
Issues and Perspectives in Business and Social Sciences

Women at work: decoding the economic and demographic drivers in ASEAN

Nurfadlin Abdul Malek¹, Asmah Mohd Jaapar^{2*}, Nurhatiah Ahmad Chukari²

¹Faculty of Science and Technology, Universiti Sains Islam Malaysia, Malaysia

²Risk and Analytics Research Group, Faculty of Science and Technology, Universiti Sains Islam Malaysia, Malaysia

*correspondence: asmah.jaapar@usim.edu.my

Abstract

Throughout history, women have faced significant challenges in achieving equal representation in the workforce, often dealing with lower wages and limited opportunities. In ASEAN countries, female labor force participation is vital for economic growth, yet it remains much lower than that of men. This study explores the factors affecting women's participation in the labor force across ASEAN nations, focusing on education, GDP per capita, fertility rates, and the old-age dependency ratio. Using data from 1990 to 2021, panel data analysis was conducted with a fixed effects model, and Clustered Robust Standard Errors were applied to address issues of heteroscedasticity and autocorrelation. The findings indicate that GDP per capita has a positive and significant impact on women's labor force participation, while the old-age dependency ratio has a negative but insignificant effect. Education and fertility rates, however, do not show significant results, suggesting the need for further research. These results highlight the importance of economic and demographic factors in shaping women's participation in the labor market, which is crucial for the economic development of ASEAN countries.

Keywords:

ASEAN countries study; Female labor force participation; Panel data analysis; Economic growth; Fertility rates.

Received:

April 10, 2025

Accepted:

April 1, 2026

Published:

May 5, 2026

1. Introduction

The participation of women in the labor force is crucial for both social and economic development. In ASEAN, a combination of diverse economies structures, cultural traditions, and government policies shapes labor market dynamics, making female labor force participation (FLFP) vital for fostering inclusive growth and achieving gender equality. Despite gradual improvements, FLFP rates in the region remain below the global average, reflecting enduring gender disparities. According to the International Labor Organization (ILO), the average FLFP rate in ASEAN stood at 55% in 2020, compared to 80% for men. For instance, in Malaysia, FLFP rate was 55.6% in 2019, while male participation surpassed 80% (Department of Statistics Malaysia, 2024). In Thailand, the female participation rate rose to 61%, yet still lagged that of men, highlighting the persistent gender imbalances in ASEAN labor markets.

In response, several ASEAN countries have introduced policies to increase women's workforce participation. Inspired by Japan's Womenomics strategy under former Prime Minister Shinzo Abe, which focused on funding childcare and promoting flexible work arrangements, Malaysia has set ambitious targets. In 2023, Prime Minister Anwar Ibrahim announced Malaysia's target to

increase the FLFP rate from 55.5% to 60%, supported by initiatives such as affordable childcare and flexible working conditions under the Madani Economy Framework (Bernama, 2023). These policy efforts highlight the importance of removing institutional barriers, including inadequate childcare, inflexible work environments, and persistent gender discrimination, all of which hinder women's participation in the workforce.

While extensive research on FLFP has focused on Western contexts, empirical evidence within the ASEAN region remains comparatively scarce. A deeper understanding of region-specific drivers is necessary to inform effective policy intervention. Education and economic development are widely recognized as key drivers of women's labor participation rates. Higher educational attainment is generally associated with increased labor market participation among women (Barro & Lee, 2013). However, the effect of education on FLFP can vary significantly depending on socio-cultural norms and the type or level of education attained. Similarly, rising GDP per capita often correlates with higher FLFP, but this relationship is not strictly linear, as certain labor structures may privilege male employment or undervalue women's contributions (Tsani et al., 2013).

Against this backdrop, this study investigates the multifaceted determinants of FLFP in ASEAN. Specifically, it aims to: (i) determine the correlation among the key factors influencing FLFP in ASEAN countries; (ii) identify the significant determinants of FLFP in ASEAN countries using panel regression analysis; and (iii) determine the most significant factors influencing FLFP in ASEAN countries. By achieving these objectives, this study contributes to a more holistic understanding of the socioeconomic and demographic factors shaping FLFP. The findings aim to support evidence-based policymaking by guiding ASEAN governments and stakeholders in designing effective and inclusive strategies. In light of post-pandemic economic recovery, where women have faced disproportionate setbacks, this study provides timely insights for developing targeted interventions to close gender gaps in the workforce. Furthermore, this study holds practical relevance for employers seeking to promote workplace diversity and productivity and for communities striving for equitable and sustainable development.

2. Literature review

The labor force participation rate represents the proportion of adults aged 15 and over who are employed or actively seeking work (Department of Statistics Malaysia, 2024). This measure is essential for evaluating a country's economic development and future potential. The FLFP rate (FLFPR), which reflects the proportion of women in this group who are working or seeking employment, is a key indicator of women's economic empowerment. The FLFP is a widely studied topic, with extensive research focusing on factors such as education, GDP per capita, fertility rates, and old-age dependency ratios. It is a subject of global importance, recognized for its critical role in shaping economic dynamics and social structures, and is a key component of labor demographics. Women's workforce participation is essential for fostering and sustaining economic growth (Verick, 2014). Studies consistently highlight the significant contributions of women to advance a nation's social and economic development.

Women's participation in the labor force has grown significantly since 1990 but declined globally to 47.7% in 2019, with notable regional variations (Amber & Chichaibelu, 2023). There are notable regional variations in the percentage of female workforce. Over a 20-year period, Mincer (1985) found significant differences in women's labor force participation rates across 12 industrialized countries. However, the analysis also shows that the 12 industrialized countries included in the study, Australia, Britain, France, Germany, Israel, Italy, Japan, the Netherlands, Spain, Sweden, the United States, and the USSR, experienced an overall increase in women's labor force participation. The only exception was the USSR, where a slight decline occurred after 1970. Malaysia reports comparatively high FLFP among newly industrialized economies in the Asia-Pacific region (Abu Bakar & Abdullah, 2010).

2.1 The influence of COVID-19 on FLFP in ASEAN

The COVID-19 pandemic has had a profound impact on labor markets globally, affecting industries and disproportionately impacting women's workforce participation, particularly in ASEAN countries. Almost all sectors experienced disruptions in operations and employment, and the situation of working women worsened due to increased pressure at both the workplace and home. According to the International Labor Organization (ILO), lockdowns and movement restrictions implemented across ASEAN in 2020 impacted over 80% of the global workforce, with female employees being among the hardest hit due to their concentration in the service industries, retail, and informal work sectors (International Labor Organization, 2021).

In ASEAN countries, both Thailand and Indonesia show a sharp decline in their FLFPRs. Thailand's FLFPR decreased from 61% in 2019 to 59.4% in 2020, whereas Indonesia's dropped from 54.1% to 52.7% during the same period (Pande et al., 2023). Malaysia also followed this trend, with an FLFPR of 56.1% in 2019, declining to 55.3% in 2020 (Department of Statistics Malaysia, 2024). These declines show the challenges hindering ASEAN from attaining gender equity in labor markets and enhanced economic development objectives.

The pandemic significantly limited women's rights, as many women took on extra household responsibilities, lost their jobs or had their employment terminated, and experienced resulting instability and stress. According to ILO data, COVID-19 caused a 4.2% decline in global female employment, leading to the loss of 54 million jobs for women, compared to a 3% decline in male employment, equating to 60 million jobs (Khackien, 2021). The significant effect of COVID-19 on FLFPR in ASEAN highlights the urgent need for policies that support women's employment and strengthen economic resilience in the region.

2.2 Influencing factors

Understanding the factors that drive FLFP is essential for developing effective policies that promote gender equality and economic development in the country. Various economic, social, and cultural influences shape women's employment decisions and opportunities. These factors may interact in complex ways, affecting the extent and nature of women's workforce involvement. The following section highlights one of these key influences and its potential impact on labor force participation.

2.2.1 Education

The relationship between education and FLFP has been widely studied, with research consistently showing a strong association between these two variables. Education plays a crucial role in enhancing women's quality of life and empowering them to take on more active roles in decision-making in their families, workplaces, and communities. Studies indicate that higher educational attainment among women leads to greater participation in the labor force, benefiting the economy while also improving their personal financial well-being (Assaad et al., 2020).

Moreover, women's employment increases as awareness of their rights and opportunities grows, especially for those pursuing higher education. Women with higher education are more likely to secure better job prospects, earn higher salaries and enjoy greater financial freedom. However, cultural expectations, family responsibilities, and limited access to supportive workplace policies can sometimes weaken the positive impact of education, indicating that higher education does not always lead to increased workforce participation among all women (Chatterjee et al., 2018). Based on these considerations, we propose the following hypothesis:

H1: There is significant relationship between education and FLFP.

2.2.2 GDP per capita

Recent studies have extensively explored the relationship between the FLFP and economic development. Higher GDP per capita often reflects improved infrastructure and economic growth, which can create more opportunities for employment, healthcare, and education, particularly among women. While this correlation varies across contexts, economic growth is generally linked to higher FLFP (Psacharopoulos & Tzannatos, 1989). Furthermore, a widely discussed hypothesis suggests a U-shaped relationship between economic development and women's labor force participation (Gaddis & Klasen, 2013). However, this theory is not universally supported, as factors such as social norms, educational attainment, and growth patterns can influence this relationship (Verick, 2014).

Meanwhile, in middle- and higher-income countries, GDP growth is positively correlated with rising FLFP rates. This trend is driven by factors such as higher education levels, lower fertility rates, and greater access to white-collar jobs for women in the labor force. Without social constraints, employment in white-collar sectors tends to increase alongside women's educational attainment and the declining fertility rates. Moreover, if productivity per worker remains constant, an increase in the proportion of working-age individuals due to higher FLFP directly boosts GDP per capita. Higher rates of FLFP lead to more employment opportunities and higher levels of household income, which boost consumption and raise the country's overall income. Recent research by Omran and Bilan (2023) and Verick (2014) supports the significance of female labor participation in fostering economic growth, indicating a positive and statistically significant relationship. Therefore, we propose the following hypothesis:

H2: There is significant relationship between GDP per capita and FLFP.

2.2.3 Fertility rate

Several studies have examined the relationship between fertility rates and FLFP. Toward the mid-1980s, the traditionally negative correlation began to shift toward a positive association (Ahn & Mira, 2002; Adserà, 2005). These studies suggest that the income effect of women's wages started to outweigh the substitution effect, accounting for the reversal in the trend. Furthermore, the expansion of market-based childcare services has reduced the childcare burden on women, supporting a more positive relationship between fertility rates and women's participation in the labor force.

However, considering that it might be difficult for women to balance work and parental responsibilities, several studies have indicated a negative correlation between female employment and fertility. The labor force participation rate among women tends to decline with an increase in fertility, especially among women between the ages of 20 and 39 (Bloom et al., 2009). Liu and Marois (2023) found that the likelihood of a woman with one child entering the labor force is reduced by 20.7% compared to 37.7% for those with two or more children, suggesting that women may choose to leave the workforce or not engage in the workforce in response to having more children. Thus, fertility significantly influences the FLFP, with higher fertility rates often resulting in lower participation rates due to the complex interplay of economic, educational, cultural, and societal factors. Thus, we propose our third hypothesis as follows:

H3: There is significant relationship between fertility rate and FLFP.

2.3.4 Old-age dependency ratio

Research has also explored the relationship between the old-age dependency ratio and FLFP, revealing that this relationship is not always linear. Cross-national data reveal a U-shaped pattern, with involvement being lowest in middle-income nations and highest in high- and low-income countries (Ortiz-Ospina et al., 2018). This may be due to the shift from agriculture to an industrial economy. The rise in FLFP is influenced by demographic shifts, such as an increasing working-age

population; however, this relationship is not consistent, depends on cultural, economic, and institutional factors, and varies across nations. Age-related impacts on involvement vary across cohorts and life phases.

The dependency ratio also has an impact on the participation of females in the labor market as it reflects changes in the age structure of the population (Kelley, 1973). The proportion of women in the labor force may increase if the working-age population rises in comparison to the number of dependents. Women frequently have to stay at home to care for their dependents. As a result, women find it more difficult to join and stay in the workforce. This occurs because managing the household and taking care of their old dependent often takes up a lot of time, which leaves less time for paid jobs. On the other hand, women may find it easier to work when there are fewer dependents, as they have fewer caregiving duties. Moreover, the impact of this ratio on the employment of women may vary depending on the accessibility of social services such as eldercare. Kotsadam and Finseraas (2011) pointed out that even in countries with a large number of dependents, more women are able to work when there are enough support services available. Family support can also significantly boost women's motivation to pursue employment. Thus, the age dependency ratio significantly impacts women's workforce participation, which can be influenced by existing support systems and cultural norms. Thus, we propose our fourth hypothesis as follows:

H4: There is a significant relationship between the old-age dependency ratio and the FLFP.

3. Data and methodology

3.1 Data

This study uses secondary data from 1990 to 2021, focusing on 160 observations from five ASEAN countries: Brunei, Indonesia, Malaysia, Singapore, and Thailand. Data were sourced from the World Bank Databank, which offers over 71 databases on the economy, education, and health, regularly updated for public use (World Bank, 2025). Reliable data were also accessed from sources such as the UN World Population Prospects (World Population Prospects, 2024). In this study, the dependent variable is FLFP, while the independent variables include female education, gross domestic product, fertility rate, and old dependency ratio. Table 1 provides a detailed description of these variables.

3.2 Model

The study utilized panel data, a regression analysis structure often estimated using Ordinary Least Squares (OLS), to achieve the Best Linear Unbiased Estimation (BLUE). Panel data, which combine time-series and cross-sectional elements, are commonly used in social science research to study topics such as political behavior, health outcomes, and labor market trends. It offers valuable insights by capturing the relationships between variables and reducing bias through the use of grouped data.

The relationship between the independent variables and FLFP rates (FLPR) is analyzed using the following equation:

$$FLPR_{it} = \beta_0 + \beta_1 EDUC_{it} + \beta_2 GDP_{it} + \beta_3 FER_{it} + \beta_4 ADR_{it} + \varepsilon_{it} \quad (5)$$

In this model, FLPR represents FLFP rates, EDUC denotes female education, GDP refers to gross domestic product per capita, FER indicates the fertility rate (children per woman), and ADR signifies the old-age dependency ratio. The parameter β_0 represents the intercept, β_1 to β_4 are the regression coefficients for each variable, and ε_{it} is the error term.

Table 1: Description of variables

	Formula	Unit	Data source
Dependent variable:			
Female Labor Force Participation Rate (FLPR)	$FLPR = \frac{\text{Number of employed} + \text{number of unemployed}}{\text{Female population working age}}$ (1)	%	The World Bank and the International Labor Organization (ILO)
Independent variables:			
Education (EDUC)	$EDUC = \text{Mean years of schooling (MYS)}$ (2)	years	The United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics (UIS)
GDP per Capita (GDP)	$GDP = \frac{\text{Total GDP}}{\text{Total population}}$ (3)	USD	The World Bank's World Development Indicators dataset
Fertility Rate (FER)		children per woman	The United Nations Population Division's World Population Prospects: 2022 Revision
Old-Age Dependency Ratio (ADR)	$ADR = \frac{\text{Population aged 65 and above}}{\text{Population aged 15 - 64}}$ (4)	-	UN, World Population Prospects (2024)

3.3 Panel data regression - estimation approaches

Panel data analysis uses three main methods for estimating regression models: the common constant model (pooled ordinary least squares (OLS)), fixed effects model, and random effects model (Zulfikar, 2018).

3.3.1. Pooled regression

The common constant model, also known as pooled regression, can be represented by the following equation:

$$Y_{it} = \beta_{0i} + \beta_1 X_{it} + \varepsilon_{it} \quad (6)$$

To rewrite the equation based on the model:

$$FLPR_{it} = \beta_{0i} + \beta_1 EDUC_{it} + \beta_2 GDP_{it} + \beta_3 FER_{it} + \beta_4 ADR_{it} + \varepsilon_{it} \quad (7)$$

In this model, it is assumed that the data remain consistent across time and individuals. This model applies a single intercept β_0 for all observations. It is generally estimated using the least squares or Ordinary Least Squares (OLS) method. The analysis covers the period from 1990 to 2021, utilizing panel data regression with five countries as the cross-sections. The panel observations were balanced, indicating that each panel covered an equal time frame.

3.3.2. Fixed effects model

Next, the fixed effects model is represented by the following equation:

$$Y_{it} = \beta_{0i} + \beta_1 X_{it} + \mu_{it} \quad (8)$$

To rewrite the equation based on the model:

$$FLPR_{it} = \beta_{0i} + \beta_1 D2_{it} + \beta_2 D3_{it} + \beta_3 D4_{it} + \beta_4 D5_{it} + \beta_1 EDUC_{it} + \beta_2 GDP_{it} + \beta_4 ADR_{it} + \varepsilon_{it} \quad (9)$$

According to Bell and Jones (2015), the fixed effects model assumes that individual-specific effects (such as firm, country, or individual characteristics) are correlated with the explanatory variables. It controls for these effects by allowing each entity to have its intercept, effectively removing time-invariant characteristics. This is useful when omitted variables are suspected to be correlated with independent variables.

3.3.3. Random effects model

The random effects model can be represented by the following equation:

$$Y_{it} = \beta_{0i} + \beta_1 X_{it} + (\varepsilon_{it} + v_i) \quad (10)$$

This model assumes that individual-specific effects are not correlated with explanatory variables (Bell & Jones, 2015). Instead of treating them as fixed, they are considered as part of the error term. This allows for a more efficient estimation because it uses both within-entity and between-entity variations.

3.4 Panel data model selection: key tests

The results of the model were generally interpreted conventionally. Nevertheless, it is important to determine whether the pooled OLS, fixed effects, or random effects model is the most appropriate. As noted by Zulfikar (2018), several tests can be performed to identify the most suitable models.

Figure 1 presents the tests used to select the appropriate panel data model. This study applied the Hausman, Chow, and Lagrange Multiplier tests for model determination. The Hausman Test assesses the choice between fixed and random effects, with a p-value greater than 0.05 indicating random effects and a p-value less than 0.05. The Chow Test is utilized to determine the optimal choice between Pooled OLS and fixed effects, rejecting the null hypothesis and favoring fixed effects. Finally, the Lagrange Multiplier Test compares common and random effects, where a p-value greater than 0.05 suggests random effects, and a p-value less than 0.05 favors common effects.

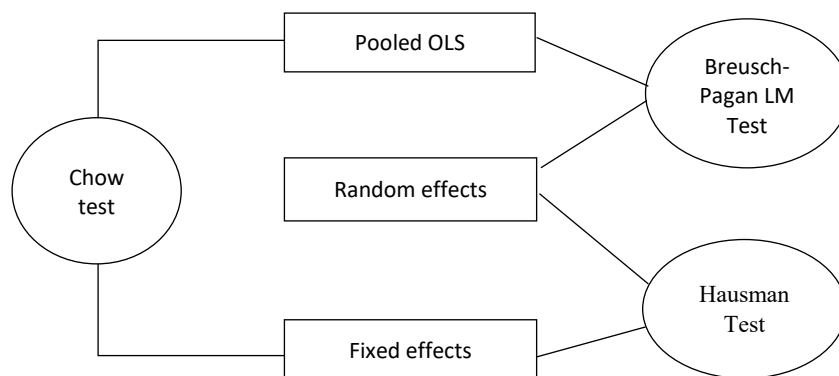


Figure 1: Tests for panel data model selection

3.5 Diagnostic checks

This study uses diagnostic checks for the validity of its regression model, including multicollinearity, heteroscedasticity, and autocorrelation. The variance inflation factor (VIF) was

used to estimate multicollinearity and assess the relationships among independent variables. The Modified Wald test is used to test heteroscedasticity, while the Wooldridge test is used to check autocorrelation. To address these issues, Cluster Robust Standard Errors are employed to ensure accurate factors affecting FLFP in ASEAN countries, considering within-group correlation and cluster-level differences.

4. Results and discussion

This section presents and discusses the results to determine the factors affecting FLFP in ASEAN countries. Various models were used, including pooled ordinary least squares (OLS), Fixed Effects, and Random Effects. Diagnostic tests identified heteroscedasticity and serial correlation problems, which were addressed using Clustered Robust Standard Errors. The most suitable model was selected based on the test outcomes and theoretical considerations to ensure accurate and reliable data.

4.1 Descriptive statistics

Table 2 presents descriptive statistics for dependent and independent variables, focusing on FLFP Rate (FLPR), Education (EDUC), GDP per capita (GDP), Fertility Rate (FER), and Old-Age Dependency Ratio (ADR). The data is presented with mean, standard deviation, minimum and maximum values for each variable.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Standard Deviation	Minimum	Maximum
FLPR	160	54.06	6.67	43.09	67.51
EDUC	160	8.08	1.88	3.22	11.92
GDP	160	34977.58	28862.10	4519.72	107741.12
FER	160	2.05	0.62	0.95	3.38
ADR	160	8.27	3.00	4.05	19.06

4.1.1 FLFP Rate (FLPR)

The average FLPR across ASEAN countries is 54.06%, with a standard deviation of 6.67%, indicating moderate variability. The minimum and maximum FLPR were 43.09% and 67.51%, respectively. These figures highlight the significant differences in female workforce participation within the region. For example, countries with low FLPR, such as Indonesia, might experience social or economic constraints that hinder women's employment, while countries that record high FLPR, such as Singapore and Thailand, have embraced women's employment into their labor markets.

4.1.2 Education (EDUC)

The EDUC variable which is the average years of schooling based on the World Bank, has a mean of 8.08 years with a standard deviation of 1.88 years, ranging from 3.22 to 11.92. Lower levels of education indicate poor standard education, particularly among women, which may also result in limited employment opportunities. Conversely, countries with higher education levels, such as Singapore and Malaysia, demonstrate strong investments in human capital, resulting in a more skilled workforce and broader employment opportunities.

4.1.3 GDP per Capita (GDP)

The GDP per capita (GDP), which serves as an indicator of the average economic output per person, demonstrates significant variation, with a mean of 34,977.58 USD and a standard deviation of 28,862.10 USD. The minimum value is 4,519.72 USD, and the maximum value is 107,741.12 USD, suggesting considerable economic disparities across countries. Countries with higher GDP per capita, such as Singapore, are likely to provide greater economic opportunities and resources to facilitate FLFP, while countries with lower GDP may struggle to offer such support. Fluctuations in GDP per capita are commonly influenced by external economic shocks, fiscal or monetary policy adjustments, and structural changes in key economic sectors (Blanchard & Johnson, 2013).

4.1.4 Fertility rate (FER)

The fertility rate (FER), as described by the World Bank, is the average number of children that would be born to a woman over her lifetime, based on current age-specific fertility rates. It has a mean of 2.05 and a relatively low standard deviation of 0.62, indicating moderate variation across countries. The minimum and maximum values were 0.95 and 3.38, respectively. Generally, countries with higher fertility rates, such as Indonesia, tend to experience lower FLFP due to caregiving responsibilities, while countries with lower fertility rates, such as Singapore and Thailand, are often linked to higher participation as women have more opportunities to join the workforce due to urbanization and greater access to family planning.

4.1.5 Age dependency ratio (ADR)

The ADR has a mean of 8.27 and a standard deviation of 3.00, indicating higher variability in demographic structures across the countries. The minimum value was 4.05, whereas the maximum reached 19.06. A high old dependency ratio implies a greater burden on the working-age population, which may limit the FLFP. In contrast, countries with lower ADR, such as Indonesia, followed by Brunei, tend to reflect more balanced demographic structures, encouraging greater female participation in the workforce.

4.2 Correlation analyses

The analysis in Table 3 reveals significant correlations among variables, addressing the first objective of this study, which is to determine the correlation among the factors influencing FLFP in ASEAN countries. FLPR and FER exhibit a strong negative correlation (-0.63), indicating that higher fertility rates reduce the FLFP. FLPR also has a moderate positive correlation with ADR (0.42), suggesting a link between caregiving responsibilities and labor force participation. Additionally, EDUC was moderately negatively correlated with FER (-0.54), indicating that higher education levels are associated with lower fertility rates. However, the correlation between EDUC and ADR is moderately positive (0.30), implying that higher education levels may coexist with higher age dependency ratios in some contexts. Finally, the FER and ADR show a moderate negative correlation (-0.61), highlighting the interplay between fertility rates and age dependency in shaping demographic structures.

Table 3: Correlation coefficients

Correlation	FLPR	EDUC	GDP	FER
FLPR	1			
EDUC	0.01	1		
GDP	0.14	0.67	1	
FER	-0.63	-0.54	-0.41	1
ADR	0.42	0.30	-0.11	-0.61

4.3 Gender gaps in labor force participation: ASEAN vs. Non-ASEAN countries

The comparison between ASEAN and selected developing countries provides insights into regional variations in FLFP. ASEAN countries exhibit relatively stable and higher participation rates, whereas developing countries show broader disparities between male and female participation. These differences reflect the varying socioeconomic and cultural dynamics. The period 2012–2017 was selected because of the availability of consistent and comparable labor force data across countries in the ILOSTAT database. Additionally, this mid-decade window allows for the observation of stable trends before major economic disruptions, such as the COVID-19 pandemic, offering a clearer comparative analysis. The graphs in Figures 2 and 3 illustrate the trends and disparities in labor force participation rates during this period.

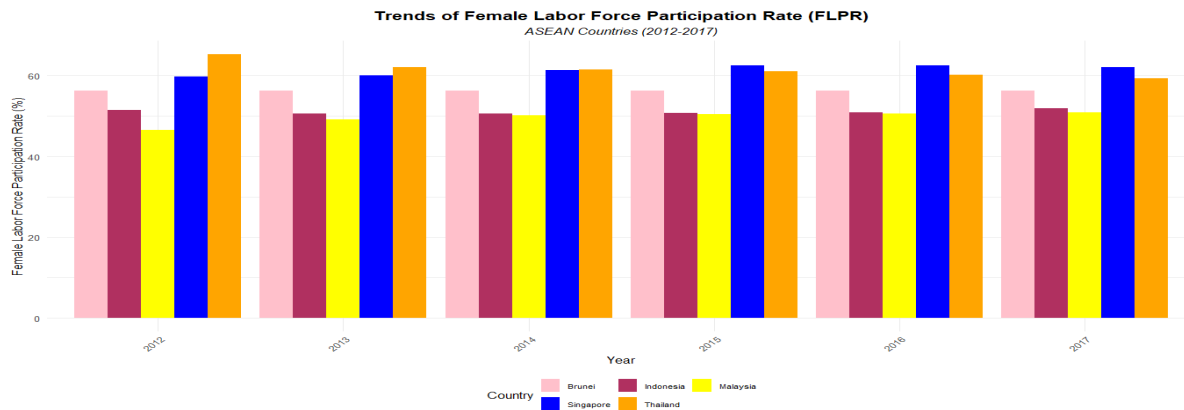
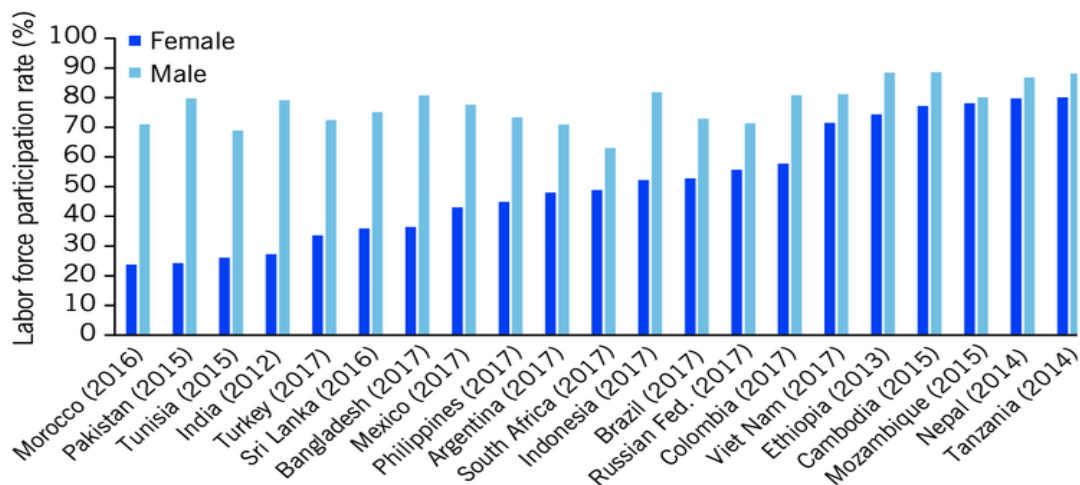


Figure 2: Trends of FLFP in Several ASEAN Countries (2012-2017)



Sources: National estimates from ILO Statistical Database, ILOSTAT

Figure 3: Gender disparities in labor force participation rates in selected developing countries (2012-2017)

From the two figures, it is evident that ASEAN countries maintain relatively high and consistent FLFP rates, ranging from 50% to 60%, with Thailand and Singapore leading the way. In contrast, selected developing countries exhibit significant gender disparities, where FLFP rates are often below 30%, particularly in countries such as Pakistan, India, and Tunisia, while male participation exceeds 70%. However, countries such as Ethiopia, Vietnam, and Tanzania show higher female participation, comparable to the ASEAN levels. This comparison highlights regional differences in gender equality within the labor market, influenced by diverse socioeconomic, cultural, and policy factors.

4.4 Estimation results of panel data model

To achieve the second objective, Table 4 presents the estimation results from the Pooled OLS, Fixed Effects, and Random Effects models, which examine the determinants influencing FLFP in ASEAN countries. It includes the coefficients and their corresponding significance levels for each independent variable, providing a comparison of the relationships between the independent variables and the FLFP Rate (FLPR) across the three models.

Based on Table 4, GDP consistently demonstrates a positive and statistically significant relationship with FLPR in all three models, with the strongest effect observed in the Fixed Effects model with a coefficient of 0.00027 ($p < 0.01$), compared to 0.0007 in Pooled OLS and 0.0000 in Random Effects. This indicates that economic growth significantly promotes female labor market participation by expanding job opportunities and fostering favorable economic environments. Omran and Bilan (2023) emphasize the critical role of fiscal policy in promoting FLFP, particularly through GDP growth, which enhances women employment prospects in developing economies.

Table 4: Estimation results of panel data models

Variables	Pooled OLS	Fixed Effects	Random Effects
C	82.76***	65.09***	82.76***
EDUC	-2.32***	-0.43	-2.32***
GDP	0.00007***	0.00027***	0.00007***
FER	-7.86***	-5.36***	-7.86***
ADR	0.45**	-0.75***	0.45***
R-squared	0.583	0.906	0.583
Adjusted R-squared	0.573	0.901	0.573
F-statistic	54.27581	182.2013	54.27581
Prob (F-statistic)	0.0000	0.0000	0.0000

*** Significance at 1% level ($p < 0.01$)

** Significance at 5% level ($p < 0.05$)

* Significance at 10% level ($p < 0.10$)

In addition, the fertility rate (FER) shows a consistently negative and highly significant impact on the FLPR in all models, with the largest magnitude in the Random Effects model with a coefficient of -7.86 ($p < 0.01$). This finding highlights the inverse relationship between fertility and women's labor market participation, as higher fertility rates reduce their formal employment availability. Nazah et al. (2021) similarly reported that fertility negatively affects the FLPR, especially for women in their childbearing years. Liu and Marois (2023) also emphasized that higher fertility rates increase the challenge of balancing work and parental responsibilities, leading to reduced labor market engagement. The Fixed Effects model reports a slightly smaller but still significant effect, with a coefficient of -5.36 ($p < 0.01$), suggesting that country-specific factors, such as childcare policies and cultural norms, partially influence this relationship.

The effects of education (EDUC) on the FLPR differ across models. In the Pooled OLS and Random Effects models, EDUC has a significant negative relationship with FLPR, with a coefficient of -2.32 ($p < 0.01$), indicating that higher education levels may delay women's entry into the labor force as they pursue further studies. Research by Psacharopoulos and Patrinos (2018) suggests that although higher education may reduce short-term labor market participation, it can significantly improve women's long-term earnings and career growth. However, in the Fixed Effects model, the relationship becomes insignificant with a coefficient of -0.43 ($p = 0.1286$), implying that unobserved country-specific characteristics, such as labor market conditions or societal expectations, may account for the differences in the education and FLPR relationship.

Furthermore, the old-age dependency ratio (ADR) has contrasting effects across models. In the Pooled OLS and Random Effects models, ADR is positively associated with FLPR, although with

different levels of significance. In the Pooled OLS model, ADR has a coefficient of 0.45 ($p < 0.05$), while in the Random Effects model, the coefficient remains the same at 0.45 but with a higher level of significance ($p < 0.01$). This suggests that financial pressure from supporting older dependents encourages women to enter the labor force. This result aligns with Amber and Chichaibelu (2023), who argued that demographic changes, such as population aging, often drive increased FLFP due to economic necessities. Conversely, the Fixed Effects model reveals a negative and significant relationship with a coefficient of -0.75 ($p < 0.01$), indicating that caregiving responsibilities for elderly family members reduce women’s participation in the labor market. This negative effect reflects the cultural and institutional factors in ASEAN countries, where women often assume primary caregiving roles.

The Fixed Effects model provides the highest explanatory power, with an R-squared value of 0.906 and an adjusted R-squared of 0.901, indicating that it accounts for most of the variance in FLPR. The *F*-statistic of 182.20 ($p < 0.01$) confirms the model’s robustness, highlighting the importance of controlling for unobserved heterogeneity to improve the estimation accuracy. In comparison, the Pooled OLS and Random Effects models report lower R-squared values of 0.583, indicating less explanatory power. These results underscore the significance of selecting an appropriate model in panel data analysis to accurately capture the complex relationship between economic growth, fertility, education, and demographic factors in determining the FLFP.

4.5 Model selection test

The Chow, Breusch-Pagan LM, and Hausman tests were employed to identify the optimal panel data model for evaluating FLPR factors in ASEAN countries. The results are presented in Table 5.

Table 5: Model selection test results

Test	Null Hypothesis	Test Statistic	<i>p</i> -value	Decision
Chow Test	Pooled OLS is suitable	<i>F</i> -statistic: 129.767129 Chi-square statistic: 238.416021	0.000	Reject
Breusch-Pagan LM Test	No random effects	358.2022	0.000	Reject
Hausman Test	Random effects are consistent	Chi-square statistic: 519.068515	0.000	Reject

Based on the model selection test, it is concluded that the fixed-effect model is the best suited to identify the key determinants of FLPR in ASEAN countries. The Chow Test results show *F*-statistics of 129.77 and Chi-square statistics of 238.42 with a *p*-value of 0.00. This leads to the rejection of the null hypothesis that pooled OLS regressions are suitable, and hence the need to use fixed effects models. The Breusch-Pagan LM Test, with a Chi-square value of 358.20 and a *p*-value of 0.00, indicates significant random effects, rejecting the common effects model. Finally, the Hausman Test presents a chi-square statistic of 519.07 with a *p*-value of 0.00, rejecting the null hypothesis that Random Effects are consistent, thereby confirming that the Fixed Effects model provides more reliable and accurate estimates by effectively accounting for unobserved heterogeneity across countries.

4.6 Determining the best model: fixed effects model

Based on the model selection test, Table 6 presents the Fixed Effects model estimation results, which is the most suitable approach for this study. It effectively accounts for unobserved country-specific factors that influence FLFP. However, to address heteroscedasticity and serial correlation issues, robust standard errors were employed, ensuring more reliable and robust estimates.

The Fixed Effects Model estimation results reveal that GDP per capita is the most significant positive determinant, with a coefficient of 0.000274 ($p < 0.01$), highlighting that economic development plays a crucial role in encouraging women to participate in the labor market. This

finding aligns with Nur Rahmawan and Aisyah (2024), who emphasized the importance of economic opportunities in boosting female labor force engagement.

Table 6: Fixed effects model estimation result

Variables	Coefficient	Standard Error	t-statistic
C	65.08797***	2.874553	22.64282
EDUC	-0.426472	0.279110	-1.527970
GDP	0.000274***	2.49E-05	11.02159
FER	-5.357625***	0.734797	-7.291302
ADR	-0.748610***	0.123637	-6.054894

*** Significance at 1% level ($p < 0.01$)

The fertility rate (FER) had a strong negative impact on the FLPR, with a coefficient of -5.357 ($p < 0.01$). Higher fertility rates are associated with reduced FLFP because more time is allocated to childcare and domestic responsibilities. This finding supports previous studies that highlight the negative impact of the correlation between fertility and labor force participation (Abdullah et al., 2013).

Next, education (EDUC) in the Fixed Effects model shows a negative but statistically insignificant relationship with FLPR, with a coefficient of -0.426 ($p > 0.01$). This insignificant result suggests that, within ASEAN countries, higher education levels may not have a clear or immediate effect on women's participation in the labor force. The negative coefficient, although not statistically significant, could reflect structural issues such as prolonged time spent in education, underemployment, or limited job opportunities that match women's qualifications. This finding diverges from the general expectation in the literature, where higher education is typically associated with increased female labor participation rates. However, in the ASEAN context, socio-cultural norms, employment rigidities, or delayed workforce entry may explain this weak and non-significant relationship between age and productivity. As Klasen and Lamanna (2009) argue, barriers such as gender inequality in employment opportunities can dampen the benefits of educational attainment for women in the labor market.

Furthermore, the old-age dependency ratio (ADR) also shows a significant negative effect, with a coefficient of -0.749 ($p < 0.01$). This indicates that higher dependency burdens, such as supporting older family members, limit women's ability to engage in the labor market. This finding aligns with studies indicating that caregiving responsibilities associated with higher dependency ratios reduce women's economic participation, particularly in countries with limited access to elder care support (Wolfe & Lahart, 2024).

Therefore, the analysis reveals that GDP per capita and fertility rates are the most significant predictors of FLFP in ASEAN countries. Higher GDP per capita encourages more women to participate in the labor market, whereas higher fertility rates hinder their entry. The Fixed Effects model emphasizes the importance of economic growth and fertility control in enhancing FLFP, while also highlighting the impact of education and demographic factors.

4.7 Diagnostic tests

This study uses diagnostic tests such as the Variance Inflation Factor (VIF) to check multicollinearity, the Modified Wald Test for heteroscedasticity, and the Wooldridge Test for autocorrelation to evaluate a panel data regression model. The results are presented in Table 7 and Table 8, respectively.

As presented in Table 7, the multicollinearity test of all explanatory variables reveals that none of the independent variables is affected. The centered VIF values for all variables were well below the threshold of 5, suggesting no problematic correlations among the independent variables ($VIF < 5$). Specifically, the centered VIF values for EDUC (2.48), GDP (2.82), FER (2.57), and ADR

(2.46) confirm the absence of significant multicollinearity among these variables. Therefore, multicollinearity did not pose a problem for the regression model.

Table 7: Multicollinearity test results

Variable	Coefficient Variance	Uncentered VIF	Centered VIF	Decision
C	13.33485	112.2163	NA	No VIF available for constant
EDUC	0.083432	48.33948	2.477715	No significant multicollinearity (Centered VIF<5)
GDP	4.05E-10	6.994375	2.822696	No significant multicollinearity (Centered VIF<5)
FER	0.795348	30.70607	2.569881	No significant multicollinearity (Centered VIF<5)
ADR	0.032720	21.29886	2.463397	No significant multicollinearity (Centered VIF<5)

The diagnostic test results in Table 8 reveal significant issues with the regression model. The Modified Wald Test reports a chi-square statistic of 76.28 with a *p*-value of 0.00, rejecting the null hypothesis of homoscedasticity and confirming the presence of heteroscedasticity in the residuals. Moreover, the Wooldridge Test for autocorrelation produces an *F*-statistic of 61.70 with a *p*-value of 0.0014, indicating the presence of first-order autocorrelation. These findings highlight the need for corrective measures, such as the application of a cluster regression model, to improve the reliability of the estimates.

Table 8: Diagnostic test results

Diagnostic Test	Null Hypothesis	Test Statistic	<i>p</i> -value	Decision
Modified Wald Test (Heteroscedasticity)	Homoskedasticity	Chi-square statistic: 76.28	0.0000	Reject Ho (heteroskedasticity present)
Wooldridge Test (Autocorrelation)	No first-order autocorrelation	<i>F</i> -statistic: 61.70	0.0014	Reject Ho (indicates first-order autocorrelation)

4.8 The fixed effects model

The Fixed Effects Model with Clustered Robust Standard Errors was utilized to address issues of heteroscedasticity and autocorrelation in diagnostic tests. By clustering standard errors at the group level, the model provides accurate estimates, thereby enhancing the reliability and validity of the regression findings. The results of the estimation are presented in Table 9.

Table 9: Fixed effects model with clustered robust standard errors

Variable	Coefficient	Standard error	<i>t</i> -statistics
EDUC	-0.4265	0.5057	-0.84
GDP	0.00027 ***	0.00005	5.46
FER	-5.3576	3.7562	-1.43
ADR	-0.7486 *	0.3046	-2.46
C	65.09 ***	12.246	5.32

*** Significance at 1% level (*p*<0.01)

** Significance at 5% level (*p*<0.05)

* Significance at 10% level (*p*<0.10)

This section addresses the final objective of the study by identifying which factors have the most significant factors influencing FLFP in ASEAN countries. The estimation results from the Fixed Effects Model with Clustered Robust Standard Errors indicate a significant relationship between several independent variables and FLFP in ASEAN countries. GDP per capita (GDP) has a positive and highly significant effect on FLPR, with a coefficient 0.00027 (*p*<0.01), suggesting that higher economic development levels are associated with greater female labor force engagement, potentially due to improved job opportunities and economic empowerment (Klasen, 2019). The

old-age dependency ratio (ADR) shows a negative and weakly significant effect on FLPR, with a coefficient of -0.75 ($p < 0.10$), indicating a slight reduction in female workforce participation as dependency burdens increase.

In contrast, education (EDUC) and fertility rate (FER) are not statistically significant in this model ($p > 0.10$), suggesting that their impacts on the FLPR are not robust when addressing heteroscedasticity and autocorrelation issues. This result deviates from previous studies, such as Voumik et al. (2023), who emphasized the negative effect of prolonged schooling on labor force participation, and Skadsen (2017), who highlighted the negative impact of fertility rates on female workforce involvement. These findings highlight that GDP per capita and the old-age dependency ratio are the most significant factors influencing FLPR in ASEAN countries, underscoring the role of economic development and demographic pressures, while the effects of education and fertility require further investigation.

5. Conclusion

In conclusion, this study investigated the factors influencing FLFP in several ASEAN countries from 1990 to 2021, focusing on education (EDUC), GDP per capita (GDP), fertility rate (FER), and the old-age dependency ratio (ADR). The findings reveal that GDP per capita plays a pivotal role in boosting FLPR, primarily by creating employment opportunities and fostering women's economic empowerment. In contrast, the old-age dependency ratio (ADR) exerts a modest negative influence, reflecting the challenges associated with the rising dependency burden on women. Interestingly, EDUC and FER did not show statistically significant effects in this analysis, diverging from some prior studies and highlighting the complexity of these relationships in the ASEAN context.

These findings underscore the importance of policy measures that foster inclusive economic growth to promote female workforce participation in the region. Introducing subsidized childcare and parental support policies can help alleviate fertility-related burdens (FER), which often deter female workforce entry. Likewise, improved eldercare services could ease the caregiving burden associated with age-related dependency (ADR), thereby enabling greater FLFP. Furthermore, better alignment between education programs and labor market needs can strengthen the connection between education (EDUC) and female labor participation outcomes.

One notable limitation of this study is its reliance on pre-pandemic data, which may not fully capture the evolving dynamics of women's labor force participation in the post-COVID era. Therefore, future research should incorporate more recent datasets and consider methodological refinements, such as incorporating interaction effects or disaggregating the analysis by age, education level, and urban-rural differences, to better understand the multifaceted determinants of FLPR in ASEAN countries.

Ultimately, this study contributes to a more contextualized understanding of FLFP in ASEAN and provides a foundation for evidence-based policy-making. As regional economies strive for equitable and sustainable growth, prioritizing gender-responsive labor policies is essential to unlock the full economic potential of female labor participation.

Acknowledgement: The authors would like to thank the Faculty of Science and Technology (FST) and the Risk and Analytics (RA) Research Group of the Universiti Sains Islam Malaysia (USIM) for providing access to the database and research support, as well as the editors and anonymous reviewers of *Issues and Perspectives in Business and Social Sciences* for their precious feedback and comments.

Funding statement: No external funding was received for this study.

Ethical compliance: Ethical approval was not required for this study as it involved the analysis of secondary data and did not include any human participants.

Data access statement: The data analysed in this study are secondary data obtained from publicly available sources, including the World Bank Databank, the International Labour Organization (ILO), the UNESCO Institute for Statistics (UIS), and United Nations databases. The data are available from the respective sources upon reasonable access and in accordance with their respective data use policies.

Conflict of interest declaration: The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

Author contributions: The authors worked together on this study. Conceptualization: A.M.J, N.A.M; Methodology: N.A.C; Formal analysis and investigation: N.A.M, A.M.J, N.A.C; Writing – original draft preparation: N.A.M, A.M.J; Writing – review and editing: A.M.J, N.A.C; Supervision: A.M.J, N.A.C. All authors have read and agreed to the published version of the manuscript.

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