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THE RELATIONSHIP BETWEEN THE SECTORAL STRUCTURE OF FEMALE EMPLOYMENT AND ECONOMIC GROWTH AND INCOME DISTRIBUTION IN TÜRKİYE: EMPIRICAL EVIDENCE FROM FOURIER-BASED COINTEGRATION AND CAUSALITY ANALYSES

Türkiye'deki Kadın İstihdamının Sektörel Yapısı ile Ekonomik Büyüme ve Gelir Dağılımı Arasındaki İlişki: Fourier Tabanlı Eşbütünleşme ve Nedensellik Analizlerinden Ampirik Kanıtlar

Aslı ÖZEN ATABEY* **& Mustafa KARAKUŞ****

Keywords: Female Employment, Sectoral Structure, Economic Growth, Income Distribution

JEL Codes: J16, J23, O11, O15, C32

Abstract

This study aims to evaluate the contribution of female labour force to the economy in a more comprehensive framework by analysing the relationship between the sectoral structure of female employment in Türkiye and economic growth and income distribution. Using data from the Turkish economy (1991–2023), the study employs FADL and RALS-FADL cointegration tests to analyze long-term relationships and the Fourier Toda-Yamamoto test to assess causality. The findings indicate significant long-run relationships between women's employment in total, services, industry, and agriculture with economic growth and income distribution. While increased female employment in all sectors improves income distribution, agricultural employment negatively impacts economic growth, and the effect of total female employment on growth remains limited. The causality analysis findings reveal that income distribution is a determining factor for female employment in the service sector and total female employment, while industrial female employment is effective on income distribution. There is also evidence that economic growth affects women's employment in the agricultural sector. These findings indicate that policies targeting female employment have sectorally differentiated impacts on economic growth and income distribution, thus underscoring the necessity for sector-specific targeted strategies.

Anahtar Kelimeler: Kadın İstihdamı, Sektörel Yapı, Ekonomik Büyüme, Gelir Dağılımı

JEL Kodları: J16, J23, O11, O15, C32

Öz

Bu çalışmada, Türkiye'deki kadın istihdamının sektörel yapısı ile ekonomik büyüme ve gelir dağılımı arasındaki ilişkiyi analiz ederek, kadın işgücünün ekonomiye olan katkısının daha kapsamlı bir çerçevede değerlendirilmesi amaçlanmaktadır. Türkiye ekonomisine ait 1991-2023 veriler kullanılarak yapılan çalışmada, değişkenler arasındaki uzun dönemli ilişkiler FADL ve RALS-FADL eşbütünleşme testleriyle, nedensellik ilişkisi ise Fourier Toda-Yamamoto testi ile analiz edilmiştir. Elde edilen bulgular toplam, hizmet, sanayi ve tarım sektörlerindeki kadın istihdamı ile ekonomik büyüme ve gelir dağılımı değişkenleri arasında uzun dönemli ilişkiler bulunduğunu göstermektedir. Analiz sonuçlarına göre, tüm sektörlerdeki ve toplam kadın istihdamındaki artış gelir dağılımını iyileştirirken, tarım sektöründeki kadın istihdamı ekonomik büyümeyi olumsuz etkilemekte ve toplam kadın istihdamının büyüme üzerindeki etkisi sınırlı kalmaktadır. Nedensellik analizi bulguları, gelir dağılımının hizmet sektöründe ve toplam kadın istihdamı üzerinde belirleyici bir faktör olduğunu, sanayi sektöründeki kadın istihdamının ise gelir dağılımı üzerinde etkili olduğunu ortaya koymaktadır. Ayrıca, ekonomik büyümenin tarım sektöründeki kadın istihdamını etkilediğine dair ampirik kanıtlar elde edilmiştir. Bu bulgular, kadın istihdamına yönelik politikaların ekonomik büyüme ve gelir dağılımı üzerindeki etkilerinin sektörel düzeyde farklılık gösterdiğini ortaya koymakta olup, politika yapıcılar için sektörel bazda hedeflenmiş stratejiler geliştirilmesi gerekliliğine vurgu yapmaktadır.

* Assoc. Prof. Dr., Kahramanmaraş Sütçü İmam University, Vocational School of Social Science, Türkiye, aatabey@ksu.edu.tr (Corresponding Author)
** ** Asst. Prof. Dr., Ankara Hacı Bayram Veli University, Faculty of Financial Sciences, Türkiye, mustafa-karakus@hbv.edu.tr

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1. Introduction

Economic growth and income distribution are key parameters of national development. Labour market efficiency and demographic diversity play a critical role in optimising these parameters. Female employment is an endogenous determinant in reducing income asymmetries by increasing economic productivity, and the integration of women into the labour force positively affects both individual welfare and macroeconomic dynamics (Goldin, 2014; World Bank, 2020).

In the literature, the impact of women's employment on economic growth has been addressed through different theoretical frameworks. Becker's (1991) human capital theory assumes that individuals' education, skills and experience play a critical role in maximising economic returns. Within this context, a rise in women's educational attainment strengthens their economic autonomy and transforms socio-economic structures by increasing their participation in the labour market. In the traditional family model, it is common for women to be allocated to childcare and domestic work, whereas in modern societies, women are employed in jobs with higher income potential due to higher levels of education. However, factors such as interrupted career patterns and motherhood in the labour market increase the likelihood of women experiencing wage disadvantages. Becker (1991) predicts that the expansion in education and job opportunities will reduce this wage asymmetry over time. On the other hand, feminist economic approaches emphasise that women's labour is not limited to market activities, and also makes important contributions to non-market production processes such as domestic labour, care services and volunteer work. Folbre (2009) argues that traditional economic models do not adequately take women's labour into account and that women's economic contributions are ignored. According to her, updating economic policies with a gender perspective and implementing regulations that support women's employment will strengthen both economic growth and social justice. Similarly, Kabeer (2016) emphasizes that female labor force engagement promotes economic growth, but economic growth does not always increase women's employment. Especially in economies of lower and middle development, women mostly work in low-paid and precarious jobs, and their access to the labour market is restricted due to patriarchal norms. Women's employment fuels economic growth by supporting household welfare and productivity. However, for this process to be effective, state policies and social support mechanisms that support gender equality are needed (Kabeer, 2016). In this framework, increasing women's employment should be considered as an essential component of economic development and income distribution.

The integration of women into the labor force generates positive outcomes for economic expansion and poverty reduction (OECD, 2017). In this context, the OECD (2013) stresses the urgent need for developing and emerging economies to tackle the gendered dimensions of poverty. The organization advocates for development assistance to prioritize gender equality and women's economic empowerment, particularly within productive sectors.

The positive correlation between female employment and economic growth is further strengthened by the adoption of gender equality policies. According to the 'Women, Business and the Law 2020' report, equal representation of women in the labour market increases household incomes, facilitates children's access to education and contributes to increased social welfare. Moreover, greater participation of women in economic life encourages innovation, increases economic diversity and contributes to sustainable growth. However, in many countries, the legal

and institutional barriers that women face in the labour market impede the full realization of this positive impact (World Bank, 2020). Therefore, strengthening policies to increase women's employment is considered a critical requirement for economic growth and social welfare.

Eliminating gender-based labour force participation gaps offers significant opportunities for economic growth, although they vary across countries (OECD, 2017). High female employment rates in advanced economies are positively correlated with per capita income and economic stability. However, the economic effects of female employment are heterogeneous depending on sectoral dynamics (Gaddis and Klasen, 2014).

To analyze the effects of female employment on economic growth and income distribution holistically, it is crucial to examine the historical development and sectoral transformation of women's participation in the labour force in Türkiye. To properly evaluate the progress made during the Republican era, the structure of female labour inherited from the Ottoman Empire must also be considered (Makal, 2010: 17). In the Ottoman Empire, "female labour was concentrated in areas such as agriculture, home-based production, and weaving, and gradually moved to small workshops and factories. In the late 19th century and during World War I, the decrease in male labour force led to Muslim women becoming more visible in industrial production (Quataert, 1999; Sussitzki, 1966; Makal, 2010). The results of the 1913-1915 Industrial Census show that approximately one third of the labour force in the industrial sector is made up of women and that this employment is concentrated especially in the textile and food sectors (Ökçün, 1970).

With the declaration of the Republic, the social position of women was strengthened through legal and institutional reforms. The 1926 Turkish Civil Code granted women equal rights in areas such as marriage, divorce and inheritance; educational reforms increased the participation of girls in education, and opened the way for women to be employed in sectors such as health, education, and public administration (İnce Yenilmez, 2023; İzgi Balcı and Akdeniz, 2011). In addition, regulations such as maternity leave and equal pay for equal work have supported women's participation in the labour market (Şenol and Mazman, 2013).

The 1927 Industrial Census data show that 23.7% of workers over the age of 14 in enterprises employing 4 or more workers were women. In large enterprises under the Law on the Encouragement of Industry, the rate of female workers hovered around 24-25%; female labour was largely concentrated in the weaving sector (Tökin, 1946; Makal, 2002). Following the 1936 Labour Law, the ratio of women among wage earners was 18.89% in 1937, while this rate increased to 17.59% in 1947 (Prime Ministry Directorate General of Statistics, 1945).

The sectoral distribution of women's labour is a legacy inherited from the Ottoman Empire. According to the data under the Labour Law, 84.4% of women were employed in the weaving, food, beverage, and tobacco sectors in 1937 and 87.6% in 1943 (Prime Ministry Directorate General of Statistics, 1945). These data show that women's labour was largely concentrated in the weaving and agricultural product processing sectors.

The decline in the male labour force during the Second World War led to an increased share of women and children in industrial production. The 1940 National Protection Law facilitated the employment of women and children (Makal, 2010: 36). By 1943, the proportion of girls among working children between the ages of 12-16 had increased to 45.92%, and when girls and women were considered together, the total proportion of women rose to 29% (Prime Ministry General Directorate of Statistics, 1945; Makal, 2010: 24). The general conclusion that can be drawn from

these developments is that women's participation in the labour force increased due to legal and institutional reforms in the Republican period, however, the sectoral distribution of women's labour continued to be largely concentrated in traditional sectors and became more visible in industrial production, especially during periods of war and crisis.

Table 1. Distribution of Employment by Gender and Economic Sectors in Türkiye (1995-2000) (%)

Gender	Years	Agriculture	Mining	Manufacturing	Electricity, Gas and Water	Construction	Trade Restaurants and Hotels	Transport and Storage	Financial Institutions	Services
Female	1955	95,6	0.0	2,3	0.0	0.0	0,2	0,1	0,1	1,1
	1960	95.0	0.0	2,7	0.0	0.0	0,1	0,1	0,2	1,4
	1965	94,1	0.0	1,5	0.0	0.0	0,1	0,1	0,2	2.0
	1970	89.0	0,1	5,1	0.0	0,2	0,5	0,3	0,6	3,3
	1975	87,5	0.0	4,3	0.0	0,1	0,8	0,3	0,9	4,9
	1980	86,5	0.0	4,6	0.0	0,1	0,8	0,4	1,2	5,8
	1985	85,6	0.0	4,5	0.0	0,1	1,2	0,5	1,4	6,4
	1990	81,3	0.0	6,7	0,1	0,1	1,7	0,5	2.0	7,4
	2000	75,2	0.0	6,6	0,1	0,2	3,7	0,7	2,9	10,5
Male	1955	63,6	0,9	8,7	0,2	2,9	4,3	2,7	0,4	6,3
	1960	61,1	1.0	9,6	0,2	3,7	4,5	3,1	0,5	7,8
	1965	58,4	1.0	10,5	0,3	4,1	3,9	3,3	0,6	8,7
	1970	52,3	1,2	10,9	0,2	4,8	7,2	3,9	1,3	15,5
	1975	53,3	1.0	11.0	0,2	5.0	7,1	4,4	1,6	14,8
	1980	42.0	1,2	14,5	0,3	6,8	9,2	4,6	2.0	18,4
	1985	41,2	1,1	14,4	0,2	5,9	10,3	4,7	2,3	19,1
	1990	36,3	0,9	14,9	0,5	8,1	11,7	5,1	2,7	18,9
	2000	32,4	0,6	16.0	0,5	7,2	13,2	4,8	3,3	21,8

Source: Turkish Statistical Institute (TURKSTAT), 2012.

Table 1 presents the gender distribution of employment by economic activity in Türkiye for the period 1955-2000. Upon analyzing the table, it is evident that women were predominantly concentrated in the agricultural sector. While 95.6 percent of women were employed in agriculture in 1955, this proportion decreased to 75.2 percent by 2000. In contrast, the share of women in the manufacturing industry saw a modest increase; employment in the manufacturing sector rose from 2.3 percent in 1955 to 6.6 percent in 2000. In sectors such as electricity, gas and water, female employment remained quite low throughout the period.

Regarding male employment, sectoral differentiation was considerably more pronounced. While the employment rates of men employed in agriculture decreased from 63.6 percent in 1955 to 32.4 percent in 2000, their employment rates in the industrial and service sectors experienced significant increases. Notably, male employment in the manufacturing and construction sectors consistently exceeded female employment throughout this period. In conclusion, despite a general shift in Türkiye 's employment structure from agriculture towards industry and services between 1955 and 2000, women's participation in this transformation was relatively limited. Consequently, the sectoral diversity of the female labor force remained low, and gender-based segregation persisted.

In Türkiye, TurkStat reorganized its employment data according to the NACE classification in the 2000s to align with European Union (EU) standards and consequently aggregated employment statistics under broader categories such as Agriculture, Industry,

Construction and Services instead of sub-sectors such as mining and manufacturing (TURKSTAT, 2024).

Table 2. Distribution of Employment by Gender and Economic Sectors in Türkiye (2005-2024) (%)

Years	Female				Male			
	Agriculture	Industry	Construction	Services	Agriculture	Industry	Construction	Services
2005	46.7	16.5	0.5	36.3	18.6	23.0	7.3	51.0
2010	40.2	16.4	0.9	42.5	16.9	23.0	8.6	51.5
2015	30.6	15.5	0.9	53.0	15.7	22.2	10.0	52.1
2020	23.1	15.9	0.8	60.2	15.3	22.6	8.0	54.0
2024	18.8	16.5	1.0	63.7	12.8	22.8	9.4	55.0

Source: TURKSTAT, 2024.

Table 2 presents the gender-based distribution of employment by economic activity in Türkiye for the period 2005-2024. Upon analyzing the data for the 2005-2024 period, a significant change has occurred in the sectoral distribution of both male and female employment. The employment rate for men witnessed a decrease in the agricultural sector from 18.6 percent in 2005 to 12.8 percent in 2024, while the service sector experienced an increase from 51.0 percent to 55.0 percent during the same period. Concurrently, male employment in the construction sector also increased, rising from 7.3 percent to 9.4 percent. Conversely, the industrial sector exhibited relative stability at 23 percent, characterized by minor fluctuations.

The sectoral transformation in female employment is clearly evident in Table 2 and Figure 1. Notably, the proportion of women employed in the agricultural sector experienced a significant decline, decreasing to 18.8 percent in 2024 from 46.7 percent in 2005. Conversely, female employment in the service sector demonstrated a substantial increase from 36.3% to 63.7%, indicating an increasing concentration of the female labor force in services. The share of women's employment in the industrial sector remained relatively stable, fluctuating between 16 and 17 percent, while the share in construction experienced a marginal increase from 0.5 percent to 1.0 percent. To summarize, agriculture's contribution to employment for both men and women has declined rapidly, with the service sector becoming the predominant area of employment for both genders. However, the shift of women from agriculture to services has been markedly faster and more pronounced. These findings suggest that in the post-2000 period, the inter-sectoral transformation in Türkiye. These results demonstrate that both the inter-sectoral transformation and the structural change in women's employment have been more pronounced in Türkiye in the post-2000 period.

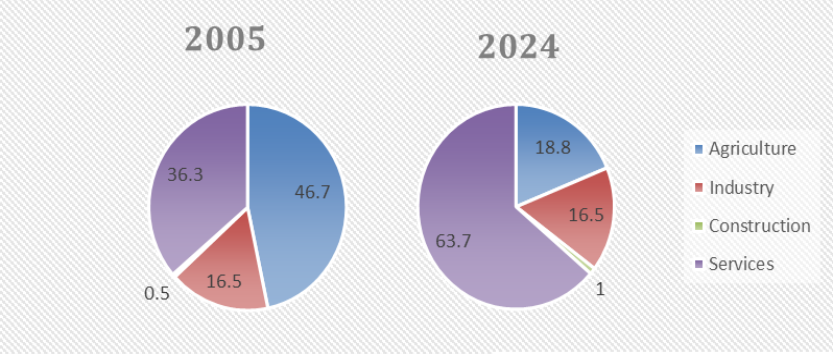

Figure 1. Breakdown of Female Employment by Sector (%)
Source: TURKSTAT, 2024.

This sectoral breakdown suggests that women's high representation in the services sector contributes to sectoral growth, while limited participation in industry and agriculture may limit growth potential. Reasons for sectoral differentiation include education level, gender roles and legal regulations (OECD, 2017).

Sectoral differences in women's employment require a comprehensive analysis of the effects on economic growth and income distribution. Blau and Kahn (2017) argue that the constraints faced by women in the industrial sector reinforce gender-based inequalities and lead to low-paid occupations. The glass ceiling effect, occupational discrimination and limited career opportunities can make it difficult for women to access high-paying positions (SOFA Team and Doss, 2011). In this context, analysing women's employment on a sectoral basis is an important requirement for labour market policies.

The Inverted-U Hypothesis advanced by Simon Kuznets (1955) in his 1955 study explains the relationship between economic growth and income inequality. According to the hypothesis, income inequality exhibits a pattern of escalation during the stages of economic growth, subsequently transitioning to a phase of reduction upon reaching a defined economic threshold. This hypothesis can be adapted to analyse the effects of female employment on income distribution and economic growth. In what the hypothesis defines as the 'Early Development Phase' female employment may increase especially in the industrial and service sectors as economies transition from agriculture to industry. However, the concentration of women mostly in low-paid jobs, gender-based wage differences, and inequalities in the labour market may cause income distribution to deteriorate further initially (Demirtaş and Yayla, 2017). In the 'Intermediate Development Phase', with the continuation of economic growth, women's higher level of education, greater integration into the labour market, and the adoption of policies towards gender equality can contribute to the reduction of income inequality (Günay and Bener, 2011). In the 'Advanced Development Phase', an increase in female employment, especially in high-skill areas such as the service sector, may result in a more balanced income distribution and sustainable economic growth (Bussman, 2009). In this context, the study examines in detail the relationship between the sectoral structure of female's employment and economic growth and income distribution.

This study examines the relationship between the sectoral structure of women's employment and economic growth and income distribution in the Turkish economy using data spanning the period 1991-2023. The remainder of the study provides a comprehensive review of the relevant literature, followed by a detailed explanation of the dataset and the methodological approach. Following the findings and discussion sections, the conclusions and policy recommendations are presented.

2. Literature Review

The effects of female's employment on economic growth and income distribution have long been the focus of academic research. Studies in this field analyse the effects of female's labour force participation on both growth dynamics and social inequalities using different methodological approaches.

In the literature, the impact of female's employment on economic growth has been analysed in various studies. Er (2012), using 1998-2008 data for 187 countries, finds that female

employment has a positive effect on growth. Kutluay Şahin (2022) reached a similar conclusion in 31 European countries for the period 2009-2020. Verme (2015), Goldin (1994) and Olivetti (2013) have revealed a U-shaped pattern in the association between women's participation in the labour force and economic development in different geographies (MENA, more than 100 countries and the USA), which means that participation decreases during the initial phases of development, followed by a subsequent increase.

Tam (2011) and Tsani et al. (2013) also investigated the impact of female employment on growth. Tam (2011) confirmed that female employment increases with income growth, while Tsani et al. (2013) empirically proved the contribution of female employment to development in Southern Mediterranean countries. Dursun and Damadoğlu (2020) stated that female labour force participation in the Southern Mediterranean is associated with growth, but is affected by cultural factors. These studies reveal the complex and context-specific effects of female employment on economic growth. To better understand this complexity, it is helpful to focus on women's entrepreneurship, a significant subset of women's employment, and explore global trends in this area. The Mastercard Index of Women Entrepreneurs (MIWE) 2022 report highlights significant heterogeneity in global women's entrepreneurship and identifies the structural factors that underlie these differences. The report attributes the success of top-performing countries such as the United States, New Zealand, Canada, and Israel to inclusive financial ecosystems, enhanced access to education and digital skills, and legal and institutional regulations that promote gender equality. In these countries, women's access to finance, institutional support mechanisms, and family-friendly workplace policies are key facilitators of entrepreneurship (Mastercard, 2022).

In contrast, high rates of women's entrepreneurship are observed in developing countries like Uganda and Botswana, where limited formal employment opportunities and economic necessity drive the trend. In this context, women's entrepreneurial activities tend to be small-scale and subsistence-oriented. The report highlights this structural distinction by emphasizing that in developed countries, women's entrepreneurship results from "choice" and systematic support, while in developing countries, it is primarily driven by "necessity."

Studies on Türkiye have extensively examined the impact of employment on economic growth, considering gender-based employment dynamics and regional disparities. Empirical studies investigating the sectoral growth-employment relationships in the Turkish economy clearly distinguish between sectors where growth translates into employment and those where it does not. Applying a causality test, Akcan and Azazi (2022) determined that growth in the service, construction, and agriculture sectors leads to an increase in employment. In contrast, their causality analysis revealed that growth alone does not create employment in the industrial sector. Similarly, Aksoy (2013) found a positive causality between growth and employment increase in the manufacturing and tourism-trade sectors, while indicating that growth in the energy sector reduces employment. At the regional level, Akıncı and Yılmaz (2013), in their study based on Shift-Share analysis, found that employment increases in the industry and services sectors positively affect regional development. They reported a generally negative trend in the agricultural sector, with the Marmara and Aegean sub-regions exhibiting high development performance, driven by both national trends and regional competition dynamics. Furthermore, they noted that employment growth in Eastern Anatolia and the Black Sea region did not sufficiently support development. The crucial role of the industrial sector in growth and productivity has been confirmed by Arısoy (2013) and Mercan and Kızılkaya (2014) within the framework of Kaldor's growth laws. Both studies, through cointegration and error correction

analyses with quarterly data, identified long-term and positive relationships between industrial production, labor productivity, and total factor productivity. Altun and İşleyen (2019) found that there was a long-term cointegration between industrial sector employment and economic growth through cointegration and causality tests, and that employment growth in the industrial sector supported growth. Dinç (2022) showed that there is a unidirectional causality from the agricultural sector to economic growth using the extended Toda-Yamamoto test with the Bootstrap approach, whereas a bidirectional causality exists between the service sector and economic growth. Telli Üçler (2022) found that growth causes employment in the industrial and service sectors through causality analysis, but no significant relationship was found with the agricultural sector. Kopuk and Meçik (2020) identified a unidirectional causality from the agricultural sector to GDP through cointegration and causality analyses, and a bidirectional causality exists between agriculture and the manufacturing industry, while no direct relationship was found between the manufacturing industry and economic growth. Turhan and Erdal (2022) also found that economic growth increases agricultural employment, and agricultural employment affects general employment; however, no significant causality from general employment to GDP was observed through causality analyses. Yıldırım and Engeloğlu (2023) determined a long-term relationship between agricultural sector employment and fluctuations in growth using latent cointegration methods. They found that employment decreases in the construction sector support growth, and employment increases in the services sector cause decreases in growth. Özgün (2023) revealed a long-term relationship between service employment and economic growth using the cointegration test, with the services sector primarily driven by growth according to the causality test.

The contribution of women's employment to economic growth in Türkiye, which is the central focus of our study, warrants special attention. Kutluay Şahin (2022) demonstrated using panel data that a 1% increase in women's employment results in a 0.95% increase in GDP. Özocaklı and Palandökenlier (2024), in their demographic-based analysis, found that manufacturing increases employment among both men and young women. Meanwhile, Pata (2018) concluded through asymmetric causality tests that women's employment supports growth primarily through the services sector.

Women's educational attainment and labour market participation have important effects on economic growth and income distribution. Lorgelly and Owen (1999) emphasised that investments in women's education contribute directly and indirectly to economic growth and that gender differences should be examined more carefully in growth models. Uyanık and Yeşilkaya (2021) analysed the effects of employment rates of women by education level on income inequality in European Union countries, and they empirically proved that employment of women who are high school graduates increases inequality. In contrast, the employment of female who are higher education graduates decreases it.

Unemployment, labour market regulations, and global economic shocks have long been among the topics discussed due to their effects on income distribution. Mocan (1999) and Nolan (1986) have shown that unemployment increase income inequality and that labour market imbalances deepen economic inequalities. These findings are also supported by the relationship between international trade and wage inequality proposed by Helpman et al. (2010). Trade opening widens the distribution of firm income and initially increases wage inequality, but in the long run, inequality may decrease if trade openness exceeds a certain threshold (Helpman et al., 2010). Roberts and Tran (2022) analyse the impact of expanding global production and labour policies on income disparity, and find that labour market regulations increase inequality in the

global South, while they decrease it in the global North by encouraging unionisation. Checchi and García-Peñalosa (2008) examine the effects of labour market institutions on income inequality and find that strong labour market regulation can reduce inequality but increase unemployment rates. Cysne (2009) found that increases in structural unemployment lead to higher income inequality. Aktaş (2021), in his panel Tobit analysis with data from 60 countries, determined that indicators such as the employment rate, investment, and the Human Development Index reduce income inequality. Conesa and Wang (2023) find that differences in sectoral income distribution in China increase income inequality in the long run. Deffo et al. (2024) examine the impact of the COVID-19 pandemic on income inequality in Cameroon, and find that families with unemployed heads of households are more affected during crisis periods. Giupponi et al. (2024) found that minimum wage policies in the United Kingdom led to a compression in the wage distribution, but did not lead to a significant decline in employment rates. These studies show that the effects of labour market policies on income distribution are complex and context-specific.

The interplay between income distribution, employment, and unemployment is significantly influenced by labor's share of income and the level of access to labor markets. Augmented unemployment rates and the structural characteristics of employment directly impact levels of inequality. Indeed, Aydın (2025), through cointegration analysis, determined that the trend of deindustrialization diminished the proportion of labor income in total value added, thereby exacerbating income inequality. The increase in the Gini coefficient, coupled with the contraction of industrial employment and production shares post-2014, further substantiates this finding. On the other hand, Duman (2019), in his long-term assessment of the relationship between functional and individual income distribution, found that despite the decrease in the share of labor in income, a relative improvement in individual income inequality was observed due to social transfers and tax policies. The study also revealed that even with increased wage incomes, income derived from employers, interest, and real estate exhibited increasing concentration among high-income strata. This situation disrupted income distribution and limited the potential of employment growth to reduce inequality. Utilizing the Nonlinear Autoregressive Distributed Lag (NARDL) model, Oktay (2019) determined that only shocks leading to increased unemployment exerted significant and adverse effects on income inequality. Kalaycı and Öztürk (2017), using cointegration tests, variance decomposition, and impulse-response analyses, examined the macroeconomic factors affecting income distribution inequality in Türkiye. Their findings indicated that while the unemployment rate exhibited a statistically significant effect on income distribution, its impact was comparatively limited when juxtaposed with other variables such as inflation, education expenditures, foreign direct investment, and external debt.

Studies conducted in Türkiye on women’s employment, income distribution, and sectoral development dynamics address the relationship between gender equality, regional imbalances, and economic growth from a multidimensional perspective. These studies reveal both the position of women in the labor market at the micro level and their connections to macroeconomic indicators. In this context, research focusing on the sectoral concentration and spatial distribution of women’s employment shows that the service sector is a primary employment area for women. The analysis conducted by Altuğ and Almammadlı (2025), employing the Location Quotient (LQ) method and spatial mapping techniques on SGK data for the period 2004-2020, revealed a concentration of women's employment in service sectors such as education, healthcare, finance, and hospitality within Türkiye. Their findings indicated that women's employment remained constrained in male-dominated sectors, including industry and construction. Conversely,

employment, initially localized in western regions, diffused towards eastern and inland areas, a trend attributed to public policies. While notable regional concentrations were identified in the finance, education, and hospitality sectors, healthcare and social services exhibited a more balanced distribution. Consequently, regional disparities in employment between women and men have diminished, and spatial inequalities have been reduced. This finding is further supported by a comprehensive report prepared by Durceylan Kaygusuz et al. (2023) using data from the 2004-2021 Turkish Statistical Institute (TurkStat) Household Labor Force Surveys and the 2018 World Values Survey. The report highlights that, despite an increase in female labor force participation after 2008, it still remains below the OECD average; there are significant differences in participation rates between regions such as the Black Sea and Southeast Anatolia; NEET (Not in Education, Employment, or Training) rates among young women in the 15-24 age group remain high; structural discrimination persists due to wage inequality and the low representation of women in managerial positions; and that COVID-19 and natural disasters have made women more vulnerable compared to men.

Studies investigating the impact of women's employment on economic growth and income distribution commonly suggest an inverse relationship between increased female employment and income inequality. Akyol Özcan (2023), in a panel study encompassing 19 EU countries including Türkiye, demonstrated that a 1% increase in female labor force participation resulted in a 1.6% decrease in Türkiye's Gini coefficient. A study focusing specifically on Türkiye by Akyol et al. (2019) found that while industrial sector growth reduces unemployment, it concurrently increases income inequality. This suggests that industrial production has contradictory effects on income distribution: although it increases employment, it is insufficient to achieve income equality. Similarly, Turgut (2019), in a literature review drawing upon Turkish data, emphasized that women are disproportionately employed in lower-paid, insecure, and informal jobs compared to men, thereby deepening female poverty and exacerbating income inequality.

The interplay between labor market dynamics (employment, unemployment, sectoral structure), economic growth, and income distribution has been extensively analyzed in both national and international scholarly works. General findings indicate that while the industrial sector contributes to economic expansion, its efficacy in mitigating income inequality remains limited, whereas the service sector is notable for its capacity to generate employment. Although the impact of the agricultural sector has diminished, a unidirectional relationship with growth persists. Within this context, women's employment emerges as a salient determinant in the nexus between growth and inequality. Internationally, female labor force participation is observed to support economic growth, and notably, the employment of women with higher education contributes to the reduction of income inequality. Studies focusing on Türkiye reveal a long-term relationship between women's employment in the service sector and economic expansion, while this connection is tenuous in the industrial sector and unidirectional in agriculture. The positive impacts on income parity are contingent upon structural factors such as sectoral concentration, NEET rates, and regional imbalances. Methodologically, these relationships have been scrutinized at sectoral and regional levels utilizing panel data analysis, cointegration tests, Granger and Toda-Yamamoto causality analyses, Shift-Share analyses, and spatial distribution modeling. The overarching trend indicates that women's employment is a fundamental factor for equitable and inclusive growth.

In light of the general trends and debates in the existing literature, although extensive studies have been conducted on the effects of women's employment on economic growth and

income distribution, these studies generally address women's employment through holistic indicators. In contrast, this study provides a more in-depth analysis by disaggregating the effects of women's employment across the agriculture, industry, and service sectors within the Turkish context. While most studies (e.g., Kutluay Şahin, 2022; Özocaklı and Palandökenlier, 2024; Pata, 2018; Akyol Özcan, 2023; Turgut, 2019) generally focus on aggregate employment or general gender-based indicators, this study examines the impact of sectoral concentration on economic growth and income distribution in greater detail. Furthermore, a time-sensitive analytical framework is presented using a long-term dataset (1991-2023) that encompasses critical periods such as the global financial crisis and the post-pandemic era. Methodologically, the study adopts an approach that accounts for structural breaks and nonlinear relationships through the application of Fourier ADL, RALS-FADL, and Fourier Toda-Yamamoto tests. Despite the existence of numerous studies examining the relationships between women's employment, economic growth, and/or income distribution, a gap remains in the literature regarding research that simultaneously addresses these three variables at the sectoral level while applying the aforementioned Fourier-based econometric methods. Therefore, this study aims to fill these gaps in the literature and make an original contribution by applying Fourier-based econometric methods to the sectoral relationships between women's employment, economic growth, and income inequality. It is anticipated that the breadth of the dataset, the comprehensiveness of its temporal scope, and the in-depth methodological approach of this research will reinforce the study's originality and its contribution to the literature.

3. Model, Data Set and Empirical Method

This section details the empirical model, data set and methods used in this study. To determine the effects of female's employment on economic growth and income distribution, a sectoral analysis framework was created and advanced time series methods were used. The methodological approach of the study aims to identify the long-run relationships and causal link between variables, and the results of the analysis aim to contribute to the formulation of policy recommendations on female employment.

3.1. Model and Data Set

The integration of women into the workforce exhibits a direct correlation with both economic expansion and distributional equity, serving as a critical determinant for achieving gender parity and sustainable development objectives. Female labour force participation is recognized not merely as an ancillary driver of economic growth, but also as a catalyst for socio-economic transformations that influence income disparities. While conventional growth paradigms typically treat female employment as a subset of aggregate labour, contemporary development frameworks underscore the multifaceted implications of female labour on both economic growth trajectories and inequality patterns (Kabeer, 2016; Seguino, 2000).

To examine the sectoral (services, industry, agriculture) and aggregate impacts of women's employment on income distribution and economic growth, this study employs a set of established and widely accepted indicators. Table 3 provides comprehensive details regarding the variables incorporated in this analysis.

Table 3. Information on variables

Variables	Symbol	Log Symbol
Women Employment Indicators (Source: (ILO, 2025; World Bank, 2025a)		
Percentage of female workforce employed in service sector (The share of women in total employment)	HiZ	LnHIZ
Percentage of female workforce engaged in industrial activities sector (The share of women in total employment)	SAN	LnSAN
Percentage of female workforce employed in agricultural sector sector (The share of women in total employment)	TAR	LnTAR
Female employment-to-population ratio (15+) (The share of female population aged 15 and above)	TOP	LnTOP
Income Distribution Indicator (Source: Solt, 2019)		
Gini Coefficient (gini_mkt: Gini index estimate based on equivalized (square root scale) household market income (before taxes, before transfers)	GINI	LnGİNİ
Economic Growth Indicator (Source: World Bank, 2025b)		
Per capita Gross Domestic Product (constant 2015 US dollars)	GDP	LnGDP

The time period from 1991 to 2023 was chosen as the analysis period, and these variables were selected to analyze the long-run effects of women's employment on income distribution and economic growth. The reason for choosing this time period is that it encompasses significant structural transformations in the global economy, providing an opportunity to analyze policy changes regarding women's employment. Moreover, since the most recent and complete data range covered by the datasets used is limited to this period, the analysis was conducted between these dates. Consequently, this temporal frame aligns optimally with the research's delineated parameters and objectives. The study analyzes two basic equations (Equations (1) and (2)):

$$Ln\dot{G}\dot{N}\dot{I}_t = \beta_0 + \beta_1 Ln\dot{H}\dot{I}Z_t + \beta_2 LnSAN_t + \beta_3 LnTAR_t + \beta_4 LnTOP_t + \varepsilon_t \quad (1)$$

$$LnGDP_t = \beta_0 + \beta_1 Ln\dot{H}\dot{I}Z_t + \beta_2 LnSAN_t + \beta_3 LnTAR_t + \beta_4 LnTOP_t + \varepsilon_t \quad (2)$$

In the analyses, natural logarithmic transformation of variables was applied to improve the data structure, to express relationships in elasticity terms, and to increase the statistical reliability of the model. Log transformation enables direct interpretation of percentage changes and increases the validity of the model by reducing heteroskedasticity (Greene, 2012; Wooldridge, 2013). It also makes error terms more consistent by normalizing right-skewed distributions (Gujarati and Porter, 2009).

Log transformation alleviates the multicollinearity problem by compensating for large scale differences (Enders, 2014) and facilitates the analysis of growth rates (Stock and Watson, 2015), making it a powerful tool in econometric analysis. For this reason, the natural logarithmic transformation of variables was applied in the analyses to obtain more robust and interpretable results.

To ascertain the existence of a long-term equilibrium relationship among the variables, this research employed the FADL and RALS-FADL cointegration tests. Complementing the analysis of long-run associations, the FTY test was used to explore causal linkages between the variables.

3.2. Empirical Method

This research utilises advanced econometric methods to analyze the influence the impact of sectoral (services, industry, and agriculture) and aggregate female employment on income

distribution and economic growth in the Turkish context. These methods address the properties of time-series stationarity, the existence of long-term equilibrium associations, and the nature of short-term adjustments. The methods used and their significance are summarized below:

Stationarity Tests: Within the scope of unit root tests, the stationary properties of the variables were assessed by applying the Fourier ADF (FADF) test. Unlike conventional unit root tests, the FADF test provides more reliable results, accounting for structural discontinuities within the time series (Enders and Lee, 2012).

Cointegration Analysis: FADL test and RALS-FADL test were used to identify the long-term association. These methods minimize the effect of structural breaks on the test power and make it possible to detect the long-run relationships between variables more precisely (Banerjee et al., 1998; Yılancı, 2019).

Cointegration Coefficient Estimation: After identifying the long-run relationship, we estimate the long-run coefficient using the Fully Modified Least Squares (FMOLS) method. The FMOLS method is widely preferred in cointegration models as it produces asymptotically consistent estimates even with small sample sizes (Phillips and Hansen, 1990).

Error Correction Model (ECM): If the existence of cointegration relationship is detected, the short-run dynamics between variables are analyzed by constructing ECM. ECM shows how long it takes to correct deviations from the long-run equilibrium and reveals how variables offset their effects on each other over time (Engle and Granger, 1987).

Causality Test: The FTY test was applied to examine the causality relationships between the variables. This test is an extension of the traditional Toda-Yamamoto test with Fourier transforms and is important because it can identify reliable causal relationships despite the presence of structural breaks in the series (Toda and Yamamoto, 1995; Tsong et al., 2016).

The applied methods are selected in accordance with the statistical properties of the variables and provide strong results in determining both short-run and long-run relationships. In particular, Fourier-based tests minimize the errors that may arise because traditional methods ignore structural breaks and provide more reliable results. The long-run coefficients obtained with the FMOLS method provide important findings on the sign and strength of the linear association among variables.

Enders and Lee extended the traditional ADF unit root test by integrating the Fourier function and introduced this method to the literature. The FADF unit root test does not require prior information about the timing, frequency or pattern of structural changes. The essential aspect of applying this test is to determine the optimal frequency value of the Fourier function. The data generation process of this test can be expressed as follows (Equation 3) (Enders and Lee, 2012):

$$y_t = c + py_{t-1} + \gamma t + \varepsilon_t \tag{3}$$

where, y_t is the dependent variable, c is the constant term, p is the coefficient of the lagged dependent variable,γ is the time trend,ε_t is the error term. The deterministic component$a(t)$ is modeled as shown in Equation (4):

$$a(t) = a_0 + \sum_{k=1}^{n} a_k \sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^{n} \beta_k cos + \left(\frac{2\pi kt}{T}\right) \tag{4}$$

In this formulation; T is the total sample size,n denotes the number of Fourier components and the condition$n \leq \frac{T}{2}$ must be satisfied.

The main objective of this model is to represent the changes in structural breaks over time in a more flexible structure. Thanks to Fourier functions, structural transformations can be integrated into the model in the form of fluctuations instead of sharp changes, thus providing more reliable forecasts for trending data sets.

Gregory and Hansen highlighted that overlooking structural breaks may result in misleading conclusions in cointegration analyses and developed a new test that allows for regime changes (Gregory and Hansen, 1996a, 1996b). Subsequent studies used dummy variables to identify sharp structural changes but missed gradual structural changes, leading to the development of more sophisticated tests using Fourier functions (Hatemi-J, 2008; Maki, 2012). Banerjee et al. (2017) introduced a modified cointegration test that incorporates structural changes through a Fourier model and allows for better analysis of long-term relationships (Tsong et al., 2016; Yilanci, 2019).

Banerjee et al. (1998, 2017) revised the cointegration test equation developed by themselves with a Fourier function to take structural changes into account. In this context, they proposed the FADL model (Equation (5)):

$$\Delta y_{1t} = d(t) + \delta_1 y_{1,t-1} + \gamma' y_{2,t-1} + \alpha \Delta y_{2t} + e_t \quad (5)$$

$d(t)$ The deterministic term as a function of time, represented by the symbol is defined in Equation (6):

$$d(t) = \beta_0 + \Phi_1 sin\left(\frac{2\pi kt}{T}\right) + \Phi_1 cos\left(\frac{2\pi kt}{T}\right), \quad (6)$$

Here *t* represents the time variable, *T* represents the total sample size, and *k* represents a predetermined number of frequency components. The optimal *k* was determined by selecting the value that minimized the sum of squared residuals. Substituting this expression in equation (5), the test equation (Equation (7)) takes the following form:

$$\Delta y_{1t} = \beta_0 + \phi_1 \sin\left(\frac{2\pi kt}{T}\right) + \phi_1 \cos\left(\frac{2\pi kt}{T}\right) + \delta_1 y_{1,t-1} + \gamma' y_{2,t-1} + \alpha \Delta y_{2t} + e_t \quad (7)$$

The test statistic expressed in Equation (8) is utilized to assess the validity of the null hypothesis of non-cointegration (Yılancı et al., 2023):

$$t_{ADL} = \frac{\hat{\delta}_1}{se(\hat{\delta}_1)} \quad (8)$$

Here; $\hat{\delta}_1$ is the ordinary least squares (OLS) estimator and$se(\hat{\delta}_1)$ is the standard error of this estimator.

The FADL cointegration test disregards the information that can be obtained from higher moments that arise when the residual terms are not normally distributed (Yılancı et al., 2023). This may reduce the power of the test and affect the reliability of the results. Studies by Lee et al. (2015) and Oh et al. (2020) suggest that taking into account the distributional properties of the residual terms can increase the statistical power of cointegration tests.

In light of these methodological developments, the model developed by Banerjee et al. (2017) is extended based on Im and Schmidt (2008) and estimated using the Residual Extended Least Squares (RALS) method instead of the OLS method. The RALS method is a simple test procedure and, unlike traditional methods, does not require predetermining the underlying functional form.

Lee et al. (2015) show that the statistical power of RALS-based tests increases significantly when the error terms are not normally distributed and yield similar results to traditional methods when the error terms follow a normal distribution. Thanks to these features, the RALS method provides more reliable and robust results, especially in time series analysis with structural changes and abnormally distributed errors.

To enhance the robustness of the FADL cointegration test regression, Equation (7) is augmented with an additional term expressed in Equation (9) below:

$$\widehat{\omega}_t = [\hat{u}_t^2 - \hat{m}_2, \hat{u}_t^3 - \hat{m}_3 - 2\hat{m}_2\hat{u}_t]' \tag{9}$$

Here $\widehat{\omega}_t$, refers to the residuals obtained from Equation 7. The first term is valid in the absence of heteroskedasticity in the data. On the other hand, the second term increases the predictive power of the model. However, if the distribution of error terms is not normal, the forecasting performance of the model may be negatively affected. In this case, the statistical efficiency of the model can be improved by making the above additions to Equation (7) as expressed in Equation (10).

$$\Delta y_{1t} = \beta_0 + \phi_1 \sin\left(\frac{2\pi kt}{T}\right) + \phi_2 \cos\left(\frac{2\pi kt}{T}\right) + \delta_1 y_{1,t-1} + \gamma' y_{2,t-1} + \alpha \Delta y_{2t} + \widehat{\omega}_t \gamma + \varsigma_t \tag{10}$$

Consequently, the RALS-FADL test statistic is derived through the estimation of Equation (8) by OLS and calculating the t-statistic for$\phi_1 = 0$ asτ_{RLM}. Equation (11) presents the asymptotic distribution of the test statistic:

$$\tau_{RLM} \rightarrow \rho\tau_{LM} + \sqrt{1-\rho^2}\, Z \tag{11}$$

This method allows for a more accurate and reliable cointegration analysis by taking structural breaks into account.

It is a prerequisite for both the FADL and RALS-FADL cointegration tests that the variables are integrated of order one, i.e. they are expected to have an I(1) process. In this framework, our models can be defined as shown in Equations (12) and (13):

$$\begin{aligned}\Delta lnGINI_t = {} & \beta_0 + \phi_1 \sin\left(\frac{2\pi kt}{T}\right) + \phi_1 \cos\left(\frac{2\pi kt}{T}\right) + \delta_1 lnGINI_{t-1} + \gamma' lnH\dot{I}Z_{t-1} \\ & + \alpha \Delta lnH\dot{I}Z_t + \gamma' lnSAN_{t-1} + \alpha \Delta lnSAN_t + \gamma' lnTAR_{t-1} \\ & + \alpha \Delta lnTAR_t + \gamma' lnTOP_{t-1} + \alpha \Delta lnTOP_t + \alpha \Delta y_{2t} + e_t\end{aligned} \tag{12}$$

$$\begin{aligned}\Delta lnGDP_t = {} & \beta_0 + \phi_1 \sin\left(\frac{2\pi kt}{T}\right) + \phi_1 \cos\left(\frac{2\pi kt}{T}\right) + \delta_1 lnGDP_{t-1} + \gamma' lnH\dot{I}Z_{t-1} \\ & + \alpha \Delta lnH\dot{I}Z_t + \gamma' lnSAN_{t-1} + \alpha \Delta lnSAN_t + \gamma' lnTAR_{t-1} \\ & + \alpha \Delta lnTAR_t + \gamma' lnTOP_{t-1} + \alpha \Delta lnTOP_t + \alpha \Delta y_{2t} + e_t\end{aligned} \tag{13}$$

The FTY test is performed by estimating the models as formulated expressed in Equations (10) and (11). In the application of the test, the most appropriate model is selected by first determining the lag length and Fourier frequency value (k). Then, the best model is constructed by using the parameters that minimize the Akaike (AIC), Schwarz (BIC), and Hannan-Quinn (HQIC) information criteria. In the final stage, bootstrap simulations, following the methodology of Nazlioglu et al. (2016), are implemented to determine the required critical values for the test.

The FTY causality test is a method that aims to analyze causality relationships without considering structural breaks, by extending the traditional Toda-Yamamoto (1995) Granger causality test with the Fourier approach. This approach, proposed by Nazlioglu et al. (2016), stands out as an effective tool for capturing gradual structural changes, especially in economic time series.

The main advantage of this method is that it does not require a priori knowledge of the dates, numbers, and shapes of structural breaks and can model them using Fourier series. While traditional methods usually use dummy variables to model sudden (sharp) breaks, the Fourier approach offers a more flexible structure, making it possible to model smooth transitions over time. The FTY test extends the traditional VAR (p+d) model by adding Fourier components and flexibly captures how structural changes manifest in the series. The model can be defined in Equation (14) (Nazlioglu et al., 2016):

$$y_t = a_0 + y_{1k} \sin\frac{2\pi kt}{T} + y_{2k} \cos\frac{2\pi kt}{T} + \beta_1 y_{t-1} + \cdots + \beta_{p+d} y_{t-(p+d)} + \varepsilon_t \qquad (14)$$

Here; a_0 is the constant term parameter, $1\gamma k$ and $2\gamma k$ represent the width and location of frequencies respectively, $\boldsymbol{k}$ is the Fourier frequency, $\boldsymbol{T}$ is the sample size, $1\gamma k$ and $2\gamma k$ represent the width and location of frequencies respectively, andyt represents the possible structural changes.

The use of the F-statistic instead of the Wald test produces more reliable results in small samples. Critical values determined using bootstrap simulation techniques make the test more robust in small samples and increase the flexibility of the model against unit root and cointegration problems. Therefore, the FTY test overcomes the limitations of traditional methods and provides a more reliable causality test that takes into account structural changes in time series analysis (Nazlioglu et al., 2016).

The Fourier-based cointegration and causality tests employed in this study (FADL, RALS-FADL, and Fourier Toda-Yamamoto) were selected to model the effects of structural breaks in economic time series. The Fourier transform provides flexibility in detecting low-frequency and nonlinear fluctuations in the deterministic structure of series, thus allowing for analysis without the need for pre-specification of the number or timing of breaks (Enders and Lee, 2012b: 196; Becker et al., 2006). In this regard, the impacts of structural transformations, such as financial crises, global shocks, and the pandemic, experienced during the period 1991–2023, have been directly incorporated into the model. However, while Fourier-based methods offer flexibility in modeling structural breaks and nonlinear trends in time series, they also possess certain methodological limitations. Christopoulos and Leon-Ledesma (2010: 1090-1091) point out that while the Fourier function is effective in capturing time-varying means and low-frequency fluctuations, it may be less effective in detecting sudden and high-frequency structural breaks. Additionally, it is stated that frequency constraints may create analytical challenges in interpreting

the components and that caution is required when translating the results into economic and political implications. These limitations are consistent with the findings of Rodrigues and Taylor (2009), who suggest that the Fourier approach is more suitable for temporary and mild breaks.

4. Findings

Before analyzing the cointegration relationship between income distribution, women's employment (in total, service, industry, and agriculture sectors), and economic growth in Turkiye, it is essential to establish the variables' integration order. A fundamental requirement of the chosen cointegration test is that all variables achieve stationarity at their first difference, denoted as I(1). To this end, the FADF unit root test, developed by Enders and Lee (2012a), is employed. Traditional unit root tests often overlook potential structural changes within the data, leading to reduced statistical power when such breaks are present. Recognizing this limitation, Enders and Lee (2012a) extended the standard ADF test to incorporate the possibility of multiple smooth transition structural breaks in the stationarity assessment.

Table 4. Findings of the FADF

Variables	**Test Statistic**	**k**	**l**	**Model with constants**		
				Critical Values		
				%1	**%5**	**%10**
LnHIZ	-1.5377	2	0	-3.97	-3.27	-2.91
LnSAN	-1.4890	2	1	-3.97	-3.27	-2.91
LnTAR	1.4266	2	0	-3.97	-3.27	-2.91
LnTOP	-3.2963	1	0	-4.42	-3.81	-3.49
LnGİNİ	-3.0859	1	1	-4.42	-3.81	-3.49
LnGDP	-0.2855	1	0	-4.42	-3.81	-3.49
ΔLnHIZ	-4.6335***	1	0	-4.42	-3.81	-3.49
ΔLnSAN	-6.8831***	2	1	-3.97	-3.27	-2.91
ΔLnTAR	-5.7696***	2	0	-3.97	-3.27	-2.91
ΔLnTOP	-5.0083***	2	0	-3.97	-3.27	-2.91
ΔLnGINI	-3.4900**	1	0	-4.42	-3.81	-3.49
ΔLnGDP	-5.4999***	1	0	-4.42	-3.81	-3.49
Variables	**Test Statistic**	**k**	**l**	**Model with Constant and Trend Critical Values**		
				%1	%5	%10
LnHIZ	-2.3881	1	0	-4.95	-4.35	-4.05
LnSAN	-3.7774	1	0	-4.95	-4.35	-4.05
LnTAR	-1.5955	1	0	-4.69	-4.05	-3.71
LnTOP	-3.1721	1	0	-4.69	-4.05	-3.71
LnGİNİ	-2.9644	1	1	-4.95	-4.35	-4.05
LnGDP	-3.0781	1	0	-4.95	-4.35	-4.05
ΔLnHIZ	-4.5665**	2	0	-4.69	-4.05	-3.71
ΔLnSAN	-7.4526***	1	1	-4.95	-4.35	-4.05
ΔLnTAR	-4.6494**	1	0	-4.95	-4.35	-4.05
ΔLnTOP	-5.6483***	2	0	-4.69	-4.05	-3.71
ΔLnGINI	-3.8852**	2	1	-4.69	-4.05	-3.71
ΔLnGDP	-5.4790***	2	0	-4.69	-4.05	-3.71

Note: The critical values for the FADF test were derived from Enders and Lee (2012). Statistical significance is denoted by ***, **, and *, corresponding to levels of 1%, 5%, and 10%, respectively. The parameter "l" represents the optimal lag length, and ‘k’ denotes the number of frequencies chosen.

Drawing upon the FADF test results delineated in Table 4, the stationarity properties of the variables were examined under both constant and constant-trend models. Given that the test statistics for all variables failed to fall below the critical thresholds, it is determined that each variable displays unit root characteristics, leading to the conclusion of non-stationarity. Similarly, under the constant and trend model, all variables exhibit non-stationarity in levels.

However, after first-order differences were applied to the variables, all test statistics fell below the critical thresholds, thus confirming the stationarity of the variables for both the models with a constant and with both constant and trend.

These findings suggest that the variables exhibit non-stationarity. at their level values but exhibit stationary properties after the application of first differences. Hence, the analysis concludes that the variables are integrated of degree one, and it is methodologically appropriate to apply cointegration tests (FADL and RALS-FADL) to examine the relationships in the long term.

Table 5. Findings of the Cointegration Tests (FADL and RALS-FADL Tests)

Dependent Variables: LnGINI	**Opt. Frequency (*k*)**	**Number of independent variables (n)**	**Min AIC**	**Test Statistic**	**Rho**
FADL	2	4	-10.614	-3.827512	0.577
RALS-FADL				-4.958509**	
Dependent Variable: LnGDP	**Opt. Frequency (*k*)**	**Number of independent variables (n)**	**Min AIC**	**Test Statistic**	**Rho**
FADL	3	4	-4.983	-4.894706***	0.596
RALS-FADL				-8.090093**	

Note: Statistical significance is denoted by ***, **, and *, corresponding to levels of 1%, 5%, and 10%, respectively. The critical values utilized in this study are derived from the work of Yılancı et al. (2023).

Table 5 reports the results derived from the FADL and RALS-FADL tests, which examine the long-run cointegration between LnGINI and LnGDP and sectoral female employment and total female employment variables (ΔLnHIZ, ΔLnSAN, ΔLnTAR, ΔLnTOP). The findings support the cointegration relationship between the variables

Results pertaining to LnGINI indicate, that the FADL test is not statistically significant, but the RALS-FADL test supports cointegration. This suggests that the long-term impact of female employment on income distribution inequality may be weaker or vary by sector. FADL and RALS-FADL tests for LnGINI yielding different results shows the importance of not relying on a single method in cointegration analysis. Using different tests together increases the reliability of the model and allows for a more robust analysis of the long-term relationships between variables. In Veli Yılancı's (2023) study, it is emphasized that the RALS-FADL test exhibits greater statistical power and is more reliable than the traditional FADL test. In the study, unlike the FADL test, the RALS-FADL test is designed to correct non-normality and small sample problems. The simulation analyses conducted in the study are used to demonstrate that the RALS-FADL test has a higher test power and can detect the cointegration relationship more accurately. Moreover, it is stated that the FADL test can give false-negative results under structural breaks, but the RALS-FADL test provides more reliable results by better modeling such structural breaks. Consequently the RALS-FADL test provides a more robust cointegration analysis compared to

the traditional FADL test by correcting for possible distortions in the error terms and taking structural breaks into account (Yılancı et al., 2023).

The findings for the LnGDP variable strongly confirm a cointegration association. The FADL test statistic is -4.894706, providing strong evidence of cointegration at the 1% significance level. In contrast, the RALS-FADL test result of -8.090093 indicates a statistically significant cointegration relationship at the 5% level. The findings indicate a long-term cointegration relationship between LnGDP and other variables.

Table 6. Long-Run Coefficients (FMOLS)

Dependent Vaiable	Independent Variable	Coefficient	Std. Dev.	Test Statistic	Probability
lnGINI	LnHIZ	-0.229379	0.016730	-13.71075***	0.0000
	LnSAN	-0.059585	0.013992	-4.258540***	0.0002
	LnTAR	-0.192849	0.015980	-12.06838***	0.0000
	LnTOP	-0.071298	0.016841	-4.233607***	0.0003
	Fixed Term	5.640226	0.163194	34.56150***	0.0000
lnGDP	LnHIZ	0.226300	0.139057	1.627387	0.1157
	LnSAN	0.031762	0.116299	0.273109	0.7869
	LnTAR	-0.273542	0.132822	-2.059462**	0.0496
	LnTOP	0.248344	0.139980	1.774143*	0.0878
	Fixed Term	8.143982	1.356455	6.003873***	0.0000

Note: Statistical significance is denoted by ***, **, and *, corresponding to levels of 1%, 5%, and 10%, respectively.

The ADL and RALS-FADL tests provide empirical evidence supporting the cointegration relationship among sectoral and aggregate female employment, income distribution and economic growth. Accordingly, FMOLS method was employed to estimate long-run coefficients and quantify the impact of women's employment-related variables on LnGINI and LnGDP, with the results presented in Table 6.

The FMOLS estimation results, as detailed in Table 4, demonstrate a statistically significant inverse relationship between LnHIZ, LnSAN, LnTAR, LnTOP, and LnGINI. A percentage point increase of one in LnHIZ decreases LNGINI by 0.229%, while LnTAR and LnSAN decrease it by 0.193% and 0.059%, respectively. LnTOP decreases income inequality by 0.071%.

FMOLS estimations reveal that the role of female employment in economic growth differs across sectors. The estimates empirically support that the empirical findings that LnHIZ and LnSAN have a positive effect on LnGDP are not statistically significant, LnTAR has a negative effect of 0.273% on LnGDP and LnTOP has a positive effect of 0.248% on LnGDP.

Following the determination of long-run coefficients for the analyzed models, an error correction model was utilized for the purpose of examining short-run dynamics. The corresponding results are presented in Table 7. The error correction terms (ECTt-1) in Table 7 are statistically significant as a measure of the speed of correction. This finding suggests that the error correction mechanism works and imbalances are eliminated over time. The ECM results reveal the short-term effects of female employment on income inequality and economic growth and the long-term equilibrium process. According to the findings in Table 7. LnHIZ, LnSAN, LnTAR and LnTOP exhibit a statistically significant negative effect on LnGINI. In particular, it is observed that an increase in LnHIZ and LnTAR significantly decreases LnGINI. In contrast, the

Table 7 shows that the observed effects of LnHIZ, LnSAN, LnTOP, and LnTAR on LnGDP are statistically insignificant.

Table 7. Findings of the ECM Test

Dependent Var.	Independent Var.	Coefficients	Test Statistic
DlnGINI	Cons.	-0.000	-0.277
	DLnHIZ(-1)	-0.112***	-4.081
	DLnSAN(-1)	-0.029**	-2.679
	DLnTAR(-1)	-0.118***	-4.068
	DLnTOP(-1)	-0.032**	-2.120
	ECT_{t-1}	-0.363**	-2.706
DlnGDP	Cons.	0.015	1.461
	DLnHIZ(-1)	0.149	0.610
	DLnSAN(-1)	0.152	0.699
	DLnTAR(-1)	-0.203	-0.788
	DLnTOP(-1)	0.108	0.825
	ECT_{t-1}	-0.477***	-2.761

Notes: Statistical significance is denoted by ***, **, and *, corresponding to levels of 1%, 5%, and 10%, respectively. The symbol 'D' represents the first difference of the corresponding variable. Lag length optimization was achieved through the application of the Akaike Information Criterion (AIC).

To examine the causal relationships among the variables, the FTY test, as proposed by Nazlioglu et al. (2016), was employed. The findings from this test are comprehensively detailed in Table 8.

Table 8. Findings of the FTY Test

Hypothesis	Optimal Frequency	Test Statistic	Boots. Pro.Value.
lnHİZ ↛ lnGİNİ	1	6.821	1.190
lnSAN → lnGİNİ	1	10.331*	0.082
lnTAR↛ lnGINI	1	7.694	0.157
lnTOP↛ lnGINI	2	8.995	0.105
lnGINI→ lnHİZ	1	10.016**	0.080
lnGİNİ↛ lnSAN	1	2.221	0.711
lnGINI↛ lnTAR	1	5.939	0.244
lnGINI→ lnTOP	2	24.716***	0.002
lnHIZ↛ lnGDP	1	2.727	0.120
lnSAN↛ lnGDP	1	2.574	0.648
lnTAR↛ lnGDP	2	6.802	0.202
lnTOP↛ lnGDP	2	1.329	0.853
lnGDP lnHIZ↛	1	0.706	0.405
lnGDP lnSAN↛	1	5.168	0.316
lnGDP lnTAR→	2	14.906**	0.033
lnGDP lnTOP↛	2	0.615	0.962

Note: Statistical significance is denoted by ***, **, and *, corresponding to levels of 1%, 5%, and 10%, respectively. Bootstrap p-values were estimated via 10,000 simulations.

When the findings in Table 8 are evaluated, it is determined that a unidirectional causal relationship originates from LnGINI to LnHIZ and LnTOP, but there is no significant relationship in the opposite direction. Furthermore, a unidirectional causal relationship is observed from LnSAN to LnGINI and there is no significant causality relationship between LnGDP and LnHIZ,

LnSAN and LnTOP. Finally, in the light of the data in the table, it is ascertained that a statistically significant causal influence exists from LnGDP to LnTAR.

5. Conclusion, Discussion and Recommendations

In this study, the relationship between the sectoral structure of women's employment and economic growth and income distribution in Turkey is analyzed using data on women's employment in different sectors (services, industry, agriculture) as well as overall women's employment. The research period is 1991-2023, which covers a period of intense structural transformations in the global economy and policy changes towards women's employment.

Firstly, the stationarity properties of the variables were assessed using the FADF unit root test., and when the first differences were found to be stationary, long-run relationships were estimated with the FADL and RALS-FADL methods and long-run coefficients were estimated with the FMOLS method. In addition, causality relationships between variables were analysed with the FTY causality test. The Fourier-based methods used in this study offer significant advantages in modeling the effects of structural breaks, but they may fall short, particularly in capturing sudden and high-frequency breaks (Christopoulos and Leon-Ledesma, 2010). This limitation in the interpretability of Fourier-based methods for policymakers has been taken into account, and the results have been evaluated in line with the direction and significance levels provided by the econometric tests.

Cointegration tests confirm that female employment in different sectors (services, industry, agriculture) and total female employment have a long-run relationship with income distribution and economic growth. The income distribution analysis reveals that female employment accross all sectors leads to a more equitable income distribution. In particular, female employment in the service and agricultural sectors is found to have a more pronounced effect. FMOLS estimates indicate that a 1% rise in female employment within the service sector reduces the Gini coefficient by 0.23%, while 1% rise in female employment within the agricultural sector reduces it by 0.19%. While an increase in female industrial sector employment exhibits a limited influence effect and decreases the Gini coefficient by 0.059%, an increase in total female employment leads to an improvement in income distribution by 0.071%. These findings indicate that an increase in female employment can be an effective mechanism for reducing social inequalities in the long run by reducing social exclusion. Indeed, the literature also indicates that women's labor force participation, particularly for individuals with higher education levels, has a reducing effect on income inequality (Uyanık and Yeşilkaya, 2021; Akyol Özcan, 2023), while employment in the industrial sector, although it increases production, can deepen inequality (Akyol et al., 2019; Turgut, 2019).

The findings of the analysis, in which economic growth serves as the dependent variable, suggest that female employment in the service and industrial sectors does not exert a statistically significant impact on economic growth. Within the scope of the analysis, it was identified that the rise in female employment within the agricultural sector adversely influences economic growth, with this negative impact quantified at 0.273%. This provides evidence hat women’s employment in the agricultural sector is predominantly concentrated in low-productivity segments, highlighting the necessity for structural adjustments within the sector. In this regard, the study aligns with the literature that suggests the contribution of women's employment to economic

growth is sensitive to contextual factors (Pata, 2018; Özoçaklı and Palandökenlier, 2024). However, it does not fully align with the findings of Kutluay Şahin (2022), which indicate that a 1% increase in women's employment leads to a 0.95% increase in GDP. This discrepancy may arise from the study's unique methodological approach based on sectoral disaggregation, as well as variations in the dataset, analytical method, and time periods covered.

The results of causality analyses indicate the correlation between income inequality and women's employment differs across sectors. Income distribution is found to be an important factor affecting women's employment in the service sector and total women's employment. In this context, it is concluded that income distribution is a determining factor in women's employment, but changes in women's employment do not directly affect income distribution. In the industrial sector, the existence of a unidirectional relationship between women's employment and income inequality was determined, and it was concluded that the increase in women's employment affects income distribution, but there is no significant reverse causality effect. These findings largely align with the literature suggesting that women's employment in the industrial sector is influenced by supply-side factors such as production processes, technological structure, and labor demand (Blau and Kahn, 2017). Furthermore, the observation that women's employment tends to be concentrated in low-wage, temporary, or unskilled jobs (Seguino, 2000) suggests that macroeconomic variables, such as income inequality, may have a limited impact on women's employment decisions. Standing (1999) and Kabeer (2015), by emphasizing the male-dominated nature of the industrial sector, the limited social support mechanisms, and prevailing gender norms, provide insight into the structural reasons why improvements in income inequality do not necessarily lead to an increase in women's employment.

The causality test results for the economic growth variable confirm that there is no statistically significant causal relationship between the service sector, industrial sector, total female employment, and economic growth. This finding supports the view that women's employment does not directly lead to economic growth but rather exerts indirect and context-specific effects. In the literature, studies such as those by Goldin (1994) and Olivetti (2013), which suggest a non-linear, U-shaped relationship between female labor force participation and economic development, partially contrast with this finding. This implies that Türkiye's demographic and sectoral structure may not align with the stages of development posited in these models. However, a unidirectional causal link was identified, running from economic growth to female employment in the agricultural sector. This suggests that employment dynamics in the agricultural sector are highly sensitive to economic fluctuations and that the growth process plays a crucial role in shaping female labour force participation in this sector. The structural characteristics of the agricultural sector, such as low productivity levels, significant seasonal fluctuations in production processes, and widespread informal employment, create a favorable environment for sectoral expansions driven by economic growth to increase the demand for female labor (SOFA Team and Doss, 2011; Blau and Kahn, 2017). These mechanisms triggered by growth dynamics may contribute to the increase in female employment in the agricultural sector; however, the nature of this increase should be carefully evaluated in terms of women's position in the labor market and working conditions. Although no direct evidence has been found regarding the causal relationship between income inequality and female employment, the findings of Dinç (2022) and Kopuk and Meçik (2020), which identified a unidirectional causality from the agricultural sector to economic growth, highlight the potential impact of the employment structure in this sector on macroeconomic outcomes. On the other hand, the findings of Turhan and Erdal

(2022), which indicate that economic growth increases agricultural employment, present a different perspective regarding the direction of causality and underscore the need for a multidimensional evaluation of intersectoral dynamics.

The findings of the study reveal that the impacts of women's employment on economic growth and income distribution exhibit significant sectoral differences. Therefore, policy recommendations focus on empirically supported intervention areas, avoiding general directives.

The study identifies a negative impact of women's employment in the agricultural sector on economic growth, while a unidirectional causality relationship suggests that economic growth leads to an increase in women's employment. This asymmetric structure indicates that the employment expansion triggered by growth is concentrated in labor-intensive, low-wage sectors, and the employment generated in these areas remains limited in terms of productivity. Similarly, the results from the FMOLS test show that women's employment is effective in reducing income inequality in the agriculture and service sectors, but this effect is quite limited in the industrial sector. Overall, employment growth is seen as an important and functional policy tool in reducing societal inequalities. These findings highlight that women's employment should be supported not only quantitatively but also through qualitative transformation. In this regard, mechanisms that increase women's access to registered and productive forms of employment in these sectors must be strengthened. Especially considering the prevalence of low productivity and informal work in agriculture, involving women in collective production and marketing structures through cooperatives will contribute to both their economic empowerment and inclusion within social protection schemes.

However, the Women's Cooperatives Workshop Report (Ankara Development Agency, 2024) revealed that women's cooperatives face structural challenges in areas such as production capacity, access to marketing channels, financial sustainability, and governance. This situation demonstrates that cooperative-based women's employment can only be effectively implemented through supportive institutional and technical infrastructures. Therefore, consistent with the findings of the workshop report, policy tools such as needs-based training programs that enhance women's professional skills and guide them into social service-based employment areas, e-commerce and foreign trade consulting, machinery and equipment support to strengthen production infrastructure, and the expansion of social procurement mechanisms should be prioritized. Many women's cooperatives face various challenges in project development, ensuring financial sustainability, and accessing marketing channels. In this regard, strengthening women's capacity in cooperative processes through training and technical support in areas such as institutional capacity, project writing, and financial management will be beneficial, especially in rural areas, in increasing productivity and institutional resilience. Additionally, the expansion of agricultural skills development programs, the provision of practical training through farmer field schools, and the involvement of experienced female farmers as trainers will facilitate rural women's access to knowledge and enable more active participation in production processes. Furthermore, the development and accessibility of women-friendly mechanization technologies (e.g., mini grain processing machines, ergonomic carrying equipment) will make significant contributions to both reducing labor burdens and enhancing production efficiency. These holistic and gender-sensitive approaches are expected to allow for a more active, registered, and sustainable participation of women in agricultural production in Türkiye.

To strengthen women's entrepreneurship and enhance its contribution to economic development in Türkiye across the service, agriculture, and industrial sectors, the establishment of specialized financial support mechanisms (e.g., ‘Entrepreneurial Mother’ funds) aimed at balancing early parenting responsibilities with entrepreneurial activities could help reduce barriers to women's business start-up and expansion. Additionally, the establishment of sectoral accelerator programs and venture capital funds to encourage female entrepreneurship in the high-tech sector could provide opportunities for innovative and value-added ventures to emerge. Furthermore, the development of structural regulations and incentive mechanisms for large-scale institutions to include more women entrepreneurs in their supply chains, as well as the creation of an accessible and up-to-date information platform encompassing all female entrepreneur support programs, could enhance the effectiveness of the entrepreneurship ecosystem. Implementing these policy recommendations has the potential to foster the sustainable development of female entrepreneurship in Türkiye and increase its contribution to economic growth.

The findings of this study indicate that women's employment in the service sector has a significant impact on improving income distribution. However, to expand this potential to broader segments, structural adjustments are required to facilitate women's access to sustainable and productive employment in the service sector. In this context, expanding flexible working models and remote working opportunities can be effective in increasing women's participation in the labour force. Supporting digital infrastructure investments that facilitate women's teleworking, particularly in sectors such as information technologies, digital marketing, and education, along with expanding e-government-based digital work platforms and online professional development programs, can contribute to enhancing women's spatially independent productivity. Additionally, employers offering flexible and remote working opportunities should be supported through measures such as gradual premium reductions, social security incentives, and tax advantages based on performance criteria that consider the continuity and quality of women's employment. Incentive policies developed in this direction will help promote the widespread adoption of women-friendly employment models in the private sector. Although flexible working arrangements and some policies encouraging women's employment exist in Türkiye, a comprehensive and gradual incentive system combining all the aforementioned elements has not yet been widely implemented. A state-sponsored 'Women-Friendly Workplace Certificate' could be introduced, with gradual incentives (such as tax reductions, SSI employer premium support, and point advantages in public tenders) provided to enterprises receiving this certificate, based on indicators such as the female employment rate, the level of flexible working practices, and the duration of women's employment. These certificates are typically targeted at companies in specific sectors or of particular sizes and do not constitute a broad incentive system covering all employers. Moreover, the participation of employers in such programs is usually voluntary, leading to limited uptake. Therefore, it is crucial to develop a gradual and sustainable incentive system based on performance criteria that encourages flexible working and women's employment. This system would motivate employers to adopt women-friendly policies and could significantly increase women's participation in the labor force.

Lastly, while various awareness campaigns have been carried out in Türkiye regarding gender equality and women’s employment, the majority of these initiatives tend to be short-term, general in scope, and implemented in a fragmented manner by different institutions and actors, without a comprehensive strategy. However, a need exists for specialized and thematic

communication campaigns focused on areas that directly impact women's employment, such as flexible working. These campaigns should underscore the mutual benefits of flexible work models for women, all employees, and employers; messages aimed at mitigating employers' biases regarding this issue should also be integrated. Additionally, the integration of content promoting the equitable sharing of household responsibilities among men into these campaigns and the development of sustainable collaborations with media organizations to systematically and effectively disseminate these messages across all societal segments could enhance awareness. Comprehensive measures, such as institutionalizing women-friendly flexible working systems, expanding care services, increasing sectoral skills development programs, and strengthening incentive mechanisms to facilitate women's access to productive employment, can play a crucial role in increasing women's employment. The policies and practices developed in this context will not only promote women's participation in the labor force but also foster the creation of an inclusive economic structure that supports gender equality. Should these reforms be implemented, Türkiye will be able to achieve its development goals, prioritizing both economic efficiency and social justice, in a faster and more sustainable manner.

This study aims to make an original contribution to the literature by examining the relationship between women's employment, economic growth, and income distribution in the Turkish economy at a sectoral level using annual data from the period 1991-2023. In the literature, the macroeconomic outcomes of women's employment are typically assessed through overall employment levels; however, this study conducts an in-depth analysis by considering the unique structural dynamics of each sector. Furthermore, the combined application of Fourier-based econometric methods (FADL, RALS-FADL, and Fourier Toda-Yamamoto) presents a modeling approach sensitive to structural breaks and nonlinear relationships. A long-term analytical framework encompassing transformation phases such as the pandemic and the global financial crisis deepens the sectoral impacts in a temporal context. Taken together, no study in the literature simultaneously analyzes the relationship between women's employment, economic growth, and income distribution while using Fourier-based methods. In this regard, the study distinctly differentiates itself from existing research both methodologically and theoretically.

The Fourier-based methods employed in this study offer notable advantages in modeling the effects of structural breaks; however, they may have limitations, particularly in capturing abrupt and high-frequency shifts (Christopoulos and Leon-Ledesma, 2010). This acknowledged limitation in the interpretability of Fourier-based methods for policymakers has been considered in the evaluation of the results, with potential effects arising from the nature of the method duly taken into account. On the other hand, while the study is grounded in a robust methodological and substantive foundation, certain areas require further exploration. First, the employment data used in the analysis exclude informal employment, which may lead to an underestimation of the true scale of women's employment, particularly in the agriculture and service sectors. Therefore, integrating data sources that account for informal labor could enhance the accuracy of future analyses and provide a more comprehensive picture of the actual extent of women's employment. Second, spatial variations (e.g., urban-rural, regional distributions) have not been incorporated into the study, though the regional distribution of women's employment shows significant structural heterogeneity. Thus, analyzing women's employment not only at the sectoral level but also at the regional level could provide a clearer understanding of spatial inequalities. Future research based on micro-level data that takes into account the sectoral and gender-based structure of informal employment could yield a more accurate representation of women's employment. In

conclusion, while this study has provided significant insights by thoroughly examining the relationship between women's employment, economic growth, and income distribution at the sectoral level, it suggests that future research, by addressing the existing limitations and utilizing broader datasets and methodological approaches, will contribute substantially to the body of knowledge in this field.

Declaration of Research and Publication Ethics
This study, which does not require ethics committee approval and/or legal/specific permission, complies with research and publication ethics.

Researcher's Contribution Rate Statement
The authors declare that they have contributed equally to the article.

Declaration of Researcher's Conflict of Interest
There are no potential conflicts of interest in this study.

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