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Mohammed Elhaj Mustafa Ali[1], Ebaidallah Mahjoub Ebaidallah[2] and Manal Osman Elhaj[3]

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Send correspondence to:
Mohammed Elhaj Mustafa Ali
University of Khartoum
mohdaj1976@gmail.com

[1] Development Studies and Research Institute, University of Khartoum, email: mohdaj1976@gmail.com
[2] Ibn Khaldon Center for Humanities & Social Sciences, Qatar University, email: ebaidalla@gmail.com
[3] Department of Economics, College of Business Administration, Princess Nourah Bint Abdulrahman University, email: MOElhaj@pnu.edu.sa

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Abstract

This study investigates the complex relationship between fertility and female labor force participation in the Arab region, where sociocultural norms often constrain women's economic empowerment. Using panel data from 1991 to 2023 across 15 Arab countries, the analysis employs the Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) model to address potential endogeneity and account for dynamic heterogeneity. The results show that higher fertility rates reduce labor market participation among women aged 15–64, while, somewhat unexpectedly, increasing participation among younger women aged 15–24. However, fertility is associated with higher unemployment rates in both age groups. These findings highlight the need for targeted policy interventions to support women's employment, including expanded access to reproductive health services, flexible work arrangements, affordable childcare, and broader gender equity initiatives. The study's key contribution lies in its region-wide, longitudinal approach, offering new insights that extend beyond previous country-specific or cross-sectional analyses.

Keywords: PMG, Females, Arab world, Labor force participation, Fertility.
JEL Classifications: J13, J16, J21, C33

ملخص

تهدف هذه الدراسة إلى اختبار العلاقة المعقدة بين الخصوبة ومشاركة المرأة في القوى العاملة في المنطقة العربية، حيث غالبا ما تحد الأعراف الاجتماعية والثقافية من تمكين المرأة اقتصاديا. تستخدم الدراسة بيانات تتبعية تمتد من عام 1991 إلى 2023 و تغطي خمسة عشر دولة عربية. يعتمد التحليل نموذج التجميع المتوسط الموزع المتأخر ذاتي الارتباط (PMG- ARDL) و ذلك لمعالجة التأثيرات الداخلية المحتملة والتغاير الديناميكي. تظهر النتائج أن معدلات الخصوبة المرتفعة تقلل من مشاركة النساء في سوق العمل وسط الفئة العمرية 15-64 عاما، بينما، و بشكل غير متوقع ، تزيد من مشاركة النساء الشابات في الفئة العمرية 15-24 عاما. ومع ذلك، عند الأخذ في الاعتبار ظروف سوق العمل، يتبين أن الخصوبة تسهم في ارتفاع معدلات البطالة بين النساء في كلا الفئتين العمريتين. تؤكد هذه النتائج الحاجة إلى تدخلات سياسية تدعم توظيف النساء، بما في ذلك توسيع نطاق الوصول إلى خدمات الصحة الإنجابية، وتوفير ترتيبات عمل مرنة، ورعاية الأطفال، وتدابير أوسع لتعزيز المساواة بين الجنسين. تكمن أهمية الدراسة في منظورها الطولانية على مستوى المنطقة، حيث تقدم رؤى جديدة تتجاوز التحليلات السابقة المقتصرة على بلد معين أو القائمة على المسوحات الأسرية.

1. Introduction

Female performance in labor market outcomes in the Arab world remains significantly below global averages and those of comparable regions (Alissa, 2007; Filali et al., 2013; El-Mallakh et al., 2018; Elhaj & Pawar, 2019; World Bank, 2025). Only 19% of females aged 15 and over actively participate in the labor force (ILO, 2025), a figure that is considerably lower than the global average of 50% over the period from 1995 to 2025 (ILO, 2025). The gap is even wider among younger women, with participation rates falling to 15% for females aged 15 to 24, compared to a global average of 41% for the same age group during the same period (ILO, 2025). This gender gap becomes more apparent when comparing female and male labor force participation within the Arab region itself. Arab males have consistently recorded much higher participation rates—74% for those aged 15–64 and 47% for those aged 15–24 between 1991 and 2020 (ILO, 2025). These contrasts underscore the persistent gender-based disparities in labor market engagement.

In addition to low participation rates, Arab females face disproportionately high unemployment levels. Over the past three decades, the unemployment rate among women aged 15 and over has averaged approximately 18% (ILO, 2025). This figure not only doubles the rate observed among Arab males, estimated at 9.5%, but also exceeds the global average unemployment rate for females, which stands at 6% over the same period (ILO, 2025). Young Arab women are particularly disadvantaged, with their unemployment rate averaging 23% higher than that of their male peers over the last thirty years. This youth unemployment rate also surpasses the global average for young females, projected at 15.5% during the same period (ILO, 2025). Together, these patterns reflect a deeply rooted structural challenge for female labor market inclusion in the Arab world.

The undesirable status of Arab females in the labor market has far-reaching consequences beyond negative economic implications, such as the deterioration of families' livelihoods, deepening poverty in societies, and the lack of economic empowerment. It also perpetuates social inequalities (Backeberg & Tholen, 2018) and reinforces traditional gender roles that restrict females' opportunities for personal and professional development (Al-Asfour et al., 2017). This cycle of disadvantage hinders not only females' individual aspirations but also the overall progress of communities, as the potential contributions of half the population remain untapped. According to the Gender Inequality Index, the Arab world's ratings hover around 61.7%, indicating that 38% of the region's gender gap remains unaddressed (UNDP, 2025). Additionally, the Arab world scores 2.6 out of 6 on the CPIA for gender equality (World Bank, 2025). This poor performance contradicts numerous studies that highlight the transformative significance of females' labor market participation for economic, political, and social empowerment (Verick, 2014). Several studies have explored the factors contributing to females' declining labor market status, highlighting the impact of elements such as fertility, workplace discrimination, and economic downturns on females' labor force participation. In this context, fertility emerges as a primary determinant that continues to capture researchers' interest (Bowen & Finegan, 2015; Goldin, 1995; Brewster & Rindfuss, 2000; Narayan & Smyth, 2006; Tam, 2011). High fertility, defined as an increase in the number of children born, consumes females' time and energy. Consequently, this creates significant challenges in balancing work and family life, often resulting in barriers to labor force participation and career advancement for females (Brewster & Rindfuss, 2000; Agüero & Marks, 2008; Bloom et al., 2009).

According to available statistics, the Arab world's total fertility rate was approximately 3.85 between 1990 and 2020, exceeding the global average for the same time period (World Bank, 2025). Exploring this high fertility rate in the context of the region's labor market suggests a strong correlation between it and female underperformance in the labor market**.** In fact, only two studies have investigated the relationship between Arab female status in the labor market and fertility (Al-Qudsi, 1998 and Ucal and Gunay, 2019). However, both of these studies used microdata derived from different types of surveys, namely population surveys and labor market surveys. This limits the generalizability of their findings, as the unique socio-economic and cultural contexts of each country can significantly influence the relationship between female labor market participation and fertility rates. Therefore, adopting a more comprehensive approach that utilizes a wider dataset across multiple Arab countries is crucial for deriving more precise conclusions and effectively influencing policy decisions.

This study aims to explore how fertility rates influence the participation of Arab females in the labor force and their unemployment rates. The study utilizes demographic and economic time series data spanning from 1991 to 2023, for 15 Arab countries. To mitigate potential biases and ensure robust analysis, the study employs the pooled mean group method, known for its ability to account for diverse factors impacting the data such as cross-country variations and time-specific effects.

The rest of the paper follows this structure. Section 2 introduces the literature review and Section 3 sketches the methodology and data. Section 4 presents results and discussion, while Section 5 concludes.

2. Literature review

Theoretically, several hypotheses have been advanced to explain the complex relationship between fertility and female labor market behavior. Among these, the incompatibility hypothesis posits that the structural demands of modern employment, such as prolonged absence from the household and the requirement for full-time physical engagement, pose significant barriers to women's participation in the labor force (Bowen & Finegan, 2015). Advocates of this perspective contend that employment in industrialized contexts necessitates sustained presence and time-intensive commitment, which often conflicts with women's reproductive and caregiving responsibilities.

These domestic roles typically require women to remain at home for extended periods, particularly during early childrearing years, thereby limiting their labor market engagement. In contrast, in agrarian societies where agricultural production dominates and a rigid separation between work and childcare responsibilities is less pronounced, women may experience greater flexibility in managing both roles (Boserup et al., 2013). In such settings, the integration of productive and reproductive labor allows for a more compatible balance between economic activity and familial obligations.

While the incompatibility hypothesis emphasizes the structural tensions between childbearing and formal employment, particularly in industrialized settings, the societal response hypothesis offers a contrasting view. It posits a positive association between fertility and female labor force participation (FLFP), suggesting that increased female engagement in the labor market has triggered adaptive changes in social norms and institutional frameworks (Brewster & Rindfuss, 2000; Narayan & Smyth, 2006). As societies increasingly accommodate the dual roles of women as both workers and caregivers, supportive policies—such as paid maternity leave, flexible work arrangements, and accessible childcare services—have emerged to reduce the incompatibility between employment and motherhood (Brewster & Padavic, 2000; Rindfuss et al., 1996). These developments underscore the potential for labor market participation and fertility to be mutually reinforcing, rather than conflicting, in contexts where policy and cultural adaptation are responsive to demographic and economic shifts.

While both the incompatibility and societal response hypotheses emphasize the role of social norms and institutional adaptation in shaping the fertility–employment nexus, the U-shaped curve hypothesis introduces a broader macroeconomic perspective by linking female labor force participation to stages of economic development. The U-shaped curve hypothesis posits a non-linear relationship between economic development and female labor force participation (FLFP), suggesting that FLFP initially declines and later rises along the path of development (Sinha, 1965; Goldin, 1990, 1995; Tam, 2011). In the early stages of development—particularly during the transition from agrarian to industrial economies—FLFP tends to fall. This decline is attributed to the increasing burden of domestic responsibilities, limited job opportunities compatible with women's roles, and prevailing cultural norms that discourage female employment outside the home (Goldin, 1994; Gaddis & Klasen, 2014). However, as economies continue to advance, FLFP begins to rise. This resurgence is driven by expanded access to education, shifting societal expectations, and growing opportunities for women in skilled and professional sectors (Gaddis & Klasen, 2013). In more mature economies, factors such as rising dual-income household needs and the gradual erosion of traditional gender norms further reinforce women's participation in the labor market (Dong & Pandey, 2012). The U-shaped hypothesis thus highlights the dynamic interplay between economic structure and gender roles in shaping labor market outcomes across different development phases.

In general, there is no strict demarcation between the theoretical frameworks used to explain female labor market behavior in response to fertility. Rather, the hypotheses often overlap and interact, reflecting the multifaceted nature of this relationship. For instance, the societal response hypothesis tends to characterize the labor market behavior of women in societies that have undergone significant economic transformation. At more advanced stages of development, it converges with the U-shaped curve hypothesis, particularly along the upward slope of the curve, where improvements in childcare access and greater availability of alternatives to childbearing contribute to rising female labor force participation (FLFP). The incompatibility hypothesis, by contrast, appears more autonomous and persistent, as its predicted constraints on FLFP continue to manifest even in the presence of economic and institutional progress. However, recent advancements in information and communication technologies—particularly the expansion of remote work options—may increasingly challenge the assumptions of the incompatibility hypothesis by easing physical constraints on women's employment. In this sense, technological change both shapes and is shaped by broader economic development and social transformation, ultimately influencing women's engagement in the labor market. These dynamics suggest that, rather than existing in isolation, the three hypotheses may operate concurrently and interactively, offering a more integrated framework for understanding the evolving relationship between fertility and FLFP.

Empirically, numerous studies have investigated the relationship between fertility and women's labor market participation, employing a variety of contexts, data types, and estimation methods. In general, the evidence points to a negative association, with higher fertility rates linked to lower levels of female labor force participation (Aguero & Marks, 2008; Bloom et al., 2009, among others). However, this relationship is not uniform, and several studies highlight mediating factors that influence women's participation in the labor force. These include access to contraception (Aguero & Marks, 2008), the availability of supportive social policies (Del Boca et al., 2009), the liberalization of abortion laws (Bloom et al., 2009), and more equitable distribution of household responsibilities (De Laat & Sevilla-Sanz, 2011). In contrast, a growing body of research documents a positive relationship between fertility and female labor force participation in contexts where institutional and cultural conditions are more supportive. Such conditions include family-friendly policies, gender role flexibility, and expanded childcare infrastructure (Azid et al., 2010; Baah-Boateng et al., 2013; Aaronson et al., 2018; Shittu & Abdullah, 2019; Guirguis et al., 2024). These divergent findings suggest that the fertility–FLFP relationship is highly context-dependent and shaped by a complex interplay of demographic, policy, and cultural variables.

Notably, both strands of empirical literature, those identifying a negative association between fertility and labor force participation and those documenting a positive link, are subject to potential endogeneity concerns, wherein fertility and female labor supply may simultaneously influence one another. For instance, while higher fertility may reduce a woman's likelihood of participating in the labor market, the reverse may also hold true: women planning to enter or remain in the workforce may choose to postpone or limit childbearing. This bidirectional relationship complicates the empirical identification of causal effects. If not properly addressed through robust econometric techniques, such as instrumental variable estimation and dynamic panel approaches, the resulting estimates may merely capture correlation rather than true causation. Such omitted variable bias or reverse causality can distort findings and lead to misleading policy conclusions, particularly in the design of labor and family welfare interventions (Bloom et al., 2009). Therefore, proper econometric modeling is critical to derive reliable policy implications.

In the Arab world, empirical studies examining the relationship between fertility and female labor force participation (FLFP) remain relatively scarce. Despite growing scholarly and policy interest, only a limited number of studies have addressed this issue within the regional context. One of the earliest contributions, by Al-Qudsi (1998), investigated the relationship between fertility and Arab women's labor supply using microdata from four countries. More recently, Ucal and Gunay (2019) employed data from 13 Arab countries using the World Values Survey (2010–2014) to assess the influence of sociocultural factors on FLFP, including fertility. Although both studies report a negative association between fertility and female labor supply, their findings are subject to several important limitations.

First, neither study addresses the problem of endogeneity, a critical methodological issue given the potential for reciprocal causality between fertility choices and labor market decisions. Second, both studies are constrained by limited country coverage and insufficient longitudinal depth, thereby restricting the generalizability and temporal robustness of their conclusions. Third, their reliance on cross-sectional survey data, without incorporating broader demographic, policy, or institutional variables, limits the analytical scope and weakens causal inference. Finally, neither study disaggregates the effects of fertility by age group, overlooking potential life-cycle variations in how fertility influences labor market behavior. This omission is particularly consequential in the Arab region, where a large and growing youth population and shifting gender norms make age-specific insights essential for designing effective and targeted policy interventions.

3. Methodology

3.1. Data

This study utilizes panel data primarily sourced from the World Bank, specifically the World Development Indicators (WDI), covering the period from 1991 to 2023 for 15 Arab countries. The time span for each variable varies based on data availability, which in turn defines the overall timeframe of the analysis. For instance, labor market indicators, including total female and young female population, labor force participation, and unemployment rates for both groups, are consistently available for the full 1991–2023 period. Other economic and demographic variables, such as total fertility rate (births per woman), inflation rate, real GDP, real GDP per capita, gross capital formation as a percentage of GDP, domestic credit to the private sector as a percentage of GDP, and total female population, are available beyond the core study period but are restricted here to maintain consistency. Data on average years of schooling for the total population were obtained from the Our World in Data database. Since this dataset is updated in five-year intervals, values for the intervening years were interpolated to ensure completeness and consistency across the panel. Table 1 provides a comprehensive description of the variables and their respective data sources, while Table 2 presents summary statistics, including the mean, standard deviation, and range for each variable.

Table 1. Variables definition and sources

Variable	Definition	Source
ln FLFP	Log of labor force participation rate, female (% of female population ages 15+)	WDI
lnYFLFP	Log of labor force participation rate for ages 15-24, female (%)	WDI
ln FUN	Log of unemployment, female (% of female labor force)	WDI
ln YFUN	Log of unemployment, youth female (% of female labor force ages 15-24)	WDI
ln FER	Log of total fertility rate (i.e. births per woman)	WDI
ln EDU	Log of average years of education for 15-64 years male and female youth and adults	Our World in Data
ln FPOP	Total female population	WDI
ln GDPP	Log of GDP per capita (constant 2015 US$)	WDI
ln GDP	Log of GDP (constant 2015 US$)	WDI
ln KGDP	Gross fixed capital formation (% of GDP)	WDI
ln CRED	Log of domestic credit to private sector by banks (% of GDP)	WDI
INF	Inflation, GDP deflator (annual %)	WDI

Table 2: Summary statistics for the variables used

Variable	Observation	Mean	Std. Dev.	Min	Max
ln FLFP	509	25.83	13.28	4.93	63.54
ln YFLFP	509	34.77	12.07	16.98	70.96
ln UNF	494	15.31	9.23	0.378	32.10
ln UNYF	494	30.58	18.49	1.48	74.62
ln FER	495	3.42	1.24	1.33	8.60
ln EDU	454	6.59	2.25	0.456	11.35
ln FPOP	510	1.00	1.09	137327	5.67
ln GDPP	509	14752.	18650.51	712.27	81608.57
ln GDP	504	1.20	1.41	9.44	7.82
ln KGDP	498	23.30	9.92	-12.88	59.34
ln CRED	458	6.59	25.78	1.26	138.41
INF	503	1.01	33.01	-28.76	396.43

3.2. Empirical modeling

To examine the effects of the fertility rate on the involvement of Arab females in the labor market, this study estimates two models. The first model examines the impact of fertility rates on females' labor force participation, whereas the second one investigates the impact of fertility rates on females' employment. To strengthen the analysis's robustness and depth, the estimation will be further disaggregated to incorporate youth females. Following Goldin (1995) and Tam (2011), the first model can be expressed as follows:

$$lnFLFP_{it} = \beta_{0i} + \beta_{1i} lnFER_{it} + \beta_{2i} lnEDU_{it} + \beta_{3i} lnFPOP_{it} + \beta_{4i} lnGDPP_{it} + \beta_{5i} lnKGDP_{it} + \varepsilon_{it} \quad (1)$$

Where lnFLFP is the log of the FLFP rate; lnFERT is the log of fertility rate; lnEDU is the log of average years of education for 15-64 years population; lnFPOP is the log of total female population; lnGDPP is the log of GDP per capita; lnKGDP is the log of the gross fixed capital formation as a percentage of GDP; β_{0i} is the cross-section specific intercept; β_{ji} are the parameters of the independent variables; t is time; i = 1,2,….,15 countries, and ε is the error term.
The second model, which examines the impact of fertility on female unemployment, can be also written as follows:

$$lnFUN_{it} = \alpha_{0i} + \alpha_{1i} lnFER_{it} + \alpha_{2i} lnEDU_{it} + \alpha_{3i} INF_{it} + \alpha_{4i} lnFPOP_{it} + \alpha_{5i} lnGDP_{it} + \alpha_{6i} lnCRED_{it} + \varepsilon_{it} \quad (2)$$

Where lnFUN is the log of the unemployment rate of the female population; INF is the inflation rate; lnGDP is the log gross domestic product; lnCRED is log of domestic credit to private sector by banks as a percentage of GDP; α_{0i} is the cross-section specific intercept; α_{ji} are the parameters of the independent variables. The rest of the variables and notations remain as they defined in Equation (1).

3.3. Estimation methodology

To estimate the models, this study employs the Pooled Mean Group (PMG) and Mean Group (MG) estimators developed by Pesaran et al. (1997, 1999). These methods are particularly well-suited for analyzing non-stationary dynamic panel data characterized by heterogeneity across cross-sectional units, in contrast to the more restrictive Dynamic Fixed Effects (DFE) approach. As noted by Pesaran et al. (1999), the PMG estimator offers a balanced framework by combining the strengths of pooling and averaging, allowing for homogeneity in long-run relationships while accommodating heterogeneity in short-run dynamics. This structure enhances the accuracy and consistency of long-run elasticity estimates when the assumption of long-run parameter homogeneity is valid. Moreover, the PMG method permits variation in short-run adjustments across countries, capturing country-specific responses to external shocks and domestic policy shifts (Kratou & Gazdar, 2016; Musibau et al., 2019). Given the structural and institutional differences among Arab countries, this flexibility is particularly valuable. Therefore, due to its methodological advantages and empirical robustness, this study adopts the PMG estimator as the preferred approach over both MG and DFE alternatives.

By setting the maximum lag to one, as suggested by AIC, the ARDL (1,1,1,1, 1,1) and the ARDL (1,1,1,1, 1,1,1) dynamic panel representations of Equation (1) and Equation (2) can be specified as:

$$lnFLFP_{i,t} = \mu_i + \theta_{10i} lnFER_{i,t} + \theta_{11i} lnFER_{i,t-1} + \theta_{20i} lnEDU_{i,t} + \theta_{21i} lnEDU_{i,t-1} + \theta_{30i} lnFPOP_{i,t} + \theta_{31i} lnFPOP_{i,t-1} + \theta_{40i} lnGDPP_{i,t} + \theta_{41i} lnGDPP_{i,t-1} + \theta_{50i} lnKGDP_{i,t} + \theta_{51i} lnKGDP_{i,t-1} + \lambda_{1i} lnFLFP_{i,t-1} + v_{it} \quad (3)$$

$$lnFUN_{it} = \varphi_i + \omega_{10i} lnFER_{it} + \omega_{11i} lnFER_{i,t-1} + \omega_{20i} lnEDU_{it} + \omega_{21i} lnEDU_{i,t-1} + \omega_{30i} lnINF_{i,t} + \omega_{31i} lnINF_{i,t-1} + \omega_{40i} lnFPOP_{it} + \omega_{41i} lnFPOP_{i,t-1} + \omega_{50i} lnGDP_{it} + \omega_{51i} lnGDP_{i,t-1} + \omega_{60i} lnCRED_{it} + \omega_{61i} lnCRED_{i,t-1} + \lambda_{1i} lnFUN_{i,t-1} + v_{it} \quad (4)$$

Reparametrizing and rearranging equation (3) and (4) to express the error correction equations as follows:

$$\Delta lnFLFP_{it} = \delta_i \left[lnFLFP_{i,t-1} - \beta_{0i} - \beta_{1i} lnFER_{it} - \beta_{2i} lnEDU_{it} - \beta_{3i} lnFPOP_{it} - \beta_{4i} lnGDPP_{it} - \beta_{5i} lnKGDP_{it} \right] - \theta_{1i} \Delta lnFER_{i,t-1} - \theta_{2i} \Delta lnEDU_{i,t-1} - \theta_{3i} \Delta lnFPOP_{i,t-1} - \theta_{4i} \Delta lnGDPP_{i,t-1} - \theta_{5i} \Delta lnKGDP_{i,t-1} + v_{it} \quad (5)$$

$$\Delta lnFUN_{it} = \eta_i \left[lnFUN_{i,t-1} - \alpha_{0i} - \alpha_{1i} lnFER_{it} - \alpha_{2i} lnEDU_{it} - \alpha_{3i} lnINF_{i,t} - \alpha_{4i} lnFPOP_{it} - \alpha_{5i} lnGDP_{it} - \alpha_{6i} lnCRED_{it} \right] - \omega_{1i} \Delta lnFER_{i,t-1} - \omega_{2i} \Delta lnEDU_{i,t-1} - \omega_{3i} \Delta lnINF_{i,t-1} - \omega_{4i} \Delta lnFPOP_{i,t-1} - \omega_{5i} \Delta lnGDP_{i,t-1} - \omega_{6i} \Delta lnCRED_{i,t-1} + v_{it} \quad (6)$$

Where δ_i represents the coefficient of the error correction term which determines the speed of adjustment resulting from changes in the explanatory variables. The β_{ij} and α_{ij} are the long run parameters that emerge with variables under estimation in the two equations. The signs of the error correction terms δ_i and η_i are supposed to be negative and statistically significant in the case that these variables maintain long run equilibriums. Specifically, if $\delta_i < 0$ and $\eta_i < 0$ this will imply that the female labor force participation and female unemployment and the right hand side variables are co-integrated and if $\delta_i = 0$ and $\eta_i = 0$ then the cointegration is no longer holds. The parameter of the error term in Equation (5) can be defined as $\delta_i = -(1 - \lambda_{1i})$ and $\beta_{0i} = \frac{\mu_i}{1-\lambda_{1i}}$, $\beta_{1i} = \frac{\theta_{10i}+\theta_{11i}}{1-\lambda_{1i}}$, $\beta_{2i} = \frac{\theta_{20i}+\theta_{21i}}{1-\lambda_{1i}}$, $\beta_{3i} = \frac{\theta_{30i}+\theta_{31i}}{1-\lambda_{1i}}$, $\beta_{4i} = \frac{\theta_{40i}+\theta_{41i}}{1-\lambda_{1i}}$, and $\beta_{5i} = \frac{\theta_{50i}+\theta_{51i}}{1-\lambda_{1i}}$. In the same way, the parameter of the error term in Equation (6) can be defined as $\eta_i = -(1 - \lambda_{2i})$ and $\alpha_{0i} = \frac{\varphi_i}{1-\lambda_{2i}}$, $\alpha_{1i} = \frac{\omega_{10i}+\omega_{11i}}{1-\lambda_{2i}}$, $\alpha_{2i} = \frac{\omega_{20i}+\omega_{21i}}{1-\lambda_{2i}}$, $\alpha_{3i} = \frac{\omega_{30i}+\omega_{31i}}{1-\lambda_{2i}}$, $\alpha_{4i} = \frac{\omega_{40i}+\omega_{41i}}{1-\lambda_{2i}}$, $\alpha_{5i} = \frac{\omega_{50i}+\omega_{51i}}{1-\lambda_{2i}}$, and $\alpha_{6i} = \frac{\omega_{60i}+\omega_{61i}}{1-\lambda_{2i}}$.

Equation (5) will be used to estimate the impact of fertility on the labor force participation rate of the total female population and young females, while Equation (6) will assess the effect of fertility on the unemployment rate of all females and young females. To ensure the reliability and robustness of the findings, it is crucial to estimate the PMG, MG, and DFE models, as suggested by Pesaran et al. (1999). Employing all three estimators allows for a comprehensive evaluation of model performance under different assumptions regarding parameter homogeneity and heterogeneity. This approach facilitates a more nuanced understanding of the short- and long-run dynamics between fertility and female labor market outcomes, enhancing the credibility of the empirical results.

3.3.1. Unit Root Test

To investigate the long-term relationship between variables, the order of integration for each series must first be verified using appropriate panel unit root tests. The Im-Pesaran-Shin (IPS) and Fisher Augmented Dickey-Fuller (ADF) tests are employed for this purpose. Unlike more restrictive tests—such as those proposed by Levin and Lin (1993), Levin et al. (2002), and Breitung (2000)—which assume a common autoregressive coefficient across cross-sections, the IPS and Fisher ADF tests allow for heterogeneity in this coefficient across units. The IPS test evaluates the null hypothesis of a unit root against the alternative of stationarity and yields a single standardized test statistic. In contrast, the Fisher ADF test provides a set of four complementary test statistics: inverse chi-square (P), inverse normal (Z), inverse logit transform (L*), and modified inverse chi-square (Pm), which are combined from individual unit root test results across cross-sections.

3.3.2. Co-integration Test

After verifying the order of integration of the variables, the next step is to examine the existence of long-run equilibrium relationships between the dependent and independent variables within the model. To achieve this, the study employs the Johansen-Fisher panel cointegration test, as proposed by Maddala (1999). The Johansen-Fisher test constructs a panel-level test statistic by combining the p-values derived from the trace and maximum eigenvalue statistics of the individual cross-sections. For example, if Π_i represents the probability value from the individual cointegration test for cross-section i, then the null hypothesis for the panel is:

$$-2\sum_{i=1}^{n}\log(\Pi_i) \sim \chi^2_{2n}$$

Where χ^2_{2n} represents the distribution of chi-square with 2N degrees of freedom. The value of chi-square is based on probabilities values for Johansen cointegration trace test and maximum eigenvalue test. The Johansen's Maximum likelihood procedure is expressed as follows:

$$\Delta Y_{i,t} = \Pi_i Y_{i,t-1} + \sum_{k=1}^{p} \Gamma_k \Delta Y_{i,t-k} + \varepsilon_{i,t}$$

Where $Y_{i,t}$ is a vector of variables, Π_i is the cointegration matrix, Γ_k are short-run adjustment matrices, $\varepsilon_{i,t}$ is the error term each cross-section and time period. The hypotheses are: H_0 : rank $(\Pi_i) = r_i \leq r$ for all i=1, ... ,n, while H_a : rank $(\Pi_i) = p$ for all i =1, ... ,n, where r is the hypothesized cointegration rank, and p is the number of variables in $Y_{i,t}$.

4. Results and discussions

Prior to estimating the models, it is essential to confirm that the variables are stationary and cointegrated. We adopted two panel unit root tests, namely the IPS and the Fisher-type Augmented Dickey-Fuller (ADF) tests. These tests are well-suited for panel data, as they account for heterogeneity by allowing parameters, such as the autoregressive coefficient, to vary independently across the 15 Arab countries in the dataset, accommodating cross-sectional differences in economic and demographic dynamics.

Table 3. Panel unit root tests results

Method	Test	Log FERT	Log EDU	Log FPOP	Log RGDPP	Log RGDP	Log CRED	Log KGDP
At level of variable								
Im-Pesaran-Shin	W-t-bar	-1.426	2.962	2.706	-0.829	-1.637	0.0253	-2.3664
		(0.077)	(0.998)	(0.997)	(0.204)	(0.051)	(0.510)	(0.009)
Fisher A. Dickey-Fuller	P	54.98	21.35	18.28	52.25	61.84	28.29	71.95
		(0.004)	(0.877)	(0.954)	(0.007)	(0.001)	(0.555)	(0.000)
	Z	1.517	2.791	2.802	-0.882	-1.725	0.135	-2.730
		(0.064)	(0.997)	(0.998)	(0.189)	(0.042)	(0.554)	(0.003)
	L*	-1.878	3.074	2.798	-1.385	-2.486	0.089	-3.147
		(0.032)	(0.998)	(0.997)	(0.085)	(0.008)	(0.536)	(0.001)
	P_m	3.225	-1.117	-1.514	2.872	4.110	-0.221	5.416
		(0.001)	(0.868)	(0.935)	(0.002)	(0.000)	(0.587)	(0.000)
At difference of variable								
Im-Pesaran-Shin	W-t-bar	-3.717	-0.381	-6.769	-9.300	-9.155	-10.25	-2.037
		(0.000)	(0.352)	(0.000)	(0.000)	(0.000)	(0.000)	(0.021)
Fisher A. Dickey-Fuller	P	69.71	84.38	122.2	182.4	185.8	219.1	68.55
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	Z	-4.034	-5.799	-7.445	-10.06	-9.827	-10.98	-2.350
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)
	L*	-4.286	-5.833	-8.368	-12.97	-13.19	-15.61	-2.796
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)
	P_m	5.126	7.020	11.90	19.68	20.11	24.41	4.976
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: p-values are in parentheses

The IPS test generates a single test statistic (W-t-bar) by averaging individual unit root test statistics, providing a straightforward assessment of stationarity across the panel. In contrast, the Fisher-type ADF test, based on Fisher's (1932) method of combining p-values, produces four distinct statistics, inverse chi-square (P), inverse normal (Z), inverse logit transform (L*), and modified inverse chi-square (Pm), offering a more comprehensive evaluation of stationarity by capturing different aspects of the data's behavior. Both tests operate under the null hypothesis that all series in the panel contain a unit root, implying non-stationarity, against the alternative hypothesis that at least some series are stationary. To ensure the tests accurately reflect the dynamic properties of the data, the lag length for each variable was carefully selected using the Akaike Information Criterion (AIC), which balances model fit and parsimony by minimizing information loss.

Table 3 presents the IPS and Fisher ADF unit root test results for each series at both levels and first differences, along with the corresponding p-values. Overall, the results are mixed, indicating that while some series exhibit stationarity at levels, others require differencing to achieve stationary behavior. Therefore, taking the first difference fully ensures the stationarity of all series used. This is evident in the lower part of the table, which shows the variables after differencing, revealing a more consistent pattern of stationarity across the analyzed series.

Upon verifying that none of the series exhibit stationarity of order higher than one, the subsequent phase of the analysis involves investigating the cointegration relationships among the variables. The Johansen-Fisher panel cointegration test (Maddala and Wu, 1999) is employed for this purpose. In this test, the null hypothesis assumes no cointegrating relationship between the variables, whereas the alternative hypothesis assumes the existence of at least one. The appropriate lag length for the test is selected based on the Schwarz Information Criterion (SIC).

The results from the four model tests, using both the trace and maximum eigenvalue statistics, are presented in Table 4. For the Total FLFP model, the Fisher statistics from the trace test (653.0, 396.3, 235.9, 140.0, 79.0, 50.3) and maximum eigenvalue test (340.4, 310.3, 124.9, 91.43, 70.73, 50.3) for hypothesized cointegrating vectors ($r = 0$ to $r \leq 5$) yield p-values of 0.000 for $r = 0$ to $r \leq 4$ and 0.012 for $r \leq 5$, rejecting the null hypothesis of no cointegration at the 5% significance level and indicating up to six cointegrating vectors, as the p-value for $r \leq 5$ remains significant. Similarly, for the YFLFP model, the trace test statistics (647.1, 386.1, 227.8, 146.0, 83.24, 61.66) and maximum eigenvalue statistics (330.4, 197.5, 107.3, 95.31, 68.79, 61.66) show p-values of 0.000 across all levels ($r = 0$ to $r \leq 5$), also confirming up to six cointegrating vectors. These results, computed using MacKinnon et al. (1999) p-values and the asymptotic Chi-Square distribution, demonstrate robust long-run relationships among the variables, suggesting that fertility and economic factors are cointegrated and move together over time in both models.

The lower part of Table 4 presents the results of the Johansen-Fisher panel cointegration tests for the Total Female Unemployment (UNF) and Youth Female Unemployment (YUNF) models, which examine the long-run equilibrium relationships among variables such as fertility, education, inflation, female population, GDP, and domestic credit in 15 Arab countries from 1991 to 2023. For the UNF model, the Fisher statistics from the trace test (735.7, 623.7, 466.5, 335.9, 224.2, 135.0, 81.05) and the maximum eigenvalue test (594.3, 305.8, 241.7, 192.7, 144.0, 110.2, 81.05) for hypothesized cointegrating vectors ($r = 0$ to $r \leq 6$) yield p-values of 0.000, rejecting the null hypothesis of no cointegration at the 5% significance level and indicating the presence of at least six cointegrating vectors. Similarly, for the YUNF model, the trace test statistics (656.7, 595.3, 457.3, 330.2, 255.5, 141.8, 88.92) and maximum eigenvalue statistics (446.3, 282.6, 238.7, 186.2, 150.3, 113.0, 88.92) also show p-values of 0.000 across all levels (r = 0 to r ≤ 6), confirming up to seven cointegrating vectors.

Summing up, these findings, based on MacKinnon et al. (1999) p-values and the asymptotic Chi-Square distribution, demonstrate that fertility, education, economic indicators, and labor market outcomes are strongly cointegrated, supporting the applicability of the Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) model for analyzing their dynamic relationships.

Table 4. Johansen Fisher Panel Cointegration Tests

FLFP model				
Hypothesized No. of CE(s)	**Fisher Stat (from trace test)**	**p-value**	**Fisher stat (from max-eigen test)**	**p-value**
r = 0	653.0	0.000	340.4	0.000
r ≤ 1	396.3	0.000	310.3	0.000
r ≤ 2	235.9	0.000	124.9	0.000
r ≤ 3	140.0	0.000	91.43	0.000
r ≤ 4	79.0	0.000	70.73	0.000
r ≤ 5	050.3	0.012	50.3	0.012
YFLFP model				
Hypothesized No. of CE(s)	**Fisher Stat (from trace test)**	**p-value**	**Fisher Sta (from max-eigen test)**	**p-value**
r = 0	647.1	0.000	330.4	0.000
r ≤ 1	386.1	0.000	197.5	0.000
r ≤ 2	227.8	0.000	107.3	0.000
r ≤ 3	146.0	0.000	95.31	0.000
r ≤ 4	83.24	0.000	68.79	0.000
r ≤ 5	61.66	0.000	61.66	0.000
UNF model				
Hypothesized No. of CE(s)	**Fisher Stat(from trace test)**	**p-value**	**Fisher Sat(from max-eigen test)**	**p-value**
r = 0	735.7	0.000	594.3	0.000
r ≤ 1	623.7	0.000	305.8	0.000
r ≤ 2	466.5	0.000	241.7	0.000
r ≤ 3	335.9	0.000	192.7	0.000
r ≤ 4	224.2	0.000	144.0	0.000
r ≤ 5	135.0	0.000	110.2	0.000
r ≤ 6	81.05	0.000	81.05	0.000
UNYF model				
Hypothesized No. of CE(s)	**Fisher Stat (from trace test)**	**p-value**	**Fisher Sat (from max-eigen test)**	**p-value**
r = 0	656.7	0.000	446.3	0.000
r ≤ 1	595.3	0.000	282.6	0.000
r ≤ 2	457.3	0.000	238.7	0.000
r ≤ 3	330.2	0.000	186.2	0.000
r ≤ 4	255.5	0.000	150.3	0.000
r ≤ 5	141.8	0.000	113.0	0.000
r ≤ 6	88.92	0.000	88.92	0.000

Notes: Chi-square statistics are based on the MacKinnon et al. (1999) p-values for Johansen's cointegration trace and maximum eigen-value tests. Probabilities are computed using asymptotic Chi-square distribution.

As shown above, the results of the unit root and cointegration tests confirm that the series included in the above models are I(1) and cointegrated. This allows us to proceed with the estimation of the parameters of the dynamic error correction models using PMG and the other two comparable methods, DFE and MG. Table 5 presents the results of these three estimators for the determinants of Arab FLFP, divided into two models: one for total females (aged 15–64) and the other for youth females (aged 15–24). The PMG results for these two models are shown in the second and fifth columns, respectively.

The negative coefficient of the fertility variable in the second column suggests that higher fertility rates reduce overall female labor force participation in the long run, consistent with the findings of previous studies (Aguero & Marks, 2008; Bloom et al., 2009; Mishra & Smyth, 2010; De Laat & Sevilla-Sanz, 2011; Ukil, 2015; Ucal & Günay, 2019; Bawazir et al., 2022; Sunday et al., 2024). However, the positive and statistically significant coefficient of fertility in the fifth column indicates that higher fertility is associated with increased labor force participation among young females. Several factors may account for this seemingly counterintuitive result. First, evolving cultural norms in Arab societies may increasingly support the dual roles of women in both paid employment and household caregiving. Second, the societal response hypothesis offers a theoretical explanation, suggesting that institutional adaptations, such as improved childcare services, maternity leave policies, and flexible work arrangements, can mitigate the traditional trade-offs between fertility and employment. Third, expanding educational attainment and employment opportunities for young women may enable them to enter the labor market despite higher fertility levels. Finally, digital transformation and remote work possibilities may allow young women to balance labor market engagement with childcare responsibilities more effectively. Collectively, these developments may reflect broader progress in gender equality and economic empowerment among young women in the Arab region.

The coefficients of the remaining explanatory variables generally conform to theoretical expectations in terms of both sign and magnitude. In both models, the coefficients for GDP per capita and domestic credit to the private sector are positive and statistically significant. A number of studies have demonstrated that higher GDP per capita—often considered a proxy for rising wages—encourages greater female participation in the labor force by increasing the financial returns to employment (Tam, 2011; Gaddis & Klasen, 2014; Dhar, 2021). Likewise, improved accessibility to bank credit reflects financial sector development and heightened economic activity, which in turn expand employment opportunities (Elouaourti & Ibourk, 2024). Interestingly, the coefficient for the education variable is statistically insignificant in the total FLFP model, yet positive and significant in the youth female model. This divergence suggests that while education may not be a key determinant of labor force participation among the broader female population, it plays a more critical role in shaping labor market entry among young women. This is to be expected: as young females transition into the workforce, the skills and qualifications gained through formal education can substantially enhance their employability, enabling them to play a more active role in the labor market.

The coefficients associated with the capital variable in both models are positive and statistically significant, indicating that capital accumulation is positively associated with female labor force participation. This finding suggests that the relationship between female labor and capital accumulation is complementary rather than substitutive, implying that increases in capital stock may create employment opportunities that draw more women into the labor market, particularly in sectors where capital enhances productivity without displacing labor.

The coefficients of the error correction term (ECT) in both models are negative and statistically significant, thereby confirming the existence and robustness of a long-run cointegration relationship among the variables. Specifically, the ECT coefficient of –0.11 in the FLFP model implies that approximately 11% of the deviation from long-term equilibrium is corrected in the following period, indicating a moderate speed of adjustment. In contrast, the ECT coefficient of –0.08 in the YFLFP model suggests a slower adjustment process, with only 8% of the disequilibrium corrected in each subsequent period. This difference implies that while youth female labor force participation responds to long-run disequilibria, the adjustment is somewhat more sluggish compared to the overall female labor force. These findings reinforce the dynamic nature of labor market responses and highlight the importance of age-specific analysis in understanding adjustment mechanisms.

The analysis of the Hausman test results confirms the appropriateness of the Pooled Mean Group (PMG) estimator for the current study, indicating its superior performance relative to the Mean Group (MG) model. The test statistics—0.981 for the FLFP model and 0.823 for the YFLFP model—fail to reject the null hypothesis of no systematic difference between the PMG and MG estimators. This outcome suggests that the assumption of homogeneity in the long-run coefficients holds, thereby justifying the use of the PMG approach. These results underscore the robustness and reliability of the PMG estimator in capturing the underlying long-run dynamics of the data.

Table 5. Total and youth female labor force participation models estimates

	DV: ln FLFP, ARDL (1,1,1,1,1)			DV: ln YFLFP, ARDL (1,1,1,1,1)		
	PMG	MG	DFE	PMG	MG	DFE
Long run coefficients						
ln FERT	-0.368***	0.0908	-2.300	0.274***	1.208	-0.0272
	(0.0796)	(0.796)	(2.104)	(0.0775)	(0.818)	(0.440)
ln EDU	-0.0551	0.217	-6.600	0.346***	0.792	-0.912**
	(0.110)	(0.646)	(5.618)	(0.104)	(0.893)	(0.457)
ln FPOP	-0.00657	-1.897*	1.230	-0.000129	-0.459	0.171
	(0.0225)	(1.143)	(1.079)	(0.0542)	(0.749)	(0.304)
ln RGDPP	0.0783***	0.561	0.315	0.140***	-0.293	-0.562
	(0.00976)	(0.397)	(0.696)	(0.0424)	(0.380)	(0.374)
ln KGDP	0.0268***	-0.0971	0.277	0.0426**	-0.0771	0.161
	(0.00952)	(0.162)	(0.414)	(0.0179)	(0.109)	(0.178)
ECT	-0.108**	-0.369***	-0.0187	-0.0817**	-0.319***	-0.0332**
	(0.0466)	(0.0929)	(0.0173)	0.274***	1.208	-0.0272
Short run coefficients						
Δln FERT	0.210	-0.167	0.210**	0.0288	-0.110	0.0414
	(0.143)	(0.220)	(0.0951)	(0.0784)	(0.141)	(0.0734)
Δln EDU	0.0478	-1.068	-0.221	1.070**	-0.279	0.251
	(0.286)	(1.251)	(0.193)	(0.543)	(0.490)	(0.153)
Δln FPOP	1.847	2.293	0.0605	0.379	0.00866	0.0454
	(1.343)	(1.962)	(0.0847)	(0.472)	(0.640)	(0.0658)
Δln RGDPP	0.120	0.118	0.0189	0.110	0.0887	0.0283
	(0.0807)	(0.120)	(0.0223)	(0.0679)	(0.0692)	(0.0175)
Δln KGDP	0.00646	0.00494	0.00541	-0.0187*	-0.0313*	-0.00105
	(0.00927)	(0.0205)	(0.00775)	(0.0108)	(0.0186)	(0.00606)
Constant	0.279*	0.109	-0.0830	0.0746	1.190	0.212
	(0.152)	(4.833)	(0.177)	(0.0541)	(2.627)	(0.166)
Countries	15	15	15	15	15	15
Obs.	424	424	424	424	424	424
Hausman test,pmg/mg		0.823			0.981	

*Notes: The numbers in parentheses represent the standard errors, *** p<0.01, ** p<0.05, * p<0.1*

Table 6 displays the results of the second model estimate, which examines the impact of fertility on females' unemployment. For robustness, the model is estimated for both the total female population and youth females using PMG, MG, and DFE. A glance at the table shows that findings largely agree with prior expectations. For instance, the coefficients of the fertility variable emerge with PMG estimates are positive and statistically significant, indicating that higher fertility are associated with an increase in unemployment for both total and youth females. This suggests that as females take on greater reproductive responsibilities, they may face challenges in securing or maintaining employment. This outcome lends further support to the previous findings pertaining to the Arab region, which indicate that cultural and societal norms significantly influence females' employability (Spierings et al., 2010, and Sidani, 2016). Unexpectedly, the coefficient of the educational attainment variable is positive and statistically significant in both models. This indicates that higher levels of education are correlated with increased unemployment rates among Arab females, contrary to what might typically be expected (Ali, 2015). One possible explanation for this counterintuitive finding could be that educated females are more likely to seek employment that matches their qualifications, leading to a prolonged job search in a competitive market. Moreover, in the context of the Arab region, cultural and societal factors may further exacerbate this phenomenon, as females with higher educational qualifications often face additional barriers to get employed.

Table 6: Total and youth female unemployment models estimates

	DV: ln UNF, ARDL (1,1,1,1,1,1)			DV: ln YUNF, ARDL (1,1,1,1,1,1)		
	PMG	MG	DFE	PMG	MG	DFE
Long run coefficients						
ln FERT	0.560***	-2.437	0.615	0.540***	0.0840	0.977
	(0.216)	(4.052)	(1.116)	(0.166)	(2.932)	(1.611)
ln EDU	0.826***	-1.627	0.798	1.228***	-0.538	0.846
	(0.300)	(1.485)	(0.784)	(0.0874)	(1.227)	(1.083)
INFL	0.00144	0.00538*	-0.0155*	0.00467***	0.0060*	-0.0261
	(0.00093)	(0.00312)	(0.00842)	(0.00143)	(0.0034)	(0.0168)
ln FPOP	-0.466*	3.472	0.483	-0.690***	4.183	0.305
	(0.275)	(3.110)	(0.713)	(0.207)	(3.181)	(0.964)
ln RGDP	-0.0897	-0.517	-0.630	0.000403	-0.421	-0.339
	(0.182)	(0.469)	(0.610)	(0.115)	(0.405)	(0.831)
ln CRED	0.0640	-0.193	0.0978	0.00697	-0.273*	0.0123
	(0.0411)	(0.123)	(0.288)	(0.0401)	(0.145)	(0.403)
ECT	-0.222**	-0.692***	-0.0604***	-0.259***	-0.813***	-0.0459*
	(0.0926)	(0.0813)	(0.0221)	(0.0878)	(0.0970)	(0.0260)
Short run coefficients						
Δ ln FERT	-1.935***	-1.096	-0.278	-1.696***	-0.693	-0.0602
	(0.577)	(0.849)	(0.287)	(0.649)	(0.657)	(0.291)
Δln EDU	0.248	-0.740	-0.270	0.598	-3.377	0.00904
	(2.201)	(4.178)	(0.607)	(2.537)	(3.996)	(0.627)
ΔINFL	-0.00061*	-0.00152	0.000732*	-0.00112**	-0.00183*	0.000616
	(0.00035)	(0.00106)	(0.000378)	(0.000567)	(0.0010)	(0.00039)
Δln FPOP	-5.823	-5.137	-0.612**	-7.848	-1.045	-0.269
	(5.218)	(7.498)	(0.311)	(5.187)	(8.122)	(0.321)
Δln RGDP	-0.344*	-0.196	-0.102	-0.261	0.0718	-0.129
	(0.176)	(0.252)	(0.0824)	(0.188)	(0.330)	(0.0852)
Δln CRED	-0.0958	-0.0499	-0.101***	-0.0799	0.0225	-0.0919**
	(0.0883)	(0.0753)	(0.0357)	(0.0825)	(0.0765)	(0.0368)
Constant	2.278**	-13.76	0.547	3.045***	-16.70	0.236
	(0.993)	(11.54)	(0.783)	(1.075)	(13.03)	(0.775)
Countries	15	15	15	15	15	15
Obs.	397	397	397	397	397	397
Hausman test,pmg/mg		0.74			0.59	

*Notes: The numbers in parentheses represent the standard errors, *** p<0.01, ** p<0.05, * p<0.1*

The coefficient of the female population is negative and statistically significant. This indicates that an increase in the female population correlates with a decrease in females' unemployment rates. One possible interpretation for this outcome may be that as the female population grows, more females may be entering workforce, leading to greater employment opportunities and improved support networks. Moreover, this trend may reflect societal shifts towards greater gender equality and the removal of barriers that have historically hindered Arab females' participation in the labor market.

Turning to the short-run results, the fertility seems to have a negative impact on Arab females' unemployment. The coefficients of the variable in both models are negative and statistically significant, indicating that as fertility rates increase, the chances of Arab females being unemployed decrease in the short run. This suggests that females with higher fertility may be more likely to engage in the workforce, potentially due to the need for financial stability to support their families. In both models, the short-run coefficients of the inflation rate variable are negative and statistically significant, which supports the Phillips curve's argument. Interestingly, the coefficient of the GDP variable in the total female model is positive and maintains significance. This indicates that as the economy grows, the likelihood of Arab females securing employment increases, reinforcing the Okun 's law (1963), which argues that increased economic activity correlates with lower unemployment rates.

The coefficients of the error correction terms are negative and statistically significant. This supports the existence of the long-run or cointegration relationships among the variables included in these models.

Finally, the Hausman test results show that the autoregressive lagging model in the PMG estimator works better than the MG method when it comes to model fit and accuracy of prediction. Therefore, employing the PMG estimator not only improves model performance but also enhances our understanding of the dynamics at play in the labor market for Arab females.

5. Conclusion

The modest performance of Arab women in the labor market, coupled with persistent empowerment deficits and gender inequality, necessitates further empirical analysis of the factors hindering their progress. However, existing studies investigating these factors are limited, not comprehensive, and fail to fully explain the observed underperformance. This study examines the impact of fertility on Arab women’s labor market behavior. To achieve this, it employs panel time series data from 15 Arab nations, spanning 1991–2023. The study adopts the PMG approach, which offers advantages over methods such as MG and DFE, including addressing endogeneity and avoiding spurious results in short- and long-run relationships. To our knowledge, this is the first study based on panel data covering 15 countries in the Arab region. The two prior studies (Al-Qudsi, 1998; Ucal and Günay, 2019) relied on cross-sectional survey data or included only a few countries, limiting their ability to explore the relationship between fertility and women’s labor market behavior across diverse contexts and time periods. Additionally, this study disaggregates the analysis to examine labor market participation and unemployment for both total women and young women. The primary finding is that higher fertility reduces overall women’s labor market participation. Conversely, evidence suggests that rising fertility rates increase young women’s labor force participation. Furthermore, increased fertility is associated with higher unemployment among both overall and young women, indicating that fertility’s adverse effects intensify when unemployment is considered. The reliability of the PMG approach was confirmed by comparing it to the MG method and applying the Hausman test, with results consistently favoring PMG in terms of fit and reliability.

Several measures can be implemented to mitigate the negative impact of fertility on Arab women's labor force participation. First, providing accessible and affordable childcare services can enable working mothers to balance professional and family responsibilities. Second, policies such as flexible work hours and childcare subsidies can encourage more women to enter the labor market. Third, challenging cultural norms and stereotypes, such as expectations that women prioritize caregiving over career advancement, can significantly enhance their participation. Fourth, offering education and training opportunities to develop skills and support career advancement can increase women's presence in the workforce. Finally, fostering inclusive work environments that promote diversity can remove barriers and encourage Arab women to actively participate in the labor force.

This study has two primary limitations. First, it may not fully account for all cultural and societal factors influencing Arab women's labor market behavior. Second, the panel time series data may not capture individual-level variations in factors affecting labor market outcomes. Nevertheless, the study offers valuable insights into the complex relationship between fertility and women's labor market participation in the Arab region. Future research should incorporate a broader set of variables to address potential omitted variable bias. Additionally, employing qualitative methods, such as interviews, could provide deeper insights into the cultural and societal influences on Arab women's labor market behavior.

References

Abraham, A. Y., Ohemeng, F. N. A., & Ohemeng, W. (2017). Female labour force participation: Evidence from Ghana. *International Journal of Social Economics*, *44*(11), 1489-1505.

Aguero, J. M., & Marks, M. S. (2008). Motherhood and female labor force participation: evidence from infertility shocks. *American Economic Review*, *98*(2), 500-504.

Al-Asfour, A., Tlaiss, H. A., Khan, S. A., & Rajasekar, J. (2017). Saudi females's work challenges and barriers to career advancement. Career Development International, 22(2), 184-199.

Ali, M. E. M. (2015). The Determinants of Urban Youth Unemployment in Sudan: A Co-Integration and VECM Analysis. Urban Youth Unemployment in Eastern and Southern Africa, 206.

Alissa, S. (2007). The school-to-work transition of young people in Syria. ILO.

Al-Qudsi, S. S. (1998). Labour participation of Arab females: estimates of the fertility to labour supply link. *Applied Economics*, *30*(7), 931-941.

Azid, T., Ejaz Ali Khan, R., & Alamasi, A. M. (2010). Labor force participation of married females in Punjab (Pakistan). *International Journal of Social Economics*, *37*(8), 592-612.

Baah-Boatenga, W., Nketiah-Amponsah, E., & Frempong, R. (2013). The effect of fertility and education on female labour force participation in Ghana. *Ghanaian Journal of Economics*, *1*(1), 119-137.

Backeberg, L., & Tholen, J. (2018). The frustrated generation youth exclusion in Arab Mediterranean societies. Journal of Youth Studies, 21(4), 513-532.

Bawazir, A. A., Osman, A. F., & Aslam, M. (2022). Factors affecting female labor force participation in the Middle East: An empirical evidence from panel data approach. *The Journal of Developing Areas*, *56*(1), 59-72.

Bloom, D. E., Canning, D., Fink, G., & Finlay, J. E. (2009). Fertility, female labor force participation, and the demographic dividend. *Journal of Economic growth*, *14*, 79-101.

Boserup, E., Kanji, N., Tan, S. F., & Toulmin, C. (2013). Woman's role in economic development. Routledge.

Bowen, W. G., & Finegan, T. A. (2015). The economics of labor force participation. Princeton University Press.

Brewster, K. L., & Padavic, I. (2000). Change in gender-ideology, 1977–1996: The contributions of intracohort change and population turnover. *Journal of Marriage and Family*, *62*(2), 477-487.

De Laat, J., & Sevilla-Sanz, A. (2011). The fertility and females's labor force participation puzzle in OECD countries: the role of men's home production. *Feminist Economics*, *17*(2), 87-119.

Del Boca, D., Pasqua, S., & Pronzato, C. (2008). Motherhood and market work decisions in institutional context: a European perspective. Oxford Economic Papers, 61(suppl_1), i147-i171.

Dhar, S. (2020). Economic development and female labor force participation in Bangladesh: A test of the U-shaped hypothesis. Journal of South Asian Studies, 8(3), 99-111.

Dong, X. Y., & Pandey, M. (2012). Gender and labor retrenchment in Chinese state owned enterprises: Investigation using firm-level panel data. *China Economic Review*, *23*(2), 385-395.

Elhaj, M., & Pawar, P. (2019). Socio-economic and environmental factors affecting female labor force participation in Saudi Arabia: ARDL bounds testing approach. Int. J. Adv. Study Res. Work, 5, 2581-5997.

El-Mallakh, N., Maurel, M., & Speciale, B. (2018). Arab spring protests and females's labor market outcomes: Evidence from the Egyptian revolution. Journal of Comparative Economics, 46(2), 656-682.

Elouaourti, Z., & Ibourk, A. (2024). Financial Technologies for All MENA citizens: Tackling barriers and promoting inclusion. *Regional Science Policy & Practice*, *16*(6), 100019.

Filali Adib, F. Z., Driouchi, A., & Achehboune, A. (2013). Education attainment, further female participation & feminization of labor markets in Arab countries.

Gaddis, I., & Klasen, S. (2014). Economic development, structural change, and females's labor force participation: A reexamination of the feminization U hypothesis. *Journal of population economics*, 27, 639-681.

Goldin, C. (1990). Understanding the gender gap: An economic history of American females (No. gold90-1). National Bureau of Economic Research.

Goldin, C. (1994). The U-shaped female labor force function in economic development and economic history.

Guirguis, H., Donlon, T., McCarthy, M., Mehovic, A., & Mehta, R. (2024). The future of the labour force: a quantitative examination of the drivers of female labor force participation and total fertility rate in developed economies. *Applied Economics*, *56*(44), 5238-5248.

International Labor Office (ILO). (2025). Statistics on the population and labor force. Retrieved January 11, 2025, from https://ilostat.ilo.org/data/#

Kratou, H., & Gazdar, K. (2016). Addressing the effect of workers' remittance on economic growth: evidence from MENA countries. *International Journal of Social Economics*, 43(1), 51-70.

Musibau, H. O., Yusuf, A. H., & Gold, K. L. (2019). Endogenous specification of foreign capital inflows, human capital development and economic growth: A study of pool mean group. International Journal of Social Economics, 46(3), 454-472.

Narayan, P. K., & Smyth, R. (2006). Female labour force participation, fertility and infant mortality in Australia: some empirical evidence from Granger causality tests. Applied Economics, 38(5), 563-572.

Okun, A. M. (1963). *Potential GNP: its measurement and significance*. Cowles Foundation for Research in Economics at Yale University.

Pesaran, M. Hashem, Yongcheol Shin, and Ron P. Smith. "Pooled mean group estimation of dynamic heterogeneous panels." Journal of the American statistical Association 94, no. 446 (1999): 621-634.

Rindfuss, R. R., & Brewster, K. L. (1996). Childrearing and fertility. *Population and development review*, *22*, 258-289.

Shittu, W. O., & Abdullah, N. (2019). Fertility, education, and female labour participation: Dynamic panel analysis of ASEAN-7 countries. *International Journal of Social Economics*, *46*(1), 66-82.

Sidani, Y. M. (2016). *Working females in Arab countries: a case for cautious optimism* (pp. 689-701). Springer Netherlands.

Sinha, J. N. (1965). Dynamics of female participation in economic activity in a developing economy.

Spierings, N., Smits, J., & Verloo, M. (2010). Micro-and macrolevel determinants of females's employment in six Arab countries. *Journal of Marriage and Family*, *72*(5), 1391-1407.
Sunday, A. L., Lihawa, R. M., & Mkuna, E. (2024). The effect of fertility on female labour force participation in Tanzania. *Plos one*, *19*(1), e0292122.
Tam, H. (2011). U-shaped female labor participation with economic development: Some panel data evidence. Economics Letters, 110(2), 140–142.
Ucal, M., & Günay, S. (2019). Female employment status: A survey analysis of selected member states of the Arab League. *Eurasian Economic Review*, *9*, 373-394.
Ukil, P. (2015). Effect of fertility on female labour force participation in the United Kingdom. Margin: The Journal of Applied Economic Research, 9(2), 109-132.
Verick, S. (2014). female labor force participation in developing countries. IZA World of Labor.