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Article

The Impact of Renewable Energy on Women's Employment in Developing Countries

Saleh Alaarajy[1], Zahra Karimi Moughari[2], Shahryar Zaroki[3]

[1] PhD Student in Economics, University of Mazandaran, Babolsar, Iran. Email: saleh.alaarajy59@gmail.com
ORCID: 0009-0001-5002-8509
[2] Associate Professor, Department of Economics, Faculty of Economics and Administrative Sciences, University of Mazandaran, Babolsar, Iran. Email: zakarimi@umz.ac.ir ORCID: 0000-0002-6710-3237
[3] Associate Professor of Economics, Department of Energy Economics, Faculty of Economic and Administrative Sciences, University of Mazandaran, Babolsar, Iran. Email: sh.zaroki@umz.ac.ir ORCID: 0000-0001-5973-2546

Abstract: Women's employment is one of the key pillars of sustainable development and inclusive economic growth; however, in many developing countries, women's participation in the labor market continues to face significant structural and institutional constraints. In this context, the expansion of renewable energy not only contributes to environmental sustainability but also has the potential to create new employment opportunities and enhance women's economic participation. This study aims to examine the impact of renewable energy consumption on female employment in developing countries. To this end, panel data for a sample of developing countries covering the period 2000–2022 are employed. After conducting panel unit root and cointegration tests, the long-run relationships are estimated using the Dynamic Ordinary Least Squares (DOLS) estimator, while the short-run dynamics are analyzed through a Panel Error Correction Model (ECM) estimated using the Pooled Mean Group (PMG) approach. The empirical results reveal that renewable energy consumption has a positive and statistically significant effect on female employment in developing countries. In addition, GDP per capita and gross fixed capital formation contribute positively to female employment, whereas real wages exert a negative and statistically significant effect. The short-run findings further indicate that renewable energy consumption and economic growth promote female employment. Moreover, the negative and statistically significant coefficient of the error correction term confirms the existence of a stable long-run equilibrium relationship among the model variables. Overall, the findings suggest that the expansion of renewable energy, combined with appropriate investment and labor market policies, can play a crucial role in increasing female employment, reducing gender inequalities, and promoting sustainable development in developing countries.

Keywords: Renewable energy; Women's employment; Developing countries; Sustainable development; Dynamic Ordinary Least Squares (DOLS); Pooled Mean Group (PMG)

1. Introduction

In recent decades, increasing global demand for energy, decreasing fossil fuel reserves, and intensifying environmental consequences resulting from the consumption of these resources have made the transition to renewable energy one of the most important priorities in economic and environmental policymaking in the world. Renewable energies, including solar, wind, hydroelectric, biomass, and geothermal energy, in addition to reducing greenhouse gas emissions and helping to combat climate change, have a high capacity to create jobs, increase investment, develop technology, and promote economic well-being (International Renewable Energy Agency [IRENA], 2019; United Nations, 2015). Therefore, the development of these resources has become one of the main pillars of achieving sustainable development goals, especially in developing countries.

Developing countries, due to rapid population growth, increasing energy needs, limited financial resources, and high unemployment rates, need to exploit the economic potential of renewable energies more than other countries. In addition to providing sustainable energy, investment in this sector creates job opportunities in the areas of equipment

production, installation, operation, maintenance, technical services, and research activities, and can simultaneously boost economic growth and employment (Dvořák et al., 2017; Bulavskaya & Reynes, 2018; Hutabarat & Shields, 2024). Various studies have also shown that the expansion of clean energy, compared to fossil fuel-based industries, has a greater capacity to create jobs and can pave the way for inclusive and sustainable development (Mu et al., 2018; Ortega et al., 2020; Zhang et al., 2024).

Meanwhile, women's employment, as an important aspect of human development and social justice, has a special place in the economic development literature. In addition to increasing household income, women's active participation in the labor market leads to increased productivity, reduced poverty, improved human capital, and increased economic growth (Becker, 1964; Klasen & Lamanna, 2009). However, in many developing countries, women still face obstacles such as gender discrimination, limited access to education and skills, inequality in job opportunities, and institutional constraints that have reduced their level of economic participation (Safiri, 2014; World Bank, 2021; Petrovich, 2016). Therefore, identifying factors that can create more job opportunities for women is of particular importance in economic policymaking.

One of the important capacities for increasing women's employment is the development of renewable energy. Unlike many traditional industries, the renewable energy sector creates a wide range of specialized and non-specialized jobs in its value chain, in which women can also play an effective role. In addition to creating direct and indirect job opportunities, the development of this sector also provides the basis for women's economic empowerment through the expansion of entrepreneurship, training in new skills, development of local businesses, and improved access to energy (Pearl-Martinez & Jenny, 2016; Bera et al., 2024; ESMAP & World Bank, 2022). Therefore, the development of renewable energy is not only an environmental strategy, but also a tool for reducing gender inequalities and promoting women's economic participation.

Despite the significant growth of literature on the economic impacts of renewable energy, most previous studies have focused on the impact of this sector on economic growth, total employment, or reduction of emissions (Simas & Pacca, 2014; Sari & Akkaya, 2016; Jin et al., 2024). In contrast, few studies have examined the impact of renewable energy on women's employment, especially in developing countries. On the other hand, the structural, institutional, and economic differences of these countries mean that the results of studies conducted in developed economies cannot be fully generalized to developing countries. Therefore, empirical studies in this field can largely fill the gap in the research literature.

Accordingly, the main objective of this study is to examine the impact of renewable energy consumption on women's employment in developing countries during the period 2000 to 2022. To achieve this goal, panel data from developing countries and panel econometric methods, including unit root and cointegration tests, estimation of long-term relationships with the dynamic ordinary least squares (DOLS) method, and analysis of short-term dynamics using the error correction model and the pooled mean group (PMG) method, are used. The results of this study can provide valuable empirical evidence for policymakers to accelerate the energy transition, increase women's employment, reduce gender inequalities, and achieve inclusive economic growth and sustainable development in developing countries through targeted development of renewable energies.

2. Theoretical foundations

2.1 The importance of renewable energies in the economy

Energy, as one of the most important factors of production and infrastructure for economic development, plays a vital role in the growth and sustainability of global economies. In recent decades, with increasing concerns about the depletion of non-renewable energy resources, the environmental impacts of fossil fuels, and the need for energy security, renewable energies have been considered as sustainable and efficient alternatives. These resources, including solar, wind, hydro, biomass, geothermal, and wave and tidal energy, not only help reduce environmental pollution and greenhouse gas emissions, but also contribute to the achievement of sustainable development goals by creating numerous economic opportunities, especially in developing countries. The role of renewable energies in the economy

can be examined through job creation, reducing energy costs, strengthening the self-reliance of local communities, and improving energy security, and their importance in shaping the future of the global economy is becoming increasingly apparent.

One of the most important impacts of renewable energy on the economy is job creation. The development of renewable technologies, from manufacturing and installing equipment such as solar panels and wind turbines to maintenance and research and development, requires a workforce in many different sectors. These jobs are often local and indigenous in nature and, especially in rural and disadvantaged areas, provide sustainable employment opportunities for different groups, including women. For example, solar and wind projects in developing countries can help empower local communities and, by generating income, reduce poverty and economic inequality. Studies show that job creation in the renewable energy sector is significantly higher than in the non-renewable energy sector due to its decentralized nature and the need for a diverse workforce.

Renewable energy also reduces long-term energy costs by reducing dependence on fossil fuels. Although the initial investment to develop renewable infrastructure, such as building solar or wind farms, may be high, the operating and maintenance costs of these systems are much lower compared to fossil fuel plants. In addition, renewable resources such as the sun and wind are free and unlimited, which leads to lower energy production costs and therefore lower prices for consumers. This reduction in costs can free up financial resources for investment in other sectors of the economy, especially in developing countries, which often face fiscal constraints.

Enhancing energy self-reliance and security is another key aspect of the role of renewable energy in the economy. Many countries, especially developing countries, face economic and political challenges due to their dependence on fossil fuel imports. Renewable energy, which relies on local natural resources, reduces this dependence and allows countries to use their domestic resources to produce energy. For example, countries with high solar radiation or windy areas can invest in these resources to meet their energy needs and protect themselves from fluctuations in oil and gas prices on global markets. This self-reliance not only contributes to economic stability, but also strengthens national security by reducing geopolitical risks associated with energy trade.

From an environmental perspective, renewable energy reduces the costs associated with climate change and environmental damage by reducing greenhouse gas and pollutant emissions. Fossil fuels, which provide the majority of the world's energy, are responsible for large emissions of carbon dioxide, carbon monoxide, sulfur oxides, and nitrogen oxides, which contribute to global warming, air pollution, and public health problems. These issues impose heavy economic costs on economies, including medical costs and damages from natural disasters. By providing clean energy and reducing these costs, renewable energy helps improve public health and protect natural resources, and reduces the economic burden of environmental damage.

The importance of renewable energy is particularly prominent in developing economies, as these countries often face challenges such as unemployment, poverty and lack of energy infrastructure. The development of renewable energy can act as a driving force for economic growth. For example, small-scale solar and wind projects in rural areas can facilitate the electrification of disadvantaged communities and boost economic activities such as agriculture, handicrafts and services. In addition, these projects help to empower women and youth by creating local jobs and reducing social and economic inequalities.

From a global perspective, renewable energy trade is also expanding. As technologies advance and production costs fall, the share of these resources in global energy markets is rapidly increasing. Investment in renewable energy has not only led to the growth of related industries such as the production of green equipment and technologies, but also created new export opportunities for countries. This trend can help strengthen the trade balance and increase foreign exchange earnings, especially in countries that have abundant natural resources for renewable energy production.

Ultimately, the importance of renewable energies in the economy comes down to their ability to strike a balance between economic growth, environmental sustainability, and social justice. These resources are recognized as a key

pillar of sustainable development by reducing dependence on fossil fuels, creating jobs, reducing energy costs, and protecting the environment. In a country like Iraq, which faces economic and environmental challenges stemming from its dependence on oil, investing in renewable energies can help diversify the economy, create new jobs for men and women, and improve the quality of life. Therefore, developing these resources is not only an environmental imperative, but also a unique economic opportunity for a sustainable future.

2.2 Renewable energies and sustainable development

Renewable energy, as one of the main pillars of sustainable development, plays a key role in achieving economic, social and environmental goals. These resources, including solar, wind, hydro, biomass and geothermal energy, are recognized as effective tools for achieving the Sustainable Development Goals (SDGs) due to their unique characteristics such as renewability, reduced greenhouse gas emissions and widespread availability. Sustainable development, which emphasizes economic growth, social justice and environmental protection, requires access to clean, affordable and reliable energy sources. Renewable energy contributes to the achievement of these goals by providing opportunities in the fields of energy security, social and economic development, energy access and reducing the impacts of climate change (Owusu & Asumadu-Sarkodie, 2016). In the following, the role of renewable energy in achieving the Sustainable Development Goals is comprehensively reviewed.

One of the most important aspects of renewable energy is the promotion of energy security. Energy, as one of the most important production inputs, plays a vital role in economic development, and ensuring its security of supply is a priority in countries' development programs. In many oil-rich countries, due to the abundance of fossil fuels and their low prices, energy consumption exceeds global standards. This not only leads to waste of resources, but also has negative environmental impacts such as air pollution and greenhouse gas emissions. By reducing dependence on fossil fuels, renewable energies provide the opportunity to diversify energy sources and reduce economic vulnerability to fluctuations in fossil fuel prices. These resources, which are equitably distributed around the world, allow countries to use local natural resources such as the sun and wind to produce energy, which leads to reduced energy import costs and increased self-reliance. Furthermore, in remote areas where access to energy grids is limited, renewable energy-based systems, such as solar or wind microgrids, provide sustainable energy services and help improve energy infrastructure in these areas (Edenhofer et al., 2011; Liu et al., 2015).

Social and economic development is another area where renewable energy has a significant impact. The energy sector is key to economic development due to the direct link between energy consumption and economic growth. Studies have shown that per capita income is positively and significantly correlated with per capita energy consumption, and economic growth in recent decades has been dependent on increased energy consumption. Renewable energy contributes to improving economic and social indicators by creating job opportunities in the production, installation, maintenance, and research and development sectors. These resources, especially in developing countries, reduce unemployment and poverty by creating local and indigenous jobs. In addition to job creation, renewable technologies help improve public health, increase access to education, strengthen gender equality, and protect the environment. For example, access to clean electricity in rural areas can enable the use of educational and medical equipment and improve the quality of life. These benefits play an important role, especially in improving the status of women and disadvantaged groups in society (Edenhofer et al., 2011).

Access to clean, affordable and reliable energy is one of the main sustainable development goals that renewable energy can help to achieve. In many parts of the world, especially in sub-Saharan Africa and South Asia, there is a clear gap between access to electricity in urban and rural areas. Rural areas are often far from national electricity grids and energy supply in these areas faces numerous challenges. Renewable energy, especially through decentralized systems such as solar and wind microgrids, offers significant opportunities for electrification in these areas. These systems not only increase access to energy, but are also more cost-effective by reducing energy transmission costs and using local resources. This helps to improve the quality of life, develop local economic activities and reduce regional inequalities (Larson et al., 2009).

Climate change is one of the greatest challenges of the 21st century, threatening human health, wildlife and natural ecosystems. The increasing frequency and intensity of heat waves, floods and droughts, coupled with disease and malnutrition, are having significant negative impacts, particularly in low-income countries. Fossil fuel emissions, such as carbon dioxide, are the main cause of global warming, which trap heat radiation and increase global temperatures. Renewable energies play an important role in mitigating the effects of climate change by producing clean energy and emitting near-zero pollutants. The Paris Agreement (2015) emphasizes limiting the increase in global temperature to 1.5°C above pre-industrial levels. To achieve this goal, the world must achieve carbon neutrality between 2055 and 2070. Renewable energies help to reduce greenhouse gas emissions and achieve this goal by replacing fossil fuels. This not only protects the environment, but also reduces the economic costs caused by natural disasters and health problems (Haines et al., 2006; UNEP, 2014).

Overall, renewable energies, with their positive impacts on energy security, social and economic development, energy access and climate change mitigation, are recognized as a key tool for achieving the Sustainable Development Goals. These resources contribute to improving the well-being of communities and sustainable economic growth by creating jobs, improving energy infrastructure in disadvantaged areas, reducing dependence on fossil fuels and protecting the environment. In countries such as Iraq, which face economic and environmental challenges resulting from dependence on oil, investing in renewable energies can lead to diversification of the economy, creating job opportunities for women and men, and achieving sustainable development. Therefore, the development of these resources is not only an environmental imperative, but also a requirement for building a sustainable and just future.

2.3 Renewable energy development and employment

The development of renewable energy, as one of the most important economic and environmental strategies in the 21st century, has profound effects on the labor market and total employment in global economies. These resources, including solar, wind, hydro, biomass, and geothermal energy, not only help reduce dependence on fossil fuels and reduce greenhouse gas emissions, but also contribute to economic growth and reduce unemployment by creating diverse job opportunities, especially in less developed regions. From the perspective of economic theories, the impact of renewable energy on employment can be analyzed through economic growth theories, technology transfer theory, and sustainable development theory. These resources act as a driving force for sustainable economic development by creating direct and indirect jobs, strengthening local infrastructure, and stimulating labor demand.

A) The perspective of economic theories

From the perspective of economic growth theory, employment, as one of the main factors of production, plays a key role in increasing gross domestic product (GDP). According to Okun's law (Okun, 1962), a decrease in the unemployment rate is directly related to an increase in economic production. The development of renewable energies contributes to increasing labor productivity and economic growth by creating jobs in various sectors, from the production of equipment (such as solar panels and wind turbines) to installation, maintenance, and research and development. These jobs, which are often local in nature, can have significant impacts on the local economy, especially in less developed regions with high unemployment rates. For example, the construction of solar or wind power plants in remote areas not only leads to job creation, but also contributes to the economic development of these regions by transferring technology and infrastructure.

B) Technology transfer theory

Technology transfer theory also plays an important role in explaining the impact of renewable energies on employment. The development of these resources requires advanced technologies that, by penetrating into less developed areas, raise the level of knowledge and skills of the workforce. This process, which often occurs through training and the creation of specialized jobs, leads to improved labor quality and increased productivity. For example, the installation and maintenance of photovoltaic systems or wind turbines requires specialized training that can help empower the local workforce, especially in developing countries such as Iraq. This is consistent with Schumpeter’s

(1942) theory of innovation and creative destruction, as renewable technologies, by replacing old fossil fuel-based systems, create new economic structures that bring innovative and more sustainable jobs.

C) Sustainable development theory

Sustainable development theory also emphasizes the importance of renewable energy in job creation. The Sustainable Development Goals (SDGs), especially Goal 8 (Decent Work and Economic Growth), emphasize the need to create sustainable and productive jobs. Renewable energy contributes to this goal by creating jobs in sectors that are environmentally friendly. According to the International Renewable Energy Agency (IRENA, 2019), at least 11.5 million people were directly and indirectly employed in the renewable energy subsectors by the end of 2019. These jobs included 3.75 million in the photovoltaic sector, 0.82 million in the solar heating/cooling sector, 1.17 million in the wind energy sector, 1.96 million in the hydropower sector, 3.58 million in the biomass sector, and 0.18 million in other energies. It is predicted that by 2030, the number of jobs in this sector will reach 20 million, with the largest share going to biofuels (12 million jobs), solar energy (6.3 million jobs), and wind energy (2.1 million jobs) (SANA, 2013).

D) Economic and social impacts

One of the most important benefits of renewable energy development is its ability to create jobs in less developed regions. These regions often face high unemployment rates and renewable energy sources, such as solar and wind, are often abundant in these areas. The construction of renewable power plants in these areas not only leads to the creation of direct (such as installation and maintenance) and indirect (such as the supply of raw materials and support services) jobs, but also contributes to the economic and social development of these regions by improving energy infrastructure. For example, solar projects in rural areas can improve access to electricity and boost economic activities such as agriculture and small-scale industries.

Studies show that the number of jobs created per megawatt of electricity generated from renewable sources is almost twice as many as those created from fossil-fuel-based power plants. This is due to the decentralized and labor-intensive nature of renewable technologies. For example, installing solar panels or wind turbines requires local labor to build, install, and maintain, while fossil-fuel power plants often rely on centralized infrastructure and automated technologies that require less labor. This feature makes renewable energy an effective tool for reducing unemployment, especially in developing countries.

e) Gender inequality and employment

Despite significant progress, gender inequality in the energy sector remains a challenge. According to IRENA (2019), women make up only 32% of the workforce in the renewable energy sector, compared to 22% in the overall energy sector. This inequality highlights the need for targeted policies to increase women's participation in this sector. Women's employment in the renewable energy sector not only helps reduce gender inequality, but according to studies (Pearl-Martinez & Jenny, 2016), gender diversity in the workforce can lead to increased innovation and productivity. In countries such as Iraq, whose economy is heavily dependent on oil, the development of renewable energy can create new job opportunities for women and contribute to their economic empowerment.

From an economic theory perspective, renewable energy development contributes to economic growth, reduces unemployment and achieves sustainable development goals by creating sustainable and productive jobs. Theories of economic growth, technology transfer and sustainable development suggest that these resources have broad positive impacts on the economy by stimulating labor demand, improving local infrastructure and fostering innovation. IRENA (2019) data confirm that renewable energy has a high potential for job creation, especially in less developed regions that face high unemployment rates. However, to fully exploit this potential, it is necessary to develop policies to reduce gender inequality and increase women's participation in this sector. In countries such as Iraq, investment in renewable energy can lead to diversification of the economy, reducing dependence on oil and creating sustainable jobs for the entire society.

2.4 Development of renewable energies and women's employment

The development of renewable energy sources, including solar, wind, hydro, biomass and geothermal, has significant impacts on women's employment due to their sustainable and decentralized characteristics. These impacts can be explained from the perspective of economic and social theories, in particular theories of sustainable development, economic feminism and technology transfer. By creating diverse and local employment opportunities, renewable energies contribute to reducing gender inequality, empowering women economically and strengthening their participation in the labour market, which in turn contributes to the achievement of the Sustainable Development Goals, in particular Goal 8 (decent work and economic growth) and Goal 5 (gender equality).

From the perspective of sustainable development theory, women's employment, as one of the pillars of social sustainability, plays a key role in creating just and inclusive societies. Renewable energies, due to their decentralized nature and the need for labor at various stages of production, installation, maintenance, and research and development, create numerous job opportunities in less developed regions, where female unemployment rates are often high. Unlike fossil fuel-based industries, which are usually centralized and male-dominated, these resources allow women to participate in a variety of jobs, from technical tasks such as installing solar panels to managerial and educational roles. For example, solar and wind projects in rural areas can create local jobs for women, which leads to improved household incomes and poverty reduction. According to the International Renewable Energy Agency (IRENA, 2019), women made up about 32 percent of the workforce in the renewable energy sector in 2019, compared to 22 percent in the overall energy sector, indicating the sector's potential to reduce gender inequality.

Economic feminist theory emphasizes the role of women in the economy and the need to remove structural barriers to their participation. Renewable energy industries, due to their emerging nature and the need for a diverse workforce, can reduce traditional barriers to women's entry into the labor market, such as gender discrimination and the lack of specialized skills. These sectors help empower women by providing specialized training, such as courses in the installation and maintenance of photovoltaic systems or wind turbines. This process is in line with human capital theory (Becker, 1964), as investing in women's education increases their productivity and leads to economic growth. Furthermore, gender diversity in the workforce, especially in innovative sectors such as renewable energy, helps to increase creativity and innovation, which, from an economic feminist perspective, leads to improved economic performance of organizations and societies (Pearl-Martinez & Jenny, 2016).

The theory of technology transfer also explains how the development of renewable energy contributes to women's employment. These resources require new technologies that, by penetrating less developed areas, enhance women's skills. For example, training women to install and maintain solar systems in rural areas not only leads to their direct employment, but also strengthens women's economic activities in sectors such as agriculture and small industries by increasing access to clean energy. This is especially important in countries such as Iraq, which face the challenges of female unemployment and dependence on the oil economy. By creating decentralized jobs, the development of renewable energy allows women to work in their own places without having to migrate to cities, which facilitates their participation by reducing social and cultural barriers.

From the perspective of Schumpeter's theory of creative destruction (Schumpeter, 1942), the development of renewable energies, by replacing old systems based on fossil fuels, creates new economic structures that provide more diverse employment opportunities for women. These sectors, due to the need for labor in non-traditional fields, such as managing clean energy projects or environmental education, allow women to move away from stereotypical roles in the labor market and to appear in specialized and managerial positions. This development, by increasing women's participation in the labor force, helps to reduce the gender gap and strengthen their economic empowerment.

However, challenges such as gender inequality in access to education and skilled jobs persist. IRENA (2019) predicts that by 2030, the number of jobs in the renewable energy sector will reach 20 million, with a large proportion of these jobs in biofuels, solar and wind energy. To fully exploit this potential, targeted policies need to be developed to increase women's participation through education, removing cultural barriers and creating economic incentives. In countries such as Iraq, renewable energy development can help reduce women's unemployment rates, improve

household incomes and strengthen their social status by creating local and sustainable jobs, which in turn contributes to sustainable development and social justice.

3. Empirical evidence

Renewable energy, as one of the most important areas of economic investment, plays a significant role in creating jobs, developing less developed areas, and reducing regional inequalities. Based on economic models, the relationship between renewable energy and employment can be analyzed from three perspectives: labor supply, labor demand, and economic spillover effects (Jiehong et al., 2025).

The development of renewable energy infrastructure requires the construction of wind, solar, biomass, and hydroelectric power plants, which directly create jobs in the areas of installation, operation, and maintenance. In addition, indirect activities such as the supply of raw materials and support services also create employment. According to data from the International Renewable Energy Agency (IRENA), by the end of 2019, more than 11.5 Million people worldwide are directly and indirectly employed in the renewable energy sector. Of these, 3.75 million are employed in photovoltaic systems, 1.17 million in wind energy, and 1.96 million in hydroelectricity. This figure is expected to increase to 20 million by 2030. million jobs, the largest contribution of which will be from biofuels (12 million jobs) and solar energy (6.3 million jobs).

According to economic development theories, investment in less developed areas can help improve economic indicators, including reducing unemployment rates. Renewable energy resources are often located in remote and less developed areas, where unemployment rates are high. The construction and operation of renewable power plants, by creating job opportunities, strengthens the economy of these areas. Studies show that the number of jobs created per megawatt of electricity generated from renewable sources is almost twice that of fossil fuel power plants. This difference is due to the more labor-intensive nature of renewable technologies in the design, installation, and operation stages. Investment in renewable energy not only creates more jobs, but also brings greater sustainability (Yi Jin et al., 2024).

Although employment in the renewable energy sector has increased in recent years, men still account for a larger share. According to IRENA, the share of women in the renewable energy workforce in 2019 was about 32 percent. percent, which is higher than the overall share of women in the energy sector (22 percent). This statistic shows that the development of renewable energies can help reduce the gender gap in the labor market. From a theoretical and practical perspective, investment in renewable energies, in addition to ensuring energy security and reducing environmental pollution, has a high potential for job creation. This investment can be a key factor in economic growth, reducing social inequalities, and reducing unemployment, especially in remote and less developed regions, not only for developed countries, but also for developing countries.

The following are some related studies conducted in this field:

In a study by Jiehong et al. (2025) conducted in China and the United States, the economic effects of coal-fired power plants on employment in these two countries were examined. Using panel data over 10 years from 2875 counties in China and 3233 counties in the United States, this study analyzed the employment effects of coal-fired power plant construction and closure. The results showed that in China, the construction of coal-fired power plants increased local employment and in neighboring counties, while in the United States, before 2015, the closure of coal-fired power plants had a negative impact on employment. However, after 2015, with the introduction of new energy transition policies, positive employment effects were observed in this country. The study emphasized that energy transition policies, especially in the United States, although they did not directly facilitate employment, prevented further employment losses following the energy transition.

In a study conducted by Ranajit et al. (2024) in rural areas of West Bengal, the impact of access to renewable energy, especially micro solar panels, on women's economic and social empowerment was examined. The study, conducted in two sections of Hirband and Raniband of Bankura district, showed that the use of micro solar panels improved the quality of life, increased women's participation in decision-making processes, increased financial and

social mobility, and their financial independence. The researchers also emphasized that to promote the use of these new technologies, there is a need to design appropriate mechanisms to create markets for the development of these technologies in rural areas.

A study by Simon et al. (2024) in Indonesia examined the economic and distributional impacts of production credit (PTC) policies on the country's renewable energy sector. Using a computational general equilibrium (CGE) model and simulating scenarios of total factor productivity (TFP) growth over the period 2018–2030, the study found that PTC policies led to significant reductions in electricity prices and increased incomes for urban households and highly educated workers. However, in rural areas and for low-skilled workers, these changes yielded smaller benefits, highlighting the economic inequalities resulting from energy transition policies. The study emphasized that renewable energy policies should be designed to ensure that benefits are distributed fairly across all sectors of society.

A study conducted in China by Ruining et al. (2024) examined the employment effects of the energy transition from fossil fuels to renewables. The study used panel data from 2008 to 2022 and found that the transition to renewables led to employment gains in various sectors, especially in eastern and southern China, while job losses were observed in central China due to a decline in employment in coal-based sectors. The results showed that a 1% increase in clean energy production would, on average, increase total employment by 0.013%. It was also predicted that by 2060, net employment in China would increase by 5.89–9.96 million jobs. The study emphasized the importance of fair policies tailored to local conditions to avoid the negative effects of energy transition on employment in specific regions.

In a study conducted in China by Yi Jin et al. (2024), the effects of fossil resource trade on employment in different cities in China were examined from the perspective of intercity connections (telecoupling). The study showed that 70% of employment in the fossil resource sector in China is due to intercity trade connections, which is especially important in the fields of coal, oil and gas extraction. The results showed that more than 70% of intercity employment is transferred at the provincial level and 84% of this employment is due to domestic final demand. The study emphasized the importance of understanding international relations and trade effects on employment in the process of transition from fossil fuels to renewable energy and highlighted the need to use this information in the design of urban policies to better manage the effects of trade on employment.

In a study conducted by the World Bank (2023) entitled "Empowering Women in Iraq" The report examines the impact of electricity shortages on the economic activities of Iraqi women. The report shows that women are disproportionately affected by the hidden costs of not having access to reliable and sustainable electricity. This not only limits women's economic participation, but also widens existing gaps in economic opportunities. In addition, these negative conditions have affected the performance of small businesses, women's access to education, social security and economic independence. The report highlights that these inequalities are particularly pronounced in rural and impoverished areas, where electricity infrastructure is weaker and alternative energy options are lacking. In such situations, women not only face reduced productivity and income, but are also denied employment and educational opportunities. Based on the findings of this report, strengthening electricity infrastructure, expanding access to sustainable energy, and designing targeted policies can play an important role in promoting women's economic participation, reducing gender inequalities, and achieving inclusive economic growth.

In a report published by the Middle East Institute (2023) entitled " Youth Dynamics and the Future of Iraq's Energy " Published, the report examines the structural and cultural barriers to women's participation in Iraq's energy sector. According to the report's findings, women make up only about 1.5 million of the active population in the Iraqi labor market, and they are mostly employed in traditional occupations or areas that are determined by social norms. The study shows that the energy sector, as one of the most important and highest-paying sectors of the Iraqi economy, remains heavily patriarchal, with very limited female participation. Even where women are involved in energy projects, they are usually limited to clerical, secretarial or support roles, and are less likely to have access to technical, managerial or decision-making positions. The report emphasizes that this gender gap not only reduces the productivity and diversity of the energy workforce in the sector, but also prevents the optimal use of the potential of women's labor

force in the path of sustainable energy development in Iraq. This research recommends that to create equal opportunities and empower women, comprehensive educational policies, institutional supports, and cultural reforms are necessary so that women's presence in the energy sector goes beyond marginal roles and expands effectively and purposefully.

A report by ESMAP and the World Bank (2022) entitled "Gender in Energy Interventions in Fragile and Conflict Situations", which examines the gender situation in the energy sector of the Middle East and North Africa (MENA) countries, including Iraq, points to the underrepresentation of women in this field. The report shows that despite the employment of hundreds of thousands of people in the Iraqi energy sector, the share of women in this employment is very small and limited. The study emphasizes that in addition to cultural barriers and negative social attitudes towards the presence of women in technical and engineering jobs related to energy, there are also serious institutional challenges that prevent the expansion of women's participation in this sector. These challenges include the lack of suitable working conditions for women, the lack of support facilities, the lack of specialized training programs, and the lack of effective mechanisms to combat sexual abuse and harassment in the workplace. The report also warns that the continuation of this situation will not only deepen the gender gap in employment, but will also be an obstacle to inclusive development and the full utilization of human resources in Iraq. To address these problems, it is recommended that policymakers prioritize the creation of a safe, education-oriented and egalitarian work environment in the energy sector and design and implement special programs to improve the skills and empowerment of women.

A study conducted by Ortega et al. (2020) in the European Union examined the impact of trade, technological learning, and related policies on the employment outlook for wind and solar energy development. The study analyzed gross employment from the deployment of renewable technologies such as photovoltaic (PV), onshore wind, and offshore wind in EU member states up to 2050. The findings showed that these technologies can create significant employment, but the magnitude of this impact varies across technologies, types of activities, and countries. Also, access to technologies such as carbon capture and storage plays a key role in the number of jobs created.

In a study conducted in Pakistan by lrfan et al. (2019), the barriers and policies related to the development of solar energy were examined. Data on solar radiation and wind speed were collected for a period of one year from four major cities of Pakistan. The results showed that solar energy is the best option for the development of renewable energy in this country in terms of price, lifetime, maintenance cost, and operation.

In a study in the Netherlands Bulavskaya & Reynes (2018), using the model CGEM (Multi-sector Macroeconomic Model for Evaluating Environmental and Energy Policies) examined the economic impacts of shifting towards a renewable energy mix. The results of the study showed that the transition to renewable energy could have a positive impact on the country's economy, with an estimated 50,000 new jobs and 1% of GDP expected to be created by 2030.

Another study by Dvorak et al. (2017) in the Czech Republic assessed the employment benefits of investing in renewable energy. The study examined the development of renewable energy in terms of employment creation in the period 2008–2013 and compared it with data from other EU countries, including Germany. The results showed that the largest number of jobs in the Czech Republic were created in the biomass and waste energy processing sector, and that job creation in this sector was strongly dependent on financial incentives.

Mu et al. (2017) studied the impact of renewable energy policies on employment in China using a model. CGE The study looked at direct job changes in the renewable energy sector and indirect changes in the value chains of these energies. The findings showed that the development of solar and wind energy could create up to 45.1 thousand and 15.8 thousand direct and indirect jobs, respectively, per TWh of energy. However, in some cases the overall impact on net employment may be negative.

These studies show that the development of renewable energies can have diverse impacts on employment, which depend on economic, technological, and related policy factors in each country, so examining each sample of

countries can contain appropriate policies for them, considering their different economic, social, and structural characteristics.

The innovation of this research is in examining the impact of renewable energy development on employment, especially women's employment, in developing countries, which has received less attention in previous research. Investment in renewable energy has been raised as one of the emerging challenges in global energy planning, and past studies have mainly focused on developed and industrialized countries with more limited perspectives. This research, with a more comprehensive approach, examines the impact of renewable energy on women's employment in selected developing countries. Among the key innovations of this research is the specific analysis of the role of renewable energy in women's employment through variables such as wage rates, inflation rates, gross domestic product, renewable energy consumption, and non-renewable energy consumption. This approach goes beyond conventional studies and attempts to achieve a deeper understanding of the interaction between sustainable energy development and improving gender equity in the labor market. This study can help policymakers in developing countries to exploit its results to promote women's employment and sustainable economic development.

4. Presenting the model and explaining the research variables

In order to empirically investigate the impact of renewable energy technology development on women's employment in selected countries, the process of estimating and estimating econometric models of the research is carried out in several stages. In the first step, in order to examine the statistical properties of the research variables, panel unit root tests are used to determine the stationarity of the variables and their degree of cointegration. This stage is important because the selection of the appropriate estimation method is directly dependent on the results of the stationarity tests. In the second step, using panel cointegration tests, the existence or absence of a long-term relationship between the model variables is examined. If the existence of a cointegration relationship is confirmed, it is shown that the research variables have a common movement in the long term and a stable equilibrium relationship exists between them. In the third step, the Dynamic Ordinary Least Squares (DOLS) method is used to estimate the long-run coefficients of the model. This method, by considering the lags and pre-lags of the explanatory variables, largely overcomes the problem of simultaneity bias and autocorrelation and provides more efficient estimates than traditional methods. Finally, in order to examine the short-term and long-term dynamics as well as the speed of adjustment towards long-term equilibrium, the Pooled Mean Group (PMG) method proposed by Pesaran et al. (1999) is used. This method allows for heterogeneity of short-term coefficients and homogeneity of long-term coefficients across countries and provides a suitable framework for analyzing the impact of renewable energy development on women's employment in the countries under study.

Accordingly, the empirical model for examining the impact of renewable energy development on women's employment in developing countries is defined as follows:

$$WOMANEMP_{it} = f(RENEWC_{it}, GDPPC_{it}, WAGE_{it}, GFC_{it}) \qquad (4\text{-}1)$$

where it represents the country and represents the time period.

Defining variables

$WOMANEMP_{it}$: It shows the female employment rate in the country and period. This variable is defined as the ratio of the number of employed women to the total population of the country and is used as an indicator of the status of women's economic participation in the labor market. The data for this variable are extracted from the World Bank database.

$RENEWC_{it}$: It indicates the total consumption of renewable energy in the country and period. This variable includes solar energy, hydroelectricity, biomass and other renewable sources. The development and expansion of renewable energy can provide the basis for increasing women's employment by creating new jobs, especially in green and sustainable sectors. Data for this variable are collected from international organizations related to renewable energy.

$GDPPC_{it}$: It shows the GDP per capita in the country and period. An increase in the level of production and per capita income, through increasing aggregate demand and expanding economic activities, can lead to the creation of new job opportunities. Hence, it is expected that there will be a positive relationship between per capita production and women's employment.

$WAGE_{it}$: It shows the real wage rate in the country and period. Due to statistical limitations, the share of employees with wage contracts (wage employment) is used as a proxy for wages. Data for this variable are extracted from the World Bank. An increase in the real wage increases the real cost of labor for firms and can lead to a decrease in labor demand; therefore, an inverse relationship is expected between the real wage and the level of employment.

GFC_{it}: It represents gross fixed capital formation in the country and period. This variable includes investment in infrastructure, machinery, equipment, residential and commercial buildings, and other fixed assets. From a theoretical perspective, domestic investment can lead to increased employment by increasing production capacity and stimulating aggregate demand. However, in the long run and with the possibility of substitution between capital and labor, increased investment may have a negative effect on labor demand. Therefore, the final effect of this variable on women's employment is an empirical matter that is tested in this study.

It should be noted that all research variables have been entered into the model in natural logarithm form to allow the coefficients to be interpreted as elasticity and to reduce severe fluctuations in the data. The information and data required for this study have been collected from reputable international sources including the World Bank and organizations related to renewable energies. Table (4-1) provides a summary of the definitions of the variables, the method of measurement, and the relevant statistical sources.

Table 4-1-Introduction of variables, definitions and data sources

Variable name	Symbol	Variable definition	How to measure	Data source
Women's employment	**WOMANEMP**	**Women's employment rate in the country I and period t**	**Ratio of employed women to the total population of the country**	**World Bank (WB)**
Renewable energy consumption	**RENEWC**	**Total renewable energy consumption**	**Total consumption of solar energy, hydroelectricity, biomass and other renewable sources**	**International Renewable Energy Organizations / World Bank**
GDP per capita	**GDPPC**	**Production level and per capita income**	**GDP per capita (constant prices)**	**World Bank (WB)**
Real wage	**WAGE**	**The real cost of labor**	**Share of employees with wage contracts as a proxy for wages**	**World Bank (WB)**
Gross fixed capital formation	**GFC**	**Fixed domestic investment**	**Percentage of gross fixed capital formation as a percentage of GDP**	**World Bank (WB)**

4.1-Panel unit root test

Before estimating the long-run and short-run relationships between research variables, it is essential to examine the statistical properties of the data and the degree of stationarity of the variables. In this regard, panel unit root tests are used to determine the presence or absence of a unit root in the variables under study and to identify their degree

of cointegration. Performing these tests allows for the selection of the appropriate cointegration method and estimation of econometric models and prevents the occurrence of spurious regressions. Panel unit root tests, due to the simultaneous use of cross-sectional and temporal information, have higher statistical power than single time series tests and are able to take into account heterogeneity among cross-sectional units. In addition, these tests allow for direct examination of the differences in the behavior of variables across countries and, for this reason, have found widespread use in panel studies.

In this study, in order to increase the validity of the results and cover the limitations of single tests, a set of common panel unit root tests were used, including the Levine, Lin, and Cho (LLC) test, the Im, Sons, and Shin (IPS) test, the Madala-Wu-Choi (MWC) test, the Brightong test, and the Hadry test. The LLC test is one of the common panel unit root tests that is based on the generalized Dickey-Fuller test and is performed with the assumption of homogeneity of coefficients among cross-sectional units. In contrast, the IPS test is a more generalized version of the LLC test that abandons the assumption of homogeneity of coefficients and allows for heterogeneity of autocorrelation coefficients among panel components.

However, both the LLC and IPS tests are based on the assumption of cross-sectional independence among the panel units (except for common time effects), an assumption that may not be realistic in cross-country studies, especially in developing countries. For this reason, recent research has paid special attention to the issue of cross-sectional dependence and tests have been developed that are less sensitive to this limitation.

In this framework, the Brightong test has been proposed as a suitable alternative to the LLC and IPS tests. Brightong (2000) shows that the LLC and IPS tests are not sufficiently reliable in the presence of cross-sectional special trends and uncorrected bias, while the Brightong test is more robust to these issues and provides more reliable results.

In addition, the Madala-Wu-Choi (MWC) test, as a nonparametric test based on the Fisher test, has been used to examine the existence of a unit root in panel data. One of the important advantages of this test is that its results do not depend on the choice of different lag lengths in individual Dickey-Fuller regressions and have higher accuracy than the IPS test.

Finally, Hadri's unit root test has also been used as a residual-based Lagrange coefficient test. The distinctive feature of this test is that its null hypothesis, unlike other panel unit root tests, indicates the stationary of the variables and the absence of a unit root. Using this test simultaneously with other tests allows for a more accurate assessment of the degree of stationary of the research variables.

Accordingly, the results of the panel unit root tests for the research variables at levels and first differences are reported in Table (4-2), and the basis for decision-making for conducting panel cointegration tests and estimating long-run and short-run models is provided in the subsequent sections of Chapter 4.

Table 4-2-Unit root test of panel variables

Test type	**Levin, Lin and Chu (LLC)**		**Spread t-stat**	**Im , Pesaran And Shin (IPS) W-stat**	**MW– ADF Fisher Chi-square**	**MW–PP Fisher Chi-square**
Variable						
Women's Employment (WOMANEMP)	**Statistics**	**9.76374-**	**2.56017-**	**1.82375-**	**81.9870**	**120.802**
	Probability	**0.0000**	**0.0052**	**0.0341**	**0.0004**	**0.0000**
Renewable energy	**Statistics**	**11.1752 -**	**1.89524-**	**1.97963-**	**84.3142**	**147.039**

consumption (RENEWC)						
	Probability	**0/0000**	**0/0029**	**0.0239**	**0.0002**	**0/0000**
Gross fixed capital formation (GFC)	**Statistics**	**13.5096 -**	**0.76569**	**4.87364-**	**115.775**	**121.722**
	Probability	**0.0000**	**0.7781**	**0.0000**	**0.0000**	**0.0000**
Gross Domestic Product Per Capita (GDPPC)	**Statistics**	**8.78554-**	**2.74481**	**2.86602-**	**88.8352**	**116.440**
	Probability	**0.0000**	**0.9970**	**0.0021**	**0.0001**	**0.0000**
WAGE	**Statistics**	**4.51983 -**	**11.9516**	**2.23595-**	**81.8765**	**76.8248**
	Probability	**0.0000**	**0.8500**	**0.0127**	**0.0005**	**0.0015**

Source: Research calculations

The results of the panel unit root tests for the research variables are presented in Table (4-2). In order to increase the validity of the results, a set of different tests including Levin, Lin and Chu (LLC), Breitung, Im, Pesaran and Shin (IPS), and Fisher tests based on ADF and PP (MW– ADF) and MW–PP) are used. The null hypothesis in the LLC, Breitung, IPS, and Fisher tests is the existence of a unit root and the invariance of the variables.

Based on the LLC test results, the test statistic for all variables is negative and statistically significant, such that the null hypothesis of the existence of a unit root is rejected at the 99% confidence level. These results indicate that the variables of female employment, renewable energy consumption, gross fixed capital formation, gross domestic product per capita, and real wages are stationary from the LLC test perspective.

IPS test also indicate the rejection of the null hypothesis of the existence of a unit root for all variables at a confidence level of at least 95%. Negative statistics and probability values less than 0.05 for all variables indicate the stationarity of the variables with respect to heterogeneity among cross-sectional units. This finding is of great importance because the IPS test is more flexible to panel heterogeneity than the LLC test.

In the Breitung test, the results are somewhat different. While for the variables of female employment and renewable energy consumption, the null hypothesis of the existence of a unit root is rejected, for the variables of gross fixed capital formation, GDP per capita and real wages, the probability values are high and the null hypothesis is not rejected. This difference in results is to be expected, given the sensitivity of the Breitung test to the data structure and the presence of cross-sectional trends, and justifies the necessity of using multiple unit root tests simultaneously.

Fisher tests based on ADF and PP (MW– ADF) and MW–PP) for all variables reject the null hypothesis of a unit root at the 99% confidence level. The high statistical values and strong statistical significance of these tests provide strong evidence in favor of the stationarity of the variables. Since these tests are less sensitive to the choice of lag length and some restrictive assumptions, their results are highly reliable.

In general, given the majority of the results of the panel unit root tests, it can be concluded that the research variables are mostly stationary or, at worst, have the same degree of cointegration. These findings indicate that the use of panel cointegration methods and the estimation of long-run relationships between variables, including the DOLS and PMG methods, is justified and defensible from an econometric perspective. Accordingly, in the next section, panel cointegration tests will be conducted to examine the existence of a long-run equilibrium relationship between renewable energy development and women's employment.

4.2-Panel Cointegration Test

After examining the stationarity of the research variables and determining their degree of cointegration, the next step in the empirical analysis is to test the existence of a long-run equilibrium relationship between the model variables. In this regard, panel cointegration tests are used to examine the existence or absence of a long-run relationship between the variables under study in the framework of panel data. Confirmation of cointegration shows that although the variables may fluctuate in the short term, they move towards a common equilibrium path in the long term.

Panel cointegration tests have higher statistical power than individual time series tests because they use cross-sectional and temporal information simultaneously and allow for the consideration of heterogeneity among cross-sectional units. Hence, these tests are considered a suitable tool for examining long-run relationships in cross-country studies, especially in developing countries.

In this study, in order to increase the robustness of the results, two common panel cointegration tests, including the Kao test and the Westerlund test, have been used. The Kao cointegration test is based on the generalized Dickey-Fuller test and is based on examining the stationarity of the residuals obtained from the long-term panel regression. In this test, the null hypothesis indicates the absence of a cointegration relationship between the variables, and the rejection of this hypothesis indicates the existence of a common long-term equilibrium relationship between the model variables. Since the Kao test assumes the homogeneity of long-term coefficients among the cross-sectional units, it is mostly used to examine the existence of overall cointegration in the panel.

In contrast, the Westerland cointegration test is based on the panel error correction model and its main focus is on examining the existence of an adjustment mechanism towards long-run equilibrium. In this test, the null hypothesis states that there is no cointegration, and its rejection indicates that a long-run equilibrium relationship exists for at least some of the cross-sectional units. The main advantage of the Westerland test over traditional tests is that it can take into account the heterogeneity of coefficients, cross-sectional dependence, and short-run dynamics among countries; a feature that makes it more suitable for cross-country studies.

Using the Kao and Westerland tests together allows for a more comprehensive assessment of the existence of a long-run relationship between renewable energy development and women's employment. If the results of both tests indicate the existence of cointegration, then the long-run coefficients of the model can be estimated with more confidence through methods such as DOLS and PMG. The results of these tests are reported in the tables below.

Westerlund Panel Cointegration Test

Null hypothesis: No panel cointegration		
Model	**Statistics**	**Probability**
WOMANEMP, RENEWC , GDPPC, GFC , WAGE	**2.3128**	**0.0104**

Source: Research calculations

Cointegration Test Remainder Kavo

Model	**Statistics Dickey-Fuller Generalization Found (ADF)**	**Probability**
WOMANEMP, RENEWC , GDPPC, GFC , WAGE	**1.694777-**	**0.0351**

Source: Research calculations

The results of the panel cointegration tests to examine the existence of a long-run equilibrium relationship between women's employment, renewable energy consumption, GDP per capita, gross fixed capital formation, and

real wages are reported in Tables (4-3) and (4-4). The null hypothesis in both the Westerland and Kao tests indicates the absence of a cointegration relationship between the model variables. Based on the results of the Westerland cointegration test presented in Table (4-3), the value of the test statistic is 2.3128 and its probability value is 0.0104. Given that the probability value is less than the 5 percent error level, the null hypothesis of no cointegration is rejected. This result indicates that a long-term equilibrium relationship exists between the variables under study and that, at least for some of the cross-sectional units, there is an adjustment mechanism towards long-term equilibrium. Since the Westerland test is based on the error correction model and allows for the consideration of heterogeneity and short-term dynamics, its results are highly reliable.

The results of the Kao cointegration test reported in Table (4-4) also confirm this finding. The value of the generalized Dickey-Fuller (ADF) statistic is-1.694777 and its probability value is 0.0351. Since the probability value is less than the 5% error level, the null hypothesis of no cointegration is rejected and the existence of a common long-run relationship between the model variables is confirmed. This result indicates the stability of the residuals obtained from the long-run panel regression and, as a result, the existence of cointegration between the variables.

The concurrence of the results of the Westerland and Kao tests provides strong evidence for the existence of a long-run equilibrium relationship between renewable energy development and women's employment in developing countries. Accordingly, it can be concluded that although the research variables may experience temporary fluctuations in the short run, they converge towards a common equilibrium path in the long run.

As a result, it is econometrically justified and defensible to use long-run estimation methods such as dynamic ordinary least squares (DOLS) and pooled mean group (PMG) to estimate the long-run and short-run coefficients of the model. In the next section, we will estimate the long-run coefficients of the model using the DOLS method.

4.3 Model estimation and coefficient interpretation

Given the results of the panel unit root tests and the confirmation of the existence of a cointegration relationship between the research variables based on the Westerland and Kao tests, this section estimates the long-run coefficients of the model. Since traditional ordinary least squares methods may encounter the problem of bias and simultaneity in the presence of cointegration, in this study, the Dynamic Ordinary Least Squares (DOLS) method has been used to estimate the long-run relationship between the variables.

DOLS method allows controlling for simultaneity, autocorrelation, and bias due to omitted variables, and provides efficient and reliable estimates compared to other panel cointegration methods. These features, especially in cross-country studies and heterogeneous panel data, have made the DOLS method one of the appropriate methods for estimating long-run relationships.

Accordingly, the long-term model of women's employment as a function of renewable energy consumption, GDP per capita, gross fixed capital formation, and real wages has been estimated using the panel DOLS method. The results of this estimation are presented in Table (4-5) and are analyzed and interpreted below.

Table 4-5-Estimation of factors affecting women's employment in selected developing countries

Probability	t -statistic	Standard error	Coefficient	Variable names
0.0000	490575/5	021210/0	116455/0	Renewable energy consumption (RENEWC)
0.0000	481965/5	071581/0	392403/0	Gross Domestic Product Per Capita (GDPPC)
0052/0	064921/2-	086243/0	178085/0-	WAGE

0046/0	863662/2	074609/0	213656/0	Gross fixed capital formation (GFC)
969697/0				R2
968483/0				R 2 modified

The results of estimating the factors affecting women's employment in selected developing countries using the Dynamic Ordinary Least Squares (DOLS) method are presented in Table (4-5). The value of the coefficient of determination (R^2) is 0.9697 and the adjusted coefficient of determination is 0.9684, which indicates that the model has been able to explain a significant part of the changes in women's employment by the explanatory variables used. These high values indicate the appropriate fit of the model and the adequacy of the selected variables in explaining women's employment behavior in the countries under study.

The coefficient of the renewable energy consumption variable (RENEWC) is positive and statistically significant at the 99% confidence level. The value of this coefficient indicates that increasing renewable energy consumption leads to an increase in women's employment in the long run. From an economic perspective, this result indicates that renewable energy development has a high potential to attract female labor in developing countries by creating new jobs in the fields of production, installation, operation, maintenance, and related services. Unlike traditional energy sectors that are often capital-intensive and people-oriented, the renewable energy sector is more user-friendly and decentralized in nature, allowing for greater participation of women in economic activities. This finding is consistent with the green employment theory and related empirical studies and confirms the main hypothesis of the study that renewable energy development has a positive effect on women's employment.

The coefficient of GDP per capita (GDPPC) is positive and significant at the 99% confidence level. This result shows that economic growth plays an important role in increasing women's employment in the long run. An increase in per capita income creates more job opportunities for women through the expansion of economic activities, increased aggregate demand, and the development of service and manufacturing sectors. However, in developing countries, the effect of economic growth on women's employment is highly dependent on the economic structure, quality of institutions, and labor market policies. The results of this study show that overall, economic growth has been able to act as a factor enhancing women's economic participation.

The coefficient of the real wage variable (WAGE) is negative and statistically significant at the 5 percent level. This result indicates that an increase in real labor costs in the long run leads to a decrease in female employment. From a theoretical perspective, an increase in real wages increases the cost of production for firms and leads them to reduce labor demand or replace labor with capital. This effect can have a greater negative impact on female employment in developing countries, whose labor markets are faced with institutional constraints, informal employment, and low flexibility. In particular, women, as one of the vulnerable groups in the labor market, are more affected by the increase in labor costs than other groups.

The coefficient of gross fixed capital formation (GFC) is positive and significant at the 5% confidence level. This result shows that increasing domestic investment in the long run leads to an increase in women's employment. Investment in infrastructure, manufacturing industries and development projects, by increasing production capacity and stimulating aggregate demand, creates new job opportunities, part of which can be allocated to attracting female labor. This finding indicates that in developing countries, the complementary effect of capital and labor in the long run is dominant over its substitution effect and domestic investment has played a positive role in improving the employment situation of women.

Overall, the DOLS estimates show that renewable energy development and economic growth, as two key factors, play a positive and significant role in increasing women's employment in developing countries, while increasing real wages can have a deterrent effect on women's employment. Domestic investment also helps improve women's economic participation by expanding productive capacities and creating new job opportunities.

4-3-1-Estimation of the short-term coefficients of the model

After estimating the long-run relationships among the research variables using the dynamic ordinary least squares (DOLS) method, this section examines the short-run dynamics and the speed of adjustment of women's employment to short-run shocks. In order to achieve this goal, the framework of the panel error correction model and the Pooled Mean Group (PMG) method are used. This method allows for the separation of the short-run and long-run effects of the variables while allowing for the short-run coefficients to be heterogeneous across countries.

PMG method is based on the assumption that in the long run, the coefficients of the explanatory variables are homogeneous across countries, while short-run responses and the speed of adjustment towards long-run equilibrium can vary across countries. This feature is particularly important in cross-country studies and in developing economies, which have significant differences in economic, institutional, and labor market structures.

In the framework of the error correction model, the error correction term coefficient (ECT) plays a key role in analyzing short-term dynamics. This coefficient indicates the speed of adjustment of short-term deviations from the long-term equilibrium path. The negative and significant error correction coefficient indicates that in the event of short-term shocks, women's employment gradually returns to the long-term equilibrium and the system has long-term stability. The value of this coefficient indicates what proportion of the imbalance created in each time period is adjusted.

In addition to the error correction coefficient, the short-run coefficients of the variables renewable energy consumption, GDP per capita, real wages, and gross fixed capital formation reflect the immediate and transitory effects of these variables on women's employment. These coefficients allow us to examine the differences in the response of women's employment to short-term economic and energy shocks across the countries studied.

Accordingly, the results of the short-term estimation of the panel error correction model using the PMG method are reported in Table (4-6) and are analyzed and interpreted below.

Table 4-6-Estimation of the short-run relationship between Variables

Short- term				**Independent variables**
Probabilities	**Statistics t**	**Standard error**	**Coefficient**	
0/0009	**541985/2**	**078229/0**	**198857/0**	**D(RENEWC)**
0/0002	**800394/3**	**034458/0**	**130954/0**	**D(GDPPC)**
0/0003	**206183/3-**	**054660/0**	**175250/0-**	**D(LGFC)**
0/0004	**663318/4-**	**026580/0**	**123951/0-**	**D(LWAGE)**
0113/0	**576421/2**	**959816/0**	**472891/2**	**C**
Long term				
0/0003	**324814/3-**	**196903/0**	**654666/0-**	**COINTEQ**

The results of estimating the short-run relationship between women's employment and explanatory variables using the panel error correction model and the pooled mean group (PMG) method are presented in Table (4-6). These results allow for the examination of the instantaneous and transient responses of women's employment to short-run changes in economic and energy variables, while at the same time testing the stability of the long-run relationship between the variables through the error correction coefficient.

The coefficient of variation of renewable energy consumption (D(RENEWC)) is positive in the short term and statistically significant at the 99% confidence level. This result indicates that increasing renewable energy consumption can lead to increased female employment even in the short term. From an economic perspective, this finding indicates that the development of renewable energy projects, in addition to its long-term effects, also has the

capacity to attract female labor in the short term by creating immediate job opportunities in the installation, commissioning, and ancillary services phases. This result emphasizes the dynamic role of the renewable energy sector in creating green employment in developing countries.

The coefficient of variation of GDP per capita (D(GDPPC)) is positive and significant at the 99% confidence level. This finding suggests that improving economic conditions and increasing economic activity, even in the short term, can have a positive effect on women's employment. Short-term economic growth creates more job opportunities for women through increased aggregate demand and expansion of service and manufacturing activities, although the sustainability of this effect requires economic stability and complementary labor market policies.

The coefficient of variation of gross fixed capital formation (D(LGFC)) is negative and statistically significant. This result indicates that increasing investment in the short run may lead to a decrease in female employment. From an economic perspective, this finding could reflect the capital-intensive nature of investment projects in the short run; in such a way that in the early stages, investment is more directed towards machinery, technology, and equipment, and the substitution effect of capital instead of labor overcomes its complementarity effect. This result is consistent with theoretical predictions that the short-run and long-run effects of investment on employment are different.

The coefficient of variation of real wages (D(LWAGE)) is negative and significant at the 99% confidence level. This result indicates that an increase in real labor costs in the short run leads to a decrease in female employment. An increase in real wages increases the cost of production of firms and in the short run can lead to a decrease in hiring or layoffs. This effect can have a particularly negative impact on female employment in developing countries, where labor markets face institutional constraints and low flexibility.

The coefficient of the width of origin (C) is positive and significant, indicating the existence of structural and institutional factors affecting women's employment that are not directly included in the model, but affect the level of women's employment in the short term. These factors can include labor market policies, social, institutional and cultural conditions of the countries under study.

The coefficient of the error correction term (COINTEQ) is negative and statistically significant at the 99% confidence level. The negative and significant nature of this coefficient indicates the existence of an adjustment mechanism towards long-term equilibrium and the stability of the relationship between the model variables. The value of this coefficient indicates that in the event of short-term shocks, part of the imbalance created in each time period is adjusted and women's employment gradually returns to the long-term equilibrium path. In other words, the system has long-term stability and temporary shocks do not have permanent effects on women's employment.

Overall, the short-term estimation results show that renewable energy consumption and economic growth have a positive effect on women's employment even in the short term, while increasing real wages and capital-intensive investment can have a deterrent effect on women's employment in the short term. Also, the presence of a significant negative error correction coefficient confirms the stability of the long-term relationship between the variables. These findings, together with the long-term results, provide a comprehensive picture of the dynamics of women's employment in developing countries.

5. Conclusions and suggestions

The main objective of this study is to examine the impact of renewable energy development and consumption on women's employment in developing countries, with a particular emphasis on the Iraqi economy. To this end, a combination of panel and time series econometric methods was used to accurately analyze both the general pattern of developing countries and the specific characteristics of an oil-based economy.

The results of the panel unit root tests showed that the research variables mainly had the same order of cointegration or were a combination of stationary variables at the level and non-stationary variables of the first order. Also, the Westerlund and Kao panel cointegration tests confirmed the existence of a long-run equilibrium relationship between female employment, renewable energy consumption, GDP per capita, gross fixed capital formation and real

wages. These results indicate that the variables under study, despite short-term fluctuations, move towards a common equilibrium path in the long run.

Long-term panel estimates using the dynamic ordinary least squares (DOLS) method showed that renewable energy consumption has a positive and significant effect on women's employment in developing countries. This finding suggests that the development of renewable energy can lead to increased women's economic participation by creating green jobs, expanding emerging economic sectors, and reducing the concentration of employment in people-oriented sectors. Also, GDP per capita and gross fixed capital formation also had a positive and significant effect on women's employment, indicating the role of economic growth and domestic investment in creating job opportunities for women. In contrast, real wages showed a negative and significant effect on women's employment, indicating an increase in labor costs and a decrease in the demand of firms to hire labor, especially women, in developing countries.

The results of the short-term estimation using the panel error correction model (PMG) showed that renewable energy consumption and economic growth have a positive and significant effect on women's employment even in the short term. In contrast, the increase in real wages and gross fixed capital formation had a negative effect on women's employment in the short term, which indicates the dominance of the substitution effect of capital for labor and the rapid response of firms to the increase in labor costs. The negative and significant error correction coefficient also confirmed the existence of an adjustment mechanism towards long-term equilibrium and the stability of the relationship between the research variables. Dickey-Fuller unit root tests showed that the research variables are a combination of stationary variables at the level and non-stationary variables of the first order. The Engel-Granger cointegration test also confirmed the existence of a long-run equilibrium relationship between the variables in the Iraqi economy. The estimation of the long-run relationship using the time series DOLS method showed that renewable energy consumption, GDP per capita and gross fixed capital formation have a positive and significant effect on women's employment in Iraq, while the wage rate shows a negative and significant effect on women's employment.

Comparing the panel results and the results specific to Iraq showed that although the direction of the effect of the variables is consistent at both levels of analysis, the magnitude of the effect of renewable energy consumption on women's employment in Iraq is stronger than the average for developing countries. This result indicates that in an oil-based economy like Iraq, the development of renewable energy can serve as an effective tool for economic diversification, reducing dependence on the oil sector, and creating new job opportunities for women.

Overall, the findings of this study indicate that the development of renewable energy is of strategic importance not only from an environmental perspective, but also from the perspective of job creation and gender equity. The results of the study emphasize that energy policies can be used as an effective tool to promote women's employment and achieve sustainable development in developing countries, especially in the Iraqi economy.

5.1-Policy implication

The main objective of this study was to investigate the impact of renewable energy consumption on women's employment in developing countries during the period 2000 to 2022. To achieve this goal, panel econometric methods were used, including unit root and cointegration tests, estimating long-run relationships with the dynamic ordinary least squares (DOLS) method, and analyzing short-run relationships using the error correction model and the pooled mean group (PMG) method. The results of the unit root tests showed that the research variables are a combination of stationary variables at the level and first-order non-stationary variables. Also, the results of the cointegration tests confirmed the existence of a long-run equilibrium relationship between women's employment, renewable energy consumption, GDP per capita, gross fixed capital formation, and real wages, which indicates the long-run convergence of these variables.

The results of long-term estimates showed that the use of renewable energy has a positive and significant effect on women's employment in developing countries. This finding indicates that the development of renewable energy can provide more job opportunities for women and increase their economic participation by creating green jobs, expanding new economic activities, increasing investment in clean technologies, and developing the value chain of

related industries. Also, GDP per capita and gross fixed capital formation also had a positive and significant effect on women's employment, which indicates the role of economic growth and investment in creating job opportunities and improving the labor market situation of women. In contrast, real wages showed a negative and significant effect on women's employment, which could be due to increased labor costs and a decrease in the willingness of firms to attract labor, especially in developing economies.

The results of short-term estimates also showed that renewable energy consumption and economic growth have a positive and significant effect on women's employment even in the short term, while an increase in real wages and gross fixed capital formation have a negative effect on women's employment in the short term. This result indicates that in the short term, some investments may be directed towards capital-intensive technologies and lead to the substitution of capital for labor, especially female labor. Also, the negative and significant error correction coefficient indicates the existence of an adjustment mechanism and the return of variables to the long-term equilibrium path after the occurrence of short-term shocks.

Overall, the findings of this study show that the development of renewable energies is of strategic importance not only from the perspective of environmental protection and reduction of pollutant emissions, but also from the perspective of job creation, women's economic empowerment, and achieving inclusive growth. Therefore, the transition to clean energies can be used as one of the effective policy tools to reduce gender inequalities in the labor market, increase women's economic participation, and achieve sustainable development goals in developing countries.

Based on the research results, it is recommended that policymakers design and implement renewable energy development in an integrated manner with employment and women's empowerment policies to facilitate women's presence in all links of the industry's value chain, from design and production to installation, operation, maintenance, and technical services. Also, developing technical and vocational training, improving women's specialized skills in the field of clean energy technologies, and supporting women's entrepreneurship in green industries can pave the way for their broader entry into this market.

In addition, channeling domestic and foreign investment into renewable energy projects, especially small-scale, local, and employment-generating projects, can create more job opportunities for women. On the other hand, reforming labor market policies by reducing non-wage employment costs, providing tax and insurance incentives to firms that employ female labor, and implementing support programs to increase women's economic participation can reduce the negative effects of rising labor costs on women's employment. Finally, strengthening economic diversification, reducing dependence on traditional industries, and continuing investment in green technologies and renewable energies will, in addition to promoting energy security and economic growth, pave the way for sustainable employment and reducing the gender gap in the labor market of developing countries.

References

1. Amini, Alireza, Neshat, Haji Mohammad, and Eslahchi, Mohammadreza. (2007). Revision of the time series estimation of the employed population by economic sectors of Iran, 1335-1385. Journal of Planning and Budgeting, 51, 35-65.
2. Berimani, Mehdi, and Kaabi Nejadian, Abdolrazzaq. (2014). Renewable Energy and Sustainable Development in Iran. Volume 1, Issue 1, 21-26.
3. Behnamian, Mehdi. (2012). The Effect of Real Exchange Rate on Unemployment Rate in Iran. Economic Journal, 11 and 12, 23-40.
4. Jang-Avar, Hassan, Emami-Meybodi, Ali, Noorollahi, Younes, Sattarifar, Mohammad, and Khorsandi, Morteza. (2017). Study and analysis of the impact of renewable energy development on macroeconomic indicators. Strategic Studies of Public Policy, 7(24), 137-158.
5. Hafeznia, Mohammad Reza. (2012). An Introduction to Research Methods in the Humanities. Samt Publications.
6. Hassani Sadrabadi, Mohammad Hossein, Emad al-Islam, Hedieh, and Kashmari, Ali. (2007). Investigating the causal relationship between energy consumption, employment and gross domestic product of Iran during the years 1971-2005. Journal of Humanities and Social Sciences of Economic Sciences, 24.
7. Iranian New Energy Organization. (2013). Renewable Energy Development Report. Ministry of Energy, Islamic Republic of Iran.
8. Saadi, Mohammad Reza, and Mousavi, Mir Hossein. (2014). Study of factors and policies affecting labor force employment. Quarterly Journal of Economic Research, 13(49), 177-198.

9. Safiri, Khadija. (2014). Obstacles and problems of women's employment. Work and Society, 39, 80.
10. Sharafat Jahromi, Mohammad Naser, and Shakeri, Mohammad. (2010). Study and comparison of crude oil price and petroleum product tax on price and equilibrium demand of petroleum products in OECD countries. Economics and Modeling, 1(1), 1-21.
11. Sharifi, Alimorad, Khoshakhlaq, Rahman, Bahalu Hoore, and Sadeghi Hamedani. (2014). Evaluating the impact of energy price increases on employment: A computable general equilibrium approach. Quarterly Journal of Economic Modeling Research, 4(16), 153-180.
12. Shiri, Yahya, and Rahmani, Leila. (2009). Analysis and Estimation of the Demand Function for Labor in Kermanshah Province. Planning and Budget, 14(1), 101-128.
13. Sadeghi, Zein-El-Abedin, Shams-Al-Dinpour, Fatemeh, and Mirzaei, Hamidreza. (2016). Employment Potential of New Energies: Photovoltaic and Wind Energy Project Using Input-Output Approach. Year 5, Issue 19, 145-177.
14. Safari, Fatemeh. (1999). Social model, position and role of Muslim women in Islamic society. Islamic Propaganda Organization.
15. Saydaei, Seyed Eskandar, Bahari, Isa, and Zarei, Amiri. (2011). A study of the employment and unemployment situation in Iran during the years 1956-2010. Yas Strategy, 25, 216-224.
16. Becker, GS (1964). Human capital: A theoretical and empirical analysis, with special reference to education. University of Chicago Press.
17. Bera, R., Mishra, P., & Patnaik, P. (2024). Renewable energy for women empowerment: Experiences from rural West Bengal. Renewable and Sustainable Energy Reviews, 198, 114446. https://doi. org/10.1016/j. rser.2024.114446
18. Breitung, J. (2000). The local power of some unit root tests for panel data. In BH Baltagi (Ed.), Nonstationary panels, panel cointegration, and dynamic panels (pp. 161-177). JAI Press.
19. Bulavskaya, T., & Reynès, F. (2018). Job creation and economic impact of renewable energy in the Netherlands. Renewable Energy, 119, 528-538. https://doi. org/10.1016/j. renene.2017.12.039
20. Dickey, DA, & Fuller, WA (1979). Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74(366), 427-431. https://doi. org/10.1080/01621459.1979.10482531
21. Dvořák, P., Martinát, S., Van der Horst, D., Frantál, B., & Turečková, K. (2017). Renewable energy investment and job creation: A cross-sectoral assessment for the Czech Republic with reference to EU benchmarks. Renewable and Sustainable Energy Reviews, 69, 360-368. https://doi. org/10.1016/j. rser.2016.11.158
22. Elfani, M. (2011). The impact of renewable energy on employment in Indonesia. International Journal of Technology, 2(1), 47-55.
23. Engle, RF, & Granger, CWJ (1987). Co-integration and error correction: Representation, estimation, and testing. Econometrica, 55(2), 251-276. https://doi. org/10.2307/1913236
24. ESMAP, & World Bank. (2022). Gender in energy interventions in fragile and conflict-affected situations: Middle East and North Africa. World Bank. https://doi. org/10.1596/978-1-4648-1846-7
25. Hadri, K. (2000). Testing for stationarity in heterogeneous panel data. The Econometrics Journal, 3(2), 148-161. https://doi. org/10.1111/1368-423X.00043
26. Hutabarat, SPH, & Shields, M. (2024). Powering prosperity: Unveiling the impacts of renewable energy policies on economy, employment, and income distribution in Indonesia. Next Research, 1(2), 100080. https://doi. org/10.1016/j. nexres.2024.100080
27. Im, KS, Pesaran, MH, & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. Journal of Econometrics, 115(1), 53-74. https://doi. org/10.1016/S0304-4076(03)00092-7
28. International Labor Organization. (2020). World employment and social outlook: Trends 2020. ILO.
29. International Renewable Energy Agency. (2019). Renewable energy and jobs: Annual review 2019. IRENA.
30. Irfan, M., Zhao, ZY, Ahmad, M., & Mukeshimana, MC (2019). Solar energy development in Pakistan: Barriers and policy recommendations. Sustainability, 11(4), 1206. https://doi. org/10.3390/su11041206
31. Jin, Y., Yang, J., Feng, C., & Li, Y. (2024). The employment impacts of fossil fuel trade across cities in China: A telecoupling perspective. Energy, 307, 132751. https://doi. org/10.1016/j. energy.2024.132751
32. Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. Journal of Econometrics, 90(1), 1-44. https://doi. org/10.1016/S0304-4076(98)00023-2
33. Klasen, S., & Lamanna, F. (2009). The impact of gender inequality in education and employment on economic growth: New evidence for a panel of countries. Feminist Economics, 15(3), 91-132. https://doi. org/10.1080/13545700902893106
34. Levin, A., Lin, CF, & Chu, CSJ (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. Journal of Econometrics, 108(1), 1-24. https://doi. org/10.1016/S0304-4076(01)00098-7
35. Lou, J., Hu, G., Shen, X., & Cui, RY (2025). Quantifying the economy-wide employment effects of coal-fired power plants: Two different cases China and the United States. Applied Energy, 377, 124561. https://doi. org/10.1016/j. apenergy.2024.124561
36. Maddala, GS, & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. Oxford Bulletin of Economics and Statistics, 61(S1), 631-652. https://doi. org/10.1111/1468-0084.0610s1631
37. Middle East Institute. (2023). Youth dynamics and Iraq's energy future. Middle East Institute.
38. Mu, Y., Cai, W., Evans, S., Wang, C., & Roland-Holst, D. (2018). Employment impacts of renewable energy policies in China: A decomposition analysis based on a CGE modeling framework. Applied Energy, 210, 256-267. https://doi. org/10.1016/j. apenergy.2017.10.086

39. Okun, AM (1962). Potential GNP: Its measurement and significance. American Statistical Association.
40. Organization for Economic Co-operation and Development. (2019). Income inequality and Gini coefficient analysis. OECD.
41. Ortega, M., del Río, P., Ruiz, P., Nijs, W., & Politis, S. (2020). Analyzing the influence of trade, technology learning and policy on the employment prospects of wind and solar energy deployment: The EU case. Renewable and Sustainable Energy Reviews, 122, 109657. https://doi. org/10.1016/j. rser.2019.109657
42. Pearl-Martinez, R., & Jenny, J. (2016). Powering change: Women in the energy transition. IUCN Global Gender Office.
43. Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and Statistics, 61(S1), 653-670. https://doi. org/10.1111/1468-0084.0610s1653
44. Pesaran, MH (2004). General diagnostic tests for cross section dependence in panels. University of Cambridge, Faculty of Economics.
45. Pesaran, MH (2007). A simple panel unit root test in the presence of cross-section dependence. Journal of Applied Econometrics, 22(2), 265-312. https://doi. org/10.1002/jae.951
46. Pesaran, MH, Shin, Y., & Smith, RP (1999). Pooled mean group estimation of dynamic heterogeneous panels. Journal of the American Statistical Association, 94(446), 621-634. https://doi. org/10.1080/01621459.1999.10474156
47. Petrovich, N. (2016). Gender and sustainable development: Maximizing the economic, social and environmental role of women. OECD.
48. Sari, A., & Akkaya, M. (2016). Contribution of renewable energy potential to sustainable employment. Procedia-Social and Behavioral Sciences, 229, 316-325. https://doi. org/10.1016/j. sbspro.2016.07.143
49. Schumpeter, JA (1942). Capitalism, socialism and democracy. Harper & Brothers.
50. Simas, M., & Pacca, S. (2014). Assessing employment in renewable energy technologies: A case study for wind power in Brazil. Renewable and Sustainable Energy Reviews, 31, 83-90. https://doi. org/10.1016/j. rser.2013.11.046
51. Stock, JH, & Watson, MW (1993). A simple estimator of cointegrating vectors in higher order integrated systems. Econometrica, 61(4), 783-820. https://doi. org/10.2307/2951763
52. Tobin, J. (1965). Money and economic growth. Econometrica, 33(4), 671-684. https://doi. org/10.2307/1910352
53. United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development. United Nations.
54. Westerlund, J. (2007). Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics, 69(6), 709-748. https://doi. org/10.1111/j.1468-0084.2007.00477. x
55. World Bank. (2021). Women, business and the law 2021. World Bank.
56. World Bank. (2023). Empowering women in Iraq: The hidden cost of electricity shortages. World Bank Group.
57. Zhang, R., Li, W., Li, Y., & Li, H. (2024). Job losses or gains? The impact of supply-side energy transition on employment in China. Energy, 308, 132804. https://doi. org/10.1016/j. energy.2024.132804