Bridging the digital divide with gender equity in the digital world: empirical insights from OECD countries

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Abstract

Purpose – This paper highlights an important question of equal access for women, particularly those in rural and economically weaker sections, to digital infrastructure. It flags how high internet connectivity costs and expensive digital devices act as major bottlenecks that impede the participation of women in the digital economy and deny them new frontiers of e-commerce and remote employment opportunities.

Design/methodology/approach – A woman-centred analytical framework is adopted by this study for the relationship investigation between digitalization and participation by women in Organisation for Economic Co-operation and Development (OECD) countries' employment force between the years 2010 and 2023. It uses proxies measurable in mobile cellular subscriptions and using the internet that can show either the short- or long-run technological progress effect on women's employment.

Findings – The findings underline the continuing risks associated with digital inequality, especially among women in marginalized communities. While digital technologies provide immense opportunities in the form of remote work and flexible employment arrangements, digital exclusion remains a barrier that prevents women from accessing these tools and thus being able to participate economically.

Originality/value – This research is singularly contributing to offering a gendered perspective on how digitalization impacts labour market dynamics, deviating from existing literature that mainly narrows down to broader economic effects. It provides actionable policy recommendations to enhance digital inclusion and gender equity in labour markets, including the promotion of flexible work arrangements, strengthening legal protections against digital discrimination and increasing inclusive digital literacy initiatives.

Keywords Digital inclusion, Women's labour force participation, Gender equity, Digital economy

Paper type Research paper

1. Introduction

Successive industrial revolutions changed economic systems and transformed labour markets, workforce structures and social norms. Each of these revolutions, from the Agricultural to the Fourth Industrial Revolution, has influenced the participation of women in labour markets in different ways. This paper examines the interaction between digitalization and female labour markets in Organisation for Economic Co-operation and Development (OECD) countries, bringing a fresh perspective by locating recent developments in broader historical, economic and technological contexts.

The Agricultural Revolution established rigid social hierarchies that constrained women's economic participation to domestic and agricultural roles (Yankın, 2019). The First Industrial Revolution in the 18th century brought about mechanization and a demand for labour that started drawing women out of their homes and into formal work settings. More often than not, this placed them in low-skilled, low-paying positions that entrenched economic inequalities (EBSO, 2005). The Second Industrial Revolution (19th century) was all about mass production and industrial efficiency, which expanded employment in general but continued to sideline women in technical and leadership positions (Leventer and Ada, 2023).

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The 3rd Industrial Revolution went under the name of the Digital Revolution. In most respects, it deviated from past traditional patterns of labour. New digital technologies—computers and the internet—opened up non-traditional employment opportunities, remote work and e-learning for women, slowly dismantling institutional barriers (Genç, 2018). Building on this momentum, the Fourth Industrial Revolution—Industry 4.0—brings automation, artificial intelligence and the Internet of things to the labour markets. While these changes create high-skilled opportunities and entrepreneurship potential for women, they also threaten low-skilled job categories through automation (Sukhodolov, 2019).

Digitalization in the Fourth Industrial Revolution offers scalable tools uniquely suited to address longstanding gender inequities:

(1) Bridging access gaps: Digital platforms make access to education, training and employment democratic, mainly in regions where traditional infrastructure is lacking (Yoshida *et al*., 2024).

(2) Redefining work norms: Digital entrepreneurship and remote work allow women to reconcile care work with economic participation, challenging the deepest gender roles.

(3) Promoting inclusion: The digital space decreases structural discrimination present in traditional labour markets, giving a stronger voice to women in economic decision-making (Mercer, 2016).

Active participation of women in labour markets is one of the founding stones of development economics, as it increases welfare in the household and overall societal well-being. Digital technologies increase this potential for women to contribute to economic activities, education and decision-making processes (Salman *et al*., 2023). While existing literature investigates the general impacts of digitalization on labour markets, this study specifically analyzes the impact on women's employment in OECD countries and is hence more focused and policy-relevant.

This research distinguishes itself through several key contributions:

(1) Historical contextualization: Placing digitalization within the bigger continuum of industrial revolutions, the study flags its unprecedented potential to resolve deep-seated gender inequalities.

(2) Empirical rigour: Using strong panel co-integration techniques and causality testing, the analysis conducted with data from 22 OECD countries for the period 2010–2023 empirically validates the link between digitalization and women's participation in the labour force.

(3) Theoretical contribution: This paper develops a comprehensive framework analysing the intersection of workforce transformation with gender dynamics, digitalization and socioeconomic outcomes. Beyond the employment effects, it explores the implications of this analysis for policy innovation and the empowerment of women.

The paper is organized into sections that critically review both the opportunities and challenges presented by digitalization with respect to women's employment in OECD countries. It does so in a way that offers insights useful in policy-making about the dynamic interplay between gender, technological progress and labour market dynamics.

2. Literature review

The relationship between digitalization and employment has been a subject of scholarly inquiry for a long time, while studies focussing specifically on women's employment within the OECD context remain relatively few in the literature. Nikulin (2017), through a study in 60 developing countries, showed the positive effects of information and communication technologies (ICTs) on women's participation in the workforce. While this study was on developing economies, its results hint at more general implications for the role of digitalization

in addressing gender disparities. Similarly, Pinzone *et al*. (2017) have pointed out the necessity of re-skilling the workforce in light of Industry 4.0 and emphasized the potential of digital tools to reformat labour markets, including fostering inclusiveness if properly implemented. However, much of the literature flags that digitalization can also perpetuate existing inequalities if the gaps in skills, cultures and systemic biases are not addressed (Mehta *et al.*, 2021).

In OECD countries, Acemoğlu and Restrepo (2020) adopted a critical view of the negative consequences of automation for employment and wages in the US labour market. Their results showed that even though digitalization brings inefficiencies, it is capable of displacing low-skilled workers, and such tendencies disproportionately affect women in certain sectors. On the other hand, the OECD Employment Outlook 2023 has shown that digitalization helped offer women a chance to have better inclusion in labour force participation, particularly via remote and hybrid models of work (Dikmen *et al*., 2022). These empirical studies bring to the forefront a twin narrative of digitalization as both an enabler and a probable barrier to the inclusion of women into the workforce, given the different structural and policy frameworks.

Empirical studies in OECD countries have nuanced insights on how digitalization affects the employment of women. Wu and Yang (2022), using provincial data from China, found a strong positive effect of the digital economy on employment structures, which is consistent with the findings of Salman *et al*. (2023) in the Middle East and North Africa (MENA) region. Both studies have shown that ICT has the potential to empower women by offering them more opportunities, especially through better access to information and flexible work arrangements. However, they also reported common challenges, including digital literacy gaps and cultural barriers, which are shared by many findings in the OECD contexts.

This becomes all the more true for Europe, where focused initiatives have brought very promising results: in line with this, the European Commission (2023) report on digital transition and gender equality notes that Sweden and Estonia succeeded in increasing women's employment in tech through reforms in gender-sensitive science, technology, engineering and mathematics (STEM) education and policies of workplace inclusion (Ince Yenilmez and Darıcı, 2024). Such examples prove the need for proactive interventions to ensure that women benefit equally from digitalization.

One of the recurring themes in literature is how gender stereotypes influence the adoption of technology and dynamics at work. Cheryan *et al*. (2017) noted that societal stereotypes deter women from seeking careers in tech-intensive fields, thus creating a pipeline problem that limits their representation in high-demand digital jobs. Similarly, Cortina *et al*. (2021) and Türkcan *et al*. (2024) noted that while digital tools can be an advantage in lessening gender inequality, they often amplify biases in hiring and promotion processes. The barriers are especially strong in STEM fields, where women are underrepresented despite considerable policy efforts in many OECD countries.

Rotondi *et al*. (2020), in a meta-analysis of 56 studies, underlined the systemic issues of unequal access to digital technologies and low levels of digital literacy among women. These findings are corroborated by the ILO (2023), which stated that while digital platforms create new job opportunities, structural barriers prevent women from gaining full integration into the digital economy.

Policy-focused studies strongly underline the role that targeted interventions can play in promoting digitalization-related gender disparities. Ecevit Satı and Oktay Yılmaz (2019) and Günsan and Yergin (2022) argued, in different studies, that STEM education and digital literacy are needed for the preparation of the female labour force for new job opportunities created by Industry 4.0. This is further highlighted by the OECD Employment Outlook (2023), showing countries with strong, gender-sensitive policies, like Norway and Denmark, to have higher rates of employment among women in tech-driven sectors.

Therefore, it remains for future research to address longitudinal trends to analyse the long-term effects of digitalization on women's employment. This is very important for understanding how policies already implemented in OECD countries could set benchmarks

for other nations. Linking the empirical findings with theoretical insights will help scholars and policymakers develop holistic strategies for bridging the gender gap in digital economies. Also, those findings on the dual role of digitalization confirm earlier research, with the added dimension of policy relevance for OECD contexts. Some of the unique contributions include the integration of temporal trends, the impact of the COVID-19 pandemic and targeted analysis of gender-sensitive policies. Divergences come out in the opportunities for women in high-skill sectors, countering the traditional negative narrative on automation.

This paper diverges from the theoretical expectations and earlier research by underlining the potential of digitalization to create opportunities for women in high-skilled sectors, while Acemoğlu and Restrepo (2020) focused on the displacing effects of automation on low-skilled workers. These findings provide insight into how, through digitalization and especially among OECD countries, women have accessible flexible work in high-demand technology jobs, often because of policy-related efforts focused on gender-sensitive STEM education reforms and initiatives concerning workplace inclusion. In contrast to earlier work that highlighted the negative impact of automation, this research study encapsulates new developments like the COVID-19 pandemic, which has accelerated remote work adoption and improved the participation of women in the digital economy. These differences perhaps stem from this study's longer time frame and inclusion of structural and policy changes that bring about reduced risk of displacement.

Another salient difference lies in how systemic obstacles—like gender stereotypes—are overcome. If, before this work, some studies (like Cheryan *et al.*, 2017) found evidence of such barriers deterring women from entering the tech fields, this one, by extension, proves that effective interventions are underway for those impediments. Proactive reforms in countries like Sweden and Estonia have already shown that with the right policies, women's representation in digital sectors can be improved. With a global perspective and empirical data from OECD countries, the research presented demonstrates the dynamic nature of digitalization in terms of inclusivity initiatives and digital literacy programs that have been so transformative in reshaping women's employment opportunities. This comprehensive approach does, however, give a more optimistic view of how digitalization can bridge gender gaps if coupled with strong policy frameworks.

3. Sample, data and methodology

3.1 Sample

This study focuses on 22 OECD countries that have been selected because of the relevance of studying the relationship between digitalization and women's employment in advanced economies. OECD countries ensure internationally comparable datasets on labour market statistics, digital infrastructure, and socio-economic indicators and thus are fit for this research. Their inclusion enables an analysis of the impact of digitalization on female labour force participation in a manner that minimizes confounding factors concerning economic and developmental disparities.

The main reason for choosing OECD countries is their high level of comparability for economic, social and institutional development. Many studies include countries with highly divergent levels of industrialization, but this research has maintained analytical consistency by focussing on similar structures for economies. For instance, the comparison of a highly digitalized, high-income country such as Sweden with a lower-income developing country would introduce substantial heterogeneity and make it difficult to establish causal relationships. This paper isolates the effects of digitalization on women's employment by confining the sample to OECD countries and, thus, netting out the policy differences within a broadly similar economic framework.

The period of this study covers from 2010 to 2023, a period selected for its coherence and appropriateness in capturing major changes in digital infrastructure. This time frame covers the widespread diffusion of mobile technologies and increased internet accessibility—two

crucial dimensions of digitalization that are hypothesized to impact female labour force participation. It also discusses major global events that have strongly reshaped labour markets: the aftermath of the 2008 financial crisis, the acceleration of digitalization under COVID-19 and the increasing implementation of gender-focused labour policies across OECD nations. Looking at this period allows for an in-depth analysis of short- and long-term trends in digitalization and its relationship with women's employment.

The second choice of using OECD countries is related to the availability of high-quality, standardised and comparable data. The main sources used for this research include the World Bank database and OECD reports, which provide reliable indicators of female labour force participation, mobile cellular subscriptions, internet use, fertility rates and GDP per capita. These datasets strengthen empirical modelling and assure accuracy in the findings. Moreover, using panel data analysis that combines cross-sectional and time-series dimensions strengthens the ability of this study to capture both country-specific variations and overarching trends in digitalization and employment. Applying a rigorous methodological approach, this paper deepens our understanding of how digitalization has influenced women's employment and derives valuable implications for policymakers and scholars in labour economics.

3.2 Methodology

The rapid advance of digital technologies has dramatically reshaped the structure of labour markets around the world, with specific effects on job availability, skill requirements and flexibility at work. These changes have significantly affected the employment of women, requiring a rigorous analytical approach to capture temporal trends and cross-country variations. This article applies econometric panel data techniques to analyse the impact of digitalization on female labour force participation in 22 OECD countries to make such an assessment complete.

To ensure robustness, this study employs both fixed effects (FE) and random effects (RE) models:

(1) FE model: Controls for time-invariant unobserved country-specific characteristics, such as cultural norms and institutional factors, preventing omitted variable bias. The FE model assumes that these characteristics are correlated with the explanatory variables:

$$\omega_{it} = \beta_0 + \sum_{j=1}^{4} \beta_j X_{jit} + \mu_i + \varepsilon_{it}$$

(2) RE model: Assumes that country-specific traits are uncorrelated with the explanatory variables, leading to more efficient estimates under the condition $E(\mu_i|X_{jit}) = 0$. The Hausman test was conducted to determine the appropriate model selection.

(3) Diagnostic tests: To confirm that the estimated results are reliable, the following statistical tests are performed:

- The heteroskedasticity test is used to detect variance discrepancies in residuals.
- Serial correlation test is used to detect potential autocorrelation concerns.

By combining various econometric methodologies, this study offers a methodologically robust analysis of the influence of digitalization on women's employment in OECD countries. The findings provide important insights into the structural and policy-driven mechanisms that influence labour market inclusion in the digital age.

3.3 Dataset and variables

This paper investigates the impact of digitalization on women's employment using panel data for 22 OECD countries over the period 2010–2023. The analysis is based on women's labour

force participation as a dependent variable, while key indicators of digitalization, together with socioeconomic factors, are independent variables. It relies on data from the World Bank database, guaranteeing comparability and reliability of the data across countries and over time. Variable selection is guided by existing empirical studies, especially works by Nikulin (2017) and Salman *et al*. (2023), which underline the nexus between technological advancements and trends in female employment. Table 1 presents a summary of the variables included in the model.

3.3.1 Dependent variable. Women's Labour Force Participation Rate w: The main outcome variable is the labour force participation rate of women, defined as the percentage of females aged 15–64 years who are actively engaged in the labour market, either through employment or in seeking work. This indicator measures both the direct and indirect effects of digitalization on workforce inclusion.

3.3.2 Independent variables. Mobile cellular subscriptions (mb): This variable shows the number of mobile cellular subscriptions per 100 persons. It is used here as a proxy for digital accessibility and mobile penetration, which are very relevant to employment participation in the digital economies.

Individuals Using the Internet (web): This variable is the percentage of the population that uses the Internet in a country. Access to the Internet is the basic enabler of remote work, e-commerce and digital entrepreneurship, which may provide opportunities to help women get into and remain in the labour market.

GDP per capita in US dollars: One considers the overall economic development of the countries. There is a close link between high GDP per capita and good working opportunities, adequate infrastructure and a rise in women's participation in the labour force.

Total fertility rate (f): This is the average number of births per woman. This is an important socioeconomic determinant of women's employment, as high fertility rates are usually accompanied by lower participation in the workforce by women due to caregiving. To empirically examine the relationship that exists between digitalization and the employment of women, this study uses the econometric model:

$$w = \beta_0 + \beta_1 mb_{it} + \beta_2 web_{it} + \beta_3 gdp_{it} + \beta_4 f_{it} + \mu_{i+}\varepsilon_{it}$$

The model will serve to estimate the extent to which digitalization—captured through mobile phone and Internet penetration—affects women's participation in the workforce while controlling for economic and demographic factors. The study accounts for country-specific heterogeneity and temporal variations in digitalization trends by using panel data techniques. Variables are selected based on theoretical and empirical insights in existing literature. Of the measures of digitalization, mobile phone subscriptions and internet usage have been viewed as

Table 1. Information on variables

Abbreviation	Variables	Explanation	Resources
w	Women's Labour Force participation rate	Percentage of the female population aged 15–64	World Bank (WB)
mb	Mobile cellular subscriptions	Per 100 people	World Bank (WB)
web	Individuals using the Internet	% of population	World Bank (WB)
gdp	Gross Domestic Product	GDP per person ($)	World Bank (WB)
f	Total Fertility Rate	Total birth per woman	World Bank (WB)

Source(s): Author's own creation/work

most facilitating for female employment due to the way they permit flexible work arrangements, digital entrepreneurship and access to remote jobs (Pinzone *et al.*, 2017; Wu and Yang, 2022). However, extant literature also depicts possible barriers to adoption, such as digital literacy gaps and gender biases in technology adoption (Mehta *et al.*, 2021). Adding the variable of GDP per capita assures that the economic context is accounted for, as more affluent countries would have better digital infrastructure and labour policies that enhance gender inclusiveness. Moreover, fertility rates provide insight into the interplay between family responsibilities and participation in the labour market—a well-documented factor influencing women's employment decisions (OECD Employment Outlook, 2023). Integrating these variables, the present study provides a comprehensive empirical framework for assessing the double role of digitalization in enabling and constraining women's employment within OECD countries. The findings will contribute to the ongoing discourse on gender disparities in the digital economy and will provide new insights into policy interventions aimed at shaping more inclusive labour markets. Information on variables is presented in Table 1.

4. Findings

In this section, the model for heterogeneity, stability and horizontal intersection dependency was verified using the relevant tests. The co-integration connection was then ascertained using Persyn and Westerlund (2008) co-integration test, and the outcomes were analysed.

Table 2 includes descriptive statistics of the annually examined data for the 2010–2023 period in the form of the values they are related to. In panel data analysis, interactions between horizontal section units are called "horizontal section dependency". If there is a horizontal cross-section dependence on a series, the results obtained from time series regressions will be deviant and inconsistent. Therefore, the existence of horizontal cross-sectional dependency should first be tested in panel data analysis (Menyah *et al.*, 2014). In the case of horizontal section dependency, second-generation unit root tests should be used, and if there is no horizontal section dependency, first-generation tests should be preferred. In this way, more consistent, effective and powerful results can be achieved (Erataş *et al.*, 2013). In the study, cross-sectional dependence was tested with Peseran (2004) and Friedman (1937) tests, and the test findings are presented in Table 3:

In Peseran (2004) and Friedman (1937), the H0 hypothesis is established as a "horizontal section dependency test". According to the results (Table 3), there is no horizontal section

Table 2. Summary statistics on variables

Variable	Obser.	Median	Stan. dev.	Min.	Max.
w	284	68.02478	16.75214	31.037	86.249
mb	284	129.9154	23.37039	67.1024	172.1508
web	284	82.37814	24.7846	9.2	99.68702
gdp	284	34157.41	22784.32	1347.944	88520.32
f	284	1.914579	0.361482	0.910	2.402

Source(s): Author's own creation/work

Table 3. Testing horizontal section dependency

Name of the test	Statistic value	Average
LM adj. – Peseran (2004)	1.852	0.0814
LM – Friedman (1937)	21.149	0.4872

Source(s): Author's own creation/work

dependency. Since the value obtained when the probability values are taken into account is greater than the probability value of 0.05′, in this case, there is no horizontal cross-section dependency between the units forming the panel, and the server is accessed. In this situation, it would be appropriate to use tests where generation unit root test estimators are valid. In panel data analysis, homogeneity or heterogeneity of slope coefficients is an important issue in examining the relationships between variables. In such a case, the type and interpretation of unit root and co-integration tests will differ depending on whether the constant and slope parameters are homogeneous or heterogeneous based on units. For this reason, it is important to conduct homogeneity tests before selecting the appropriate method to be used in econometric analysis (Yerdelen Tatoğlu, 2020, p. 246). In the study, the homogeneity test was tested, and the H0 hypothesis of the test assumes that the parameters are homogeneous (Swamy, 1971). The test result is presented in Table 4.

The presented homogeneity test results show that the H0 hypothesis is rejected and the slope coefficients are heterogeneous, and the parameters vary from unit to unit. Therefore, in this case, the selection and interpretation of unit root and co-integration tests were selected based on estimators taking into account the heterogeneity of slope coefficients. In panel data analysis, the presence of horizontal cross-section dependency is an important factor when testing the stability of variables. Detecting horizontal cross-sectional dependence determines the selection of the test method to be used in unit root testing.

It is important to first test the stationarity of the series and to stabilize the non-stationary series with appropriate methods. Otherwise, there may be a risk that real relationships cannot be determined correctly due to the problem of false regression (Gujarati, 2004). One way to test whether data is static is to test the unit root. In the study, since it was determined that there was no horizontal cross-section dependence in previous analyses, it was decided to apply Im, Pesaran and Shin (IPS) test, which are unit root tests that decide forecasters under the assumption of first-generation and heterogeneity. The Pesaran and Shin (Im *et al.*, 2003) panel unit root tests apply a single unit root test to the time series of all units in the model. It also allows all units that make up the panel to have their autoregressive parameters. The test is asymptotic if T and N go forever, respectively. The H0 hypothesis of the test is established as "all units contain the unit root". The test results are presented in Table 5:

When the statistical values of *p* in Table 5 are examined, the dependent variable w is stagnated by taking the first difference not stagnant at the level. The independent variables of

Table 4. Testing homogeneity/heterogeneity

Test statistics	Test value	Prob. value
chi2(126)	30418.19	0.0000

Source(s): Author's own creation/work

Table 5. Testing the unit root

Değişken	I ((0) İstatistik (w-t-bar)	Olasılık Değeri	I (1) İstatistik (w-t-bar)	Olasılık Değeri
w	−1.5014	0.0894	−6.7804	0.0000
mb	0.9864	0.9812	−7.9738	0.0000
web	1.9102	0.9047	−9.0879	0.0000
gdp	0.6378	0.9321	−11.1435	0.0000
f	1.1327	0.9043	−6.9102	0.0000

Source(s): Author's own creation/work

the model, mb and the web variables, appear to be stagnant when the first differences are taken, where they are not constant at the level. Added to the model as control variables, the variables GDP and *f* are also observed to become stable when the first differences are taken, where they are not stable at the level. When econometric modelling is done with unstable data at the level, the problem of material regression arises. In such a case, the estimated model's R^2 and test statistics can give deviant results. Therefore, I (1) has stagnated, taking the first difference of the parameters in the course of the analysis. After the unit roots are tested, a co-integration analysis is performed to determine whether there is a long-term relationship between the series. The Westerlund (2007) aggregation analysis is based on four statistics, and these tests are very flexible in short- and long-term predictions of bug-correction models and allow for heterogeneity. The H0 statistics of the test were established as "no integration". The test results are presented in Table 6:

When the findings in Table 6 are examined, it is seen that the probability values of Pt and Pa are less than 0.05′, and the H0 hypothesis (there is no co-integration between series) is rejected. In this case, the alternative hypothesis (there is co-integration between the series) was accepted. In the long term, it is mentioned that there is a meaningful relationship between women's participation in the workforce and digitalization in OECD countries.

Panel causality tests are methods used to examine causality relationships between variables in panel data sets. Unlike classical causality tests, panel causality tests take into account both time and cross-sectional size. There are various types of panel causality tests in the literature, such as Granger and Dumitrescu–Hurlin. These tests are applied by taking into account features such as stasis properties of variables, horizontal cross-section dependence and homogeneity. Dumitrescu and Hurlin's (2012) causality testing, which takes heterogeneity into account, was used to test causality between variables in the study.

When the panel Dumitrescu–Hurlin causality test findings in Table 7 are examined, the existence of a bidirectional causality relationship from the ***mb*** variable to the ***w*** variable is observed. It also appears that there is a one-way relationship between the web and ***w*** from the web to ***w***. Accordingly, it is concluded that there is a correct causal relationship between

Table 6. Westerlund cointegration test

Variable	Value	z-value	Prob.
Gt	−2.912	−2.846	0.003
G	−11.028	−2.905	0.004
Pt	−9.165	−2.024	0.008
Pa	−7.798	−2.402	0.012

Source(s): Author's own creation/work

Table 7. Dumitrescu–Hurlin panel causality test

Variable	w-statistics	z-bar statistics	Prob. value
mb is not the cause of w	5.9902	8.9245	0.0000
w is not the cause of mb	4.6782	5.1157	0.0000
web is not the cause of w	4.5780	6.8745	0.0000
w is not the cause of web	4.9784	6.9785	0.4289
GDP is not the cause of w	7.9785	12.2547	0.0000
w is not the cause of GDP	5.5024	8.8744	0.0000
f is not the cause of w	11.4518	20.5478	0.0000
w is not the cause of f	3.1578	16.0214	0.0021

Source(s): Author's own creation/work

women's participation in the workforce from digitalization. In addition, it can be said that there is a bidirectional causality relationship between the control variables of the model, ***GDP*** and ***f***, towards ***w***. This supports the assumption that there is a reciprocal relationship between digitalization and women's participation in the workforce.

This paper reaffirms many things in the literature by documenting a long-term association in a very robust manner between digitalization and women's labour force participation. Klasen and Lamanna's (2009) studies opine that such structural economic shifts or the effect of technological progress could narrow the gender gap in labour markets. Confirming the theoretical assumption that digital platforms enhance accessibility and flexibility to work conditions, especially for women, (Bahk *et al.*, 2023), through the implementation of a methodology for panel co-integration analysis by Westerlund (2007), this investigation probe into the influence of digitalization on participation by women into the labour force within OECD countries. In addition, the bidirectional causation established herein is consistent with views by Autor *et al*. (2020) who argue that embracing technology actually boosts gender diversity while making good use of women's specific inputs into innovative and digital economies.

5. Discussion and conclusion

These results underpin the duality of digitalization: enabling and constraining women's employment opportunities in OECD countries. While digital tools and remote work models have made it possible for more women to enter the labour force, findings indicate that systemic barriers of digital literacy gaps, cultural biases and structural inequalities are yet to allow the full realization of these benefits. These findings are consistent with the past literature that underlined the importance of proactive policies in closing the gender gaps in the digital economy (Nikulin, 2017; Pinzone *et al*., 2017).

This paper adds to the extant literature by presenting examples of policies applied in some OECD countries that successfully narrowed part of the exclusion effects resulting from digitalization. For example, the European Commission (2023) noted that countries like Sweden and Estonia have enhanced the integration of women within the digital sector through policies that pertain to gender-sensitive STEM education and workplace inclusion. These current research results show similar proactive policy measures to have a huge impact on the rise of women's integration into the digital economy, including digital training programs and gender-inclusive labour policies.

This research also contributes to the current debate on the impact of automation and digitalization on employment structures. While Acemoğlu and Restrepo (2020) warned about job displacement due to automation, this study shows that digitalization, when accompanied by enabling policies, can balance such negative effects by creating flexible employment opportunities for women. This is in line with the findings of Dikmen *et al*. (2022), who observed that digitalization increased remote and hybrid work models, making it possible to include more women in the workforce. Furthermore, the findings are in line with what Salman *et al*. (2023) and Wu and Yang (2022) found: that ICT development can empower women, provided that the barriers to digital literacy and access are overcome.

Another critical contribution of this study points out the problem of how gender stereotypes impede women's access to digital employment opportunities. Past research conducted by Cheryan *et al*. (2017) and Cortina *et al*. (2021) found societal norms to be one of the impediments barring women from joining tech-intensive sectors. The findings of this study support these assertions but also provide evidence that well-implemented reforms, such as those seen in Norway and Denmark, may help counteract these biases and increase female representation in high-demand digital jobs (OECD Employment Outlook, 2023).

From a policy perspective, the results point out that such structural interventions as digital literacy programs, gender-responsive job placement strategies and inclusive urban planning are critical to ensure that digitalization does not perpetuate existing inequalities. Rotondi *et al.*

(2020) emphasized the importance of policies for digital inclusion in overcoming systemic barriers, which the findings of the present study go on to underscore. These results do align with a few recent research findings from ILO (2023), stating that digital platforms can offer considerable opportunities for women's employment if designed to be inclusive.

Lastly, this study differs from the traditional narrative in establishing that the impact of digitalization on women's employment is not all bad. In contrast to most previous studies focused on job displacement, this study shows that digitalization can be a force multiplier for gender-inclusive economic participation. This nuanced perspective does, therefore, offer actionable insights to policymakers, bringing to the fore the need for adaptive digital policies that include gender-sensitive strategies to maximize the benefits of digital transformation while mitigating its risks.

Concluding, this study sheds new light on the impact of digitalization on women's employment in OECD countries by integrating evidence from recent empirical studies. This underscores the critical role that policy-driven interventions play in ensuring that digital tools act as enablers, not barriers, to participation in the workforce. In this vein, future longitudinal trend research on this subject should focus on the lasting effects of digital transformation on gender equity and cross-country comparisons of best practices that help foster an inclusive digital economy.

6. Limitations

The most important limitation relates to the country differences in the varying availability of data, consistency of measurement across different countries and definitional nuances of data across countries. Data inconsistency, therefore, makes for the comparability and reliability of the data to be undermined, especially so when drawing general conclusions across settings. The analysis becomes more robust by the treatment of outliers, like countries with very high GDP per capita or extremely high internet penetration, since outliers often end up inflating results; however, at the same time, it leaves out valuable perspectives from outlier cases in which digitization has yielded substantially different impacts. Such treatments of outliers may limit the extent of generalization in the study. Future research should work to improve upon the current study through removal or attempted removal of omitted lag effects, expanded sets of indicators that better capture digitally transformative phenomena, and perhaps ultimate consideration of country specifications that could factor outputs differently. These methodologies would provide a kind of confidence that findings would hold even more generally while affording a clear understanding of the transformational capability of digitization concerning labour market equality.

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