Does Digital Economy Improve Female Employment in Pakistan? An Empirical Investigation using Autoregressive Distributed Lag Model

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DECLARATION

I, ***Mahnoor Anjum,*** hereby declare that my MPhil thesis titled **"Does digital economy improve female employment in Pakistan? An empirical investigation using autoregressive distributed lag model"** is original work and has not been submitted elsewhere for any degree. If the statement is found to be incorrect at any time, even after I have completed my degree, the university has right to withdraw my MPhil degree.

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Signature: _____

Date: _____

DEVOTION

To My Parents

This is a dedication to my Parents, who have instilled in me a belief in hard work and trust in Allah Almighty. They have taught me that a lot can be achieved with limited resources.

To My Respected Teacher

(Dr. Amanat Ali)

Teachers are an endless source of motivation and inspiration for me. One teacher, however, remained a guiding light for me. His sincere guidance and prudent leadership aided me not only in completing this dissertation but also in determining clear career goals.

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ABSTRACT

Researchers in recent days are found studying digital economy putting special emphasize on its different dimensions. From this renewed attention, this study undertakes a research agenda to investigate the impact of digital economy on female employment in Pakistan based on time series data from 1990 to 2021. The digital economy is measured by five different variables i.e., subscriptions for fixed telephones, subscriptions for fixed broadband, subscriptions for mobile phones, secure internet servers, and individuals using the internet. To obtain empirical outcomes, this study uses the ARDL. The empirical evidence shows that there is a positive association between female employment and digital economy in both short and long run. It also finds that digital economy and control variables explain 91% of the variability in female employment. Similarly, few control variables (education, fertility rate and GDP) used in the study have also resulted in positive relations with female employment. ECM reports the speed of adjustment of 74 percent from disequilibrium to equilibrium. The principal implication of our findings directs that Pakistan can empower females by upgrading its digital infrastructure and presence. The study suggests that Pakistan needs to ensure enough funds available for supporting digital innovation in public services and improving access to the internet by regulating prices which will engage female counterparts to get benefitted from the digital divide.

Keywords: Digital economy, female employment, autoregressive distributed lag model, error correction model, cumulative sum chart

INTRODUCTION

1.1.Background of the Study

Digital or web economy provides women with a plethora of economic opportunities, regardless of whether they are rejected from the mainstream workforce. This is more valid for those in the developing countries, where social predisposition, movability restrictions, social security, and time constraints frequently keep women away from assuming their legitimate position in the workforce. ICTs (Information and Communication Technologies) are increasingly being promoted in Global South for inclusive poverty alleviation, development, and empowerment of historically marginalized population groups, i.e., minorities and female (Melhem et al., 2009; Marshall & Taylor, 2005; Maier & Nair-Reichert, 2008; Islam, 2015; Friedman 2005, International Telecommunication Union, 2005). It is argued that ICT (Information and Communication Technologies) have ability to contribute significantly to development enhancers (International Telecommunication Union, 2005). To capitalize from this digital dividend, the World Bank presently funds over one thousand projects having component of Information Technology (World Bank Gender Group, 2006 as cited in Maier and Nair-Reichert, 2008). Developed economies are ahead of others as they have already developed digital infrastructure to permit and support remote working, where orientation does not make any difference as much as in the actual economy. It opens a universe of opportunities for women in unfortunate nations. However, the hindrances to participating in the digital economy could be as hard to conquer as those that keep women away from participating in the mainstream economy. These limitations and requirements keep women separated from exploiting the digital dividend. Countries need to work hard to develop digital infrastructure considering the respective socio-cultural and

economic context (Roztocki et al., 2019). Simultaneously, it is important to ensure an enabling environment for women through policy supports so that they could be brought in regular economic activities to drive empowerment and inclusive development. Based on time series data from 1990 to 2021, this study addresses this issue by highlighting effect of digital or web economy on women employment in Pakistan.

Various studies consider digital or web economy's impact on economic growth (Zhang et al., 2022; Tian et al., 2022; Gomes et al., 2022; Pang et al., 2022; Elgendy & Hanafy, 2020), carbon productivity (Zhao et al., 2022), female employment (Sovbetov, 2018; Robinson et al., 2018; Cadena, 2020; Lechman & Popowska, 2022) etc. With differences in contexts and considerations, most of the studies show positive influence of digital economy on the numerous dimensions studied. In this study, we look at the effect of the web economy, sometimes known as the digital economy, on female employment in Pakistan. The digital economy refers to the global network of economic processes, corporate transactions, and professional relationships facilitated by ICTs. In simple words, it is an economy centered on digital technologies (European Commission, 2013). In this technology driven era, studies on digitization and employment generation receive additional attention and merit (Maier and Nair-reichert, 2007). Very aptly in the context of a Pakistan (developing country), this study addresses the issue of female employment level caused by digital economy and brings some policy issues, suggestions and recommendations for immediate attention based on empirical findings.

In Islamic countries, females cannot easily participate in regular economic activities due to various cultural, social, and religious issues (Moaddel, M. 1998). However, digital economy supports gender blind operations through which most of the barriers could be removed, and it offers opportunities to female to work from home or to start up their own business. Women

continue to be 7 percent on average more unlikely than men to own a smartphone and 16 percent less probably to access the internet on their phones. This indicates that 264 million fewer women than males are using mobile internet. (Mobile Gender Gap Report, 2022[1]). In South Asia, this gap is further widened while the worldwide computerized orientation partition in web utilization remained at around 11%, practically unaltered somewhere in the range of 2013 and 2017. According to the report of OECD, women-owned startup enterprises receive 23 percent less financing and are 30 percent male-owned enterprises are less likely to have a successful exit. (OECD, 2018). In Pakistan, necessary support to female workforce is still well beneath levels in comparison with different nations with comparative livelihoods, notwithstanding developing countries be the greater part throughout the course of recent many years. Indeed, even among women with an elevated degree of schooling, workforce support is low for working outside the home as only 25% of Pakistani women have a college education.

1.2.Problem Statement

Technological awareness to women is less as compared to other countries in Pakistan. Hardly 10% women know the concept of digital economy. However, from the last few years, the involvement of women in technological aspects is increasing rapidly. In future, this will bring many opportunities to the female entrepreneur to utilize their skills in digital economy. There is certainly not a solitary report accessible up to this point, which investigated the effect of digital economy. This contextual background provides us with a unique chance to investigate the contribution of Pakistani females to the country's economic development through the use of various digital platforms.

[1] Available at https://www.gsma.com/r/gender-gap/ retrieved on February 18, 2023.

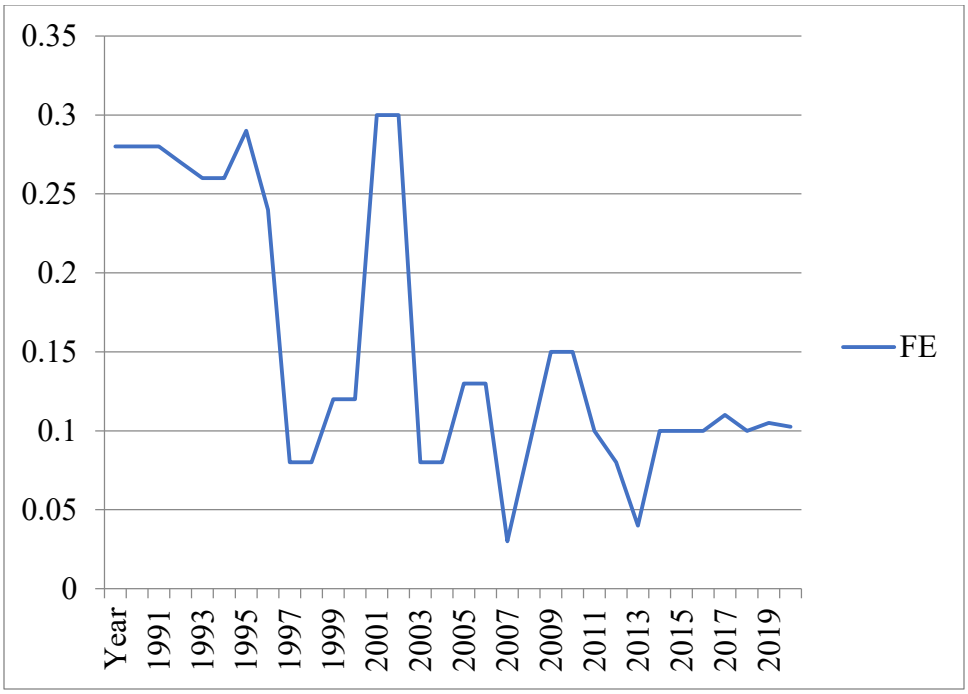

Figure 1: Female Employment in Pakistan

The decline in female employment rates in Pakistan over time (Figure 1) can be explained by a variety of causes, including cultural and societal standards that discourage women from participating in the workforce, lack of education and skills, limited access to economic opportunities, and family responsibilities. Women often face challenges balancing work and family responsibilities, leading them to drop out of the workforce or work part-time. Addressing these underlying factors such as promoting gender-sensitive labor market policies, increasing access to education and training programs, and addressing cultural norms can help promote gender equality and increase female employment rates in Pakistan. One plausible reason for a decrease in female employment could be a sustained economic downturn. During periods of recession or economic instability, companies may implement cost-cutting measures, leading to layoffs and hiring freezes. Historically, women have sometimes faced disproportionate job losses during economic downturns, as certain industries traditionally dominated by female workers,

such as retail and hospitality, may be particularly vulnerable (Smith, J. 2018). Different organizations work on various sponsorship programs and training sessions to train more and more women in the field of digital platforms. This, in return, will open numerous opportunities for women in future. This region is likewise laden with difficulties for women. While the simplicity of carrying on with work that comes from utilizing advanced stages obviously works with women's support, it additionally exposes them defenseless to abrupt challenges in business open doors or variances in the economy. The discriminatory wage structures are common in numerous gig areas which is further magnified and multiplied by an absence of work freedoms, advantages, or government-managed retirement plans. It implies that numerous women are constrained into exceptionally shaky monetary circumstances.

1.3.Research Significance

A thorough investigation of the relationship between female employment and digital or web economy in Pakistan becomes an essential research agenda. This research has the potential to open up new ways for women to work from home and generate income. Constructing an index to assess the scope and current situation of female employment in Pakistan can provide valuable insights into the challenges and opportunities that women face in this field.

1.4.Research Gap

Nobody has really studied how the digital economy affects women's jobs in Pakistan. Even though the digital economy is getting bigger worldwide, we don't know much about how it's impacting female employment, especially in Pakistan. This research wants to fix that gap by looking closely at how the digital economy and women working connect in Pakistan. It will

try to figure out what opportunities and challenges there are, and what it means for women working in this changing economic situation.

1.5.Objective of the Study

Researchers in recent days are found studying digital economy putting special emphasis on its different dimensions. From this renewed attention, we are motivated to investigate the impact of digital economy on female employment in Pakistan.

1.6.Research Question

Under this circumstance, this study undertakes two research questions, namely,

(a) What effect does the digital economy have on women employment in Pakistan?

(b) Can Pakistan empower female by upgrading digital infrastructure?

1.7.Plan of The Study

By using time series data for thirty-two years, the study deploys quantitative research method to explore the objectives of the study. The study considers female employment as dependent and digital economy as independent variable (proxied by subscriptions for fixed telephones, subscriptions for fixed broadband, subscriptions for mobile phones, secure internet servers, and individuals using the internet) with gross domestic product, education, fertility rate, unemployment, and poverty as control variables. In both the short and long run, ARDL (Autoregressive Distributed Lag) model is used to investigate the potential relation between chosen variables. The remaining portion of the article is structured as follows. The literature

review is presented in Section 2, and the study methodology is presented in Section 3. Section 4 contains the results and discussions, while Section 5 concludes the study.

LITERATURE REVIEW

2.1.Introduction

Research on digital economy and its impact have received considerable attention in recent years. Existing literature gives a rich archival record in this regard. Keeping our research objectives under consideration, we have presented relevant existing research outcomes across our major themes i.e., digital economy, female employment, other variables, and their interrelationships to logically position our study. It provides a glimpse of the existing body of knowledge on the selected areas and helps us to identify potential research gaps.

2.2.Digital Economy

Economic activities, referred to the internet economy which is popularly known as digital economy or e-commerce or online economy, are based on the use of digital technologies such as cell phones, internet, and many other digital platforms. In recent decades, the digital economy has risen quickly, driven by spectacular growth in gig economy, rise of e-commerce, innovations in technology etc. As a result, researchers focus on digital economy from various perspectives within their research interests and contexts. The majority of such study looks at various aspects of economic growth and development. Shahbaz et al. (2013) investigated the link between digital transformation and economic growth. The study shows that a 10% increase in digital score of a

country causes its GDP per capita increase by 0.75 percent. In different countries the impact of digital transformation is different. Production of digitalization can be improved in developing economies and there is measurable impact on development. Furthermore, it may have an impact on job availability by transferring lower skilled, lower value-added work to emerging markets where labor is less expensive.

Digital economy brings momentum to national economy and redefines the lifestyle of people. A digital economy focused mostly on Information and Communication Technology aids in increasing capital and labor productivity and obtaining goods and services at reduced rates (Dahlman et al., 2016). With the rapid growth of digital technologies such as information and communication technology, an increasing number of scholars have focused on the role of the digital economy in determining consumer surplus (Brynjolfsson et al., 1996), e-commerce supply chains (Swaminathan et al., 2003) and smart cities (Hernández et al., 2011). In a study, Seo et al. (2009) developed a cumulative growth model to investigate the beneficial association between ICT investment and economic growth in 29 countries and discovered that nations with poor productivity use ICT to close the productivity gap with developed countries and can benefit from the spillover effects of knowledge. Furthermore, Vu (2011) discovered that ICT can increase productivity by accelerating technological innovation, enhancing decision-making quality, and reducing manufacturing costs.

Zhang et al. (2021) conducted a study to explore the current state of web economy in China which affects the economic growth premium. For 30 cities of China, this study creates the web economy growth index from three dimensions of digital integration, digital infrastructure & digital industry. Data is taken from 2015 to 2019. Panel data is used to find the nexus between gross domestic product premium and web economy. The study concludes that China's web

economy is growing, with significant growth in digital infrastructure and slower growth in the digital industry. The study also shows that there is a positive impact on regional total factor productivity across all the three dimensions. The study also shows that high-tech advancement plays a mediating role in transmission techniques from web economy to economic growth premium. The study emphasizes the digital economy's regional dispersion, with the eastern area having advanced levels of innovation as compared to other areas. These findings provide both practical and theoretical strategic support to the government on the growth of web economy (Zhang et al., 2021).

Economic growth and development driven by digital economy also bring challenges to survive in a global competitive space. As a result, global digital governance becomes very important to reap benefits and address challenges related to digital economy (Jia & Chen, 2022). Many authors (e.g., Melnyk et al., 2019) have discussed the concept of technological developments, which are inventions that initiate new cycles of development of productive force and lead to transformation of socio-economic formations. PCs, internet, broadband, global positioning system, cellular devices, digital technology, robots, radio-frequency identification tags, renewable energy, 3D printers, artificial intelligence and cloud technologies have been identified as disruptive technologies in the growth of the Internet of Things (IoT) and by 2024, 37 billion devices will be connected to the ICT. Positive as well as negative effects of disruptive technologies and its economic implications are also discussed in this paper as well as the dilemma of innovator with two disruptive technology’s principles, i.e., creativity and destructive. The study estimates the effects of important variables on global GDP per capita and finds that all factors i.e., growth in subscribers of cellular devices, increases in longevity, fixed subscribers of telephone and energy use, gross capital formation etc. have a favorable impact on economic productivity (Melnyk et

al., 2019). In this study, we have considered the potential impact of digital economy which is proxied by similar variables like subscriptions for fixed telephones, subscriptions for fixed broadband, subscriptions for mobile phones, secure internet servers, and individuals using the internet (Islam, 2015) and address the context of a developing country, Pakistan.

2.3.Female Employment and Digital Economy

Digital technologies bring a transformation in the world of work (Rani et al., 2022) and offers challenges and opportunities for females. It is true that gender gaps in employment and wages have persisted despite many efforts to address them. Gender identity norms, work-life balance considerations and differences in preferences are a few factors that contribute to widening the gap. Various studies (Barbara et al., 2019; Blau & Kahn, 2017) conclude that these factors play a vital role in shaping observed gender trends.

There have been very few studies that directly address the influence of the digital economy on female employment. Sovbetov (2018) investigates the effect of digital economy on women employment from 1994 to 2016. This study shows that 80.74 percent of the variation in female employment is due to control variables & e-commerce. Using autoregressive distributed lag analysis, the study empirically confirms that variables are correlated. Every one unit increase in per credit card e-commerce transaction leads to 0.13-unit increase in the female employment rate in the long run and 0.33 percent increase in the rate of female employment is due to 1% increase in internet penetration in Turkey. Using error correction model (ECM), the study shows 75.43 percent as the speed of adjustment to the equilibrium. This study (Sovbetov, 2018) contributes to women's empowerment in Turkey with special focus on developing e-commerce policies.

In another study (Aly, 2022), the author investigates the link between economic growth, employment, digital transformation, and productivity of workers in a group of developing countries. This paper uses the functional generalized least squares method to study these relationships using the Digital Evolution Index. The conclusion of the study is that there is a positive relationship between mentioned variables i.e., economic growth, employment, digital transformation, and productivity of worker. Moreover, it is also found that women benefit higher rather than men from digitalization, as the study shows a positive correlation at first and an insignificant correlation for latter. To determine the effect of digital transformation on employment, however, more evidence is needed. This study focuses on the effect of digital transformation on total employment. It suggests that economists need to examine the effects of changes in labor market occupations and composition in future.

Tonkikh et al. (2019) examine the attitudes of women in Russia towards distance employment, also known as remote work or telecommuting. The researchers conducted a sociological survey to gather data on this topic and found that distance employment is increasingly becoming popular among women in Russia. Many women perceive distance work positively and see it to improve their quality of life in terms of social, cultural, family, and reproductive factors. The study (Tonkikh et al., 2019) also found that more than one-third of women looking for work prefer the remote format to traditional employment, thereby putting a significant reliance on digital infrastructure.

2.4.Female Employment & Other Variables

Women employment gets affected by lots of variables other than different measures of digital economy. To eliminate the effects of these variables on female employment, this study includes a set of control variables. In a study, Yousefya and Baratalib (2011) discovered that women with

greater educational levels had better work opportunities. According to the survey, higher education has an important influence in the employment and advancement of women in their working lives. Voumik et al. (2023) empirically find that female education has a significant positive impact on female employment in the short run and long run. On the other hand, Baye et al. (2020) perform a study that finds female education has a diminishing direct effect on full-time work, with the inverted-U-shaped connection indicating that women with seven or more years of schooling are less likely to be routinely employed than their peers with less years of schooling.

In 2006, Fuster and Rocha states that unemployment causes females to delay and space their births, lowering the total fertility rate. However, there is no clear pattern between women's employment and total fertility rates in Asia-Pacific countries. Until the early 1980s, female labor force participation and total fertility were inversely related. The large entry of women into the labor force at the start of the 1960s coincided with a fall in fertility rates (Adserà, 2005). However, since the mid-1980s, an increasing number of studies have shown a reversal of this negative correlation (Ahn and Mira, 2002; Hoem, 2000; Kravdal, 1996).

Women's declining employment rates were linked to negative effects on poverty, showing an increase in poverty. Overall, these findings indicate that a 1% reduction in poverty necessitates a 10% increase in women's employment rates (Nieuwenhuis et al., 2020). The findings of Stier and Lewin (2002) also confirm the common claim that women's employment is negatively connected to poverty in both female- and couple-headed families. Poverty levels are significantly lower in households where women participate in the labour market, either full-time or part-time, than in households where the woman is not economically active. Tasseven (2017), on the other hand, discovered that unemployment has a negative impact on female labour force participation rates. However, the study discovers that the gross domestic product and education have a positive

impact on female labour force participation. Okun (1962) and Phillips (1958) used two control variables (inflation rate and real Gross Domestic Product) to demonstrate the impact of selected control variables on employment rates empirically. Considering the context of Pakistan and available literature, we use a set of control variables (five), i.e., education, fertility rate, unemployment, poverty, and GDP in this study.

2.5.Literature Gap

There are a lot of literatures available on digital economy and female employment done separately and only one study (Sovbetov, 2018) in turkey explores the impact of digital or internet economy on the women occupation. However, this study considers e-commence activities to refer to digital economy. Lu et al. (2023) also concludes that Digital economy significantly promotes female employment. Another study (Islam, 2015) highlights the status of ICT and women empowerment in South Asian countries. ICT is proxies by variables like cell subscriber (%), fixed broadband (%), internet server per million, internet user (%), and telephone line user (%) which are converted into linearly uncorrelated variable called 'digital divide'. For women empowerment, this study has used three different variables, namely, female enrollment to total enrollment in primary (%), female enrollment to total enrollment in secondary (%), and female labor to total labor (%). Based on empirical research, this paper found that ICT has a positive impact on women empowerment. However, there is no such studies done in Pakistan before which motivates the authors to find out the nexus between digital economy and female employment. The digital economy has the potential to help reduce gender difference in Pakistani labor markets. According to a World Bank (2018) research, women in Pakistan face major challenges to accessing the formal labor market, such as restricted access to education and

training, social norms that prevent women from working outside the home, and employer discrimination. Women's labor force participation stands at only 23% even though women make up 48% of the population of Pakistan[2]. Nonetheless, the rise of Pakistan's digital economy has offered new chances for women to enter the work field. This includes an increase in the number of online markets, remote work options, and digital skills training programs. Considering an obvious research gap, this study focusses on the nexus between digital economy and female employment in the context of Pakistan.

RESEARCH METHODOLOGY

3.1 Data

The purpose of this research is to emphasize the relationship between the digital economy and female employment in Pakistan. This quantitative study uses 32 years data from 1990 to 2021 published by World Bank in its World Development Indicators (WDI) report. Female employment is used as dependent variable while digital economy is used as independent variable which is proxied by fixed telephone subscription, fixed broadband subscription, mobile phone users, internet subscribers, and internet security servers. In addition, GDP, education, unemployment, fertility rate and poverty are used as control variables in the model. **Table 1** below gives further details to the variables used in this study.

Table 1: Variable description & source of data

Name of the Variables	Notations	Description	Source

[2] https://data.worldbank.org/indicator/SL.TLF.CACT.FE.ZS?locations=PK

Female Employment	FE	% of female employment (self-employed)	WDI
Subscriptions for fixed telephones (Per 100 People)	FTS	Users of telephone line	WDI
Subscriptions for fixed broadband (Per 100 People)	FBS	Wireless technology users or users of public internet	WDI
Subscriptions for mobile phones (Per 100 People)	MSS	Mobile phone use	WDI
Secure internet servers (Per Million People)	SIS	Secure network under government supervision	WDI
Individuals using internet (Percentage of Population)	USI	Use of internet per person	WDI
Gross Domestic Product	Ln(GDP)	GDP in US$ converted from domestic currencies	WDI
Education	EDU	School enrollment, tertiary (% gross)	WDI
Unemployment	UNEMP	Unemployment, female (% of female labor force)	WDI
Poverty	POVERTY	Poverty headcount ratio at $2.15 a day (2017 PPP) (% of population)	WDI
Fertility Rate	FR	Births per woman	WDI

3.2 Variables Selection

3.2.1 Female Employment

A handful number of studies (Goldin, 1994; Thaddeus et al., 2022; Mujahid and Zafar, 2012; Fatima and Sultana, 2009) use female labor force participation rate to denote female employment and investigate the impact of female employment on economic growth/development. This study uses % of female employment (self-employment) rate as the dependent variable and attempts to highlight the potential impact of digital economy on female employment which is rarely addressed in existing literature. Though existing literature explores the impact of e-commerce/digital economy on economic growth (Gomes et al., 2022; Jurayevich & Bulturbayevich, 2020); however, the impact of digital economy on female employment is mostly overlooked. Sovbetov (2018) has studied the impact of digital economy on female employment in Turkey where digital economy is measured by various e-commerce activities. This study is different in how digital economy and female employment is measured and thus, it enriches the extant literature by filling gaps in existing body of knowledge.

3.2.2 Digital economy

The digital or web economy is our core explanatory variable in this study. Researchers prefer to use different proxies to denote digital economy as it cannot be observed directly. Some researchers adopted a comprehensive index for digital economy. Islam (2015) highlights the issue of ICT and women empowerment in South Asian countries. Using the principal component analysis, Islam and Mamun (2013) used variables like cell subscriber (%), fixed broadband (%), internet server per million, internet user (%), and telephone line user (%) which are converted into a linearly uncorrelated variable called ‘digital divide’. We investigate the impact of digital economy on female employment by using five proxies for digital economy, i.e., subscriptions for

fixed telephones (measured by number of subscribers per 100 people), subscriptions for fixed broadband (measured by number of subscribers per 100 people), subscriptions for mobile phones (measured by number of subscribers per 100 people), secure internet servers (measured by secure network under government supervision per million people), and individuals using the internet (use of internet per person measured as a percentage of total population).

3.2.3 Control variables

To strengthen our econometric model searching for factors affecting female employment in Pakistan, we have identified and used five control variables in addition to our main explanatory variable, digital economy. The control variables used in this study are education (Yousefya and Baratalib, 2011; Voumik et al., 2023; Baye et al., 2020), gross domestic product (Tasseven, 2017; Okun, 1962; Phillips, 1958), fertility rate (Rocha and Fuster, 2006; Adserà, 2005; Ahn and Mira, 2002; Hoem, 2000; Kravdal, 1996), unemployment (Rocha and Fuster, 2006; Tasseven; 2017) and poverty (Nieuwenhuis et al., 2020; Stier and Lewin, 2002), which are being extensively used in existing studies. This will help us to determine the influence of the digital economy on female employment more accurately if we can manage these macroeconomic factors and this will also make our econometric model strong enough controlling the residuals. Although many other macroeconomic factors may potentially be related to female employment, most of them have an impact on female employment through these variables' channels. Moreover, adding more control variables could create a collinearity issue in the model, resulting in estimates and standard errors that may generate misleading outcomes. We measure education by % of gross school enrollment at tertiary level, GDP by log of GDP in US$ converted from

domestic currencies, unemployment by % of female labor force unemployed, poverty by % of population with headcount ratio at $2.15 a day, and fertility rate by number of births per woman.

3.3.Conceptual Framework

Theoretical review is essential for formulating new hypotheses and establishing the connection between existing theories. The theoretical review assists in identifying current theories, their relationships, the depth to which existing concepts have been researched, and the formation of new hypotheses to be tested. This technique is widely used to illustrate a lack of acceptable theories or the inadequacy of present theories for addressing new or emerging research concerns. A single theoretical concept or an entire theory or framework might serve as the unit of analysis. (Fink, 2019). This paper develops a framework (conceptual) based on existing literature connecting core issues surrounding female employment and digital economy.

The aim of this research is to look into the potential impact of the digital economy on female employment, which is further influenced by a variety of variables such as GDP, poverty, unemployment, fertility, and education level. According to research performed by the United Nations Conference on Trade and Development, women are underrepresented in high-skilled digital jobs; however, policies addressing gender-based limitations can increase access to digital skills and education (Canton, 2021). A World Bank (2019) study also confirms that e-commerce could provide fresh prospects for women entrepreneurs in developing countries provided policies address gender-based barriers to technology, funding, and training.

In a separate study, Acharya (2008) opines that increasing women's labor-force participation can successfully reduce poverty. On the other hand, the impact of female employment on poverty can be influenced by a variety of factors such as job quality, access to education and training, and

gender-based discrimination. Thus, the impact of digital economy on female employment is complex and multidimensional, as digital technology can both generate new opportunities for women and reinforce gendered inequality and exclusion. With mobile phones being the dominant mode of access, developing countries will see a significant shift in internet use (Ipsos Insight, 2006). In order to influence the overall development of the community, infrastructure should be created to deliver the greatest possible user experience with the available resources. Although Evangelista et al. (2014) discovered that information and communication technology use has a favorable and significant impact on labor productivity; there is no agreement on the impacts of different forms of ICT on employment and labor productivity.

Studying existing literature, we acknowledge that the impact of the digital economy on female employment is complicated, and the idea is still developing leaving a room for further study. While digital technologies can open new doors for women, they also have the potential to exacerbate gendered inequality and exclusion. Policies addressing the digital gender divide and encouraging inclusive growth are critical to ensure that women can fully participate in and profit from the digital economy. Considering this, we have developed our conceptual framework as figured (**Figure 1**) below:

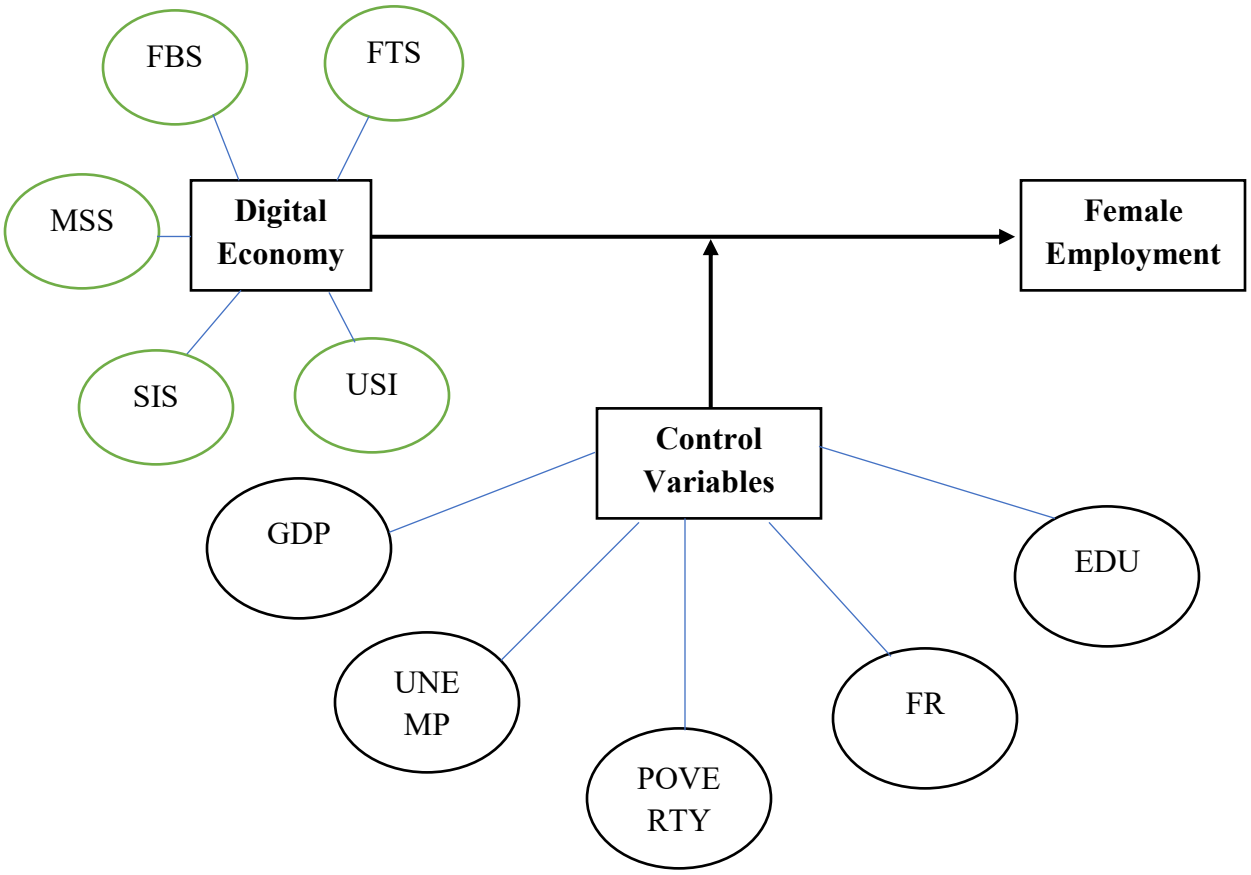

Figure 2: Conceptual framework of the study

3.4.Econometric Model

Considering the data and conceptual framework, we have developed our econometric model for estimation by following Sovbetov (2018). This study (Sovbetov, 2018) considers impact of

digital economy on female employment in Turkey. We have brought improvements to the model based on available literature with the combination of critical considerations, thoughts, and explanation of relationships among the factors. Our econometric model (female employment is a function of digital economy) is presented in **eq. 1** below:

$$\boldsymbol{FE}_t = \boldsymbol{\alpha}_o + \sum_{i=1}^{5} \boldsymbol{\alpha}_i \boldsymbol{X}_{i,t} + \sum_{i=6}^{10} \boldsymbol{\alpha}_i \boldsymbol{Z}_{i,t} + \boldsymbol{\varepsilon}_t \qquad (\boldsymbol{eq.1})$$

Here, $\boldsymbol{FE}_t$ represents the rate of female employment in Pakistan at time t, $\boldsymbol{\alpha}_o$ is the intercept, $\boldsymbol{X}_{i,t}$ indicates the parameter i of digital economy at time t which are proxied by five variables: fixed telephone subscription (FTS), fixed broadband subscription (FBS), mobile phone users (MSS), internet subscribers (USI), and internet security servers (SIS). Besides, $\boldsymbol{Z}_{i,t}$ stands for control variable i at time t. Finally, $\boldsymbol{\varepsilon}_t$ represents error at time t.

3.4.1. Data Stationarity

The basic assumption about the data used in time series econometrics is that it is stationary. If figures are not static of time series, then the general term of statistics for Ordinary Least Square (OLS) is not applicable. If time series data results in a high R-squared trend across time, the estimated results may be worthless or irrelevant (Ashley & Granger, 1979). Thus, the first step in time series analysis is to determine whether the variables are stationary or not. If series is not fixed, the time for viability is all that matters. In this situation, the inverse feature of this time series prevents generalizing its behavior to other time series. Additionally, stationarity is a crucial factor to consider while creating reliable and precise econometric models. Resuming will give inaccurate results if the series is insufficient with respect to this feature. Technically speaking, such a model would give inaccurate findings, and any conclusion based on it would be

flawed. That's why the stationarity test is so important for time series analysis (Jalil and Rao, 2019).

To test stationarity, we have applied the widely used and popular test, ADF (Augmented Dickey Fuller test. The assumption of ADF is false that current series has a unit root and optimal theory is available that the unit root doesn't affect the series badly. The accompanying first order autoregressive (AR(1)) model is presented in **eq. 2** below to better capture this. Unit root may have negative impacts on this. An AR model with independent factors has at least one slow upside of the dependent variable called an autoregressive model in a time series test (Ng and Perron, 2001).

$$Y_t = \alpha_o + \rho Y_{t-1} + \mu_t \qquad (\boldsymbol{eq.2})$$

In above equation, Y_t depends on its past value, α_o is constant, Y_{t-1} is past series, μ_t is error term and ρ stands for the unit root coefficient of interest. If ρ value is smaller than 1, the shocks in Y_t will be temporary and won't last over time (Engle and Granger, 1987). The series in this situation will be stationary in nature. Besides, when ρ =1 then the shocks in Y_t can exist for a long time and do not die out with the passage of time. In this case, the series is referred to as a unit root. If ρ >1, then series will explode (Javaid, 2017). The issue with this situation is that fixed exists, and therefore, its condition is evaluated at level. In this manner, the model will be as follows if we rework on it by main distinction:

$$Y_t - Y_{t-1} = \alpha_o + \rho Y_{t-1} - Y_{t-1} + \mu_t$$

$$\Delta Y_t = \alpha_o + (\rho - 1) Y_{t-1} + \mu_t$$

$$\Delta Y_t = \alpha_o + \delta Y_{t-1} + e_t \qquad (\boldsymbol{eq.3})$$

Here, we expect the series to be non-stationary, and thus, the model is estimated in a structure of contrasts. Dickey and Fuller stated a similar strategy (Mushtaq, 2011). There is just an AR(1) process set up by the ordinary Dickey and Fuller test. This prevents the execution of the plan. In equation, δ is the unit root or the overall result coefficient to assure stationarity. If the value of δ is nothing, the shocks in Y_t will be temporary and end over time. All things considered; the nature of the series will be defined. Furthermore, the shocks in Y_t persist over time if the value of δ is not equal to anything (Pesaran et al., 2001). The series appeared as a unit root in this instance which is known as unit root hypothesis.

$$\Delta Y_t = \alpha_o + \alpha_{1t} + (\rho - 1)Y_{t-1} + e_t \qquad (\boldsymbol{eq.4})$$

In **eq. 4**, α_{1t} refers to time trend. The AR(ρ) process affects most time series; however, the Dickey-Fuller test only considers the AR(1) process. ADF is the most appropriate technique for including such higher-order autocorrelation.

$$\Delta Y_t = \alpha_o + \alpha_{1t} + \delta Y_{t-1} + \Sigma j = 2\rho\alpha Y_{t-j} + e_t \qquad (\boldsymbol{eq.5})$$

Eq. 5 is basically the ADF (Engle and Granger, 1987). One may argue that the estimated equation does not provide robust results if the trend and intercept of the above equations are ignored (Rummel, 2015). This is a justified criticism that makes sense and requires careful study. So, the intercept and trend can be added. More specifically, the higher order correlation is parametrically corrected by the ADF test by applying a greater number of lags on the right-hand side of the equation. Furthermore, in the previous equation, increasing the number of lags on the right side is frequently seen as a viable solution. Applied economists advise researchers to include appropriate lags in their models to get removal of autocorrelation in the residuals (Jalil and Rao, 2019). However, due to the loss of degree of freedom imposed on by the addition of

delays, it is not always useful. Another disadvantage of Augmented Dickey Fuller is that it does not account for structural changes in the data series.

3.4.2. Bound Test:

The bound testing approach is used to find both long and short term factors of gross output. The testing strategy is limited to three verifications. First and foremost, Pesaran et al. (2001) demonstrate employment of Autoregressive Distributive Lag model gauge for the aim that model offers assuming ARDL request has been sensed at level relations, then variable relationship may possibly be appraised by OLS technique. Second, I(1) and I(0) factors can be identified as repressors via headed co-mix testing. In other words, it is impossible to compare a request for a combination of appropriate elements with certainty. As a result, the ARDL strategy execution has the benefit of not requiring precise evidence of the nature of the request for unique numbers. Bound test execution is appropriate for smaller and more limited tester sizes.

Autoregressive Distributive Lag co-incorporation method was pioneered by Pesaran and Shin (1995). Using ARDL over other time series methods has several advantages; as a result, analysts frequently use the ARDL procedure. When a few model components are included at level one and others are coordinated at first contrast, ARDL produces powerful results (Shahbaz et al., 2013). When sample size is small, Pesaran and Shin (1995) discovered that the ARDL process provides more precise bounds than co-mix strategy of Johansen (1988). As a result, this is especially relevant in our situation, as we have limited knowledge and a low level of coordination. In this manner, the subsequent step is examined for factor co-mix. As a result, the bound testing method, which is based on the F-test, is favorable. All long run limits of the Auto Regressive Distributed Lag condition have no impact on the subordinate variable, making the F-

test an incorrect supposition. For instance, equation 5 illustrates the completion of a crucial test that indicates no co-mix.

Pesaran et al. (2001) propose two crucial values at different levels. The first assumption is that the variables are stationary at I(0), whereas the second is that they are steady at I(1). When the calculated value exceeds the upper critical bound value, the H0 is rejected; when it falls within the critical boundaries, the test is judged dubious; and when it goes below the critical value, no co-integration is recommended. The current inquiry, which is referenced in eq. 6 below, employs Autoregressive Distributive Lag modeling.

$$\Delta lnY_t =$$

$$\beta_0 + \sum_{n=1}^{\rho} \beta_n \Delta lnY_{t-n} + \sum_{n=1}^{q} \gamma \Delta lnK_{t-n} + \sum_{n=1}^{m} \emptyset \Delta lnL_{t-n} + \sum_{n=1}^{k} \pi_n \Delta lnE_{t-n} + \lambda_1 lnY_{t-1} +$$

$$\lambda_2 lnK_{t-1} + \lambda_3 lnL_{t-1} + \lambda_4 lnE_{t-1} + \mu_t \qquad (\boldsymbol{eq.6})$$

In eq. 6 above, expression from 1 to 4 reflects the long term relationship between the variables, but the look from β_1 to β_4 with the summation symbols corresponds to the variable's short-run subtlety. However, β_o indicates a steady drift and μ_t refers white noise Gaussian (Javaid, 2017). The Null-Hypothesis is now H0: ($\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$). It denotes that no long term relationship exists between the variables. And the other is H1: at least one parameter is not zero (Javaid, 2017).

ARDL's core phase is the bound testing stage, which guides us on the long-term relationship between model's elements. For this, the established advantages of F-measurements are contrasted with the higher and lower basic qualities provided by Pesaran et al. (2001). If the determined F-measurement worth is more than the upper basic worth, the incorrect hypothesis will be rejected. After the affirmation of bound testing, the next undertaking is to actually look at the short run

dynamic behavior of the model through ECM. The no-nonsense concern of ECM is if the concerned model is forcefully consistent.

3.4.3. Error Correction Model (ECM)

The ECM expresses short term dynamics with a long-run relationship. Short-run association between variables is tested using ECM. Error correction model(-1) explains relationship in long run and its negative sign confirms the consistency of the model which is known as adjustment parameter. Error correction model(-1) shows the speed of adjustment to the equilibrium. ECM is then estimated in the third step.

$$\Delta Y_t = \beta_0 + \sum_{n=0}^{\rho} \delta_n \Delta Y_{t-n} + \sum_{n=1}^{\rho} \varphi_n \Delta K_{t-j} + \sum_{n=1}^{\rho} \delta_n \Delta Y_{t-1} + \sum_{n=1}^{\rho} \varpi_n \Delta L_{t-1} + \sum_{n=1}^{\rho} \delta_n \Delta Y_{t-1} + \sum_{n=1}^{\rho} \lambda_n \Delta E_{t-1} + \sigma ECM_{t-1}\, \mu_t \qquad (\boldsymbol{eq.7})$$

Through the long run relationship, Error correction model(-1) describes dynamics in short run. The change boundary is ECM(- 1) and they indicate union speed towards the balance (Shahbaz et al., 2013). Furthermore, it indicates that last year's disequilibrium will be altered in the coming year. The presence of an incorrect amendment clause (change boundary) is also a negative indicator (Ajide and Lawanson, 2012). This negative sign strategy keeps the assembly from seeing the balance. The coefficient elasticity of the ECM is estimated by equation 8.

$$lnY_t = lnA_t + \beta lnK_t + \gamma lnL_t + (1 - \beta - \gamma) ln\tau E_t + \epsilon_t \qquad (\boldsymbol{eq.8})$$

$$L.R = \varepsilon_y^S = \frac{dy}{d\tau}.\frac{\tau}{y} = \frac{(1-\beta-\gamma)}{\beta+\gamma} \qquad (\boldsymbol{eq.9})$$

$$S.R = \varepsilon_y^l = \frac{dy}{d\tau}.\frac{\tau}{y} = \frac{(1-\beta-\gamma)}{\gamma} \qquad (\boldsymbol{eq.10})$$

Finally, equation 9 gives the long run elasticity of ARDL model, while equation 10 gives the short run elasticity. In this study, logs of each variable are taken, and the long run elasticity of the valued variables is represented by the coefficients of the variables in the ARDL model.

RESULTS AND DISCUSSIONS

4.1 Introduction

This section presents the results of the quantitative analyses followed by discussions. In this study we tried to investigate the impact of the digital economy on female employment in Pakistan from 1990 to 2021. Hence, we found that there is a positive association between female employment and digital economy. Different econometric techniques/tests we have applied and will discuss in this chapter in detail.

4.2 Descriptive Statistics

Table 2 initially displays descriptive statistics related to the variables of interest. Descriptive statistics include mean, median, maximum, minimum, skewness, standard deviation, kurtosis, and Jarque-bera. This is calculated based on time series data consisting of 32 years of annual observation from 1990 to 2021. It shows that the average of female employment is 0.150 with standard deviation 0.086. The average FBS is 0.376 with standard deviation 0.466. The average of EDU is 5.837 with standard deviation 3.237. The average GDP is 3.242 with a standard deviation 0.027. The average of UNEMP is 2.027 with standard deviation 2.722. The average of POVERTY and FR is 16.619 and 4.744 with standard deviations of 9.379 and 0.865

respectively. All the variables are found positively skewed except GDP. Kurtosis statistic of the variables indicate that FE, FBS, FTS, MSS, EDU, GDP, POVERTY and FR are platy-kurtic (lower peak or short tail) because their value is less than 3 whereas, SIS, USI and UNEMP is lapto-kurtic (high peak or long tail) because their values are greater than 3. The Jarque-bera (JQ) p value of GDP results 2.7 that is greater than 10%. Thus, we accept the null hypothesis with the meaning that the data is normally distributed. The Jarque-bera values of all the other variables are also greater than 10% which leads us to accept the null hypothesis that the data are normally distributed.

Table 2: Descriptive Statistics

Variables	**Mean**	**Med.**	**Max.**	**Mini.**	**Std. Err.**	**Skew**	**Kurt.**	**JQ**
FE	0.150	0.110	0.300	0.030	0.086	0.693	1.943	3.922
FBS	0.376	0.016	1.222	0.009	0.466	0.654	1.639	4.602
FTS	2.183	2.073	3.500	1.008	0.783	0.202	1.690	2.428
MSS	32.255	21.038	79.507	0.008	32.654	0.181	1.220	4.263
SIS	15.585	0.659	115.066	0.591	32.993	2.051	5.806	31.906
USI	6.734	6.500	25.000	0.000	6.667	0.942	3.398	4.786
EDU	5.837	4.986	12.221	2.137	3.237	0.483	1.696	3.402
Ln(GDP)	3.242	3.244	3.281	3.200	0.027	-0.017	1.529	2.795
UNEMP	2.027	0.500	9.282	0.252	2.722	1.511	4.015	13.132
POVERTY	16.619	20.200	33.300	4.900	9.379	0.138	1.524	2.911
FR	4.744	4.526	6.291	3.555	0.865	0.332	1.846	2.288

Source: Authors own compilation

4.3 Correlation Analysis

The correlation coefficients of all the variables have been shown in **Table 3**. It indicates the direction in which the variables are related. The results indicate that female employment maintains positive correlations with digital economy measures through FBS, FTS, and MSS while SIS and USI demonstrate the negative correlation with dependent variable (female employment). The four control variables (Education, unemployment, fertility, and GDP) also show a significant positive impact on female employment while poverty report a negative correlation with dependent variable. The table directs that female employment has a positive correlation with MSS with a correlation coefficient of 0.60 which shows that MSS causes increase in female employment rate by 0.60%. Results also indicate that FTS and FBS also have positive correlation with the value of 0.32 and 0.48 respectively.

Table 3: Correlation Coefficients

Variables	FE	FBS	FTS	MSS	SIS	USI	EDU	Ln(GDP)	UNEMP	POVERTY	FR
FE	1.00	0.48	0.32	0.60	-0.25	-0.52	0.59	0.665	0.354	-0.48	0.69
FBS	0.48	1.00	-0.08	0.71	0.68	0.85	0.53	0.18	0.85	-0.85	-0.62
FTS	0.32	-0.08	1.00	0.05	-0.48	-0.09	-0.02	0.14	-0.44	-0.09	-0.22
MSS	0.60	0.71	0.05	1.00	0.59	0.88	0.45	0.55	0.74	-0.65	-0.70
SIS	-0.25	0.68	-0.48	0.59	1.00	0.73	0.61	0.62	0.75	-0.55	-0.57
USI	-0.52	0.85	-0.09	0.88	0.73	1.00	0.89	0.30	0.48	-0.86	-0.49
EDU	0.59	0.53	-0.02	0.45	0.61	0.89	1.00	0.43	0.82	-0.50	-0.69
Ln(GDP)	0.66	0.18	0.14	0.55	0.62	0.30	0.43	1.00	0.73	-0.43	-0.38
UNEMP	0.35	0.85	-0.44	0.74	0.75	0.48	0.82	0.73	1.00	-0.69	-0.69
POVERTY	-0.48	-0.85	-0.09	-0.65	-0.55	-0.86	-0.50	-0.43	-0.69	1.00	0.58
FR	0.69	-0.62	-0.22	-0.70	-0.57	-0.49	-0.69	-0.38	-0.69	0.58	1.00

Source: Authors own compilation

4.4 Heteroskedasticity Tests

We have reported the tests of heteroskedasticity in Table 4. The generated probability values become greater than 0.05 (at 5% level of significance) which means that in the data set, there is no heteroskedasticity present.

Table 4: Heteroskedasticity Tests

Tests	Value	Probability
BPG	3.497	0.678
Harvey	3.267	0.985
Glejser	4.365	0.305
White	3.225	0.109

Source: Authors own compilation

4.5 Augmented Dickey Fuller

To check the stationarity of the time series data used in the study, we have conducted the ADF (Augmented Dickey Fuller) test with the results shown in Table 5. Results show that some variables i.e., fixed broadband subscriptions (FBS), fixed telephone subscriptions (FTS), education (EDU), log of GDP, mobile phones subscriptions (MSS), individuals using internet (USI) and secure internet servers (SIS), poverty, and unemployment are stationary at first difference whereas female employment (FE) and fertility rate are stationary at level. In this case, the Autoregressive Distributive Lag bound testing approach for cointegration must be used to determine the presence of a long run relationship among the variables (Pesaran et al., 2001).

After confirming the stationary, the next step is to analyze the Autoregressive Distributive Lag bound testing approach to discover if there is a long run link between the variables.

Table 5: ADF

Variables	Integration Order	Test-statistic	Critical Value	D.W Test
FE	I(0)	-4.282	-3.568	1.878
FBS	I(1)	-5.484	-2.963	1.922
FTS	I(1)	-4.093	-2.963	1.924
MSS	I(1)	-5.307	-2.967	1.959
SIS	I(1)	-17.76	-2.998	1.533
USI	I(1)	-11.10	-2.967	2.003
EDU	I(1)	-8.241	-2.963	0.000
Ln(GDP)	I(1)	-5.087	-2.963	1.947
UNEMP	I(1)	2.423	-3.02	2.40
POVERTY	I(1)	-13.20	-2.96	2.60
FR	I(0)	-3.546	-2.96	0.91

Source: Authors own compilation

Note: At level, critical value > statistical value, thus, rejected at 5% significance level

4.6 Akaike Information Criterion

The Akaike Information Criterion (AIC) is utilized in this study to determine the model's appropriate lag order **(Figure 2).** To investigate cointegration, the appropriate range of lag length is used to calculate Autoregressive Distributive Lag (F-statistic) (Johansen, 1992). The study

selects a lag length of 1 based on the AIC. The reason for this is that AIC has higher power properties (Jalil et al., 2013).

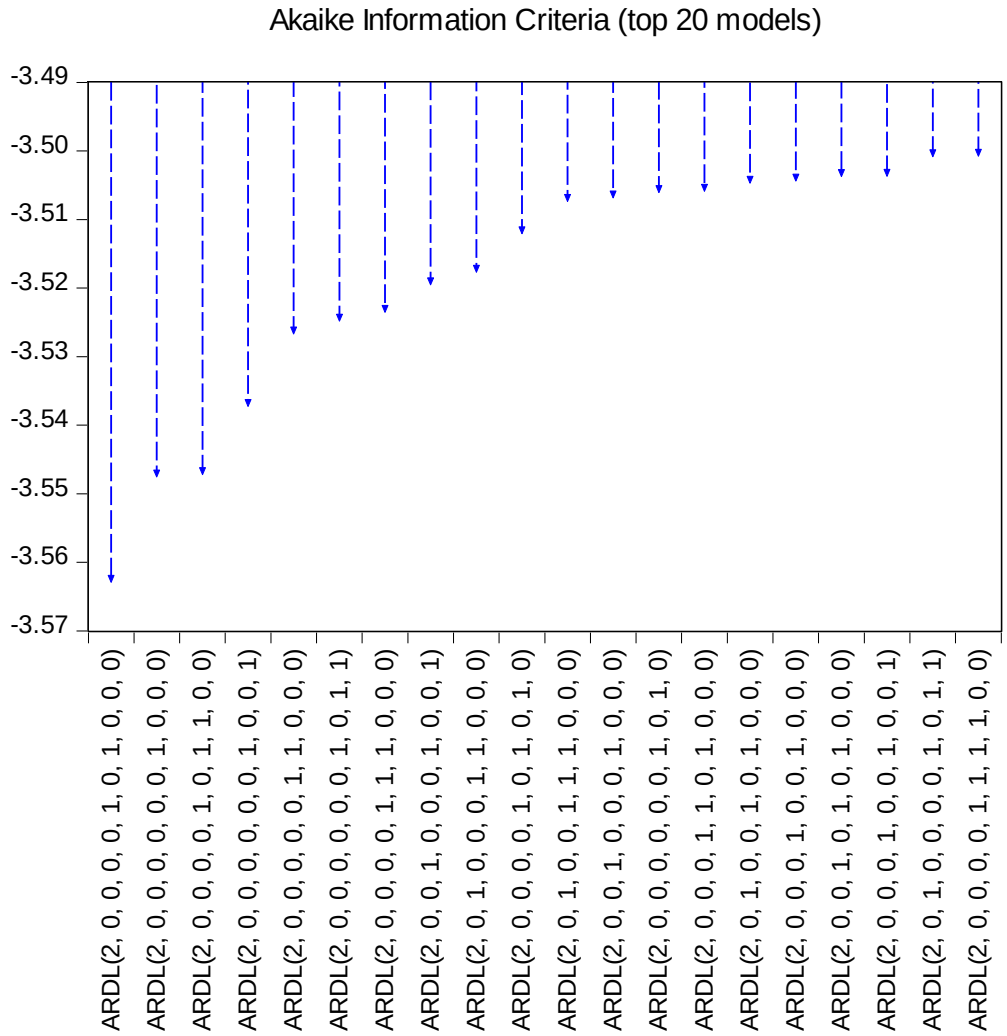

Figure 3: AIC (top 20 models)

Source: Authors own compilation

4.7 Bound Test

Table 6 below displays results of the Autoregressive Distributive Lag bounds testing and it was found that at the 5% significance level calculated the F-statistic exceeds the upper critical bound. F-statistics value is calculated at 8.80 and F-stat critical are 1.98 and 3.04. The F-statistics value

becomes greater than the critical values at 5% or 0.05 level of significance rejecting null hypothesis (H_0: No level relationship) (Pesaran et al., 2001). Rejection of H_0 confirms a long term association of female employment with digital economy. This shows that the variables have cointegration. After confirming the existence of cointegration, the model must be estimated.

Table 6: Bound Test

F-Statistics	8.809	
Level of Sig.	Lower Bound I(0)	Upper Bound I(1)
5%	1.98	3.04

Source: Authors own compilation

4.8 Short Run

The estimation results of ARDL model (Table 7) explain that one and two year lagged female employment has a positive but statistically significant association with current female employment. Likewise, current year FBS has a positive correlation with female employment with a coefficient of 0.1 and plays statistically considerable role in determining female employment. Contrarily in short run, one-year lagged USI shows a positive but statistically insignificant relationship with female employment. A single unit rise in one year lag USI is raising current female employment by 0.01%. Furthermore FTS, MSS, SIS have positive role in determining female employment. One year lagged control variable (GDP) have a positive and significant association with female employment. The study reveals that a single unit rise in one year lagged GDP increases current female employment by 8.09 units. In Pakistan, the study conducted by Junaid et al. (2019) found that there is a definite positive association between unemployment and female employment. According to the study, the positive relationship could

be attributable to variables such as higher household income demands and the necessity for women to supplement family income during economic downturns. Our results are consistent with Alaedini and Razavi (2005). On the other hand, result shows the positive relation between fertility rate and female employment. This is known as the "fertility-employment nexus." In a study, Lappegrd and Rnsen (2013) discovered a positive association between fertility and female employment in industrialized nations with high levels of gender equality. Women who have more children, according to the study, are more likely to continue in the labor force because they have access to supportive workplace policies such as paid parental leave and flexible work arrangements. The R^2 value of 0.915 indicates that the variables are 91% change in dependent variable (FE) due to independent variable (Digital economy) and control variables (Poverty, unemployment, education, fertility rate and GDP). Finally, a value of 0.837 for the adjusted R-square means that the model explains 83.70% of the variance in female employment.

Table 7: Short Run Results

Variables	**Coef.**	**St. Err.**	**T-stats**	**Prob.**
FE(-1)	0.36	0.13	2.81	0.01
FE(-2)	0.90	0.14	6.53	0.00
FBS	0.10	0.06	1.71	0.11
FTS	0.06	0.02	2.39	0.03
MSS	0.01	0.00	4.39	0.00
SIS	0.00	0.00	1.53	0.15
USI	0.00	0.01	0.49	0.63
USI(-1)	0.01	0.01	1.15	0.27

EDU	0.02	0.01	1.61	0.13
Ln(GDP)	6.88	3.10	2.22	0.04
Ln(GDP)(-1)	8.09	3.58	2.26	0.04
UNEMP	0.00	0.01	0.32	0.76
POVERTY	-0.01	0.00	-5.41	0.00
FR	0.26	0.10	2.62	0.02
C	-4.76	13.62	-0.35	0.73
R sq.	0.915		Prob(F-stats)	0.000
Adj. R sq.	0.837		D.W stat	2.712
F-stats	11.64		SIC	-2.929

Source: Authors own compilation

4.9 Error Correction Model

We apply ECM which shows that in short run, the dynamic model depicts the speed of convergence to equilibrium that there exists a significant relationship between our dependent and independent variables. The co-efficient value of the error correction model is -0.74, which is both negative and significant **(Table 8)**. This negative and significant ECM coefficient suggests the presence of a long-run causal link. ECM represents the rate of adjustment from disequilibrium to equilibrium.

Table 8: ECM

Variables	Coefficient	St. Err.	T-stats	Probability
CointEq(-1)	-0.744	0.114	-13.53	0.0000

R-sq.	0.876			
Adj. R sq.	0.862			
SIC	-4.17			
D.W stat	2.712			

Source: Authors own compilation

4.10 Long Run

We present the long-run ARDL outcomes in Table 9. It shows that the error correction term has a negative and significant effect, showing that the system returns to long-run equilibrium after a shock. The long-run results show that female employment is positively linked with the FBS but statistically insignificant. More specifically, in the long run, one unit rise in the FBS tends to increase female employment by 0.067% every year. FTS is also positively related to female employment. One unit increase by the FTS leads to increase the female employment by 0.037%. The results of the MSS and SIS also have positive impact on female employment. The coefficient values for both the terms are positive and significant. The control variables education and GDP are positive but reports statistically insignificant impact on female employment. If the level of education increases by 1%, it will tend to increase female employment by 0.011%. The outcomes of the study are consistent with that of Majid and Siegmann (2021). One dollar increase in GDP leads 0.78% increase in female employment. The coefficient of unemployment is positive and statistically insignificant. Study done by Khan et al. (2017) found a definite positive association between unemployment and female employment in Pakistan which is further confirmed by this study. Fertility rate also shows a positive impact on female employment. Poverty, on the other hand, results in a negative and statistically significant impact on the

dependent variable. A one unit increase in poverty leads to decrease in female employment by -0.009%. According to one study (ILO, 2016), poor women are most likely to work in low-wage, precarious employment, such as domestic employment, which generally provides little job security or social safety. The study also discovered that poverty could restrict women's access to education and training, limiting their employment options. Our findings are fully consistent with International Labor Organization (ILO) 2016.

Table 9: Long Run Results

Variables	Coef.	Standard Error	t-stats	Probability
FBS	0.067	0.038	1.761	0.099
FTS	0.037	0.015	2.396	0.030
MSS	0.004	0.001	5.111	0.000
SIS	0.001	0.000	1.506	0.053
USI	0.006	0.004	1.515	0.151
EDU	0.011	0.007	1.636	0.123
Ln(GDP)	0.785	2.627	0.299	0.769
UNEMP	0.002	0.007	0.314	0.758
POVERTY	-0.009	0.002	-5.313	0.000
FR	0.166	0.058	2.874	0.012
C	-3.083	8.758	-0.352	0.730

Source: Authors own compilation

4.11 Cumulative Sum

Figure 3 below exhibits the output of CUSUM of recursive residuals and validates CUMULATIVE SUM plot within 5% or 0.05 significance level. So we conclude that the study must accept the H_o (null hypothesis) of stability over H_1 (alternative hypothesis) of unstable relation between models.

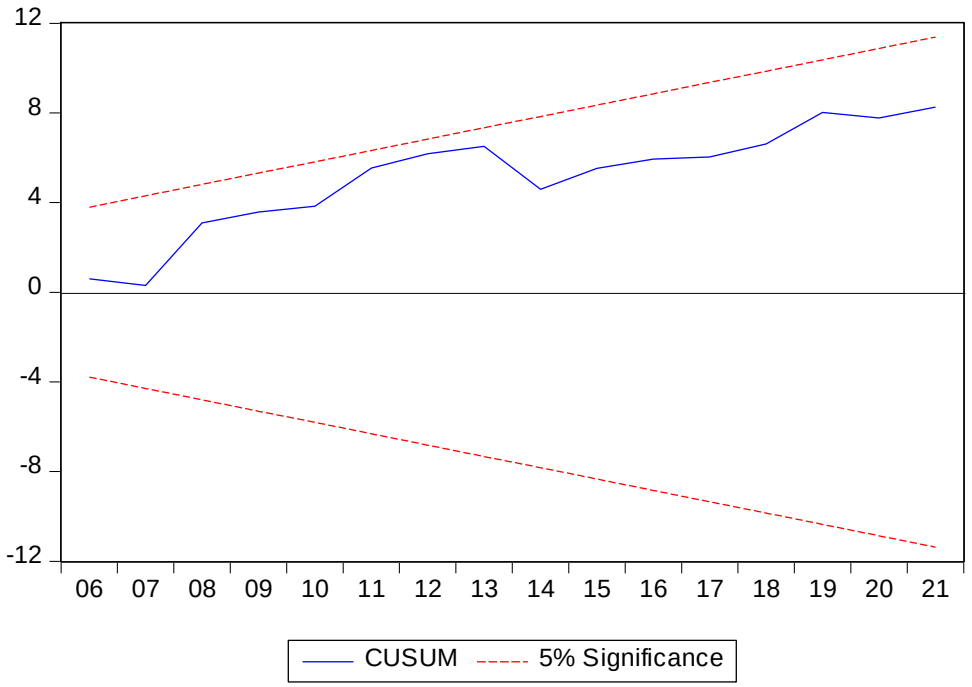

Figure 4: CUSUM test for stability

Source: Authors own compilation

CONCLUSION AND POLICY SUGGESTIONS

5.1 Conclusion

Digital economy plays a key role in improving the level of women empowerment through offering various opportunities of being financially independent (Hendriks, 2019). Researchers also show keen interest in studying the impact of digital economy on different variables like gross national product, employment generation etc. (Rani et al., 2022; Sovbetov, 2018; Cadena, 2020). In this study, we look into the possible link between the digital economy and female employment in Pakistan based on time series data for 32 years.

The stationarity of the equation 1 residual denotes the possibility of a long-term cointegrated relationship between the variables, and Augmented Dickey Fuller test recommends framing an ARDL model. The findings show that 91% of the variability in female employment is due to digital economy measures and control variables. The empirics of Autoregressive Distributed Lag model show that there is a positive association between female employment and digital economy in both long and short run. The results also direct that the increase in digital economy leads to increase in female employment significantly in Pakistan. A one-unit increase in FTS leads the female employment to grow by 0.01% in the short run and 0.37% in long run whereas a percent increase in MSS leads the female employment to grow by 0.01% in the short run and 0.004% in long run. In addition, the control variables, e.g., education, fertility rate, and GDP shows a positive association with female employment except poverty which indicate that increase female

employment leads to decline poverty in the long run. The ECM represents speed of adjustment 74 percent to equilibrium from disequilibrium.

The study is based on the analysis of time series data, thus, suggests that Pakistan needs to invest in internet infrastructure and promote e-commerce. In addition, Pakistan needs to ensure enough funds available for supporting digital innovation in public services and improving access to the internet by regulating prices. The country can ensure women empowerment by upgrading its digital infrastructure and presence. It will bring a breakthrough improvement in online commerce activities and ultimately lead to increased employment opportunities for women in the long run connecting them in mainstream workforce, who has to otherwise face lot of challenges caused by cultural and religious formalities.

5.2 Policy Suggestions

Policy to promote digital economy is necessary as this would increase female employment and decrease overall unemployment in the country. The digital infrastructure needs to be improved for flourishing the digital economy. It is capable of fostering the economy's and society's steady and healthy growth. To achieve better engagement and improve its ICT and innovation policies, the Pakistani government should include more stakeholders such as research centers, academia, private sector, civil society organizations, and citizens at large. The government should streamline its policymaking process by reducing the number of agencies with similar agendas and become more transparent and communicative by providing data, open data sources, and innovation hubs. The industry of financial services should also be modified to give individual users with access to financial services and firms and reduce the costs of ICT infrastructure to bring it comfortable with every household (Roztocki et al., 2019). To boost women's

involvement in Pakistan's digital economy, it's crucial to offer skill-building programs that go beyond what AI can teach. Focus on training that emphasizes not just technical know-how but also skills like problem-solving, creativity, adaptability, coding, digital marketing, and online communication. These skills are super important in the digital world and can give women a strong edge. By providing tailored training programs that foster these abilities alongside technical skills, we can empower women to excel in the evolving digital job market and take on more diverse roles, driving a more inclusive and dynamic economy. The government should develop digital security standards and prioritize skill-building in various sectors including education and health. To ensure priority, the development of a digital economy strategy should be seen as a country issue including this as a policy agenda and not just a government issue.

By using quantitative data and applying ARDL model, the study finds empirical evidence in support of the causal relationship between female employment and digital economy which is the prime focus of the study. Subscription towards mobile phones, broadband connections, secured internet servers situation of the country needs careful attention which can act as important development enhancers. At the same time, the study brings some policy advice for the relevant stakeholders to develop digital infrastructure and presence which will impact GDP, unemployment, education, poverty, and fertility rate. Still, the study acknowledges few limitations which offer new research opportunities. As the study applies time series analysis, it fails to address regional disparities with more classified data based on regions. If some regions are found well ahead of others, it may provide some practical insights on the necessity of digital infrastructure in regions where females cannot participate in economic activities due to lack of digital presence. Even, studies may accommodate digital divide and its development over time by distinguishing the indicators of digital economy by gender. Such study may highlight the

comparative efficiency of utilizing digital platforms by male and female. Due to lack of relevant data and objectives of this study, we limited our investigation to highlighting the causality of selected variables, and the study was successful in generating scope for future research based on the findings.

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