The Effect of Automation (ICT) on Job Polarisation: Evidence from Turkey Manufacturing Firms

[1]Lamia Guseinova, [2]Xie Sisheng

College of Economic and Management
Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China

Abstract - **Turkey is a developing economy, and the increasing application of information technologies such as automation has impacted changes in employment structures. This paper proposes the hypothesis that the application of information technology has impacted job polarization significantly. Utilizing official data from the Turkish Statistical Department for the years 2011-2021 and employing methods such as principal component analysis and multiple regression analysis for analysis in real-time, the study concludes: (1) Information technology applications can lead to job polarization, whereby the employment share of high-skill and low-skill jobs increases, while the employment share of middle-skill jobs decreases.(2) The impact of information technology application on job polarization exhibits regional heterogeneity; Not all regions exhibit the same polarization trend as the national level, and some areas have not yet shown clear signs of polarization. (3) The application of information technology impacts the structure of employment in industries; specifically, the extensive adoption of information technology results in reduced employment opportunities for medium-skill industries, while having a positive impact on employment for high-skill industries and low-skill service industries.**

Based on the above research results, we suggest that the government should strengthen public policy support for the development of information technology and improve relevant infrastructure. Businesses should establish more comprehensive training systems, clarify career development pathways, encourage flexible working, create an inclusive corporate culture, and promote knowledge sharing and collaboration among employees. Workers need to pay attention to the trend of digital transformation, actively improve their skills, and enhance employability and competitiveness.

Keywords: **Automation (ICT), Job Polarization, Multivariate Regression Analysis, Employment Structure.**

I. INTRODUCTION

The widespread incorporation of Information Communication Technology (ICT) and Intelligent Technology (IT) is fundamentally transforming labor markets on a global scale. The profound influence of this disruptive force extends to the job environment, effecting people across all skill levels and sectors. The aim of this research is to examine the relationship between information and communication technology (ICT) and job polarization within the specific context of Turkey. By doing so, this study aims to provide valuable insights and advancements to the current body of scholarly work in this field. The labor markets worldwide have been significantly transformed by the advent of Information and Communication Technology (ICT), and Turkey is not an exception to this trend. As countries navigate the profound impacts of automation, they undergo changes in the dynamics of their labor force, industrial frameworks, and economic competitiveness. The purpose of this research is for analyzing the various effects of ICT indicators in the Turkish environment. The study encompasses all 81 provinces in Turkey and analyzes the period from 2011 to 2021. The aim is to provide insights into the influence of these technologies on the country's labor. The two studies, while distinct in their research scopes, share a common thread-the profound influence of technology on labor markets. The first study delves into the implications of ICT and IT on job polarization in Turkey, with a particular focus on workers' skill levels. It underscores the need to understand how technological advances both can create and displace jobs, potentially leading to skill-based disparities in the labor force [1],[2].

The second research expands the scope by analyzing the overall effects of ICT indicators on Turkey's provinces and Industries over a period of ten years. This study shows the complex correlation between the adoption of technology and job dynamics within a nation characterized by regional differences. The study improves our understanding of how Turkey's labor environment is changing through an analysis of industry-and region-specific structures, with a special focus on information and communication technology (ICT). These studies provide insight into the intricate relationship between technology and employment within the Turkish setting. These sources offer significant perspectives on the way countries and regions respond to the many difficulties and possibilities arising from the increasing prevalence of automation and information and communication technology (ICT). Understanding this information is of most importance for governments, corporations, and communities that are endeavoring to use the advantages of technology while reducing its potential effects on worker dynamics and regional inequalities [3].

II. THEORY AND HYPOTHESES

A. Theory

In the context of the theory of skill-biased technological progress, there has been extensive documentation and discussion of the idea of skill-biased technological change (SBTC) in the literature. According to the theory of routine-biased technological change (RBTC), workers with routine task skills have fewer job possibilities because of automation, while workers with non-routine task capacities have more options. Although there is a lot of evidence supporting RBTC overall, less is known about how it effects individual employees. M. Goos, [4] created the routinization hypothesis to expand on this approach. They contended that employment polarization, especially a decreasing middle class in labor markets, can be caused to technology's ability to supply labor more easily for -routine jobs. This implies that technology augments the jobs of highly skilled individuals while replacing middle-skilled jobs, which are frequently routine-based [5],[6] routinization hypothesis clearly defines the theory of skill-biased technological development. This concept divides tasks into three categories: non-routine abstract, routine cognitive and physical, and non-routine physical, with each demanding an additional level of skill. Non-routine intellectual jobs require creativity and complicated thinking, which corresponds to high-skilled labor. The use of computer technology significantly enhances these activities, which frequently involve problem-solving and interaction responsibilities. As a result of the high level of creative and mental effort necessary in their work, experts, professors, and managers who do such responsibilities are less likely to be replaced by computers. Routine cognitive and physical jobs are the most suitable to automation due to their dedication to set standards and processes. The widespread adoption of computer technology in different industries has resulted in improved manufacturing productivity, but also in the loss of workers in tasks with specified and limited scope, such as administration, secretarial labor, and library services [7], [8]. Non-routine physical work that needs flexibility, adaptability, and often social abilities, especially those performed by security guards, waiters, and cleaners, are untouched by computer technology. The human factor inherent in these occupations, as well as their necessary physical presence, protects them from automation. In general, the introduction of computer technology decreased demand for intermediate-skilled labor, especially for regular task-based occupations, while increasing demand for both low-and high-skilled labor [9]. This polarization of employment need corresponds with the routinization theory, as it reflects the varied effects of technology throughout the labor skill range [10]. Several studies focused on the effects of technology advances on different categories of job skills confirmed the theory of labor market polarization as examined through the routinization hypothesis. Acemoglu and others have been significant in this subject, analyzing tasks and skill matching and proposing a classification of employment activities based on high and low skill levels. They claim that as technology improves, it raises the productivity of highly trained labor, which effects demand for mid-level skilled labor, especially in developed countries including Turkey, where a significant percentage of occupations may be effected by automation [11].

B. Hypothesis

In scientific study, a hypothesis is a prediction that suggests a possible explanation or result based on early information. It functions as a testable hypothesis by implying a connection between two or more variables and outlining potential outcomes under circumstances. An important feature of a hypothesis is its testability, which is the ability to verify or disprove it using empirical techniques like observations, experiments, and data analysis.

A hypothesis directs the process of research design by specifying the kinds of data that need to be gathered and the methods by which they should be examined. It gives the study a distinct focus and aids in creating a rational framework for the research technique. Also, a hypothesis is inherently falsifiable, which means that there should be a way to refute it. This feature is necessary for the hypothesis to be accepted as scientific since it permits the hypothesis to be disproved in the face of contradicting data, supporting the iterative process of scientific research and the growth of knowledge.

Based on the presented economic data and the effect of Information and Communication Technology (ICT), The following hypothesis has been proposed:

H1: It is predicted that the widespread adoption of ICT across several industries would cause a polarization of the labor market, with potential growth in high-skilled and low-skilled positions and decrease in middle-skilled jobs.

H2: ICT's impact on employment will probably show geographical shifts, with some regions facing more significant changes in the composition of the workforce because of differences in ICT adoption, facilities, and financial situations.

H3: It is expected that the effects of ICT on employment would highlight industry-specific heterogeneity, with some industries facing greater modifications in the number of jobs because of the different adoption of and incorporation of ICT capabilities.

III. DATA AND METHODOLOGY

A. Data sources

The empirical data that was obtained from the Turkish Statistical Institute [10] over a ten-year period, from 2011 to 2021. This dataset gave the study a thorough and nationally representative sample by containing extensive data from all 81 at the provincial level of Turkey's administrative statistics regional unit level 1 (Nomenclature of Territorial Units for Statistics-NUTS-1:12 Regions). Principal component analysis was used in the study to examine how Information and Communication Technology (ICT) effects different workplace outcomes (PCA). And ICT index was created using this advanced statistical method, and it was a crucial measurement indication for the investigation. PCA-derived ICT index played a crucial role in measuring the amount of ICT usage

over time and in various locations. It offered a consistent measure that could be applied to research any connections between ICT use, work environment, stress at work, and worker distress in the Turkish labor market. Using this index, the study sought to identify trends and make inferences on the impact of ICT on worker well-being and the development of work settings during the studied time.

B. Variable Measurement

The choice of independent, dependent, and control variables is important to the research design and makes to establish a cause and effect link while controlling for variability

Dependent Variables: The study's intended explanation or prediction of the outcome of interest is represented by the dependent variables. The dependent variables in this paper are the percentages of working people broken down by level of education. Because the study intends to comprehend how employment rates fluctuate with educational degrees in the setting of ICT growth, these variables are the main emphasis. This study examines the distribution of employment shares across educational levels within regional labor markets, replacing the traditional skilled labor employment proportion with actual counts of employed individuals with different qualifications for education. In this research, the classification of vocational skill levels is based on the education level of the labor force. High-skilled workers are those who 15 years and over: % higher education. High-skilled workers have a high school diploma or a junior college diploma. Intermediate skilled worker educational status 15 years old and over: % high and vocational high school. This displays the proportion of working people who have either completed a high school education or vocational training that is on par with a high school education. Those with 15 years old and over: % Illiterate or less than high school as low skilled labor

Independent Variables are the factors or causes that are thought to have an impact on the dependent variable. The different measures of ICT utilisation in the context of your study, including internet access, broadband access, mobile broadband access, and electricity consumption, are the independent variables. The study looks at the potential effects of these various ICT usage factors on employment rates in various educational levels.

(1) Proportion of households accessing the internet: The percentage of homes with internet access within a specific population is shown by this statistic. This covers all forms of internet connections, including mobile networks (3G and 4G), broadband (DSL, cable, or fiber-optic), and other internet service providers.

(2) Proportion of households accessing the broadband access: households surveyed: The percentage of households with broadband internet access among those polled is seen in this data. Broadband access encompasses a range of high-speed internet services, including satellite, DSL, cable, fiber-optic, and fixed wireless, and is characterized by a minimum internet connection speed.

(3) Proportion of households accessing with fixed broadband access (ADSL, Cable, Optic fiber, etc.): households surveyed: This statistic shows the proportion of homes that, according to a study, said they had access to fixed broadband connections via cable, optical fiber, Asymmetric Digital Subscriber Line (ADSL), and other technologies. The metric is a crucial gauge of the infrastructure's ability to provide homes with high-speed internet access and the degree to which the populace uses these services.

(4) Proportion of households accessing with Mobile broadband access (3G,4.5G via Mobile Phone or Modem) households surveyed: This statistic shows the proportion of households in a surveyed population that have access to mobile broadband internet services via mobile phones or modems, including third-generation (3G) and fourth-generation (4.5G) technology.

(5) Proportion of households with Electricity Consumptions by Users-Total Consumptions (MWh): Obtain information from utility companies: This figure shows the proportion of households that have access to electricity as well as the overall amount of energy used, expressed in megawatt hours (MWh).

(6) Information Exports by Economic Activities (ISIC, Rev.4) (1000USD) This value reflects the total revenue generated from exporting goods and services classified under the 'Information and Communication' sector of the International Standard Industrial Classification of All Economic Activities (ISIC), Revision 4.

(7) Imports by Economic Activities (ISIC, Rev.4) (1000USD) Information and Communication: As per the International Standard Industrial Classification of All Economic Activities (ISIC), Revision 4, this figure represents the total monetary value of all goods and services imported into a country that are classified under the 'Information and Communication' sector. Since the total is expressed in thousands of US dollars, handling and interpreting the large amounts frequently found in data on international trade and the economy is made simpler.

(8) Sectorial Share of Gross Domestic Product (2009 Base)-Information and Communication

Governmental statistics offices: This measure, which uses a constant price base of 2009 to account for inflation, shows what percentage of a nation's overall GDP is attributable to the "Information and Communication" industry. By accounting for the effects of inflation, the use of a 2009 base ensures that the rise or reduction in the sector's contribution is assessed in real terms and facilitates comparability across time.

(9) Number of Enterprises According to Business Registers Information and Communication

Business registers and databases: This value is the total number of companies in the "Information and Communication" industry that are listed in official databases and company registrations. Business registers are extensive databases that incorporate

information about the traits and operations of businesses, and they are kept up to date by relevant government authorities or institutions. They are an important resource for comprehending the composition and structure of the economy.

Principal Component Analysis (PCA), a statistical method, is utilized to merge nine specific indicators into a single composite variable. This variable effectively represents the application of Information and Communication Technology (ICT). The descriptive statistics for these ICT measurement indicators are detailed in *Table B.1 Descriptive Statistical of Measurement Indicators of ICT on Job*

Table B.1 Descriptive Statistical of Measurement Indicators of ICT on Job

Indicators	Count	mean	min	max	std_error
I1	132	68.40	21.15	97.06	1.723
I2	132	65.82	19.97	97.06	1.83
I3	132	37.2	12.077	78.96	1.237
I4	132	54.36	1.105	94.79	2.61
I5	132	19309.7	2034.7	44909.2	1154.2
I6	132	9005.26	3	91444	1815.2
I7	132	21344.71	1	332307	5529.6
I8	132	1.364	0.4	5.9	0.127
I9	132	3645	414	27883	442

Control Variables are extra variables: that are incorporated by the researcher into the analysis in order to separate the impact of the independent variables on the dependent variables. To make sure that the observed effects are only the result of the independent variables, they "control" for other possible influences. The control variables in your research are the GDP per capita and the GDP change as a percentage. In order to prevent these more general economic factors from confusing the relationship between ICT measures and employment, they take into account the overall economic conditions that may effect both ICT utilisation and employment rates.

Per capita GDP (2009 Base) ($): The value of this, which is calculated by dividing the GDP updated to 2009 constant dollars by the total population, represents the average economic output per person. The GDP is standardized to 2009 price levels to account for inflation and facilitate year-to-year comparisons.

Gross Domestic Product, Percentage Change (2009 Base): The amount shown, that is stated in terms of 2009 constant prices and adjusted for inflation, shows the percentage change in value over time of all goods and services produced domestically.

Exports by economic activities (ISIC, Rev.4) (1000 USD) Total: The total value of a nation's sales of products and services to overseas markets, as categorized by the International Standard Industrial Classification of All Economic Activities (ISIC), Revision 4, is represented by this figure. The uniform comparison of economic activity across national boundaries is made possible by this classification scheme.

Imports by economic activities (ISIC, Rev.4) (1000 USD) Total: The International Standard Industrial Classification of All Economic Activities (ISIC), Revision 4, is used to classify the total value of goods and services imported into a nation. To economic analysis, the ISIC system offers a framework for grouping economic activities into a logical and consistent structure.

C. Model Construction

This section aims to investigate the actual impacts of job polarization generated by the implementation of ICT, drawing on earlier theoretical analysis and research assumptions. The established benchmark regression model construction.

$$Employment_{ijt} = \beta_j + \beta_j + \beta_j ICTijt + \delta_j X_{ijt} + \lambda_{jt} + u_{ij} + \varepsilon_{ijt}$$

In the previous model, $Employment_{ijt}$ represents the employment proportion of skilled labor of level j in regional provinces level 1, i in year t. The core explanatory variable ICT represents the level of ICT technology in province i in year t. The variable $X_{ijt}$is a series of control variables. λ_{jt} is the time effect, is the individual effect, and ε_{ijt} is the random error. In addition, corner markers j =1, 2, and 3 denote low-skilled, intermediate-skilled, and high-skilled labor respectively, i denote province, and t denotes different years.

IV. GENERAL RESULT

*Table C.1 Descriptive Statistics of VariablesTable C.1 Descriptive Statistics of Variables*displays the descriptive statistical data for each variable. ICT index has a standard error of 0.214 and minimum of -3.997 to maximum 4.975 at its highest. The intermediate-skilled labor percentage of laborers with different skill levels employed is 58%, with low-skilled labor coming in second at 21.82%, and high-skilled labor 20%, per the statistics. These numbers show that intermediate-skilled workers make up

most employed workers in Turkey, while just a tiny percentage have intermediate skills and a much smaller percentage have high capabilities. The difference draws attention to how unequal Turkey's employment system is and emphasizes the importance of improving and efficiency. Significant geographical differences in the employment of this specific labor segment are suggested by the remarkable 0.6332 standard deviation of the employment proportion for Intermediate labor.

Table C.1 Descriptive Statistics of Variables

Variable	count	mean	min	max	std_error
DH	132	21.823	17.906	28.087	0.168
DI	132	58.004	40.54	71.210	0.633
DL	132	20.172	9.850	35.481	0.523
ICT index	132	-5.382	-3.997	4.975	0.214
C1	132	323,6	0.155	2088	330.3
C2	132	5.383	-4.4	15.1	0.315
C3	132	14,307.5	151. 24	10,866	2012.4
C4	132	1,7521.2	129.1	146,056.5	3018.22

Table C.2 Regression Results of The Effect of ICT on Job Polarisation shows the impact of ICT on different labor skill levels. For every 1% rise in ICT application, the ICT Index provides an important benefit of 3.85% in employment for high-skilled labor, a decrease of the employment impact of ICT on intermediate-skilled workers is negative. In detail, for every 1% increase in ICT application level, there is -4.39% decline in intermediate-skilled labor employment. At the 1% statistical significance level, this has a considerable negative impact, with an influence coefficient of -0.439. This means that as ICT becomes more common, jobs requiring intermediate levels of ability are likely to reduce of digitization and the automation of tasks that these jobs normally undertake. It's a significant discovery because it shows possible labor-market difficulties, including requiring upgrading or improving steps to minimize the negative effects of technological improvements on specific job categories. An increase of 0.54% for low-skilled labor. At the 1% and 5% levels, these effects are statistically significant. Other variables, such as C1 and C2, as wellAS C3, have different effects on employment at different skill levels. The table more confirms the inclusion of person and time-based factors in the regression analysis, with strong R2 values indicating a good fit of the hypothesis and a substantial amount of observations (132 total).

Table C.2 Regression Results of The Effect of ICT on Job Polarisation

	DH	**DI**	**DL**
ICT Index	3.85*** (25.4)	-4.39*** (-20.87)	0.54*** (4.611)
C1	0.0005*** (7.136)	-0.0008*** (-8.101)	0.0003*** (5.296)
C2	0.090* (1.78)	-0.148** (-2.108)	0.058 (1.476)
C3	-1.052* (-2.34)	9.040 (1.44)	1.479 (0.41)
C4	-9.735*** (-3.38)	1.450*** (3.64)	- 4.852** (-2.15)
Individual factors	Yes	Yes	Yes
Time factors	Yes	Yes	Yes
R^2	0.895	0.861	0.3
F-value	215.6	156.3	15.43
Observation	132	132	132

Note: t value is shown in brackets, *** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$

A. Robustness checks

The following techniques will be applied for robustness tests in order to guarantee the validity and resilience of the regression results while evaluating the influence of Information and Communication Technology (ICT):

⑴ICT investment intensity, which is measured as the ratio of yearly internal ICT spending to the regional GDP in each province, is included as a control variable. This illustrates how much each region has committed to ICT.

⑵Period shortening: the dataset has been reduced so that only the years 2011-2021 are included in the analysis. This makes it possible to examine how ICT effects employment in a modern setting and may help to illustrate the effects of current technology developments.

⑶The percentage of employed people who have completed elementary, middle, high school, junior college, bachelor's degree, and graduate school, as well as those who are illiterate, reflecting the employed with low skills, were added to the dependent variable by classifying employed workers into various educational groups. A thorough analysis of the ways in which ICT effects employment at different educational attainment levels is made possible by this classification.

The results are powerful when these changes cause the coefficients' size and direction to change very little, while their statistical significance stays the same, which is the same as what happened in the benchmark regression. This supports the main findings of the regression analysis and shows how strong the study model is. The detailed regression from these robustness tests are not shown in this paper because there is not enough room for them. By applying these robustness tests, researchers can enhance the reliability and validity of their regression results when examining the impact of ICT on various outcomes, thereby strengthening the empirical evidence and the conclusions drawn from the analysis.

B. Regional differences in the impact of ICT on employment

The results of a regression analysis that examined at how information and communication technology (ICT) applications effect job polarisation across skill levels in Turkey's twelve statistical regions (TR1 to TRC) appear to be presented in this table. Job polarisation describes a surge in employment in high and low-skill jobs while middle-skill jobs are on the decline. Three categories-high skill labor, Intermediate skill labor, and low skill labor-are employed in the table to describe the effects. TRA, TRC, TR1, TR3, TR4, TR5, TR7, this indicates how the application of ICT technology in these areas is linked to a rise in the percentage of high-skill labor employed. These regions are benefiting from a shift toward more knowledge-and capital-intensive sectors, which is driving economic growth. TR2 and TR8 have distinct economic structures that favour labor with intermediate skill levels. If these areas are focused on ICT-enabled industries that still need a large number of workers with intermediate skills, like some manufacturing or service sectors.

Table C.3 Regression Result of Impact of ICT on Job Polarisation by Region

	DH	**DI**	**DL**
TR1	1.44*** (3.7)	-1.23** (-2.5)	-0.20 (-1.4)
TR2	-0.002*** (-3.01)	1.00*** (3.0)	-0.25* (-1.8)
TR3	0.95*** (5.5)	-1.25*** (-5.1)	0.29** (2.2)
TR4	2.10*** (5.2)	-2.66*** (-4.8)	0.56*** (2.6)
TR5	1.22*** (5.0)	-1.13*** (-3.7)	-0.09 (-0.7)
TR6	0.84** (3.1)	-1.009*** (-4.7)	0.16 (1.4)
TR7	0.70*** (3.6)	-2.59*** (-2.96)	1.88** (2.4)
TR8	-0.40*** (-2.6)	1.25*** (4.3)	-0.86 (-46)
TR9	-0.04 (-0.1)	-1.86** (-2.5)	1.91*** (3.0)
TRA	1.86*** (3.0)	1.74** (-2.0)	-0.11 (-0.3)
TRB	0.34 (0.4)	-0.46 (0.6)	0.11 (0.8)
TRC	1.00** (2.5)	-1.12*** (-2.7)	0.11 (0.7)
Individual factor	Yes	Yes	Yes
Hausman test	Fixed effect	Fixed effect	Fixed effect
R^2	0.93	0.89	0.78
Observation	132	132	132

TR3, TR4, TR7, TR9. In these regions, the employment share of low-skill labor increases with ICT. The effects on the other regions are insignificant. This discrepancy may be the result of the other region's balanced development across several industries. Even with the widespread usage of ICT, low-skilled laborers are still required by many organizations to do simple interactive activities. However, the higher concentration of traditional industries in the other three regions-including manufacturing-requires lower levels of ICT-related interaction, which could reduce the demand for low-skilled labor.

C. Industry differences in the impact of on employment

An analysis is conducted on the impact of ICT on the employment in various industries

$$labor_{ijt} = \beta_j + \beta_j ICT_{ijt} + \delta_j X_{ijt} + u_{ij} + \varepsilon_{ij}$$

The dependent variable, laborijt, represents the proportion of urban employment in the industry j to total employment. 13 industries are selected from Turkey to see the impact of ICT *Table C.4 Regression Results of The Impact on Employment in Various Industries* present significant regression result for the industries.

The results indicate significant effects of ICT and automation is on the manufacturing, then transport and storage and then business industry. These industries include intermediate-skilled occupations with tasks that can be automated by machines due to their fixed procedures. Thus, employment in these industries has declined. An early adopter of information and communication technology (ICT), has witnessed changes in task nature as industrial robots can replace repetitive and simple tasks, leading to reduced employment in the industry. Transport and Storage industry, involving routine cognitive and physical activities, have also experienced weaker employment due to the introduction of ICT technology.

Table C.4 Regression Results of The Impact on Employment in Various Industries

	Business Industry	**Agricultural, Forestry Fishery**	**Manufacturing**	**Electricity, gas, steam, AC production**
ICT index	8.73*** (19.01)	1.85*** (3.15)	1.31*** (21.15)	2.38*** (15.91)
Time factors	Yes	Yes	Yes	Yes
Hausman test	Fixed effect	Fixed effect	Fixed effect	Fixed effect
R^2	0.73	0.07	0.77	0.66
Observation	132	132	132	132

Water supply Industry		**Wholesale, retail trade Industry**	**Transport and storage**	**Information and communication**
ICT index.	1.18* (1.5)	6.88*** (2.4)	2.68* (1.5)	8.74 (1.4)
Time factors	Yes	Yes	Yes	Yes
Hausman test	Fixed effect	Fixed effect	Fixed effect	Fixed effect
R^2	0.64	0.81	0.65	0.61
Observation	132	132	132	132

Finance, insurance Industry		Real estate activities	Administrative activities	Education	Other service activities
ICT index	6.29 (1.2)	1.98** (2.09)	7.29* (1.8.)	1.94 ** (2.3)	7.92 *** (2.6)
Time factors	Yes	Yes	Yes	Yes	Yes
Hausman test	Fixed effect	Fixed effect	Fixed effect	Fixed effect	Fixed effect
R^2	0.56	0.77	0.72	0.80	0.84
Obs	132	132	132	132	132

V. *CONCLUSIONS AND IMPLICATIONS*

A. *Conclusion*

The conclusions drawn from the Principal Component Analysis (PCA), Multivariate multiple regression analysis, and the specific impact of different labor skill levels provide a comprehensive and accurate review of the study on the impact of Information and Communication Technology (ICT) and automation in Turkey. The study focused on variables such as internet access, broadband, mobile broadband, electrical consumption, and economic activity exports to create an index for ICT applications using PCA. This index offered a comprehensive evaluation of ICT adoption levels. The association between job activities (the dependent variable) and other work qualities (independent variables like education level, technical abilities, and cognitive capacity) has been demonstrated by multivariate multiple regression analysis. This research made it easier to understand how automation and ICT are changing the nature of work requirements in the labor market.

1)The most significant finding was the varying effect based on the skill level. The regression study revealed that for every 1% increase in the level of ICT application, workers with intermediate levels of education faced a significant loss of -4.3990 at the 1% level of significance. Conversely, workers with few skills saw an improvement. This indicates that jobs that require basic skills and predominantly involve routine tasks are more likely to be automated, making these jobs less desirable. There are multiple reasons for the significant decrease in intermediate skill labor. The progression of ICT has made it easier to automate intermediate skill professions, which usually consist of repetitive operations, leading to a decreased requirement for human labor in these positions. The rapid advancement of technology has created a gap where the abilities of mid-level workers do not match the rising technical requirements, negatively influencing their job prospects. There is a growing need for advanced talents that are harder to automate, such as complex problem-solving and critical thinking. This transition has a negative impact on intermediate skilled labor, as their abilities might not align with these new requirements.

2)ICT index has a standard error of 0.2148 and minimum of -3.997 to maximum 4.975 at its highest. The intermediate-skilled labor percentage of laborers with different skill levels employed is 58%, with low-skilled labor coming in second at 21.82%, and high-skilled labor 20%, per the statistics. These numbers show that intermediate-skilled workers make up most employed workers in Turkey.

For every 1% rise in ICT application, the ICT Index provides an important benefit of 3.85% in employment for high-skilled labor, a decrease of the employment impact of ICT on intermediate-skilled.

workers is negative. This means that as ICT becomes more common, jobs requiring intermediate levels of ability are likely to reduce of digitization and the automation of tasks that these jobs normally undertake. It's a significant discovery because it shows possible labor-market difficulties, including requiring upgrading or improving steps to minimize the negative effects of technological improvements on specific job categories. An increase of 0.54% for low-skilled labor.

The control variables, C1 positively effects the employment of high-low and intermediate-skilled workers Also, when ICT is invested, the percentage of low-skilled labor employment declines while the percentage of intermediate and high-skilled labor employment rises noticeably. This suggests that higher education spending has enhanced our nation's workforce's knowledge makeup, because economic growth generates more job opportunities for individuals, employment across all skill levels is directly correlated with the level of regional economic development. The theory set ahead in the research is confirmed: the use of ICT does in fact contribute to job polarisation. In particular, the employment of low and high-skilled labor is positively impacted by ICT, but the employment of intermediate-skilled labor is negatively impacted.

The results of a regression analysis that examined at how information and communication technology (ICT) applications effect job polarisation across skill levels in Turkey's twelve statistical regions (TR1 to TRC).

TRA, TRC, TR1, TR3, TR4, TR5, TR7, this indicates how the application of ICT technology in these areas is linked to a rise in the percentage of high-skill labor employed. These regions are benefiting from a shift toward more knowledge-and capital-intensive sectors, which is driving economic growth. TR2 and TR8 have distinct economic structures that favor labor with intermediate skill levels. If these areas are focused on ICT-enabled industries that still need many workers with intermediate skills, like some manufacturing or service sectors.

TR3, TR4, TR7, TR9. In these regions, the employment share of low-skill labor increases with ICT. The effects on the other regions are insignificant. This discrepancy may be the result of the other region's balanced development across a few industries.

3)The study also addressed the differences in the effects of ICT and automation across different regions and sectors. Different regions exhibit specific trends in the impact of ICT and automation on skill levels, favoring highly skilled employment while negatively effecting intermediate and low skilled labor. Similarly, industries such as manufacturing and transportation experienced a more pronounced effect due to their reliance on intermediate-skilled professions that are subject to automation, although sectors that demand higher levels of intelligence experienced an increase.

B. Implications

The worldwide scenario of technology disruptions in labor markets demonstrates a consistent pattern of employment polarization and the displacement effect, wherein there is a decline in mid-level occupations while high and low-skilled roles are increasing. This trend is observable in diverse countries and economies. Research has indicated that the implementation of novel technologies may result in a rise in the need for highly skilled laborer's, potentially leading to the displacement of less skilled laborers. This pattern is seen everywhere, even in nations like Hungary and India.

Rapid technology breakthroughs are the hallmark of the Fourth Industrial Revolution, which has the potential to drastically alter the labor market. According to experts, emerging technologies like automation and artificial intelligence (AI) have the potential to significantly effect labor markets and decrease the need for low-skilled workers. Middle-skill jobs are more likely to be automated due to their repetitive nature, which makes them more automatable than low-skill jobs, which need more human labor. Automating low-skill jobs has been less viable due to low pay at the bottom of the skill distribution; however, this could alter with additional technological developments. Implications of Inequality Automation may cause inequality to rise uniformly as it develops, particularly if low-skill, low-paying jobs are more vulnerable to automation. Automation's Future different consequences could arise from the next phase of automation, which might extend to lower-paying jobs and change the dynamics of the labor market and inequality.

From the conclusion, it is evident that there is a job polarization in Turkey and even in different regions of the country. Most of the job polarization is for the intermediate skilled labor, and when compared to the industry, most of the areas which are impacted are the manufacturing, transportation and storage and business sector where most of the jobs are for the intermediate skilled labors. This impact is also seen in the different regions. When all conclusion in different areas is compared to each other it can be explained that varying effects of information and communication technology adoption on labor employment ratios result in the emergence of job polarization. Particularly, there is a notable impact on laborers with intermediate skills, whose jobs are more susceptible to substitution or transformation, which lowers their share of the labor force. High-skilled labor and ICT technology have a complementary relationship, which means that ICT can make it easier to hire highly skilled labor. Since ICT is still limited in its application to jobs requiring social interaction, emotional intelligence, or adaptability, low-skilled labor is currently facing challenges in being replaced by technology.

References

[1] Z. Ozbay Das, "WAGE INEQUALITY AND LABOUR MARKET POLARIZATION IN TURKEY? *," *Finans Polit. Ve Ekon. Yorumlar Derg.*, vol. 0, no. 658, Art. no. 658, 2021.

[2] G. Peng, Y. Wang, and G. Han, "Information technology and employment: The impact of job tasks and worker skills," *J. Ind. Relat.*, vol. 60, p. 002218561774192, Jan. 2018, doi: 10.1177/0022185617741924.

[3] D. E. Bailey, "Emerging Technologies at Work: Policy Ideas to Address Negative Consequences for Work, Workers, and Society," *ILR Rev.*, vol. 75, no. 3, pp. 527–551, May 2022, doi: 10.1177/00197939221076747.

[4] M. Goos, E. Rademakers, and R. Röttger, "Routine-Biased technical change: Individual-Level evidence from a plant closure," *Res. Policy*, vol. 50, p. 104002, May 2020, doi: 10.1016/j.respol.2020.104002.

[5] J. Jung and J. Mercenier, "Routinization-Biased Technical Change, Globalization and Labor Market Polarization: Does Theory Fit the Facts?".

[6] "The Future of Work: Augmentation or Stunting? | Philosophy & Technology." Accessed: Dec. 08, 2023. [Online]. Available: https://link.springer.com/article/10.1007/s13347-023-00631-w

[7] M. Poláková, J. H. Suleimanová, P. Madzík, L. Copuš, I. Molnárová, and J. Polednová, "Soft skills and their importance in the labour market under the conditions of Industry 5.0," *Heliyon*, vol. 9, no. 8, p. e18670, Aug. 2023, doi: 10.1016/j.heliyon.2023.e18670.

[8] O. Kolade and A. Owoseni, "Employment 5.0: The work of the future and the future of work," *Technol. Soc.*, vol. 71, p. 102086, Nov. 2022, doi: 10.1016/j.techsoc.2022.102086.

[9] "What are some jobs that remain relatively unchanged by technology?" Quora. Accessed: Dec. 10, 2023. [Online]. Available: https://www.quora.com/What-are-some-jobs-that-remain-relatively-unchanged-by-technology

[10] A. Bongers and B. Molinari, "Economic Growth, Technological Progress, and Employment," in *Decent Work and Economic Growth*, W. Leal Filho, A. M. Azul, L. Brandli, A. Lange Salvia, and T. Wall, Eds., Cham: Springer International Publishing, 2021, pp. 313–324. doi: 10.1007/978-3-319-95867-5_62.

[11] D. Acemoglu and D. Autor, "Skills, Tasks and Technologies: Implications for Employment and Earnings," in *Handbook of Labor Economics*, vol. 4, Elsevier, 2011, pp. 1043–1171. doi: 10.1016/S0169-7218(11)02410-5.