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Female Labor Force Participation and Government Digitalization

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Abstract: The global female labor force participation rate decreased over the last two decades. Moreover, women are increasingly falling behind men in digital skills and literacy while the world is experiencing rapid technological transformation driven by digital technologies. The purpose of this study is to explore whether a country's online participation induces female labor force participation. Using cross-section data for 113 United Nations member countries for the year 2022, this paper investigates how a country's use of government implemented digital platforms influences female labor force participation. The results reveal that the impact of the utilization of digital platforms on female labor force participation is positive and statistically significant. Additionally, this study finds that the effect of e-participation on female labor force participation is stronger for relatively low-income countries.

Keywords: Labor force participation, gender divide, e-government, e-participation, prosperity

JEL Classifications: J2, L86, H11

I. INTRODUCTION

Globally, the female labor force participation rate (FLFPR) for the age group fifteen years and older has dropped from 50.7 % in 2005 to 48.8% in 2025 (Verick, 2025; ILO modelled estimates, http://www.ilo.org/ilostat). Despite a significant negative impact of Covid-19 lockdowns on the female labor force participation rate, the pandemic did not have a lasting effect. The ILO estimates show that the FLFPR recovered to around one percentage point above the pre-Covid-19 downward trend over the 2022-24 period (Verick, 2025). Research consistently shows that

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women face significant barriers to participate in the labor market compared to men and in the age of digital innovations, digital gender divide, the gap between women's and men's access to internet and related technologies, is becoming the primary barrier.

A 2021 Alliance for Affordable Internet report states, "Across the world, millions of people are still unable to access the internet and participate online – and women are disproportionately excluded. Men are 21% more likely to be online than women globally, rising to 52% in Least Developed Countries." Women are increasingly falling behind men in digital skills and literacy while the world is experiencing rapid technological transformation driven by digital innovations ranging from sophisticated computer systems, software, and mobile telephony, digital platforms, robotics to new advances in AI and machine learning that has been changing the way we work and live. The digital divide does not just reflect inequality between genders; it also reflects an inequality among different groups of workers in general. However, the gender digital divide is one of the primary barriers to labor market for women. Brussevich, Norris and Khalid (2019) find that women work, on average, in more routine jobs, more prone to automation, than men.

Digital technologies undoubtedly produce new opportunities and avenues in both product and labor markets. Grover (2025) finds that expanding broadband and mobile internet leads to an increase in employment and labor force participation. Using firm-level data, Yang (2022) finds positive effects of AI technology on productivity and employment. The author finds that AI-inventing firms demand 3.5% more workers than their non-AI inventing counterparts. Hjort and Poulsen (2019) show that the use of fast internet by firms leads to increased firm entry, productivity, and exporting, which in turn result in higher net job creation. Viollaz and Winkler (2022) discover a positive link between digital technologies and female labor force participation in Jordon, a country with one of the lowest female labor force participation rates. However, the authors find that the use of internet does not increase employment for all women. Only older women with higher levels of education enjoy an increase in employment because of internet adoption. Using a sample of forty-eight African countries, Ngoa and Song (2021) also find that the utilization of information and communication technologies (ICT), measured by internet and mobile phone, leads to a rise in female labor force participation and the impact of ICT use on female labor force participation is enhanced by women's human capital and a country's financial development.

However, the benefits of digitalization are not evenly shared in either market (Paunov and Rollo, 2016). Autor et.al. (2022) argue that large firms at technological frontier generally enjoy the benefits of digital innovations as they have more resources compared to small firms to invest in digitalization, resulting in an increase in inequality in productivity performance among firms. While product markets have seen rising inequality among firms, labor markets have seen rising inequality among workers. Automation and digital technology are shifting demand away from labor lacking digital skills and literacy toward labor having digital skills and literacy. As technology advances and evolves, this digital divide is contributing to growing mismatch between the supply of skills and demand for skills.

As mentioned earlier, the digital divide affects female labor market outcomes more negatively compared to men. Research shows that worldwide women, on average, are less likely than their male peers to have access to internet and related technologies. Women are also falling behind their male peers in digital skills and literacy. A 2023 United Nations (UN) report states, "On average across 32 countries and territories, girls are 35 per cent less likely than their male peers to have digital skills, including simple activities like copying or pasting files or folders, sending emails, or transferring files." In the era of rapid digitalization of economic activity, women without digital skills and literacy have limited opportunities to participate in the labor market. Designing programs to equip workers with digital skills and to help their transition to new tasks that will complement new digital technologies is the best way to respond to this crisis. However, the adoption of such policies and programs is slow, reducing labor force participation and the supply of skills needed for new digital technologies. Consequently, the supply of skills that complement these new digital technologies lags the demand for skills, thereby impeding investment in new digital innovations, which in turn depresses overall productivity gains (Chinen and Montorsi, 2025).

This paper intends to examine the impact of the level of a country's utilization of its government implemented digital platforms on female labor force participation. Two indices known as the E-Government Development Index (EGDI) and the E-Participation Index (EPI), developed by the United Nations, are used to measure a country's level of digital infrastructure and the level of a country's use of that infrastructure, respectively. The EGDI is developed to measure a country's state of e-government development and the index ranges from 0, lowest level, to 1, highest level. This is a composite measure of three main aspects of e-government, namely,

scope and quality of online services, levels of telecommunication connectivity and human capital. The EPI is an index supplementary to the EGDI, and it is developed to assess the use of online services to facilitate the provision of information by government to citizens, interaction with stakeholders, and engagement in decision-making processes. A country's EPI indicates its e-participation mechanism that is implemented by its government compared to all other countries. It is a relative index.

Using cross-section data for 113 UN member countries for the year 2022, this paper estimates the impact of the utilization of digital platforms on female labor force participation. The reasons for selecting the year 2022 are twofold: a) the year 2022 was a turning point since most of the world transitioned away from strict COVID 19 mandates and lockdowns. As a result, the negative impact of COVID-19 lockdowns on labor force participation began to fade away, b) As stated earlier, the female labor force participation rate recovered to around one percentage point above the pre-Covid-19 downward trend over the 2022-24 period (Verick, 2025). Note that male labor force participation was slower to recover (Garcia-Jimeno and Hu, 2024). Therefore, the year 2022 provides a unique opportunity to study the impact of online participation on female labor force participation in the year that was a major turning point in the pandemic period. Additionally, this study explores how the effect of e-participation on female labor force participation varies with a country's level of prosperity.

The contribution of this study is primarily in terms of methodology. This study investigates the problem of likely endogeneity bias caused by the simultaneity between the female labor force participation rate and the level of online participation. Tito (2024) finds that women prefer occupations with remote ability, which lowers their probability of exiting the labor force. Also, previous studies find that the rising prevalence of flexible work hours and remote work opportunities motivate women to increase their participation in the labor market (Garcia-Jimeno and Hu, 2024). An increase in female labor force participation is thus likely to increase online participation, thereby causing simultaneity between the female labor force participation rate and the level of online participation. Therefore, this paper uses an instrumental variable approach for the analysis to address the issue of likely simultaneity between e-participation and female labor force participation. To the best of my knowledge, the problem of endogeneity bias has not been addressed in previous studies.

In general, studies on female labor market outcomes and digitalization find a positive impact of e-participation on female labor market outcomes. However, research on how digital technology impacts labor market outcomes is rather limited (Frey and Osborne, 2017). This study thus attempts to contribute to this much needed literature by providing additional evidence on the association between the use of digital platforms and female labor force participation.

II. MODELING THE EFFECT OF GOVERNMENT DIGITALIZATION ON FEMALE LABOR FORCE PARTICIPATION

1. Baseline Regression Model

This study specifies the following primary regression model to estimate the association between government digitalization and female labor force participation:

$$F_{L_i} = \beta_0 + \beta_1 EPI_i + TOT_i + \varepsilon_i, \quad (1)$$

where the dependent variable, F_{L_i}, is the female labor force participation rate of the ith country. The variable of interest in this study is EPI_i, the E-Participation Index of the ith country. The e-participation index, EPI, ranges from 0 to 1, with 1 being the highest score and 0 being the lowest score. An EPI score does not capture an absolute measurement of the e-participation level of a country, but rather it captures the e-participation performance of countries relative to one another at a particular point in time. Note that in the literature, a country's level of prosperity, measured by real GDP per capita, is found to be an important determinant of female labor force participation (e.g., Gaddis and Klasen, 2017; Verick, 2025). In equation 1, real GDP per capita is not included since a country's EPI is likely to capture the impact of its level of prosperity on female labor force participation. The linkage between a country's e-participation index, EPI, and its level of prosperity is as follows. Note that the EGDI of a country incorporates three dimensions, namely: scope and quality of online services, levels of telecommunication connectivity and human capital. Hence, a country with a high value of EGDI is likely to be a high-income country since a country with a high value of EGDI will have well-developed online infrastructure and a high level of human capital, which are the characteristics of a high-income country. Also, a country with a high value of EPI is possibly a country with a high value of EGDI (i.e., well- developed digital infrastructure) because well-developed digital infrastructure is a pre-requisite for high levels of online participation. Therefore, a country's level of prosperity is likely to affect female labor

force participation through e-participation, measured by the e-participation index (EPI) in equation (1).

TOT_i represents terms of trade, a ratio of price of exports to price of imports, for the ith country. Research shows that globalization improves female labor market outcomes because competition increases in an integrated world, which in turn is likely to raise the opportunity cost of discrimination. Note that Becker (1971) in his seminal book contends that there is probably a negative association between discrimination and competition. Also, for labor abundant countries, an improvement in terms of trade will expand export sectors using labor intensive technologies, which usually increases routine and non-high-tech jobs, which in turn increases female employment. Therefore, this study includes terms of trade (TOT) in the model to measure the effect of trade on female labor force participation. ε_i is a stochastic error term with zero mean and finite variance for the ith country.

2. Instrumental Variable Approach

As discussed earlier in this paper, the issue of endogeneity bias in equation (1) is addressed using the instrumental variable approach. The principal idea of the instrumental variable method of estimation is identifying a new set of variables that are contemporaneously uncorrelated with the error terms but correlated as much as possible with the hypothetically endogenous explanatory variables in the model. Therefore, a valid instrumental variable must satisfy these two basic conditions: a) instrument relevance i.e., correlated as much as possible with the hypothetically endogenous explanatory variables in the model, b) instrument exogeneity i.e., uncorrelated with the error terms. The challenge with performing instrumental variable analysis is identifying valid instruments for the hypothetically endogenous explanatory variables.

In this study, the regression equation for the female labor force participation rate contains one hypothetically endogenous explanatory variable, which is the E-Participation Index (EPI). This study uses e-government development, measured by the EGDI, as an instrument for e-participation, measured by the EPI. The rationale for using the EGDI as an instrument for the EPI is as follows. As discussed earlier in this paper, countries with high levels of digital infrastructure measured by the EGDI are likely to have high levels of online participation measured by the EPI. Therefore, the EGDI is likely to be correlated with the EPI. Also, the EGDI is likely to be exogeneous since the development of the digital infrastructure by a country's

government is unlikely to be influenced by its female labor force participation. Thus, the EGDI is probably a valid instrumental variable.

3. Data

This study has sourced data from the World Bank's World Development Indicators (WDI) Database (https://databank.worldbank.org/source/wdi-database-archives#), the United Nations Department of Economic and Social Affairs' Division for Public Institutions and Digital Government (https://publicadministration.un.org/egovkb/en-us/About/Overview/-E-Government-Development-Index), and the Penn World Table, version 11.0 (https://www.rug.nl/ggdc/productivity/pwt/?lang=en). The data source for the female labor force participation rate (F_L) is the World Bank's World Development Indicators (WDI) Database while the data source for the E-participation Index (EPI), and E-Government Development Index (EGDI) is the United Nations Department of Economic and Social Affairs' Division for Public Institutions and Digital Government. The ratio of export price index to import price index is calculated to compute terms of trade (TOT) and data on export and import price indices are sourced from the Penn World Table, version 11.

III. EMPIRICAL RESULTS

1. Baseline Regression Results

Equation (1) is estimated by ordinary least squares (OLS). The Breusch-Pagan test detects the presence of heteroskedasticity in equation (1). Although the presence of heteroskedasticity does not produce biased coefficient estimates, it results in biased standard errors, leading to incorrect test statistics, *p*-values, and confidence intervals. One common remedy is to use robust standard errors known as Huber-White standard errors, and this study does so. Table 1 presents the coefficient estimates. The coefficient on EPI, the variable of interest, is positive and significant at the 5% level. The positive and significant coefficient indicates that an increase in the level of online participation increases the female labor force participation rate, which aligns with the findings of previous studies (e.g., Viollaz and Winkler, 2022; Ngoa and Song, 2021). The coefficient on TOT is also positive and significant, as expected. This result shows that an improvement in terms of trade increases job opportunities for women, which in turn enhances female labor force participation.

However, the ordinary least squares coefficient estimates may be biased and inconsistent because of the presence of likely simultaneity between the female labor

force participation rate and the level of online participation. To address this problem of simultaneity bias, this study re-estimates equation (1) by two-stage least squares (2SLS) and performs a Hausman (1978) specification test for detecting endogeneity bias in equation (1). As discussed earlier, this study uses the EGDI as an instrument for the EPI variable in equation (1). The 2SLS coefficient estimates of equation (1) are presented in column (2) of Table 2 while the OLS coefficient estimates are presented in column (1) for easy comparison.

The bottom half of Table 2 reports the first-stage regression results, which indicate that the coefficient on EGDI is positive and significant at the 5% level. The results show that the EGDI score is a significant predictor of the EPI score. Also, the first-stage F-statistic of 333.23 for the excluded instrument set exceeds the critical value at the 5% level, thereby rejecting the null hypothesis of weak instruments. Moreover, the partial coefficient of determination is 75%, implying that 75% variation in the EPI variable is explained by the EGDI variable. These results indicate that the EGDI is a relevant instrument for the EPI. Additionally, the Hausman test statistic did not detect any endogeneity bias in equation (1). Notably, the results of two-stage least squares show that the coefficient on EPI remains positive and significant at the 5 percent level. Also, the 2SLS coefficient estimates are similar in terms of sign and magnitude to the OLS coefficient estimates. Hence, the estimation results of equation (1) are not likely to be driven by the role of a bi-directional relationship between the female labor force participation rate and the level of online participation.

2. Digitalization and the Level of Prosperity

In this section, this paper explores whether the impact of online participation on female labor force participation varies with a country's level of prosperity. To analyze the impact of online participation by the income level, this study first ranks all countries in the sample in terms of values of EGDI (a lower rank implies higher value of EGDI). The United Nations groups countries into four levels by EGDI values – countries with very high EGDI values ranging from 0.75 to 1 inclusive, countries with high EGDI values ranging from 0.5 to 0.7499 inclusive, countries with middle EGDI values ranging from 0.25 to 0.4999 inclusive and countries with low EGDI values ranging from 0.0 to 0.2499 inclusive. Note that all countries that belong to the top quartile of countries in the sample of this study have EGDI values ranging from 0.86 to 0.97 inclusive and so these countries belong to the group of countries with

very high EGDI values. As discussed earlier in this study, a high-income country also has a high value of EGDI. Therefore, ranks computed based on EGDI values in this study are like ranks based on income levels. In other words, countries that belong to the top quartile of countries by EGDI values in the sample of this study are also countries that belong to the top quartile of countries by income.

A dummy variable, denoted by $Highlnc_{topQ_i}$, that takes the value of 1if the ith country belongs to the top quartile of countries by EGDI values and zero otherwise is developed. Note that $Highlnc_{topQ}$ is also a dummy variable that indicates whether a country belongs to top quartile by income. In order to explore whether the impact of online participation on the female labor force participation rate varies with a country's income, this paper regresses the female labor force participation rate on a variable that is an interaction of e-participation (EPI) and the $Highlnc_{topQ}$ dummy variable, denoted by $EPI \times Highlnc_{topQ}$. Similarly, this study investigates whether the effect of terms of trade on female labor force participation varies with a country's income by creating another interaction term, denoted by TOT $\times Highlnc_{topQ}$, which is an interaction of terms of trade variable (TOT) and the $Highlnc_{topQ}$ dummy variable.

The resulting regression equation is as follows:

$$F_{L_i} = \delta_0 + \delta_1 EPI_i + \delta_2 TOT_i + \delta_3 HighInc_{topQ_i} + \delta_4 (EPI_i \times HighInc_{topQ_i}) + \delta_5 (TOT_i \times HighInc_{topQ_i}) + \epsilon_i. \quad (2)$$

A negative (positive) coefficient on $EPI \times Highlnc_{topQ}$ indicates that the effect of online participation is weaker (stronger) for relatively high-income (low-income) countries. Women in developing countries face more initial barriers in the form of human capital, digital skills, social norms, and safety than barriers faced by women in advanced countries. Therefore, it is expected that the impact of online participation on female labor force participation will be weaker for relatively high-income countries. As discussed earlier, the impact of an improvement in TOT is relatively more favorable for female employment opportunities for labor abundant countries compared to capital abundant countries. Developing countries are usually labor abundant countries. Therefore, the coefficient on $TOT \times HighInc_{topQ}$ is likely to be negative (positive), implying that the impact of TOT is weaker (stronger) for relatively high-income (low-income) countries. The test for heteroskedasticity detected the presence of the problem also in equation (2). Therefore, Huber-White standard errors are used to address the issue.

Table 3 reports the results from the estimation of equation (2). The results show that coefficients on both interaction terms are negative and statistically significant, as expected. The negative and significant coefficient on $EPI \times Highlnc_{topQ}$ indicates that the impact of the use of digital platforms on female labor force participation is weaker (stronger) for relatively high-income (low-income) countries. Also, the negative and statistically significant coefficient on $TOT \times Highlnc_{topQ}$ shows that the impact of an improvement in TOT on female labor force participation is also weaker (stronger) for relatively high-income (low-income) countries. The coefficient on $Highlnc_{topQ}$ is positive and significant, implying that female labor force participation is greater in higher income countries, which aligns with the finding of a 2022 World Bank study, showing that higher income countries usually have a higher level of female labor force participation.

In summary, the results in Table 3 show that government policies that focus on improving digital infrastructure and motivating online participation will lead to an increase in female labor participation, which in turn will enhance economic growth. Notably, the impact of these government policies will be more effective in increasing female labor force participation in relatively low-income countries.

IV. SUMMARY AND CONCLUSIONS

The findings of this paper show that online participation enhances female labor force participation. Results also indicate that the impact of online participation is stronger in relatively low-income countries. Previous studies (e.g., Baerlocher et.al., 2021; Cavalcanti et.al., 2016) show that female labor force participation enhances economic growth. Worldwide lower female labor force participation is a serious problem. This problem is more serious in developing countries. The findings of this paper underscore that governments, especially in developing countries, should make major efforts to invest in digital technologies and programs to enhance online participation of women.

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