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The relationship between information and communication technologies and female labour force participation in Turkey[1]

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Abstract: The elimination of all forms of discrimination between the sexes is not only a fundamental human right but it also is very important to support all other areas of development, particularly sustainable development. The aim of this study is to empirically investigate the role of information and communication technologies on employment inequality in Turkey. Therefore, the relationship between ICT applications and female labour force participation is investigated with the auto regressive distributed lag (ARDL) model and impulse response analysis. The results showed that there is no association between information and communication technologies and the female labour force participation rate for the period 1988–2018. These findings may suggest that developing countries also need to have a certain level of development in other areas such as democracy, fundamental rights and freedoms and the rule of law to benefit from the opportunities that information and communication technologies offer to empower the whole society including women.

Keywords: women employment, ICTs, ARDL, impulse response function.

JEL codes: C50, E24, J16, J40.

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Introduction

According to the Food and Agriculture Organization (FAO), "Information and Communication Technologies (ICTs) is a broader term for Information Technology (IT), which refers to all communication technologies, including the Internet, wireless networks, cell phones, computers, software, middleware, videoconferencing, social networking and other media applications and services enabling users to access, retrieve, store, transmit and manipulate information in a digital form" (FAO, 2021). ICTs, by reducing the costs of production, distribution and dissemination of the information offer wide opportunities for the socio-economic development of countries. ICT applications make the life of millions of people around the world easier by providing access to educational resources, health services and other services such as mobile banking, e-government and employment (Thottoli, 2021). Therefore, it has an important place to eradication of poverty, dissemination of development and the elimination of inequalities.

Gender inequality is a longstanding problematic feature of most societies in the world. Social norms and gender-based discrimination created by socio-economic and cultural patterns cause women to stay away from the labour market. In most societies, while men are employed on a paid basis women handle traditional agricultural work, housework and childcare. This division of labour, strengthened by laws and social traditions, has often made it impossible for women to own businesses or control their income (Sachs, 2015, p. 244). Women without economic independence remain weak in every sense in their society.

ICTs give women access to various developmental opportunities, such as education, health, nutrition and political participation. Through ICT practices, such as digital literacy education, women can determine their decisions, preferences and agendas and make their voices heard at national and international levels. Besides, ICTs can raise awareness of women's empowerment, promote literacy and education, associate markets with vendors and serve as a platform for dialogue (Hussain, 2016, p. 13).

ICTs empower employees, including non-specialists or busy workers, in three ways. First, thanks to ICTs labour markets become more transparent, especially in finding jobs in local or global markets. Second, ICTs enable innovation in the labour market by introducing and supporting new forms of business. Finally, ICTs allow the inclusion of low-skilled, limited access to technology and traditionally marginalized groups such as women, disabled people and workers at the base of the pyramid (BoP) in the labour market (Raja, Imaizumi, Kelly, Narimatsu, & Paradi-Guilford, 2013, p. 22).

Turkey uses ICT tools widely. However, although women's participation in the economy has been increasing rapidly in recent years it is still very low among OECD countries. In Turkey women cannot enter the labour market due to various socio-cultural norms, housework and childcare. For this reason, it

is the main subject of this study to examine whether information and communication technologies remove these barriers between women and the labour market. There is no study empirically examining the effects of information and communication technologies on women's labour force participation in Turkey. For this reason, the role of information and communication technologies on women's employment is investigated by following previous theoretical studies. Thus, this study aims to fill this gap in the literature.

To examine the long-run relationship between women's labour force participation and ICTs the Pesaran, Shin and Smith (2001) ARDL method is used. The ARDL model offers several advantages. For example, the researcher does not have to make a strict distinction between I (0) and I (1) for the independent variables. In other words, the ARDL model can be used regardless of whether the independent variables are stationary at their levels or first differences (Jordan & Philips, 2018, p. 904). Another advantage of the model is that it gives information about both the short-run and long-run relationship between the variables. Finally, since the model uses the unconstrained error correction model, it can give statistically more robust results than the classical cointegration tests (Kızıl & Ceylan, 2018, p. 202). Another method applied in this study is the impulse response function technique based on the vector autoregressive (VAR) method timeline. Impulse response functions are used to define how today's shocks will affect variables in the future and thus make an effective policy assessment (Ankargren & Lyhagen, 2018). The data set covers the years 1988–2018. Availability of data is decisive in determining the data range. It is expected that the findings of the study will guide the implementation of the necessary policies to increase women's employment, the development of new strategies and taking the necessary measures to prevent women from withdrawing from the labour market.

According to the ARDL model results no long-term relationship is detected between women's labour force participation and ICTs. In addition, according to the results of the impulse response analysis, it is determined that ICTs increased the participation of women in the labour force in the first years then decreased in the following periods. However, these results are not statistically significant. To sum up no significant effect of ICTs on women's employment in Turkey is found in the short or long run.

In Section 1 of the study the background of women's labour force participation and ICTs are explained. The literature review is presented in Section 2. In Section 3, the data set and methodology are described, and the results are discussed in Section 4. Finally, the conclusion is given in the last Section.

1. Female labour force participation and ICTs

Gender equality is not only a basic human right. It is closely related to women's empowerment and economic development. Women's labour supply can be seen as both a causal factor and a result of the development of a country (Mroczek-Dąbrowska & Gaweł, 2020). As women's labour force participation increases economies grow faster in response to higher labour inputs. At the same time as countries develop women's capabilities typically increase while social constraints weaken and allow women to work outside the home (Verick, 2014, p. 3). In other words, while economic development provides empowerment of women, the empowerment of women will bring about changes that will have a direct impact on development in the decision-making process (Duflo, 2012, p. 1076). Female labour force participation varies according to the structure of countries and societies. According to the literature the determinants of female labour force participation in developing countries are driving factors such as underemployment of men, income and status of households. On the other hand, in developed countries attractive factors such as economic freedom, free time, producing and helping others are at the forefront (Klasen & Pieters, 2012, p. 22).

Educated women are the key to the end of poverty and all segments of society profit from investment in women (Cameron & Sachs, 2010). Therefore, empowering women and increasing their productivity have a critical role in reducing poverty. One of the most important features of technology is that it enables women to be empowered economically. Technologies such as smart machines (advanced robots, machine learning), smart devices (computers, laptops, mobile networks, smartphones) and intelligent techniques (cloud computing, data analytics) have developed greatly over the last twenty years. These developments also had significant impact on employment. Information and communication technologies have created millions of direct digital business opportunities for people involved in information technology and for advanced users who use certain software and tools as a key element of their work (OECD, 2005; World Bank, 2015). ICTs reshaped the nature of the work, the workplace and the relationships between workers and employers. It can be said that three factors are effective in increasing the role of ICT applications in working life and having an increasing effect on employment. These can be listed as more links, the digitization of the economy and the globalization of skills (Raja et al., 2013, p. 10).

ICTs have the potential to redefine traditional gender roles and support an environment of understanding and knowledge in which women's interests, ideas, and rights are taken into consideration (Kelkar & Nathan, 2002, p. 430). ICTs provide women with innovative ways to acquire new skills and update their skills. For example, it allows various types and levels of education through

distance education. Distance education has become a promising educational approach for women because of the flexibility of access and working time and the potential to reach rural women and/or women who are prevented from accessing school due to social norms (Chen, 2004, p. 10).

ICTs provide economic opportunities for women in cultures where they are expected to stay at home and are not allowed to come face-to-face or travel with men outside the immediate family. Information and communication tools such as computers, telephones and the Internet allow women to work and interact with men without even facing them (Daly, 2003, p. 5). Digital technologies enhance government capability and enable citizens to participate in public and private services. For example, giving a digital identity to citizens and providing information through the use of mobile phones to poor citizens, especially in remote areas, helps individuals make better decisions about their health, safety and the education of their children (World Bank, 2016, pp. 156–157).

The mobile phone is a relatively cheap and easy to use device among communication technologies. Therefore, it is widely used as a basic communication tool in small businesses in low-income countries. At the same time, the mobile phone allows women to easily coordinate their family and work life. On the other hand, the Internet provides people access to work from any place with varied software. The Internet creates more and more business opportunities, both directly through the ICT sector and indirectly, such as the service sector. It also reduces transactions and travel costs through applications such as mobile banking. With these changes profit margins can be expected to increase and as a result women's economic empowerment will increase (Valberg, 2017, p. 7).

Most of the above-mentioned channels do not directly affect women's labour force participation. However, it contributes to women's mobility and decision-making powers. In other words, ICTs contribute women's empowerment by reducing social constraints and thus indirectly lead to more women entering the labour market (Valberg, 2017, p. 10).

In Turkey, while the labour force participation rate of women aged fifteen and over was 34.2% in 2018, it was 72.7% for men. In addition, the female employment rate in 2018 was 31.4% and the male employment rate was 68.6% (OECD, 2019, p. 143). Women's labour force participation rate is well below the OECD average of 52.5%. When the unemployment rates of men and women aged fifteen and over are examined it is seen that while the unemployment rate of men was 9.5% in 2018, the unemployment rate of women was 13.9% (TSI, 2019).

When the employment of women in Turkey is examined over the years a decrease in the rate of employment of women in the agricultural sector is observed. This decline is more than that of men which can be considered as one of the effects of internal migration from villages to cities. Besides most of

the women working in the agricultural sector work as unpaid family workers. However, the share of women in the industry and services sector has increased gradually. On the other hand, according to occupational groups, women in managerial positions are at the bottom of female employment and women of all educational levels work for lower wages than men of the same educational level (Ozcan, 2019, p. 8). About 11 million women in Turkey, due to various reasons such as housework and childcare, stay away from the labour market. As the education level of women increases their employment rate increases. However, although the enrolment rate of women in higher education is higher than that of men, women do not achieve the same rate of transition to the labour market. While women rise to a certain position in business life they face certain obstacles, also known as 'glass ceilings', so that women's representation decreases as the career ladder increases (Ozcan, 2019, p. 9).

The Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW) was adopted by the United Nations on December 18, 1979 and become valid in September 1981. Turkey ratified the convention in 1985 (Official Gazette of Republic of Turkey, 1985). In this context the General Directorate of the Status and Problems of Women was established in 1990 but it gained an organization law in 2004 (Koray, 2011, p. 35). With Turkey obtaining the EU candidate country status in 1999 a series of gender equality policies are being integrated into national laws within the framework of the labour law and other laws within the framework of Turkey's EU harmonization process. However, as a result of the distancing of both the social structure and the political will to gender equality no gain other than general expressions and some promises could be obtained (Ayata & Takkaç, 2020, p. 206).

Technology has changed the way people work, access information and communicate with each other. New technologies provide opportunities for those who can use them but they create challenges for those who cannot. Technological innovations create inequalities between developed and developing countries, as well as between regions and genders within countries. In other words there are differences in terms of access to ICTs. This is called the digital divide. Although technology has reached rural areas in most developing countries the digital divide is still a problem and rapidly developing technologies increase inequalities. For women who face a triple gulf that can be called digital, gender, and rural, these challenges are greater (Treinen and Van der Elstraeten, 2018, p. 1).

According to the 2018 global gender equality report, which considers gender discrimination in many areas such as education, health and artificial intelligence, Turkey ranks 130th in 149 countries. Accordingly, Turkey's General Gap Index score is 0.62, where 0 means absolute inequality and 1 means absolute equality. On the other hand, Gender Gap Index score in labour force participation is 0.46, and Turkey ranks 133 among 149 countries with this score (WEF, 2018, p. 277).

When analysed on a regional basis while approximately 83% of people in Europe have access to the Internet this rate drops to 28% for the African continent. Internet access rate in developed countries is almost twice that of developing countries (ITU, 2020). In addition, globally women are 23% less likely than men to access the Internet. This division exists even in countries with high Internet penetration (Wilcox, 2021). Turkey has relatively large gender difference in Internet use rates. Considering the distribution of Internet access from any location by gender this rate is 83.3% for men and 72.1% for women in 2020 for Turkey. In Sweden in the same year 95.4% of men and 93.6% of women have access to the Internet. In Iraq 98.3% of men and only 51.2% of women have access to the Internet (ITU, 2021).

In addition to this, a significant difference between men and women in terms of access to financial activity in Turkey is outstanding. Men are 29% more likely to have a bank account than women (OECD, 2018, p. 32). Although some women have financial accounts, they are 3.5% less likely to engage in mobile banking-like financial transactions than men. Mobile money ownership in Turkey, as in Latin America and South Africa, are not equal between women and men. This does not only indicate that women are less integrated into official institutions but also the existence of an informal financial economy (OECD, 2018, p. 36).

2. Empirical literature review

The interaction between the use of ICT tools and women's empowerment takes a wide range in the literature. Most studies suggest that ICTs are associated with women's economic, social and cultural empowerment (Ambujam & Venkatalakshmi, 2009; Levis, 2011). For example, ICTs enable women to transform their knowledge into innovative products and services. ICTs also provide women entrepreneurs with access to worldwide e-commerce channels that can be operated from home in real-time for 24 hours. In other words, it increases the women's desire to participate in the labour force thanks to telecommuting and flexible working hours (Davis, 2007; Brodman & Berazneva, 2007; Goyal, 2011; Baglari, 2014). ICTs increase employability and thus help women empowerment, participation in society and economic development (Anitha & Sundharavadivel, 2012; Wamala, 2012).

However, it is often debated in the literature that women's use of existing technologies is less than men and this dramatic digital gender gap creates serious disadvantages for women (Hafkin & Huyer, 2007). Women face problems in access to ICT tools and training and the software and hardware applications developed do not address women's interests and needs. Therefore, it is claimed that new technologies are designed to meet the needs of men, not women (Arun & Arun, 2002; Best & Maier, 2007; UN-DAW & UNESCO, 2010; Kogiso et al.,

2017). On the other hand, besides the gender gap in the use of ICTs, there are also divisions in terms of contributing, creating content and leading the hardware and software design of digital technologies (Ashcraft, McLain, & Eger, 2016; O'Donnell & Sweetman, 2018). Some of the studies that empirically examined in the relationship between women's labour market participation and ICT practices are given below.

Klonner and Nolen (2010) investigated the possible effects of the expansion of the mobile network on the labour market in South Africa. Regression analysis showed that the full introduction of the mobile phone infrastructure for 1995–2000 creates an increase of 15% in employment. They found that most of this impact is due to the increase in female employment, especially those who did not have to care for too many children at home.

Hilbert (2011) investigated the correlation between gender and Internet and mobile phone use for twelve Latin American and thirteen African countries. The findings of the study conducted with the data set covering the period of 2005–2008 revealed that there is a positive correlation between being a woman and ICT usage in these countries while there is a negative correlation with employment, education and income. According to the research, women do not fully benefit from the opportunities offered by the digital world. In addition, women are also less enthusiastic about using digital channels such as e-commerce and e-government e-banking. Islam (2015) while on the other hand the study investigated the effectiveness of ICT practices in empowering women in eight South Asian countries. For this purpose, he tested panel ARDL models using data for the period between 1995 and 2013. Islam observed that ICTs have a positive impact on women's enrolment to school and employment rates.

Nikulin (2016) investigated the impact of ICTs on women's labour force participation in sixty developing countries. In his study covering the years 2000–2014 panel regression test confirmed that Internet and mobile phone use had a positive effect on female labour force participation. However, it is also observed that the increase in *per capita* income decreases the participation of women in the labour force and increases income inequality. Valberg (2017), in his study that covers 156 countries, found that digital technologies had almost no effect in low-income countries. It is also observed that the increase in the ratio of the female to male labour force participation in 1991–2014 was due to the decrease in male participation. This shows that ICTs do not serve as catalysts for women's empowerment in developing countries. According to Valberg a country needs to have a certain level of development to benefit from the opportunities that ICT offers to empower women.

In her study examining the relationship between ICT and women's participation in the economy Dettling (2017) found that high-speed Internet use at home increased the participation of married women in the US by 4.1% as a result of two-stage regression analysis. Similarly, Vazquez and Winkler (2017)

conducted a review of whether telecommunication reforms in 29 European countries are related to alternative business arrangements. Regression analysis confirmed that working from home increased both men's and women's labour force participation. Efobi, Tanankem and Asongu (2018) investigated the extent to which ICTs affect women's labour force participation in forty-eight sub-Saharan countries for the period 1990–2014. As a result of panel regression and GMM analysis they observed that advances in communication technologies increased women's economic participation. According to the analysis fixed broadband subscription still has a higher impact on women's economic participation compared to Internet and mobile phone use.

Rotondi, Kashyap, Pesando, Spinelli and Billari (2020) observed that mobile phone use eliminates gender inequality and lack of information both on a micro and global scale and facilitates people's access to healthcare services. The widespread use of communication technologies can help women become more independent in their decisions and prevent maternal and infant deaths by having knowledge about reproductive and sexual health (Rotondi et al., 2020, p. 13413). In other study, Rotondi and Billari (2021) found that families who use mobile money technologies increase the chances of their school-age children to go to school for four African countries. They found that the technology in question had a higher positive impact on more vulnerable families and especially girls. These findings reveal how vital information communication technologies are for the most important building blocks necessary for the sustainability of societies such as education, health and gender.

3. Data set and methodology

3.1. Data set

It is widely argued that ICTs have a key role in empowering women and achieving gender equality. In recent years the extent and direction of the effect of information and communication technology tools to increase women's participation in the economy have been extensively discussed in the literature. In this study the effects of ICTs on women's employment in Turkey are examined. The data set range of the study is taken as 1988–2018 because the regular data on the female labour force participation rate can be achieved in Turkey since 1988. On the other hand, mobile phone subscription statistics also coincide with these periods. The female labour force participation rate is taken as the dependent variable in the econometric model. For this purpose, active (15+ years) female labour force statistics are used. The labour force participation rate of women alone does not provide information on gender equality in labour force participation. Therefore, in order to examine

the effects of ICT applications on gender equality in the labour market a second model is created where the ratio of women to men in the labour force participation is the dependent variable. On the other hand, the ICT index is established as the main independent variable. For this purpose, fixed broadband Internet subscription per 100 people and mobile phone subscription data per 100 people are used.

Figure 1 shows the female workforce and ICT usage statistics for the period 1988–2018 in Turkey. In the graph (a) the continuous grey line with the data on the left axis shows the female labour force participation rate (FLFP) and the dashed black line with the data on the right axis shows the female to male ratio (F/M) in labour force participation. Accordingly, the participation of women in the workforce is U-shaped in the period considered. As expected, in Turkey, as in all developing countries with the transition from an agricultural society to industrial society women's participation in the labour force decreased first and then increased. 1993, 2004 and 2008 are the lowest years of the female labour force participation rate. These years also indicate the periods of both domestic and global crises. Graph (b) on the other hand shows the data related to ICT applications. The dashed black line indicates the mobile phone subscription (MCS) per 100 people while the continuous grey line indicates the broadband Internet subscription (FBS) per 100 people. The mobile phone subscription rate increased rapidly since the end of the 1990s and reached 97.3% in 2018. However broadband Internet subscriptions did not increase at the same rate. This may be related to the slowness of the expansion of the telecommunications infrastructure.

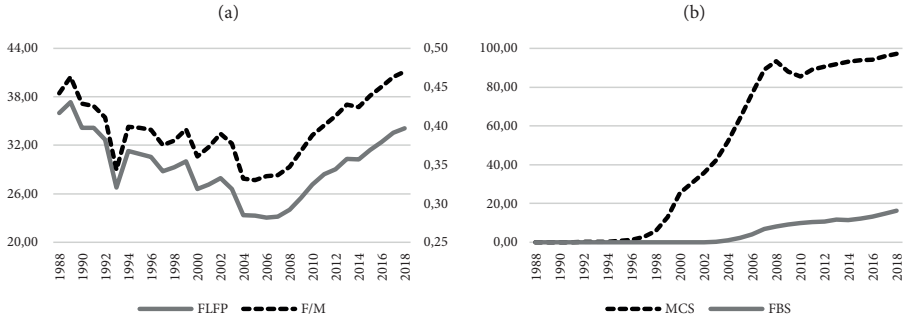

Figure 1. Female labour force and ICT statistics
Source: Authors' preparation.

Some macro variables which are thought to have effects on female labour force participation are added to the model as control variables. *Per capita* income is the first one of these variables. If there is a relationship between income and women's participation in the economy, it is expected to be positive. This is because an increase in the income of individuals can create opportunities for women to develop themselves and become more aware and therefore

to change in social norms and institutional structures. However, according to Hotz and Miller (1988), high household income reduces women's need to work. Migration from villages to cities is another factor affecting women's labour force participation in developing countries. Because the industrial sector may not be able to create additional employment for the excess labour supply shifting from the agricultural sector.

Another control variable used in the model is the trade openness ratio. Valberg (2017) stated that the increase in international trade creates new job opportunities for a country and increases the participation of women in the labour force. Therefore, if there is a relationship between trade and women's labour force participation, it is expected to be positive. However, Turkey is highly dependent on imports of intermediate goods and energy. On the other hand, Turkey's share of high-tech exports in total exports was only 2.3% in 2018. Similarly exports of ICTs in total exports of goods was 1.2% in 2017. These data provide clues about the possible extent of the impact of trade openness ratio on women's participation in the economy.

The unemployment rate is the final control variable used in the model. The effect of unemployment on women's participation in the labour force is uncertain. The reason for this uncertainty can be grouped under two effects. These effects are 'discouraged-worker effect' and 'added-worker effect'. If the unemployment rate increases the chances of women finding a job decrease. High unemployment rates increase the economic and psychological costs associated with a job search. In this case women stop looking for a job. This is called the discouraged worker effect which means that local unemployment has a negative impact on female labour force participation. The added-worker effect is defined as spouses entering the workforce to compensate for the loss of family income when unemployment increases, and men lose their jobs. In other words, according to the added-worker effect, unemployment contributes positively to female labour force participation (Tansel, 2002, p. 18).

There are many factors affecting the participation of women in the labour force such as fertility rate, education level and marital status. However, in this study it is investigated whether macro variables, which are thought to be effective on both the economy of a country and the socio-economic life of women have an impact on women's labour force participation. The logarithm of all variables used for econometric analyses, except ICT, is taken. Because of the degree of integration, the ICT variable is included in the model by taking % change. Descriptions and data sources of the variables are given in Table 1.

Considering the effects of information communication technologies, the hypotheses for this study are established as follows.

$\mathbf{H_0}$: ICTs do not affect women's labour force participation in Turkey.

$\mathbf{H_1}$: ICTs increase the labour force participation rate of women in Turkey.

Table 1. Description of variables

Variable	Code of variable	Description of variable	Database	In the model
Female labour force participation	FLFP	labour force participation rate, female (% of female population ages 15+)	International Labour Organization (ILOSTAT)	dependent variable
Ratio Female to male participation	F/M	ratio of female to male labour force participation rate (%)	World Bank National Accounts	dependent variable
Information and communication Technologies	ICT	mobile cellular subscriptions and fixed broadband subscriptions (per 100 people)	World Bank National Accounts	independent variable
Per capita income	GDP	GDP *per capita* (constant 2010 US$)	World Bank National Accounts	control variable
Trade openness	TO	the sum of exports and imports of goods and services % of GDP	World Bank National Accounts	control variable
Unemployment rate	U	total unemployment (% of total labour force 15+)	International Labour Organization (ILOSTAT)	control variable

Source: Authors' preparation.

3.2. Methodology

In this section the econometric methodology used for the analyses is presented and discussed. First the ARDL model is introduced which was employed to investigate the long-run relationship amongst the variables. Then information about the panel VAR, impulse-response and variance decomposition approaches is given.

3.2.1. Auto-Regressive Distributed Lag (ARDL) model

In order to determine the long-term relationship between information and communication technologies and women's labour force participation rate in Turkey for the years 1988–2018 the Pesaran and others (2001) bound test approach is used. The ARDL approach is more flexible than the conventional cointegration tests when the degree of integration of the variables to be used in the model is taken into account. In addition, the ARDL yields robust results in small samples and long-term and short-term coefficients can also be estimated simultaneously in the model with this approach. This ensures the

elimination of problems related to neglected variables and autocorrelation (Narayan, 2004, p. 197).

There are three stages in the ARDL model. In the first step an unrestricted error correction model is created to determine whether there is a long-term association among the variables. In the next phase, if the variables are cointegrated, long term coefficients are estimated and finally short-term coefficients and error correction coefficients are obtained. The ARDL model for the current study is as below:

$$\Delta FLFP_t = \beta_0 + \beta_1 FLFP_{t-1} + \beta_2 ICT_{t-1} + \beta_3 X_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta FLFP_{t-i} + \\ + \sum_{i=0}^{n} \lambda_i \Delta ICT_{t-i} + \sum_{i=0}^{p} \delta_i \Delta X_{t-i} + \varepsilon_t \qquad (1)$$

where the parameters β, α, λ, and δ represent coefficients, m, n, and p are optimum lag lengths, ε_t and Δ denote error term and difference operator respectively. X is a vector of n variables controlling for the logarithm of GDP *per capita*, logarithm of trade openness and logarithm of the unemployment rate. The *F*-test is used to investigate the cointegration relationship between variables. If the calculated *F*-statistic is lower than Pesaran and others (2001) table critical value the null hypothesis which suggests that there is no cointegration between the series cannot be rejected. If the *F*-statistic is within the lower and upper critical values of Pesaran and others' (2001) no information can be given about the long-term relationship. If the *F*-statistic exceeds the upper critical limit, then it is decided that the series are cointegrated. For the long-term relationship among the variables the ARDL (m, n, p) model is established as in Equation (2):

$$FLFP_t = \beta_0 + \sum_{i=1}^{m} \alpha_i FLFP_{t-i} + \sum_{i=0}^{n} \lambda_i ICT_{t-i} + \sum_{i=0}^{p} \delta_i X_{t-i} + u_t \qquad (2)$$

After estimating long term coefficients, the error correction model that is shown in Equation (3) is established and short-term variable coefficients are obtained.

$$\Delta FLFP_t = \beta_0 + \beta_1 ECT_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta FLFP_{t-i} + \sum_{i=0}^{n} \lambda_i \Delta ICT_{t-i} + \sum_{i=0}^{p} \delta_i \Delta X_{t-i} + v_t \qquad (3)$$

where $\mathrm{ECT}_{(t-1)}$ is the error correction term. The β_1 coefficient of the variable $\mathrm{ECT}_{(t-1)}$ shows how much of the short-term imbalance will improve in the long term and this coefficient is expected to be between –1 and 0.

3.2.2. Vector Autoregression (VAR) model

It is not known exactly which of the variables is internal in econometric models. In an equation system where each variable is dependent on other variables the structural shape of the econometric model cannot be defined correctly. Therefore, additional information is needed to define the structural form of the model. In the VAR model developed by Sims (1980) as an alternative to conventional simultaneous system equations, it is assumed that all variables are internal, starting from the autoregressive representation of the weak stationarity process. In a VAR model with p lags (VAR (p)), each variable depends on both its values up to p lags and other variables up to p lags (Kirchgassner & Wolters, 2007, p. 126).

The p'order VAR (p) model for this study can be written as follows:

$$FLFP_t = \alpha_{1t} + \sum_{i=1}^{p} \beta_{1i} FLFP_{t-i} + \sum_{i=1}^{p} \beta_{2i} ICT_{t-i} + \sum_{i=1}^{p} \beta_{3i} X_{t-i} + \varepsilon_{1t} \quad (4)$$

$$ICT_t = \alpha_{2t} + \sum_{i=1}^{p} \gamma_{1i} FLFP_{t-i} + \sum_{i=1}^{p} \gamma_{2i} ICT_{t-i} + \sum_{i=1}^{p} \gamma_{3i} X_{t-i} + \varepsilon_{2t} \quad (5)$$

$$X_t = \alpha_{3t} + \sum_{i=1}^{p} \delta_{1i} FLFP_{t-i} + \sum_{i=1}^{p} \delta_{2i} ICT_{t-i} + \sum_{i=1}^{p} \delta_{3i} X_{t-i} + \varepsilon_{3t} \quad (6)$$

In the above models p is the lag length and ε is the error term. The impulse response functions and variance decomposition method based on the VAR model are used to determine the dynamic interaction between the relevant variables. The impulse response functions show in which direction and to what extent any variable reacts to one unit of shock in error terms of one of the variables in the VAR model. Sims (1980) proposes the Cholesky decomposition to obtain the impulse response functions. In addition, variance decomposition is an analysis showing how much the variables in the VAR model determine each other. More specifically the variance decomposition analysis shows the ratio of the movements of one variable from its shocks to the shocks of other variables. If the error variance of the first variable to the error variance of the second variable is zero in all periods it is concluded that the second variable is an external variable (Sevüktekin & Çınar, 2017, p. 515).

4. Findings

Before proceeding to the ARDL model it is important to know the stationarity degrees of the series in order to avoid a possible spurious relationship in investigating the existence of a long-term relationship between variables. In the ARDL model the degrees of stationarity of the variables in the model can be I(0) and I(1) but not I(2). In order to avoid possible spurious regression between

the variables the degree of stationarity of the related variables is examined in the study. ADF and PP unit root tests are used for this purpose. It is observed that all variables except ICT contain unit root at the level but they are stationary at the first difference. On the other hand, the ICT variable is found to be stationary in the second difference therefore % change of the variable is included in the analysis. As a result the degree of integration of all variables is I(1)[5].

Table 2 shows the correlation relationship between FLFP, F/M, ICT, GDP, TO and U. It is seen that there is a weak positive relationship between information and communication technologies applications and the female labour force participation rate. However, this correlation is not statistically significant. In other words, information and communication technologies have no effect on female labour force participation for the years 1988–2018. In addition, ICTs are ineffective also in achieving equality between women and men in labour force participation. These results reflect the overall impact of ICTs. The lack of gender-disaggregated data on the use of ICT and clear information on the purpose of people's use of mobile phones and the Internet hinders clear interpretation.

Table 2. Correlation analysis

Variables	FLFP	F/M	ICT	GDP	TO
ICT	0.27	–0.02	1		
GDP	–0.15	0.19	–0.68***	1	
TO	–0.34*	–0.06	–0.44**	0.74***	1
U	–0.22	0.02	–0.75***	0.54***	0.31*

Note: *, ** and *** indicate rejected null hypothesis at 10%, 5% and 1% respectively.

Source: Authors' preparation.

Since the degree of integration of all variables used for econometric analysis is I(1) the cointegration test is applied for a possible long-term relationship between the series. Johansen's (1988, 1991) cointegration test can be applied if there is more than one variable and all variables are stationary at the same degree of integration. However, considering the number of independent variables and the number of observations it is appropriate to use the ARDL boundary test approach of Pesaran and others (2001), which provides more effective results in small samples than Johansen's (1988, 1991) test. The results of the appropriate ARDL model in which the labour force participation rate of women and the ratio of women to men are determined as dependent variables are shown in Table 3. As reported in the table there is no long-term relationship

[5] ADF and PP unit root test results are not reported in the study. However, results are available upon request.

Table 3. Bound Test and diagnostics tests

Dependent variable	Model	Bound Test (*F*-statistic)	Breusch--Godfrey Serial Correlation LM Test	ARCH LM Test	Jarque-Bera Normality Test
FLFP	ARDL (1,0,1,0,0)	1.65	0.803 (0.67)	0.678 (0.41)	0.917 (0.63)
F/M	ARDL (1,0,1,0,0)	1.46	2.152 (0.34)	0.129 (0.72)	1.341 (0.51)

Note: Values in parentheses for diagnostic statistics are probability values. The critical values for *F* test is provided from C1.İİİ in Pesaran and others (2001). For 5% table critical values I(0) is 2.86 and I(1) is 4.01.

Source: Authors' preparation.

between related variables. One of the prerequisites of the ARDL model is that the model does not contain a serial correlation. For this reason, it was examined whether the appropriate ARDL models contain serial correlation and it was found that there are no autocorrelation problems in error terms according to the Breusch-Godfrey LM test in both models. Furthermore, the ARCH LM test shows that there is no heteroscedasticity while the Jarque-Bera normality test shows that the error terms are normally distributed.

In Turkey, for the data set covering the years 1988–2018 any long-term relationship between information and communication technologies and female participation in the labour force is not detected. To examine whether information and communication technologies are effective in the male labour force participation in the same years the model is re-estimated by taking the male labour force participation as the dependent variable. However, the results obtained but not presented are identical in the above models. As a result, it is revealed that information and communication technologies have no effect on employment in Turkey.

It is determined by using appropriate ARDL models that there is no long-term relationship between the variables used in the study. Therefore, whether information and communication technologies, *per capita* income, trade openness and unemployment rates affect female labour force participation and gender equality in the labour force in the short term have been examined. For this purpose, the impulse response and variance decomposition methods obtained from the VAR model are used. The lag length of the VAR model is taken 1 according to the Schwarz information criterion. LM autocorrelation, White heteroscedasticity and Jarque-Bera normality tests are performed in order to determine whether the obtained VAR (*p*) models contained a structural problem. Results show that there are no autocorrelation and heteroscedasticity problems

in VAR models. However, in the VAR model where F/M is the dependent variable it is observed that the errors are not normally distributed.

The variance decomposition analysis, which is one of the VAR method analyses, shows what percentage of the change in the variables is determined by the variable itself and other variable / variables. In the study variance decomposition analysis is estimated over five periods. When the female labour force participation rate is the dependent variable. 100% of the change in the female labour force participation rate is explained by the variable itself in the first period. At the end of the fifth period, it is seen that this ratio fell to 96%. While ICT did not have an impact in the first period it is seen that it explained 2% of the impact at the end of the fifth period. The impact of *per capita* income, trade and unemployment are almost zero for all five periods. Similarly, women's labour force participation accounts for only 3% of the change in information and communication technologies at the end of the fifth period. In addition, while *per capita* income is ineffective on changes in female labour force participation, female labour force participation rate accounts for 23% of changes in income in the first period. In the fifth period, on the other hand, this rate increases to 35%. The portion of the change in the variance of unemployment rate explained by information and communication technologies increased from 5% in the first period to 22% from the second period. Variance decomposition analysis results, where the ratio of the female labour force to the male labour force is the dependent variable are very similar to the variance decomposition results.[6]

Another test within the VAR method is impulse response analysis. This analysis shows in which direction and to what extent each of the variables in the VAR model reacts to the shocks occurring in error terms. In other words, these functions represent the response of the variable itself or other variable(s) to a unit of a shock given to one of the variables. In this respect this analysis is useful in understanding the course of the responses of the variables to different shocks (Kofoğlu, Kucukkale, & Yamak, 2017, p. 890). In the impulse response function graphs the horizontal axis shows the time interval while the vertical axis shows the response of a standard error shock dependent variable. The continuous lines in the graphs show the response of the dependent variable to one unit of shock in the error terms of the model while the dashed lines indicate the confidence intervals.

Figure 2 shows the response of women's participation in the labour force (FLFP) to the shock of the relevant independent variables. As seen the response to shocks in information and communication technologies comes to equilibrium at the end of five periods. The response of the female labour force ratio to a shock in information and communication technologies is positive in the

[6] Variance decomposition analysis results are not reported due to space constraints but are available upon request.

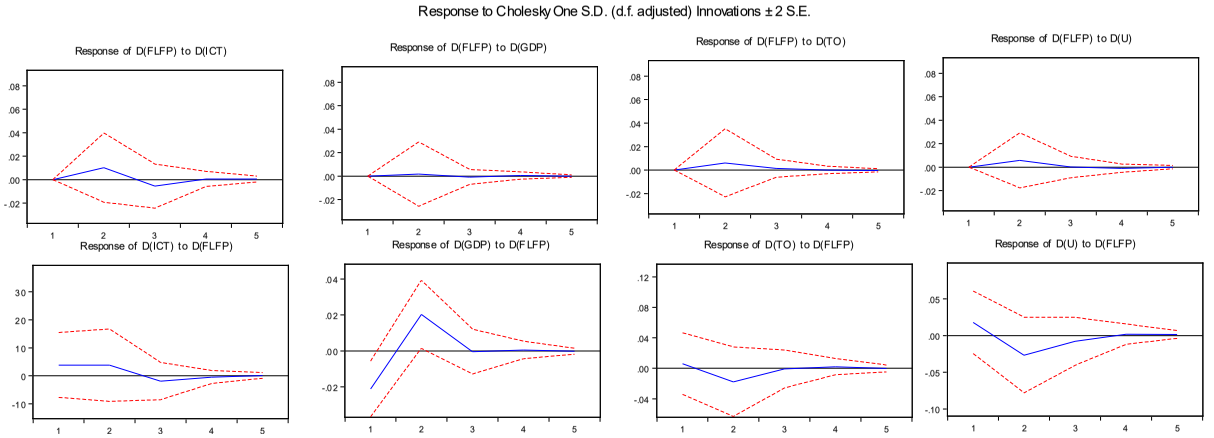

Figure 2. Impulse response functions (FLFP)

Source: Authors' preparation.

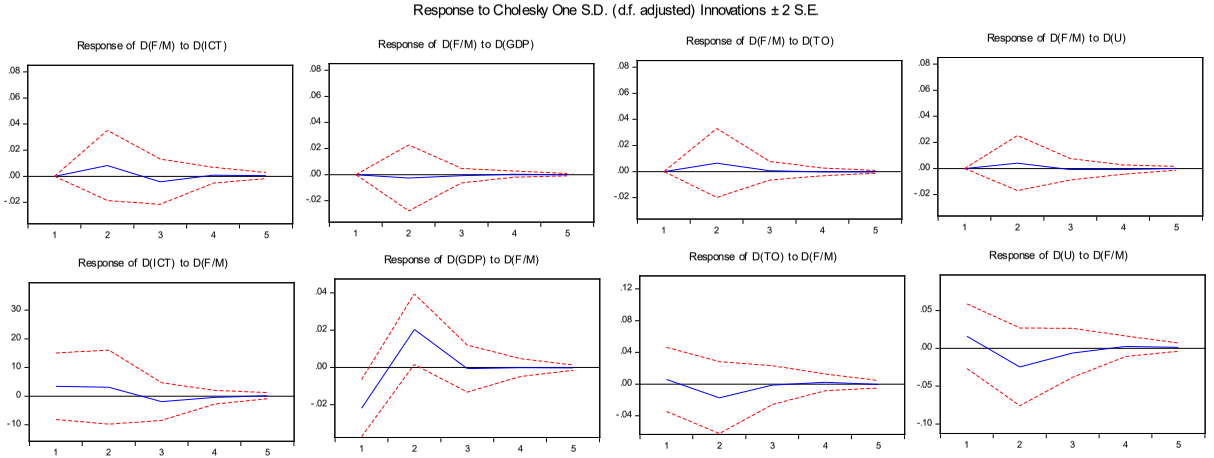

Figure 3. Impulse response functions (F/M)

Source: Authors' preparation.

first two periods. The response decreases after peaking in the second period. The negative response in the third period comes to equilibrium in the fourth period. However, the response of information and communication technologies to shocks in the female labour force is positive and stable for the first two periods. Then it decreases and becomes negative in the third period. The response of FLFP to income shocks, which is one of the explanatory variables, is almost zero whereas the response of revenue to FLFP is more visible. After the negative reaction in the first period, it turns to positive and reaches a balance in the third period. Finally, while the response of women's labour force participation rate to one-unit shocks in trade openness and the unemployment rate is positive the responses of unemployment and trade variables are negative to women's labour force participation rate. However, these results are not statistically significant. Figure 3, on the other hand, shows the response results of F/M to explanatory variables.

These results shown in Figure 3 are very similar to those of Figure 2. Therefore, the results do not change much by taking women's labour force participation rate or F/M as the dependent variable.

Conclusions

One of the most important factors to ensure sustainability is that women and men have equal rights and duties in all areas. Women are always forced to be in the background because of socio-economic, socio-demographic and socio-cultural reasons. Lagging women behind economic life causes the whole society to fall behind. Because women's empowerment ensures the economic development of countries and has a multiplier effect in all other areas such as democracy and the rule of law. Thus, many developing countries in the world are carrying out serious efforts to empower women. Information and communication technologies play a central role in these efforts.

In this study it is investigated whether there is a relationship between female labour force participation and information and communication technologies in Turkey. According to the results of the ARDL model, there is no correlation between the variables in the long term. In addition, according to the variance decomposition model, the variables are not explanatory of each other. In the literature there is no time series specific study investigating this issue for Turkey. However, the results of this study do not coincide with the panel data studies of Nikulin (2016) and Valberg (2017) where they also included Turkey. The findings also contradict the results of Dettling's (2017) study in the United States. As a matter of fact, Dettling (2017) found that high-speed Internet use at home increased the participation of married women in the workforce by 4.1%.

There are several possible reasons why ICTs are higher in developed countries than in developing countries. For instance, information and communica-

tion technologies have already developed in these countries as a result of the economic process. So, this is an internal variable. On the other hand, the spread of ICTs in developing countries can be considered as an external effect. In addition, deficiencies in infrastructure investments are another factor to consider.

As a developing country Turkey has a women's labour force participation rate at the bottom of the list for OECD countries. According to official data, the unemployment rate for 15+ age in July 2019 was 13.9%. The youth unemployment rate was 27.1% in the same period. In other words, one in four young person is unemployed. In addition, 33.2% of those in the 20–34 age range were neither in education nor employment in 2018. This rate was 51.5% for young women. On the other hand, the Gini index was 0.408 in Turkey in 2018 and the difference between the highest income group with the lowest income group is 8.8 which indicates that income distribution in Turkey is corrupt. When all this information is taken into consideration it can be said that the Turkish economy has failed to create employment not only for women but also for all citizens.

According to the data of TSI in Turkey, 92% of the population lives in cities as of 2018. This urbanization rate is increasing each year which also means a decrease in agricultural production and the country's inability to provide food for itself. Farmers should be supported by incentives in the right area so that they do not leave their land. For example, it would be an important step to provide the necessary infrastructure for the use of information and communication technologies in every field including agriculture. Thus, farmers can be aware of many issues such as seasonal agricultural risks through the Internet and mobile applications. The farmer who passes the process from production to sales away from uncertainties will not leave his land, will continue production and be more productive.

Although women's economic, sociological and political participation has increased in recent years it is still behind the developed countries. One of the reasons for this situation is the vicious circle created by strict social norms. In Turkey it is possible to come across frequently the effects of a patriarchal society. As a result of this patriarchal social structure and applications women are unemployed. In this case all the resources used during the education life of the woman are wasted. In Turkey it is considered normal for women not to be involved in the labour force and to deal with household chores, even if they are educated. These social norms also put pressure on men. Thus, men are forced to take responsibility for the lives of the whole family. Both cases lead to an inefficient workforce. In addition, high unemployment rates may also prevent women from participating in the labour force within the framework of patriarchal life. Accordingly, men are considered as the priority in employment.

On the other hand, in the information and communication industry, unlike other industries, there is no segregated job description for men or women. What needs to be answered is whether the policies implemented meet the re-

quirements of a dynamic information age. Do the ever-increasing enrolment rates, especially in women, bring quality? To what extent does the support given to women entrepreneurs help against their competitors in the international markets? When mobile phone use reaches 97%, are mobile phones or smartphones a means rather than an end? How conscious are people about what they can do through these technological tools? Correct answers to these and similar questions will help both women and the whole society to progress in socio-economic terms.

Turkey is among the countries that use information and communication technologies extensively. Due to the insufficient production of these technologies most of them are imported products. Within the framework of the structural transformation policies to be implemented in this field priority should be given to the training of qualified labour force by enhancing industrial cooperation with educational institutions. Increasing the R&D incentives in the sectors producing high-tech products will not only eliminate the import dependency but will also enable the creation of new business areas by increasing the export of these high-tech products. The presence of qualified human capital and the high-tech sector will help to shift foreign investments to this area. To summarize, the widespread use of information and communication technologies in Turkey will create opportunities by raising awareness of women's participation in the labour force. This is the key to a sustainable future. In other words, it is important to increase the awareness that women's participation in the workforce is not only a way to creating additional income for themselves but also a necessity for sustainable development.

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