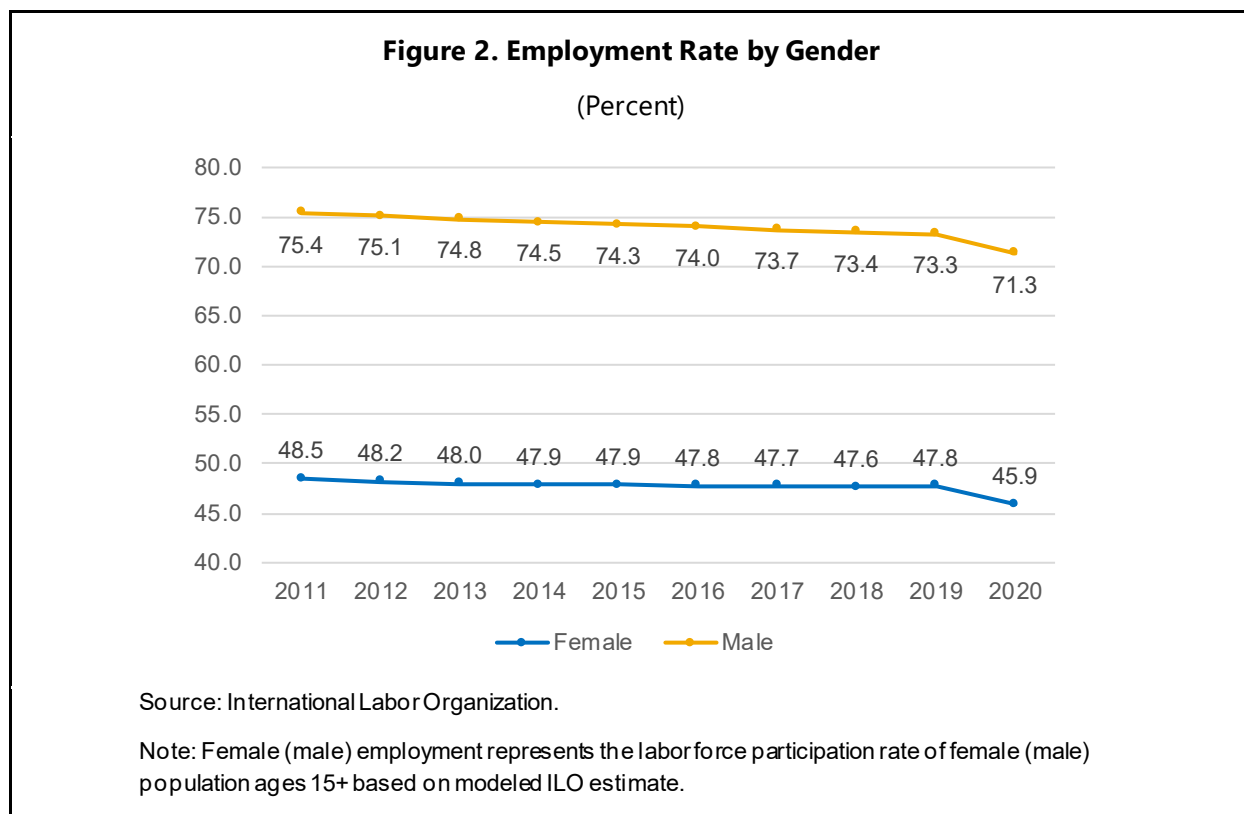
First, fintech can leverage digital financial tools to increase access to and usage of financial services, benefiting populations who have been disproportionately excluded from the traditional financial system (Sahay et al., 2020). According to the World Bank Group's latest Global Findex report, more than one billion women still do not use or have access to the financial system, and more than 70 percent of female-owned small and medium enterprises have inadequate or no access to financial services (World Bank, 2017; Demircug-Kunt, 2018). The development of fintech services enabled by fintech holds promise to provide greater convenience, privacy, and security to the traditionally unbanked or underbanked female population.

Second, fintech can help better evaluate the creditworthiness of individuals who may previously have been marginalized by the traditional financial system due to a lack of or minimal credit history. Using alternative data, for example information generated by and about consumers on digital platforms, fintech helps loan providers to make lending decisions without relying on credit reports or scores. Many of the female loan applicants, who often have neither credit reports nor credit scores, would benefit from these innovative measures to assess credit risk and model creditworthiness.

Third, fintech can facilitate access to financing, especially for female-headed households and businesses. It estimated that worldwide, a \$300 billion gap in financing exists for formal, female-owned small businesses (IFC, 2022). Without such access, women face difficulties in collecting and saving income, pulling their families out of poverty, and growing their own businesses (Sahay et al., 2015). Many fintech-based platforms which operate on "big data, small credit" propositions can contribute to women's economic empowerment and entrepreneurship by targeting small and medium enterprises, lowering interest rate, and relaxing collateral requirements.

Combining a comprehensive fintech database covering 114 countries for the period 2011–20 with firm-level statistics that have a gender composition of owner, managers and employees, we investigate the impact of

fintech on gender inequality, focusing on a particular dimension of gender inequality—gender employment gap. According to the World Bank, the current global employment rate is less than 46% for women whereas 71% for men (Figure 2), with some regions facing a gap of over 50%. We are interested in female employment not only because boosting it could generate substantial growth benefits (IMF, 2021; International Labor Organization, 2022), but also because it lays the foundation for other forms of gender equalities such as income and social status. Meanwhile, the COVID-19 pandemic has exacerbated the existing gender gap in employment, making it a pressing policy issue going forward (Fabrizio et al., 2021).



A number of studies have pointed to either finance or technology as a positive force to improve female employment. Based on a sample of 48 African countries, Ngoa and Song (2021) conclude that ICT penetration significantly stimulates female labor market participation, and the effect is enhanced by financial development. Focusing also on Africa, Asongu and Odhiambo (2019) show that promoting ICT beyond certain thresholds is necessary for ICT to mitigate inequality in order to increase female participation in the economy. The impact of finance and technology on female employment is also found to be positive in Europe, and Asia (Nassani et al., 2019; Chen et al., 2021). However, few, if any, studies have examined the intersection of finance and technology, or fintech, partly due to the lack of data, partly because of the difficulty to establish causality.

Identifying the causal effects of fintech development on female employment is challenging, due to well-known endogeneity concerns, namely the potential correlation between explanatory variables and the error term that arises from omitted variable and simultaneity. Building on the seminal work of Rajan and Zingales (1998), our paper makes progress on causality by including an array of controls and interacted fixed effects (country-industry and year) that allows us to account for a wide range of omitted variables. Lagged values of explanatory

variables are used to mitigate simultaneity concerns. As discussed earlier, fintech expands access to financial services and to credit. So fintech adoption should disproportionately help firms with financial constraints, high-tech firms that face greater information asymmetry and thus higher cost of borrowing, and firms without existing financial access. We shed light on details of economic mechanisms through which fintech development affects female employment by including a number of interaction terms between fintech and firm characteristics such as financial constraint, high-tech intensiveness, and loan access. In this way, our model specification captures the rich dynamics between fintech and firm variables, allowing for more reliable statistical inferences. It also presents specific mechanisms and mediating factors at play, which are grounded in microeconomic assumptions and provide strong evidence against reverse causality.

Our baseline results show fintech could improve female employment and reduce gender inequality. More specifically, a 1% increase in the scale of fintech usage is associated with a 1.4 percentage points increase in the number of female workers, and 0.4% increase in the ratio of female to total employees in the sample firms. The economic significance is large, given that the sample average percentage of female employees is only 32%.

We further disaggregated the fintech indicator into digital lending and digital capital raising tools, the former resembling debt financing whereas the latter having the nature of equity financing. We find that the adoption of capital raising tools is associated with a greater effect on the number of female workers in firms. This distinction is important, given the heterogeneous roles that lending and capital raising tools play. As Brown et al. (2009) indicate, there are no collateral requirements for capital financing, and thus will not increase a firm's financial distress when additional capital is needed. This feature can be especially attractive to female borrowers who have fewer financial resources.

Consistent with the literature, we find the impact of fintech to be substantially higher for firms with financial constraints, with internet access, and without outstanding loans or lines of credit. The results shed light on the mechanisms whereby new fintech functions reduce the cost of external financing, thus mitigating firms' financial constraints; they also make financial services more inclusive and credit more widely accessible, which is why we observe greater effect among firms in need of financial support while having no existing engagements with formal banking.

We also found that weak institutions reduce the positive effect of fintech. The correlation between fintech adoption and female employment is positive in advanced economies and emerging markets, whereas in the low-income country group, the effect is insignificant or even negative. We further split the sample based on institutional quality in terms of government effectiveness, regulatory quality, rule of law, and women business law. Fintech can significantly increase female employment and mitigate gender inequality in countries which with good governance, law and regulations, while its benefits are weaker in countries whose institutional quality is below median.

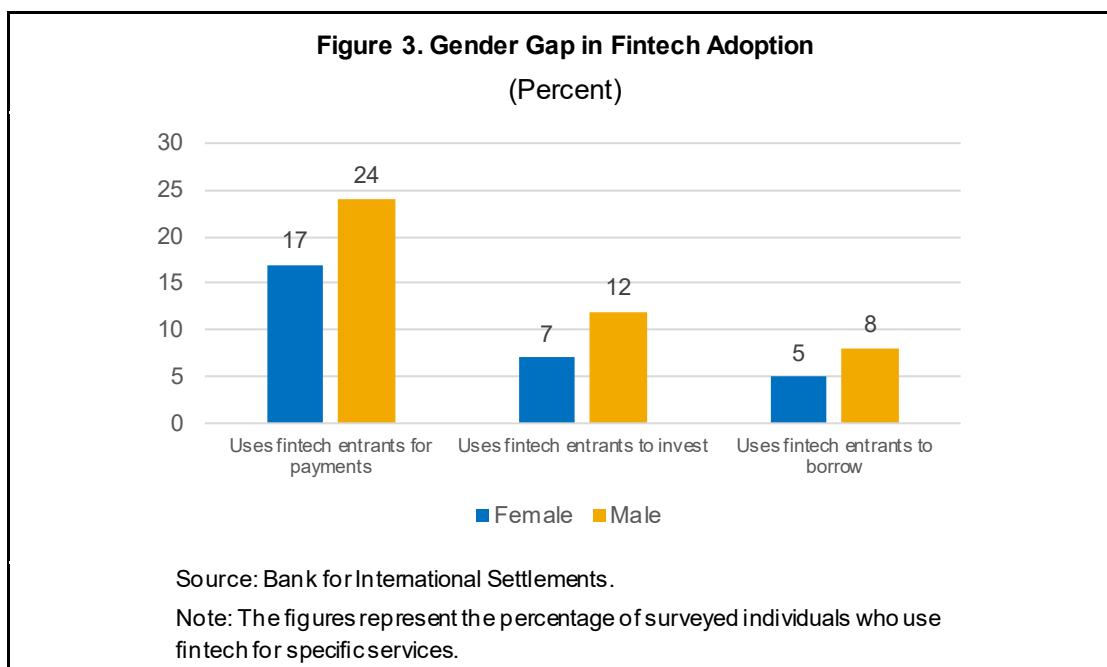
We further group the sample countries by region. The effect of fintech is positive in Sub-Saharan African, Asian and Pacific, and European countries, insignificant in the Latin American and Caribbean sample, and negative in countries in Middle East and North Africa.

Our paper seeks to make three main contributions. To the best of our knowledge, this is one of the first studies shedding some light on the link between fintech and gender inequality as measured by female employment. We push the research frontier further by examining the distributional effects of fintech using a comprehensive

definition and showing that women, who are traditionally marginalized by the formal financial system, can be included and see welfare improvements via fintech.

Second, this paper is among the first to present cross-country evidence on the effects of fintech, covering 114 economies worldwide. Extant literature mainly looks at fintech usage in specific country cases, typically in less developed economies (Andrianaivo et al., 2012), partly because with less developed financial markets, developing countries are home to fewer entrenched players than advanced economies. Our data includes both advanced and developing countries, and we examine the impacts of fintech development on a battery of gender inequality indicators at the micro, firm level.

The findings and techniques developed in this paper also contribute to an important policy discussion. One of the key promises of fintech is greater financial inclusion. Admittedly, there is a significant gender divide in accessing fintech services (Figure 3), which can be ascribed to differences in attitudes (BIS, 2019), technological and institutional factors. We identify a number of technological, legal, and regulatory barriers that have constrained access to and usage of fintech to improve gender equality. We proposed pathways to develop enabling infrastructure and improve institutional environment to build a more inclusive fintech ecosystem.



The rest of the paper is organized as follows. Section 2 describes our methodology and data. Section 3 presents empirical results and discussion. Section 4 reports robustness checks. Section 5 concludes and provides policy recommendations.

Methodology and Data

A. Variable Construction

1. *Fintech Variable*

To measure the level of fintech development, we construct three main measures. Our first measure, *Fintech*, is the natural logarithm of the total volume of finance through digital platforms, denoted in U.S. dollars. It can be further divided into two main categories—digital *lending* and digital *capital raising*—depending on the different business models with which the platforms operate.

Lending is the natural logarithm of the volume of lending instruments through digital platforms. More specifically, it comprises balance sheet lending, P2P/marketplace lending, debt-based lending, and invoice trading. *Capital Raising* refers to the natural logarithm of capital raising instruments through digital platforms. It takes the form of investment-based crowdfunding such as real estate crowdfunding, and non-investment-based crowdfunding such as donation-based or reward-based crowdfunding.

More detailed, level 3 categorization is provided in Annex II. It is worth noting that in cases where participating platforms multi-select applicable business models which best described their operations by following the established taxonomy, platforms would be asked to specify further information and provide a detailed breakdown of their activities.

The underlying data on platform activity, transaction volume, loan performance etc. is first collected from surveys and then verified with publicly available information through the platform's website, press releases and annual reports. A number of prominent reward-based platforms are unable to participate in the survey due to internal policies. To avoid under-representation issues, their data is collected and automatically updated by web-scraping techniques to ensure the most reliable and up-to-date information.

2. *Female Employment Variable*

With the rising awareness of gender issues, there have appeared over three hundred different indicators used to measure gender equality, including several well-known indices. The most prominent ones include UNDP's Gender-related Development Index (GDI) and the Gender Empowerment Measure (GEM), introduced in 1995, and WHO's Gender Inequality Index (GII), introduced in 1998. More recent measures include the Gender Equity Index (GEI) introduced by Social Watch in 2004, the Global Gender Gap Index (GGGI) developed by the World Economic Forum in 2006, and the Social Institutions and Gender Index of OECD Development Centre from 2007, all of which have extensive coverage and well-established methodologies.

However, the major problem with these cross-country indicators is that they are aggregated at the country level, unable to provide a granular view of how women fare in individual firms. Moreover, they are usually composed of slow-moving variables such as maternal mortality ratio, female education attainment, etc. making it difficult to investigate how women make economic decisions and respond to policy shocks.

In this study, we turn our attention to the female workers in firms and examine how individual firms make employment decisions, under the influence of fintech. Increasing female representation in the workforce has

been a critical aspect of women empowerment, due to its strong implications for economic development, productivity growth, and poverty reduction (Ostry et al., 2018). It has been estimated that the losses to an economy from economic disempowerment of women range from 10 percent of GDP in advanced economies to more than 30 percent in developing countries (Kochhar et al., 2017).

Fintech promises to increase female participation in the labor force. To estimate its impact, we construct two measures—number of female employees and ratio of female employees, based on data from the WBES. *Female Employees* is the natural logarithm of the number of female full-time employees. *Female Ratio* is calculated as the ratio of female employees over the total number of employees.

More recent research suggests that the economic benefits of bringing more women into the labor force exceed previous estimates (Sahay and Cihak, 2018). This is because women leaders may have different skills and ideas that are economically valuable. Studies have found gender-balanced corporate boards improve firm returns, especially in high-tech manufacturing and knowledge-intensive services (Strøm et al., 2014). With WBES, we are able to distinguish between female and male-led firms and relative firm financial performance. *Female – Led Firms* refer to the firms with female as top manager.

3. Other Firm-Level Variables

To understand the economic mechanisms and the mediating factors between fintech development and gender inequality, we look at a set of variables that reflect a firm's financial or operating status.

In its questionnaire, the WBES asks firms to characterize the severity of obstacles they face on a scale from no obstacle, minor obstacle, moderate obstacle, major obstacle, to very severe obstacle. We classify firms as having financial constraints if they report to have at least minor obstacle to financial access. Thus, *Financial Constraint* is a dummy variable that is equal to 1 if access to finance represents at least a minor obstacle for the firm, and 0 otherwise.

Apart from financial access, we assume that firm size, loan access, and internet access also affects a firm's response to fintech, hence the effect on female workers in firms. More specifically, *Small Business* is a dummy variable that equals 1 if the firm has fewer than 20 employees, and 0 otherwise. *Loan Access* is a dummy variable that is equal to 1 if the firm has no outstanding line of credit or loan from a financial institution, and 0 otherwise. We also consider the *Internet Access* dummy, which equal 1 if the firm has its own website, and 0 otherwise.

4. Institutional Quality Indices

We use the Worldwide Governance Indicators to measure a country's institutional quality. We focus on three dimensions—government effectiveness, regulatory quality, and rule of law. Both values and ranking are available for each dimension. A higher absolute value is associated with worse institutional quality, whereas on a scale from 1 to 100, the higher the ranking, the higher the institutional quality.

To examine whether fintech has a more beneficial impact on female employment when particular legal rights are present, we also make use of the Women, Business and the Law index proposed by the World Bank. On a scale from 0 to 100, the higher the value, the more progress a given country has made toward gender equality in law.

5. Control Variables

Following the existing literature, we control for an array of variables to reflect country and firm characteristics. At the country level, *GDP level* is the natural logarithm of a country's GDP, denoted in billion U.S. dollars. *GDP growth* is the percentage change of a country's GDP. *Openness* is the sum of export and import volumes over total GDP, serving as a proxy for a country's trade openness.

At the firm level, *Sales* is the natural logarithm of the total annual sales. *Age* is the natural logarithm of firm operating years. It is obtained by taking the difference of current year and the year when the firm started operations. *Export Share* refer to the share of sales that are direct or indirect exports. *Foreign Ownership* measures the share owned by private foreign entities. *Sector Specialization* differentiates between firms operating in manufacturing sectors and in service sectors.

Descriptive statistics of the variables are provided in Table 1.

Table 1. Summary Statistics					
Variable	No. of Obs.	Mean	Std. Dev.	Min	Max
Fintech	26447	15.238	2.927	5.210	21.780
Lending	17021	16.365	2.192	10.222	21.766
Capital Raising	17021	13.094	2.332	5.210	17.801
Female Employees	26447	1.817	1.307	0.000	10.373
Female Ratio	26447	0.324	0.275	0.000	1.000
Female Led	26447	0.155	0.361	0.000	1.000
GDP	26447	5.063	1.826	0.291	8.922
GDP Growth	26447	0.117	0.081	-0.046	0.782
Openness	26447	0.769	0.409	0.264	3.801
Sales	26447	16.551	3.030	0.000	32.053
Age	26447	3.119	0.795	0.180	7.616
Export Share	26447	0.117	0.273	0.000	1.000
Foreign Ownership	26447	0.068	0.236	0.090	1.000
Sector Specialization	26447	0.464	0.499	0.000	1.000
Financial Constraint	26447	0.609	0.488	0.000	1.000
Loan Access	26447	0.317	0.465	0.000	1.000
Small Business	26447	0.314	0.474	0.000	1.000
Internet Access	26447	0.556	0.497	0.000	1.000
Government Effectiveness	26447	-0.133	0.726	-1.680	2.007
Regulatory Quality	26447	-0.106	0.734	-1.654	1.906
Rule of Law	26447	-0.226	0.729	-1.656	2.058
Women Business Law	26447	73.025	17.443	26.250	100.000

The average number of female full-time employees is 20 people, and the average ratio of females over total employees is 32.4%. A typical firm in the sample has a sales volume of 14.4 billion dollars, an operating experience of 17 years, 11.7% of its revenues from exports, and 6.8% of its shares held by foreign entities. Around 46.4% of the sampled firms operate in the service sector, while the rest are specialized in

manufacturing. After dropping all the observations with missing variables, we have an average of 23.2 firms covered in a typical country in a typical year.

B. Empirical Strategy

1. Baseline Model

To estimate the relation between fintech and gender inequality, we construct the following baseline model:

$$Gender_{i,j,t} = \beta_0 + \beta_1 Fintech_{i,t-1} + \beta_2 X_{i,t-1} + \beta_3 I_{i,j,t-1} + \eta_{i,k} + \mu_t + \varepsilon_{i,j,t} \quad (1)$$

$$Gender_{i,j,t} = \beta'_0 + \beta'_1 Lending_{i,t-1} + \beta'_2 Capital\ Raising_{i,t-1} + \beta'_3 X_{i,t-1} + \beta'_4 I_{i,j,t-1} + \eta_{i,k} + \mu_t + \varepsilon_{i,j,t} \quad (2)$$

where $Gender_{i,j,t}$ refers to the level of gender inequality of country i , firm j , in year t , measured by the number of female employees and the ratio of females over total employees in the sampling firms. $Fintech_{i,t}$ captures the fintech development of country i in year t , measured by the volume of alternative finance, which can be further classified into digital *lending* and digital *Capital Raising*. $X_{i,t-1}$ is a vector of country-level controls, including the natural logarithm of per capita GDP, GDP growth rate, and trade openness. $I_{i,t-1}$ is a vector of firm-level controls, comprising firm size, firm age, export dependence, foreign ownership, and sector specialization. All explanatory variables are lagged by one year to mitigate endogeneity concerns.

By including $\eta_{i,k}$ we account for country-industry fixed effect that absorbs variations in the financial environment between countries and industries, such as systematic differences in economic development, government policies, and industry-specific reforms. μ_t denotes year fixed effect that picks up any variation in the outcome that happens over time and that is not attributable to other explanatory variables. Standard errors are clustered at the country and industry level to account for heteroskedasticity.

The coefficient of interest is β_1 , β'_1 , and β'_2 , are associated with fintech variables. If they are positive and significant, we can conclude that a higher level of fintech development is associated with a higher female representation in the workforce, hence a lower degree of gender inequality. If they are negative and significant, we can infer a negative correlation between fintech development and gender equality.

2. Identification Strategy

As discussed in our introduction, identifying the causal effects is a challenge, due to the potential correlation between right-hand-side variables and the error term that arises most notably from omitted variables and reverse causality. On one hand, omitted variables could bias the estimation that results from traditional cross-country regressions. Unobservable country or industry characteristics related to both fintech and female employment are left in the error term, making statistical inferences hard to draw. On the other hand, in the unlikely circumstance, raising female employment rate could increase the use of fintech.

In their pioneering work, Rajaa and Zingales (1998) propose a fixed-effect identification strategy with interaction terms. They show that better-developed financial markets lead to higher economic growth in industries that are heavily dependent on external finance. Inspired by this work, we establish the following model that extends

their empirical framework to the fintech setting. By estimating various forms of the model below, we examine the effects of fintech on gender inequality:

$$Gender_{i,j,t} = \alpha + \beta(Fintech_{i,t-1} \times Firm_j) + \gamma Fintech_{i,t-1} + \rho Firm_i + \delta I_{i,j,t-1} + \eta_{i,k} + \mu_t + \varepsilon_{i,j,t} \quad (3)$$

where $Firm_j$ is firm-level financial constraint, loan access, digital infrastructure, etc. that capture economic mechanisms and help with identification. Note that only additional explanatory variables that vary both with country and firm need to be included. All explanatory variables are lagged by one year to mitigate simultaneity concerns.

One key virtue of our model is that it allows to use interacted fixed effects (country-industry, and year) to control for a wide range of omitted variables. Thus, we correct for country and firm characteristics in ways that previous cross-country empirical studies were unable to correct for, and will be less subject to criticism about model specification. When interpreting the results, we focus on the signs and economic significance of β . If the coefficient is positive (negative) and significant, it indicates that fintech exerts a disproportionately positive (negative) effect on firms with financial constraints, high-tech intensiveness, loan access, and internet access. In addition, by including various interaction terms, we provide clear evidence of the specific mechanisms through which fintech affects female employment. These mechanisms are firmly grounded in economic theories, thus effectively addressing concerns of reverse causality.

3. Split Sample Analysis

We further explore how the relation between fintech development and female employment depend on institutional characteristics. We make reference to the worldwide governance indicators and partition the sample based on the level of government effectiveness, regulatory quality, rule of law, and women business law. The countries with above-the-median values in the governance indicators are labeled as the high governance group, whereas the rest belongs to the low governance group. In this way, we test for several predictions that flow from the theory. For example, low governance effectiveness signals greater risk that the state is unable to ensure law and order, to deliver public services, or to manage future emergencies, leading to higher investor risk aversion and thus an under-investment in fintech. Similarly, poor regulatory quality and weak rule of law should limit the inequality-reducing effect of fintech.

As the next step, we divide the sample by income level and rerun Model (1) and Model (2) within different income groups, assuming that advanced and emerging market economies have greater capacity to invest in fintech, facilitate its adoption, and reap its benefits. We also investigate regional heterogeneities by grouping the sampling countries based on their geographical location, under the assumption that regional differences could influence the effectiveness of fintech in improving female employment and reducing gender inequality.

C. Data Sources

Data on fintech adoption is obtained from the Cambridge Alternative Finance Benchmark, which contains the volume of finance through digital platforms from the world's 191 jurisdictions spanning 2011–20¹.

The Benchmark is based on an online survey hosted by the Cambridge Centre for Alternative Finance, Judge Business School, in partnership with The University of Agder (for the EU report), the University of Chicago Booth School of Business (for the Americas study), University of Sydney Business School, the University of Tsinghua Graduate School at Shenzhen and Shanghai Jiaotong University Law School (for the Asia-Pacific regional study) and Nesta (for the UK report).

Data on female employment comes from the World Bank Enterprise Survey (WBES). Starting from 1990s, this renowned firm-level Survey has covered a representative sample of firms in the world's major economies. a standard establishment-level survey that is representative of the non-agricultural, non-extractive private sector, covering registered establishments with 5 or more employees. The database covers a broad range of business environment topics including access to finance, corruption, infrastructure, crime, competition, and performance measures. However, it is worth noting that given the incidence of agriculture in female employment, the WBES database which only includes manufacturing and service industries has certain limitations.

In addition to the main variables of interest, our country-level control variables are retrieved from the IMF's World Economic Outlook (WEO) database. To estimate mediating effects, we complement the dataset with the Worldwide Governance Indicators proposed by Kaufmann and Kraay in 1999. The Indicators report on six broad dimensions of governance, which are voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption, for over 200 countries and territories over the period 1996–2020. Women, Business, and Law index is taken from the World Bank's annual report under the same title that analyze laws and regulations affecting women's economic opportunity in 190 economies.

We take the overlapping years of these databases and set the sample period to 2011–20. The complete list of countries covered can be found in the Annex. Data sources, along with variable definitions, are summarized in Annex III.

Empirical Results and Discussion

A. Baseline Results

Our baseline regression results are provided in Table 2. In Model (1), we estimate Equation (1) using the number of female employees as the dependent variable and the level of overall fintech finance as the independent variable. After dropping missing values, we end up with a sample of 22,631 firms. The coefficient

¹ We choose the current fintech indicator over other fintech related indexes including Global FINDEX compiled by WB and FAS compiled by IMF for the following reasons: 1) They are published in waves and the only available years are 2011, 2014, 2017, making it difficult to perform reliable panel-based analysis. 2) The fintech landscape has been changing rapidly since 2017. It is thus preferable to use the latest data available to reflect the most recent developments. 3) Global FINDEX and FAS do not make the distinction between lending and equity financing, which is economically important given the vastly different natures of and incentives offered by debt and equity financing. The index that we currently use studies alternative finance, including financial channels and instruments that emerge outside of the traditional financial system. Use of mobile money and internet banking that are oftentimes operated by traditional banks are thus not included.

on Fintech is positive and significant at the 1% level. The result appears to be consistent with our hypothesis that fintech development is associated with a significant increase in female employment. More specifically, a 1% increase in the volume of transactions through fintech platforms is associated with a 1.363 percentage points increase in the number of female full-time employees in our sample firms.

A likely explanation is that with easier financial access enabled by fintech, firms have more financial resources to expand their businesses, make investments, and boost production. Since capital and labor are complements in the production process (Allen, 1968), increased investments create more demand for laborers, including female laborers (Benmelech et al., 2011).

Table 2. Fintech Development and Female Employment

VARIABLES	(1) Female Employees	(2) Female Ratio	(3) Female Employees	(4) Female Ratio
Fintech	1.363*** (0.456)	0.375*** (0.112)		
Lending			-0.143* (0.083)	-0.047*** (0.011)
Capital Raising			0.776*** (0.112)	0.152*** (0.019)
GDP	2.931** (1.318)	0.642* (0.330)	-1.344*** (0.114)	-0.334*** (0.020)
GDP Growth	-0.627* (0.329)	-0.094 (0.084)	0.098** (0.046)	0.060*** (0.006)
Openness	6.764** (2.774)	1.543** (0.702)	-0.023 (0.826)	0.595*** (0.110)
Sales	0.354*** (0.005)	-0.003*** (0.001)	0.366*** (0.006)	-0.006*** (0.001)
Age	0.081*** (0.010)	-0.003 (0.002)	0.086*** (0.012)	-0.002 (0.003)
Export Share	0.109*** (0.041)	-0.014* (0.007)	0.027 (0.050)	-0.021** (0.009)
Foreign Ownership	0.306*** (0.033)	0.025*** (0.006)	0.311*** (0.043)	0.027*** (0.008)
Sector Specialization	0.068 (0.448)	-0.056 (0.076)	0.020 (0.434)	-0.056 (0.077)
Constant	-29.434*** (8.811)	-6.675*** (2.161)	-3.488*** (0.945)	0.228 (0.155)
Country-Industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	22631	26447	14631	17021
R-Squared	0.390	0.263	0.393	0.270

Note: * p<0.1, ** p<0.05, *** p<0.01

In Model (2), we replace dependent variable with the ratio of female employees over total employees and find a significantly positive correlation between fintech development and female ratio. The results indicate that fintech

adoption not only leads to more jobs for women, but also raises the ratio of female relative male workers, both of which are crucial aspects of gender equality in the workplace.

Next, we disaggregate the fintech variables into fintech lending and fintech capital raising instruments. Interestingly, we find opposite signs on the estimated coefficients. Despite the overall positive influence of fintech on female employment, the correlation between fintech lending and female employment is negative and significant. In contrast, the coefficient on *Capital Raising* is positive and significant at the 1% level, consistent with our hypothesis that equity-like instruments are more effective tools to mitigate financial distress than debt-like instruments. The results highlight the importance of distinguishing between different fintech tools in estimating the economic impact.

B. Economic Mechanisms

How does fintech disproportionately increase the number of female employees? First, fintech reduces firms' financial constraints. With more financial resources made available through fintech, employers might be able to hire female workers who require on-job trainings, maternity leave, flexible hours, etc. If this hypothesis is true, we should observe a more pronounced effect in firms with financial constraints. We explicitly test this hypothesis by interacting the fintech indicator with a firm's financial constraint and present the results in Table 3. Consistent with our hypothesis, the coefficient on the interaction term is positive and significant (Model 1), suggesting a stronger effect for financially constrained firms. Thus, fintech promotes female employment by providing firms with more financial resources to hire more employees, especially female employees.

Table 3. Economic Mechanisms Underlying the Effect of Fintech Development

VARIABLES	(1)	(2)	(3)	(4)
	Female Employees			
Fintech	0.444*	0.406*	0.555**	0.727**
	(0.238)	(0.236)	(0.282)	(0.291)
Fintech*Financial Obstacle	0.016***			
	(0.006)			
Fintech*Female-Led		0.014**		
		(0.006)		
Fintech*Small Business			0.017***	
			(0.005)	
Fintech*Service Sector				0.044**
				(0.018)
Financial Obstacle	-0.272***			
	(0.088)			
Female-Led		-0.173*		
		(0.093)		
Small Business			0.175**	

Table 4. Economic Mechanisms Underlying the Effect of Fintech Development (concluded)

			(0.075)	
Service Sector				-0.424*
				(0.255)
Age	0.186***	0.186***	0.174***	0.189***
	(0.011)	(0.011)	(0.011)	(0.011)
Export Share	0.004***	0.004***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Foreign Ownership	0.008***	0.008***	0.008***	0.008***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-5.524	-4.981	21.222*	16.140
	(3.601)	(3.580)	(12.399)	(12.873)
Country-industry FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	25,120	25,120	25,120	25,142
R-squared	0.150	0.150	0.173	0.096

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Fintech adoption could disproportionately benefit female-led firms, which are more likely to hire female workers (West & Sundaramurthy, 2019). Numerous studies have documented a gender divide in financial access (OECD, 2016). Women are less likely than men to obtain the financing needed to start a business, due to a lack of collateral guarantees, a lack of credit record, or pure gender discrimination by the bank. With lower collateral requirement and alternative ways to establish credit worthiness, fintech is expected to provide more convenient access to finance for female borrowers. Therefore, we zoom in to firms led by females, and rerun Equation (3). The results, which are reported in Model (2), confirmed our conjecture. The effect of fintech is positive and significant in female-led firms, suggesting that fintech can contribute toward a more equal distribution of financial resources between genders.

We should also observe a stronger effect of fintech on small businesses. Small firms are often unable to pledge collateral due to the lack of collateral assets (Nguyen and Qian, 2012). In the meantime, they tend to hire more women than larger firms, as the latter prefer more educated workers (Paik, 2008). We test this hypothesis by interacting the fintech indicator with a dummy that indicates small business. The positive and significant sign on the interaction term in Model (3) confirmed our hypothesis.

In addition, due to the comparative advantages of women versus men, more women cluster in the service industry (Georgieva et al. 2020). In contrast to manufacturing sector firms, service sector firms are characterized by more intangible assets, the limited collateral value of which restricts the use of traditional financial instruments such as bank loans (Hsu et al., 2014). Thus, these firms are often discriminated and marginalized by the traditional financial system and are thus more likely to be financially constrained. Consistent with our hypothesis, the coefficient on the interaction term in Model (4) is positive and significant, suggesting that fintech adoption brings additional benefits to firms in service sectors.

In summary, fintech promotes female employment mainly through a favorable allocation of financial resources to firms that are more female-labor-intensive, and at the same time are more likely to have financial constraints, such as female-led firms, small firms, and firms in service sectors.

C. Fintech Interaction with Firm Characteristics

In this subsection, we estimate Equation (3), introducing interaction terms between fintech and additional firm-level characteristics, respectively. The key variables that we look at include a firm's loan access and internet access.

Table 5. Fintech and Firm Characteristics

VARIABLES	(1)	Female Employees	(2)
Fintech	0.478** (0.235)		0.557* (0.291)
Fintech*Loan Access	0.011** (0.006)		
Fintech*Internet Access			0.016*** (0.005)
Loan Access	-0.502*** (0.086)		
Internet Access			-0.809*** (0.081)
Age	0.180*** (0.011)		0.166*** (0.011)
Export Share	0.003*** (0.000)		0.003*** (0.000)
Foreign Ownership	0.008*** (0.000)		0.007*** (0.000)
Constant	-6.162* (3.564)		17.525 (12.640)
Country-industry FE	YES		YES
Year FE	YES		YES
Observations	25,120		25,120
R-squared	0.161		0.186

Note: * p<0.1, ** p<0.05, *** p<0.01

Fintech is oftentimes described as being a disruptive force to traditional financial system (Jiang et al., 2021). It would be interesting to examine whether fintech represents a complement or substitute to traditional finance. To do this, we include the interaction of fintech and a firm's loan access. The results are shown in Model (1) of Table 4. Contrary to the popular belief that fintech disrupts the traditional financial system, we find the coefficient estimate on the interaction term to be positive and significant, suggesting that firms without existing loan access are more likely to benefit from fintech adoption. Fintech, as a form of alternative finance, extends credit to unbanked populations and fill in the vacuum left by formal finance.

We further explore how digital infrastructure affects a firm's capacity to adopt fintech, assuming that fintech adoption requires basic digital infrastructure. Constrained by data availability, we proxy for a firm's internet access the existence of its own website. The coefficient on the interaction term turns out to be significantly positive, as is shown in Model (2) of Table 4. Consistent with our hypothesis, firms with better internet access

are more favorably positioned to take advantage of fintech innovation, especially equity financing via fintech platforms.

To summarize, the positive effect of fintech on female employment is more pronounced in firms with basic digital infrastructure, and without access to traditional finance. Fintech tends to fill the gap left by the traditional financial system, but its adoption requires basic digital infrastructure in place.

D. Weak Institution Reduces Benefits of Fintech

This subsection reports the results from the split sample analysis. We further examine the impact of fintech development on female employment relying on the heterogeneity in countries' institutional quality.

We first divide the sample firms based on the institutional quality of the country that hosts their headquarters. We focus on four governance dimensions—government effectiveness, regulatory quality, rule of law, and women business law. The results in Table 5 show that countries with greater government effectiveness experience greater welfare improvement via fintech. To some extent, government ineffectiveness increases the risk aversion of the country's investors, discouraging the development of fintech innovations.

Table 5. The Effect of Fintech by Government Effectiveness

VARIABLES	High Government Effectiveness	Low Government Effectiveness
	(1)	(2)
	Female Employees	
Fintech	0.609*** (0.060)	-0.793*** (0.102)
GDP	0.982*** (0.094)	-0.568 (1.216)
GDP Growth	-0.161*** (0.018)	-0.257 (0.383)
Openness	3.437*** (0.351)	0.860 (1.557)
Sales	0.328*** (0.005)	0.427*** (0.010)
Age	0.084*** (0.013)	0.070*** (0.015)
Export Share	0.127** (0.054)	0.030 (0.061)

Table 5: The Effect of Fintech by Government Effectiveness (concluded)

Foreign Ownership	0.248*** (0.041)	0.366*** (0.055)
Sector Specialization	0.114 (0.457)	-1.109*** (0.268)
Constant	-10.482*** (1.340)	8.386* (4.880)
Country-Industry FE	YES	YES
Year FE	YES	YES
Observations	15,147	7,484
R-Squared	0.393	0.395

Note: * p<0.1, ** p<0.05, *** p<0.01

Similarly, we scrutinize the role of regulatory quality. High regulatory quality is usually associated with regulations that permit and promote private sector development. The results are shown in Table 6.

Table 6. The Effect of Fintech by Regulatory Quality

VARIABLES	High Regulatory Quality	Low Regulatory Quality
	(1)	(2)
	Female Employees	
Fintech	0.595*** (0.060)	-0.807*** (0.102)
GDP	0.953*** (0.094)	-0.604 (1.217)
GDP Growth	-0.155*** (0.018)	-0.270 (0.383)
Openness	3.420*** (0.354)	0.912 (1.559)
Sales	0.313*** (0.006)	0.433*** (0.009)
Age	0.074*** (0.013)	0.085*** (0.014)
Export Share	0.117** (0.057)	0.041 (0.057)
Foreign Ownership	0.212*** (0.043)	0.380*** (0.051)
Sector Specialization	0.142 (0.457)	-1.124*** (0.268)
Constant	-10.218*** (1.348)	8.559* (4.884)

Table 6. The Effect of Fintech by Regulatory Quality (concluded)

Country-Industry FE	YES	YES
Year FE	YES	YES
Observations	13,243	9,388
R-Squared	0.387	0.409

Note: * p<0.1, ** p<0.05, *** p<0.01

Next, we explore how a country's rule of law moderates the relation between fintech and female employment. A country with strong rule of law is marked by constraints on government powers, absence of corruption, order and security, regulatory enforcement, civil justice, and criminal justice. We report the results in Table 7.

Table 7. The Effect of Fintech by Rule of Law

VARIABLES	Female Employees	
	Strong Rule of Law (1)	Weak Rule of Law (2)
Fintech	0.610*** (0.060)	0.019 (0.173)
GDP	0.985*** (0.094)	-1.896 (1.301)
GDP Growth	-0.161*** (0.018)	-0.738* (0.405)
Openness	3.439*** (0.350)	4.070** (1.709)
Sales	0.330*** (0.005)	0.424*** (0.010)
Age	0.081*** (0.012)	0.072*** (0.016)
Export Share	0.100* (0.054)	0.073 (0.060)
Foreign Ownership	0.245*** (0.042)	0.360*** (0.054)
Sector Specialization	0.104 (0.452)	-1.108*** (0.268)
Constant	-10.488*** (1.338)	0.245 (4.667)
Country-Industry FE	YES	YES
Year FE	YES	YES
Observations	15,434	7,197
R-Squared	0.382	0.417

Note: * p<0.1, ** p<0.05, *** p<0.01

The estimated coefficients presented in Table 6 and Table 7 invariably show that in countries with higher values in the regulatory quality and rule of law indicators, the effect of fintech is positive and significant. In contrast, fintech appears to lead to more severe gender inequality in weak institutions.

Finally, we use the World Bank's women, business and the law index to measure each sample country's progress toward greater gender equality in law. Presumably, women living in countries with better legal protection are likely to benefit more from fintech. The results, which are displayed in Table 8, confirm our hypothesis.

Table 8. The Effect of Fintech by Women Business Law

VARIABLES	Stronger Law Protection	Weaker Law Protection
	(1)	(2)
	Female Employees	
Fintech	1.441*** (0.452)	0.027 (0.025)
GDP	3.238** (1.312)	0.391*** (0.091)
GDP Growth	-0.714** (0.327)	0.064*** (0.005)
Openness	7.533*** (2.766)	1.873** (0.753)
Sales	0.393*** (0.006)	0.269*** (0.008)
Age	0.083*** (0.011)	0.069*** (0.018)
Export Share	0.095** (0.047)	0.090 (0.077)
Foreign Ownership	0.285*** (0.037)	0.291*** (0.074)
Sector Specialization	0.001 (0.458)	0.607** (0.251)
Constant	-31.661*** (8.754)	-7.905*** (1.017)
Country-Industry FE	YES	YES
Year FE	YES	YES
Observations	15,849	6,782
R-Squared	0.406	0.370

Note: * p<0.1, ** p<0.05, *** p<0.01

In the second set of regressions, sample firms are partitioned into three groups based on the income level of the country in which they are headquartered. We rerun Equation (1) for each group. The effect of fintech is positive in advanced economies and emerging market economies, whereas negative in low-income countries (Table 9). Note that the definition of an emerging market economy is based on Duttagupta and Pazarbasiglu (2021). Our evidence suggests that relative to more developed countries, less developed countries lack the institutional capacity to fully tap the potential of fintech innovations.

Table 9. The Effect of Fintech by Country Income Group

VARIABLES	Advanced Economies	Emerging Markets	Low-Income Countries
	(1)	(2) Female Employees	(3)
Fintech	0.439*** (0.089)	0.149*** (0.021)	-3.929*** (0.376)
GDP	1.087*** (0.133)	-0.543*** (0.065)	4.206*** (0.312)
GDP Growth	0.154** (0.076)	0.046*** (0.013)	-0.203*** (0.026)
Openness	0.222 (0.191)	-0.391* (0.226)	13.661*** (1.912)
Sales	0.491*** (0.011)	0.348*** (0.006)	0.263*** (0.010)
Age	0.040** (0.017)	0.111*** (0.014)	0.014 (0.021)
Export Share	-0.146** (0.069)	0.114** (0.056)	0.343*** (0.097)
Foreign Ownership	0.241*** (0.058)	0.448*** (0.055)	0.145*** (0.056)
Sector Specialization	-1.174*** (0.220)	-0.148 (0.279)	0.322 (0.499)
Constant	-14.714*** (1.017)	-2.844*** (0.518)	32.811*** (3.812)
Country-Industry FE	YES	YES	YES
Year FE	YES	YES	YES
Observations	4,904	14,132	3,595
R-squared	0.450	0.385	0.331

Note: * p<0.1, ** p<0.05, *** p<0.01

We further group the sample countries by region, based on the geographical classification in WBES (Annex IV). The results, which are summarized in Table 10, suggest that fintech exerts a positive effect on female employee ratio in Sub-Saharan Africa, Asia and Pacific, and Europe and Central Asia, whereas exhibits a negative effect in the Middle Eastern and North African region. The effect turns out to be insignificant in Latin American and Caribbean countries.

Table 6. The Effect of Fintech by Region

Sub-Saharan Africa	Asia and Pacific	Europe & Central Asia	Middle East & North Africa	Latin America & Caribbean
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VARIABLES	(1)	(2)	(3) Female Ratio	(4)	(5)
Fintech	0.142*** (0.041)	0.041*** (0.006)	0.104*** (0.016)	-0.032*** (0.004)	-0.012 (0.012)
GDP	-9.370*** (2.664)	-0.068*** (0.015)	0.043 (0.096)	0.032 (0.023)	0.006 (0.026)
GDP Growth	0.966*** (0.276)	0.004 (0.017)	-0.037 (0.063)	0.000 (0.002)	0.008 (0.011)
Openness	-0.607*** (0.171)	0.066* (0.036)	0.661* (0.373)	0.063* (0.033)	-0.091 (0.197)
Sales	-0.001 (0.001)	0.001 (0.002)	-0.007*** (0.001)	-0.003 (0.002)	-0.005** (0.002)
Age	-0.008** (0.004)	-0.012** (0.006)	0.000 (0.003)	0.010** (0.005)	0.002 (0.007)
Export Share	-0.026* (0.014)	0.006 (0.020)	-0.034*** (0.011)	0.061** (0.024)	0.030 (0.028)
Foreign Ownership	-0.014 (0.010)	0.055* (0.033)	0.049*** (0.009)	0.058* (0.031)	0.028* (0.016)
Sector	-0.059 (0.068)	0.135** (0.064)	-0.293*** (0.024)	-0.114 (0.101)	0.261*** (0.062)
Constant	-1.451*** (0.416)	-0.170 (0.365)	-0.379 (0.327)	0.547*** (0.143)	0.328 (0.312)
Country-Industry FE	6,614	3,765	10,766	2,629	2,673
Year FE	0.136	0.283	0.296	0.084	0.087
Observations	YES	YES	YES	YES	YES
R-Squared	YES	YES	YES	YES	YES

Note: * p<0.1, ** p<0.05, *** p<0.01

In this subsection, we not only confirm the previous estimates about the association between fintech and female employment, but also show that prevailing governance ineffectiveness, poor regulatory quality, and weak rule of law associated with less developed countries constitute major obstacles to fintech adoption in these economies.

It is interesting to observe a positive association between fintech and female employment in the Sub-Saharan African region. With less developed financial markets, Sub-Saharan African countries are home to fewer entrenched players than advanced economies. As a result, they may offer more opportunities for innovation, as disrupting the equilibrium faces less resistance.

Robustness Checks

For robustness checks, we replace natural logarithm of fintech finance with the ratio of fintech finance over total GDP and rerun Equation (1). The results are exhibited in Table 11.

Table 7. Alternative Fintech Definitions

VARIABLES	(1) Female Employees	(2) Female Ratio
Fintech	0.754*** (0.224)	2.739*** (0.916)
GDP	-0.137 (0.108)	0.101 (0.424)
GDP Growth	0.088*** (0.033)	0.035 (0.134)
Openness	0.684 (0.461)	3.640** (1.799)
Sales	-0.003*** (0.001)	0.354*** (0.005)
Age	-0.003 (0.002)	0.081*** (0.010)
Export Share	-0.014* (0.007)	0.109*** (0.041)
Foreign Ownership	0.025*** (0.006)	0.306*** (0.033)
Sector Specialization	-0.056 (0.076)	0.068 (0.448)
Constant	-0.562 (0.371)	-7.209*** (1.509)
Country-Industry FE	YES	YES
Year FE	YES	YES
Observations	26,447	22,631
R-Squared	0.263	0.390

Note: * p<0.1, ** p<0.05, *** p<0.01

We also include additional control variables such as capital account openness and inflation. Capital account openness is obtained from the Chinn-Ito Index website (Chinn and Ito, 2008). Inflation is measured by CPI percentage change provided in the WEO database. Regardless of the model specification, the results which are displayed in Table 12 remain unchanged.

Table 8. Additional Control Variables

VARIABLES	(1)	(2)
	Female Employees	
Fintech	1.357*** (0.463)	1.446*** (0.426)
GDP	2.998** (1.249)	3.078*** (1.176)
GDP Growth	-0.664** (0.286)	-0.688** (0.270)
Openness	7.022*** (2.465)	7.334*** (2.243)
Sales	0.354*** (0.005)	0.351*** (0.005)
Age	0.079*** (0.010)	0.080*** (0.010)
Export Share	0.127*** (0.042)	0.129*** (0.042)
Foreign Ownership	0.317*** (0.036)	0.314*** (0.036)
Sector Specialization	0.074 (0.450)	0.079 (0.450)
KA Openness	-0.119 (0.284)	
Inflation		0.037 (0.081)
Constant	-29.300*** (8.988)	-31.054*** (8.055)
Country-Industry FE	YES	YES
Year FE	YES	YES
Observations	21,484	21,215
R-Squared	0.387	0.385

Note: * p<0.1, ** p<0.05, *** p<0.01

Conclusion

The main objective of this study is to evaluate if fintech has an equally positive effect on gender inequality, measured by female employment. To answer this question, we exploit a cross-country fintech database that covers 114 countries, and a fixed-effects identification strategy. We show that fintech development leads to significant welfare improvement for women. It not only increases the number of female employees in the workforce, but also raises the ratio of female relative to male employees. Our study also sheds light on the economic mechanisms: fintech provides easier financial access to firms with financial constraints, especially female-led firms, small firms, and firms in service sectors that traditionally hire more female workers. Finally, we

also find that weak institutions reduce the positive effect of fintech. Fintech can significantly increase female employment in countries which with good governance, law and regulations, while its benefits are weaker in countries whose institutional quality is below median. Consistent with these findings, fintech has a positive impact on the number of female employees in advanced economies and emerging markets, but the effect appears insignificant or even negative in low-income countries. At the regional level, the effect of fintech is positive in Sub-Saharan African, Asian and Pacific, and European countries, insignificant in the Latin American and Caribbean sample, and negative in countries in Middle East and North Africa.

Our results provide important policy implications. First closing fintech gender gaps is critical to fully reap the benefits of fintech on gender equality. In most countries, unequal access to mobile phones and other electronic devices opens up financial inclusion gaps. For example, according to OECD, worldwide 327 million fewer women than men have a smartphone and can access the mobile Internet (OECD, 2018). Our results indicate that the inequality-reducing effects of fintech are significantly weaker in firms without access to internet as compared to firms with such access. Thus, digital divide must be addressed, for example by investing in technological innovation, and increasing the supply of digital infrastructure, to fully take advantage of the fintech benefits. Second, policymakers will need to promote good governance, law and regulations to ensure that fintech effectively reduces gender inequality.

Going forward, there are important avenues of research that are worth exploring: Does fintech help reduce firms' earning inequality in addition to gender employment gap? what are the distributional effects and welfare implications of fintech on female-led households and female entrepreneurs who start their own businesses? If banks and fintech lenders are competing on credit provision, how will consumers and investors be affected. Do the new forms of financing introduced by fintech demand new forms of regulation? Answering these, we believe, will allow a comprehensive evaluation of the effects of fintech on the economy and provide important policy advice.

Annex I. Country Coverage

AEs	EMs		LICs
Austria	Albania	Malaysia	Lao PDR
Belgium	Argentina	Mongolia	Lesotho
Cyprus	Armenia	Montenegro, Rep. of	Liberia
Czech Republic	Azerbaijan	Morocco	Madagascar
Denmark	Belarus	Namibia	Malawi
Estonia	Bolivia	Nicaragua	Mali
Finland	Bosnia and Herzegovina	Nigeria	Mauritania
Greece	Bulgaria	North Macedonia	Moldova
Ireland	China	Pakistan	Mozambique
Israel	Colombia	Paraguay	Myanmar
Italy	Croatia	Peru	Nepal
Latvia	Dominican Republic	Philippines	Niger
Lithuania	Ecuador	Poland	Papua New Guinea
Luxembourg	Egypt, Arab Rep.	Romania	Rwanda
Malta	El Salvador	Russian Federation	Senegal
Netherlands	Ethiopia	Serbia	Sierra Leone
Portugal	Georgia	South Africa	Solomon Islands
Slovak Republic	Guatemala	Sudan	South Sudan
Slovenia	Hungary	Suriname	Tajikistan
Sweden	India	Tanzania	Timor-Leste
	Indonesia	Thailand	Togo
	Jordan	Tunisia	Uganda
	Kazakhstan	Turkey	Yemen, Rep.
	Kenya	Ukraine	Zambia
	Kosovo	Uruguay	Zimbabwe
	Kyrgyz Republic	Vietnam	
	Lebanon	West Bank and Gaza	

Annex II. Fintech Classification

Level 1	Level 2	Level 3
Digital Lending	Balance Sheet Lending	Balance Sheet Business Lending Balance Sheet Property Lending Balance Sheet Consumer Lending
	P2P / Marketplace Lending	P2P / Marketplace Business Lending P2P / Marketplace Property Lending P2P / Marketplace Consumer Lending
	Debt-Based Securities	Debt-Based Securities Mini-Bonds
	Invoice Trading	Invoice Trading Equity-Based Crowdfunding
Digital Capital Raising	Investment-Based Crowdfunding	Revenue / Profit Share Crowdfunding Real Estate Crowdfunding Community Shares
	Non-Investment-Based Crowdfunding	Donation-Based Crowdfunding Community Shares

Annex III. Variable Definition and Data Sources

Variable	Definition	Source
Fintech	The natural logarithm of the total volume of finance through digital platforms	Cambridge Alternative Finance Benchmark
Lending	The natural logarithm of the volume of lending instruments through digital platforms	Cambridge Alternative Finance Benchmark
Capital Raising	The natural logarithm of capital raising instruments through digital platforms	Cambridge Alternative Finance Benchmark
Female Employees	The natural logarithm of the number of female full-time employees	World Bank Enterprise Survey
Female Ratio	The ratio of female employees over the total number of employees	World Bank Enterprise Survey
Female Led	firms with female as top manager	World Bank Enterprise Survey
GDP	The natural of a country's GDP	IMF World Economic Outlook
GDP Growth	The percentage change of a country's GDP	IMF World Economic Outlook
Openness	The sum of export and import volumes over total GDP	IMF World Economic Outlook
Inflation	The percentage change of CPI	IMF World Economic Outlook
Capital Account Openness	A variable that codifies the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions	Chinn & Ito's website
Sales	is the natural logarithm of the total annual sales	World Bank Enterprise Survey
Age	The natural logarithm of firm operating years	World Bank Enterprise Survey
Export Share	The share of sales that are direct or indirect exports	World Bank Enterprise Survey
Foreign Ownership	the share owned by private foreign entities	World Bank Enterprise Survey

Annex III. Variable Definition and Data Sources (concluded)

Sector Specialization	A dummy that equals 1 if the firm operates in the manufacturing sector, and 0 if in the service sector	World Bank Enterprise Survey
Financial Constraint	A dummy variable whose value takes 1 if access to finance represents at least a minor obstacle for the firm, and 0 otherwise	World Bank Enterprise Survey
Loan Access	A dummy variable that is equal to 1 if the firm has no outstanding line of credit or loan from a financial institution, and 0 otherwise.	World Bank Enterprise Survey
Small Business	A dummy whose value takes 1 if the firm has fewer than 20 employees.	World Bank Enterprise Survey
Internet Access	A dummy variable which equal 1 if the firm has its own website, and 0 otherwise.	World Bank Enterprise Survey
Government Effectiveness	An indicator capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies	Worldwide Governance Indicators
Regulatory Quality	An indicator capturing perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	Worldwide Governance Indicators
Rule of Law	An indicator capturing perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence	Worldwide Governance Indicators

Annex IV. Country Classification by Region

Sub-Saharan Africa	Asia and Pacific	Europe and Central Asia	Middle East and North Africa	Latin America and Caribbean
Benin	Afghanistan	Albania	Egypt, Arab Rep.	Argentina
Burundi	Bangladesh	Armenia	Israel	Bolivia
Cameroon	Bhutan	Austria	Jordan	Colombia
Chad	Cambodia	Azerbaijan	Lebanon	Dominican Republic
Congo, Dem. Rep.	China	Belarus	Malta	Ecuador
Côte d'Ivoire	India	Belgium	Morocco	El Salvador
Ethiopia	Indonesia	Bosnia and Herzegovina	Tunisia	Guatemala
Gambia, The	Lao PDR	Bulgaria	West Bank and Gaza	Honduras
Ghana	Malaysia	Croatia	Yemen, Rep.	Nicaragua
Guinea	Mongolia	Cyprus		Paraguay
Kenya	Myanmar	Czech Republic		Peru
Lesotho	Nepal	Denmark		Suriname
Liberia	Pakistan	Estonia		Uruguay
Madagascar	Papua New Guinea	Finland		
Malawi	Philippines	Georgia		
Mali	Solomon Islands	Greece		
Mauritania	Thailand	Hungary		
Mozambique	Timor-Leste	Ireland		
Namibia	Vietnam	Italy		
Niger		Kazakhstan		
Nigeria		Kosovo		
Rwanda		Kyrgyz Republic		
Senegal		Latvia		
Sierra Leone		Lithuania		
South Africa		Luxembourg		
South Sudan		Moldova		
Sudan		Montenegro		
Tanzania		Netherlands		
Togo		North Macedonia		
Uganda		Poland		
Zambia		Portugal		
Zimbabwe		Romania		
		Russian Federation		
		Serbia		
		Slovak Republic		
		Slovenia		
		Sweden		
		Tajikistan		
		Turkey		
		Ukraine		

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