THE EFFECTS OF SOCIO-DEMOGRAPHIC FACTORS ON TOTAL FERTILITY RATE IN MALAYSIA: AN ARDL APPROACH

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ABSTRACT

One of the factors of the rising aging population is the decreasing fertility rate due to demographic transitions. Fertility behavior is influenced by various social and economic aspects. This study focuses on socio-demographic factors such as income, female labor force participation, female education, household consumption expenditure, and urbanization and their effect on the downward trend of the total fertility rate in Malaysia over the period of 1990 to 2021. Autoregressive Distributed Lag (ARDL) approach is used to analyze the impacts of the socio-demographic factors on fertility and to investigate their short-run and long-run relationship. Income and female labor force participation are found to have a positive relationship with fertility in the long run, while urbanization negatively affects fertility. Female education turned out to be insignificant. In the short run, all variables are found to be positively related to fertility except for female labor force participation, which has an inverse relationship. In addition to that, the Granger Causality test is employed to investigate the existence of causality between each of the socio-demographic factors and fertility. There is no causal effect found between female labor force participation and fertility rate, while other socio-demographic factors have either a unidirectional or a bidirectional relationship with total fertility.

Keywords: *ARDL, Granger Causality Test, Socio-Demographic Factors, Total Fertility Rate*

INTRODUCTION

Throughout history, fertility rates have been one of the most influential determinants in the aging of the population (World Health Organization, 2010). Increased fertility rates contribute to a youthful demographic, thereby mitigating the negative impacts of aging and mortality. In contrast, during periods of low fertility rates, the population comprises a greater proportion of older individuals and fewer youth. According to the United Nations (2022), the proportion of individuals aged 65 and above in developing nations can reach as high as 7 percent of the overall population. The Department of Statistics Malaysia (2022) anticipated that the percentage of the population that is elderly will surpass 15 percent by 2050. This phenomenon will result in a reduction in the working-age population, thereby resulting in scarcity of labor. A primary contributor to the escalating elderly population is the worldwide occurrence of demographic shifting, which entails a decline in fertility rates. The trend of fertility rates in Malaysia from 1990 to 2050, as projected by the United Nations (2022), is illustrated in Figure 1.

Malaysia, like other developing countries, experienced demographic transitions. An important aspect of demographic transition occurs when the natural pace of population expansion slows after an initial rise, coinciding with decreases in mortality and fertility rates. The primary topic of debate among researchers is whether the decline in fertility can be attributed to a reduction in mortality rates, an increase in income, or technological progress. Economists are predominantly affiliated with the second perspective, while demographers are generally linked to the former. The onset of the worldwide demographic transition occurred in Europe in 1800, when fertility and mortality began to decline (Lee, 2003). Nevertheless, in the present day, the discourse revolves around whether it is more pertinent to link the observed decrease in fertility rates with human capital development rather than population growth, given that economic productivity is followed by a demographic dividend (Ja'afar, 2020). Economic growth has a positive relationship with the social and demographic determinants (Jones, 2010). This concludes that socio-demographic factors will eventually lead to a downward pattern of fertility.

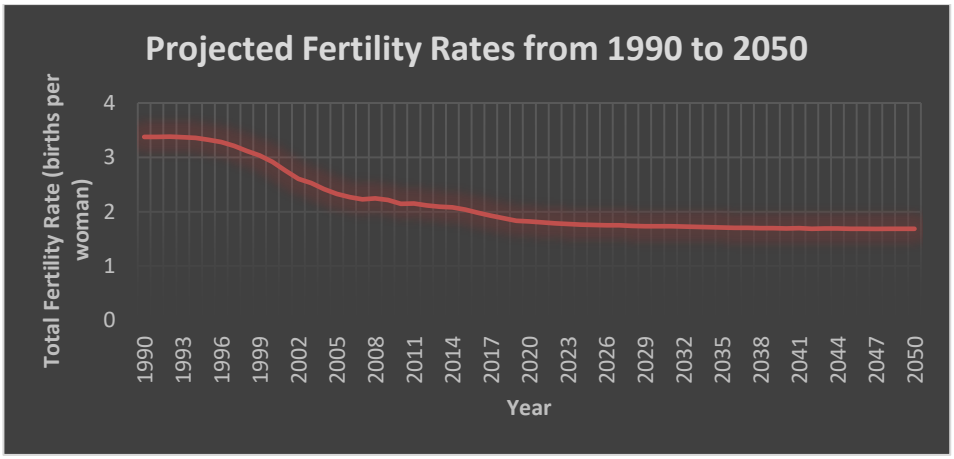


Figure 1: Malaysia's Total Fertility Rate Over Time.
Source: United Nation

In recent decades, Malaysia has witnessed a reduction in the overall fertility rate. According to World Bank data (2022), Malaysia's total fertility rate fell from roughly 6.0 children per woman in the 1960s to around 4.0 children per woman in the 1980s. The total fertility rate continued to fall during the next decades, reaching at 1.8 in 2021. Among all jurisdictions, Sabah and Sarawak are experiencing the most substantial population decline (Mahidin, 2022). According to the Department of Statistics Malaysia (2022), Song, a district in Sarawak, experienced the most dramatic fall in population growth between 2010 and 2020, at -50.5% (-10,144 individuals). Several administrative districts in Sabah followed a similar path of decline. In contrast, the remaining districts in both states, particularly metropolitan areas, experienced significant population growth. The decrease in the number of children born to women can be linked to a variety of causes, including economic development, increased access to education, which broadens career opportunities, and advanced technological advances, which allow for marriage at a younger age (Mahidin, 2022). Numerous academics have attributed the reduction in total fertility to social and economic factors. Socio-demographic factors encompass the attributes of a given population that are concurrently social and demographic in nature. Social factors include aspects such as culture, religion, ethnicity, and social norms, while demographic factors include age, gender, education, income, employment, and urbanization. A variety of economic and social outcomes may be impacted by these variables, ultimately contributing to the decline in the fertility rate.

With the advancement of technology and the growing sophistication of the economy, the opportunity costs associated with parenthood have escalated in tandem with the costs of providing essential items for one's children. The transition of the population from rural to urban areas as a result of modernization eliminated the need for large families to operate farms, ultimately impeding agricultural productivity. Social norms regarding the accessibility and utilization of contraception have also evolved in tandem with the progress of the healthcare system (Mester, 2017). Mortality rates have decreased as a result of the progress made in the fields of medicine, public health, and nutrition due to advances in knowledge and technology. Simultaneously, there was a decline in the fertility rate due to mortality exerting a preponderant influence on fertility (Lee, 2003). These circumstances contribute to the prevalence of limited family sizes, which is a result of family planning. The decline in the fertility rate has raised concerns about an aging population and potential economic consequences. Health, social security, education, sociocultural activities, family life, and the labor market are all impacted by the rising of aging population. A decline in the working-age population leads to a reduction in the workforce participation rate, thereby increasing the percentage of total retirees (Ince Yenilmez, 2015). Due to these consequences, the government needs to invent policies and programs for financial security, work-life balance, and childcare support, to encourage families to have more children.

The phenomenon of declining birth and death rates and rising life expectancy in Malaysia contribute to an upward trend in the nation's population growth. According to the Department of Statistics Malaysia (2022), the nation's population grew to 33.0 million by 1.3% increase from 2020 to 2021. The positive trend since 2016 is expected to rise at least until 2027. Although the fertility rate and mortality rate declined throughout the year 2021 by -2.1% and -10.2% respectively, the statistic shows that the population growth rate is still increasing since the life expectancy is getting higher, which indicates that the larger population is from the old-age group. Previous researchers have revised the socioeconomic factors that contributed to the decline in the total fertility rate through 2019. This revision was made by Awad and Yussof (2017), Idris et al. (2018), Zulqarnain and Yusuf (2022), and Shariff and Jonedi (2020). As a consequence of the global pandemic instigated by the COVID-19 outbreak in 2020, fertility rates may be subject to unforeseen fluctuations in demographic, social, and economic sectors. Consequently, this paper will specify the primary determinants that influence the total fertility rate in the short and long term by utilizing the most recent time frame data from 1990 to 2021. Given Malaysia's transition toward an aging population, it is critical to identify and pinpoint the factors that have a substantial impact on the fertility rate to gain a deeper understanding of the demographic trend, which will inevitably result in a profound change to a nation's economic and social progress, as well as its population expansion. The government of Malaysia is likely to obtain some valuable insight from this study that can be utilized to develop initiatives aimed at mitigating the impacts of the aging population. This study therefore aims to analyze the socio-demographic factors that influenced Malaysia's total fertility rate from 1990 to 2021 and examine their short-run and long-run relationship. In addition, this study also investigates if a causality effect between socio-demographic factors and fertility exists.

LITERATURE REVIEW

Fertility Rate

The World Bank (2022) defines the total fertility rate as the sum of all children born to each mother during her reproductive years in a given year. Substantial changes in Malaysia's economy and society have influenced the demographic transition; the country's older population has increased in tandem with a steady decline in fertility and an increase in life expectancy. This trend has resulted in substantial structural alterations in age. According to data from the Department of Statistics Malaysia (2022), the median age of the entire population experienced an upward trend from 16.2 years in 1970 to 29.5 years in 2020, with a projected increase to 40.5 years by 2050. Urbanization, rapid economic growth, a declining infant mortality rate, rising education, female labor force participation, the postponement of marriage and childbirth, and increased contraceptive use have all played a role in Malaysia's socioeconomic development, which has resulted in fertility rates remaining below replacement levels (Peng, 2020). As the population of working age has increased at a faster rate than the population of non-working age, declining fertility in Malaysia has led to a demographic dividend.

The demographic dividend stimulated socioeconomic expansion, which caused a subsequent decline in fertility. Comparable to several Southeast Asian nations, Malaysia's current total fertility rate of less than 2.0 children for the period 2015 to 2020 is quite low. Low birth rates raise concerns among nations about whether the trend will continue, resulting in a serious labor shortage, hastened population aging, and the disintegration of the family structure. According to Awad and Yussof (2017), the declining trend in Malaysia's total fertility rates can be primarily attributed to socioeconomic and demographic factors. For instance, reductions in infant mortality and enhancements in healthcare services have had a significant impact on the decline in fertility rates in terms of demographic factors. Socioeconomic factors such as the increase in female employment, education enrollment, and income have the potential to reduce fertility rates in Malaysia. For example, Chani et al. (2012) found that urbanization, female labor force participation, and female education negatively impact fertility. This is also supported by the findings by Awad and Yussof (2017) who also found that GDP and infant mortality rate presented the same impact on fertility rate. Jemna (2015) also concluded that economic growth significantly, but positively affects fertility. Empirical results by Rayhan et al. (2018) reveal that the increase in per capita GNI, female labor force participation rate, education, and urbanization cause the fertility rate to decline.

Income

Zulqarnain and Yusuf (2022) investigated the short-term and long-term impacts of fertility rate fluctuations on per capita income. Higher incomes initially resulted in improved healthcare, cleaner environments, and enhanced nutrition for the populace; subsequently, these factors contributed to an upsurge in birth and fertility rates. On the contrary, an exceptionally high income promotes family planning, stimulates female education and employment, and results in a decline in fertility rates. This demonstrates that an increase in income might have an impact on the decline in the fertility rate. A greater level of income will engender additional opportunity costs in the context of parenthood. High-income families have the means to invest more in the quality of life for their children, as opposed to providing less for a greater number of children. The research findings indicate that an increase in income has an impact on the decrease in fertility; however, this relationship is only optimal for a limited time before it begins to deteriorate. This finding highlighted the statistical significance of income on both the short- and long-term trends in fertility, from the year 1982 to 2019, with a 1% rise in household income, resulting in a 0.108% reduction in the fertility rate in both scenarios.

In their study, Idris et al. (2018) reached the additional conclusion that there exists a compromise between the quantity and quality of children. Early in the process of economic development, when the wealthy have parents with higher education and the poor have parents without education, the income disparity between the rich and the poor widens. Educated parents have a smaller birthrate, while uneducated parents have a greater number of offspring. When fertility is high, the supply of people with poor education grows quicker than the supply of highly educated people. Nevertheless, uneducated parents are willing to devote to fewer children instead of raising a large family when they predict a larger net return to education. This is highly possible due to the fact that the child of an educated parent has a greater net return on investment than the child of an uneducated parent, and the expense of childrearing is proportional to the parent's potential income. Subsequently, there is an increase in per capita output, a reduction in fertility rates, and a narrowing of income inequality as overall education levels advance. This occurs due to the inverted U-shaped curve, which indicates that impoverished parents initially dominated the economy but their influence diminished as time progressed. This finding is consistent with the prior research of Tang and Tey (2017) which concludes that the average fertility rate throughout the economy initially increases and then declines.

Female Labor Force Participation

Findings from Awad and Yussof (2017) indicated that female labor force participation had a negative and significant effect on fertility. Due to the presumptive conflicts between women's reproductive and career obligations such as societal expectations and workplace structures which are mainly because of gender-based discrimination, it is generally believed that female employment is inversely associated with fertility. The adverse relationship appears when economic conditions and social life become challenging to integrate childrearing with professions. Additionally, it is speculated that wage workers have lower fertility rates than non-wage workers. This study observed that the factors affecting female employment tend to have the greatest influence on Malaysia's fertility rates over the long term, which parallels the notion that as women spend more time at work, the likelihood of having children drops.

A study by Chandiok et al. (2016) has analyzed that one of the social and biological factors of India's fertility is women's self-determination, which is frequently assessed by their level of education and employment, and both have an impact on the family size. These independent women usually marry at a later stage and are conscientious about family planning. Logically, the workplace environment is probably unpleasant to women who are in a state of pregnancy and childcare. Working women have less time for self-development during pregnancy because they will take an extended maternity leave and be more preoccupied with things like their own and their unborn child's health (Yusuf, 2012). This hypothesis corresponds to Zulqarnain and Yusuf (2022) where over time, there is a positive relationship between female labor force participation and fertility, whereas a 1% increase in female labor force participation will cause a 0.0023% rise in the fertility rate over the short and long run. Hence, it can be concluded that the number of children in a family is influenced by the employment of the mother.

Another piece of evidence that shows that female labor force participation has a significant effect on the total fertility rate is illustrated by Shariff and Jonedi (2020), where the rising number of women joining the labor force and being economically is correlated with the number of women completing higher education. It shows that women's labor force participation rate has a positive impact on the total fertility rate which indicates that a 1% increase in women's labor force participation will result in a 0.006% increase in the fertility rate in the long run. Bakar et al. (2013) also concurred that female labor force participation was substantially affecting fertility rates in both the long-run and short-run predictions. Subramaniam and Mohd Saleh (2016) hypothesized that women today tend to be more digitally skilled than their ancestors. Due to their vast disparities in age, they had opposing views on having a large family and having more children. They found that the area of living and the working sector has great impacts on the total fertility rate. The area of living is important in measuring their living standard and the costs related to it, including the housing cost and educational expenses, both of which have an impact on their working conditions and working hours. As a result, it is important to have flexibility in the workplace and time management to balance commitments to family and profession. Women working in a formal sector with high-earning income experience greater stress at work. They also have less job flexibility causing them to have fewer children.

Female Education

A country's demographic transition is related to indications of female empowerment. According to Awad and Yussof (2017), the proportion of female students grew, rising from 52.1% in 1970 to 78.4% in 2010 at all educational levels. Additionally, between 1960 and 2010, the average number of years that girls over 15 attended school rose from 0.821 to 9.920. Fertility rates are predicted to decline as female education levels rise. Family planning knowledge may encourage efforts at preventing childbearing using a variety of contraceptive techniques through education. Apart from that, education may influence the reduction of fertility through enhanced healthcare systems. This demonstrates that education has the ability to directly alter attitudes and beliefs towards those who are more at ease with small-family norms and childrearing, which is very expensive and time-consuming for parents. This research also concludes that long-term overall fertility rates are negatively and significantly impacted by female education.

Shariff and Jonedi (2020) found that women's education has a positive and substantial relationship with the total fertility rate. For the long-term relationship, fertility rates tend to increase by 0.007% for every 1% increment in female education. According to Chani et al. (2012), fertility rates vary in different countries because of the influence of social, cultural, and demographic factors. The research has demonstrated that Pakistan's declining fertility trend is due to more educated women planning to delay having children because of the pressures from their jobs and professions. The study also discovered that from 1980 to 2009, there was a negative sign and significant effect that contributed to the inverse relationship in short-term and long-term correlations between fertility and female education.

Educated women commonly participate in economic activities such as committing to their businesses and pursuing demanding careers, which makes it more probable that they will have fewer children (Rayhan et al., 2018). They described these situations as a trade-off between the number of children and the duration of access to children's playtime. Parents' desire to spend more time with their children is the driving force for this trade-off. Thus, having fewer children would be preferable for highly educated women.

Household Consumption Expenditure

Many empirical studies suggested a negative relationship between fertility and household consumption expenditure. For example, Desta (2014) investigated how the number of children in a household affects consumption in Ethiopia. The results of the sample survey on married women in rural and urban areas confirmed the fact that having a lot of children and increasing household consumption expenditure hurts rural households, but the results are less clear for urban households. The number of children and the household's necessary consumption such as food, clothes, schooling, and housing are predicted to be negatively correlated by theoretical studies linking fertility to household poverty circumstances as having more children implies that the household's resources are shared among a larger number of household members. Therefore, people tend to be concerned about family planning and assume that low fertility as having fewer children might lighten their burden since household consumption will be bearable and not too high for them.

Idris et al. (2018) revealed that household consumption expenditure has an inverse relationship with the fertility rate in Malaysia as the reduction in fertility rate is due to the rising household consumption costs. The finding observed that in the year 1975 to 2013, a 1% rise in household consumption expenditure would result in declining fertility rates ranging from 2.9% to 3.8%. Families with higher demand for credit result in lower fertility in countries with low incomes but higher fertility in countries with higher incomes (Filoso and Papagni, 2015). Similarly, a study by Habibullah et al. (2016) also found that financial development has a

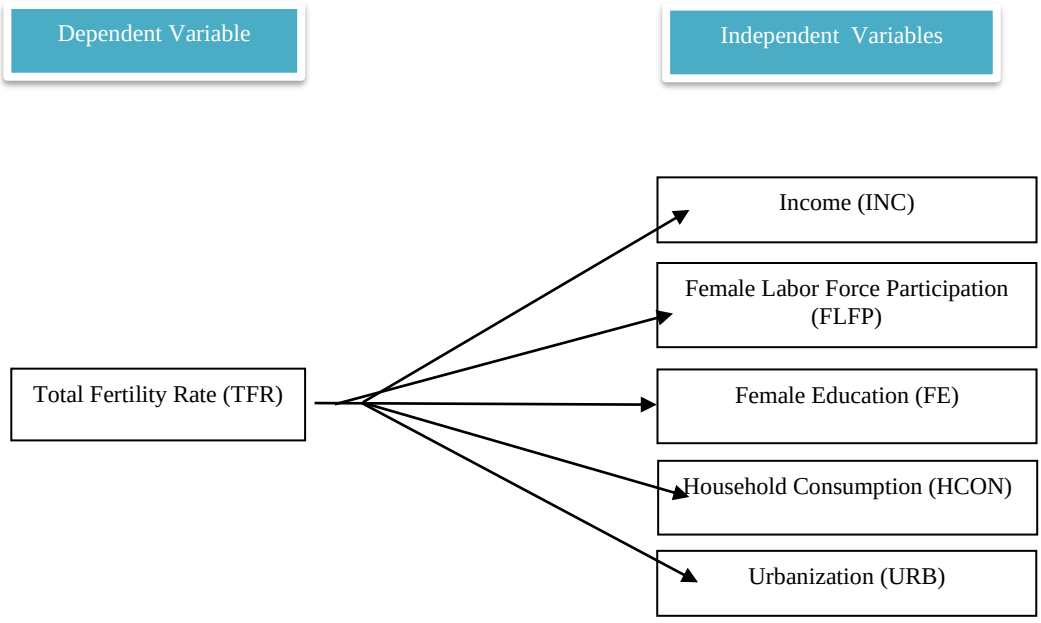
positive impact on fertility in high-income countries but has a negative impact on fertility rates in low-income countries. This indicates that the high cost of childbearing may burden some parents with less financial stability.

Urbanization

Comparison studies between rural and urban women by Subramaniam and Mohd Saleh (2016) and Chani et al. (2012) concluded that the residential environment has a substantial impact on fertility rates. Compared to their counterparts in rural areas, urban women have less children. Urban women typically defer childbearing at an earlier age than rural women do. In developed countries, urbanization and fertility are recognized to be inversely correlated. Guo et al. (2012), reported that China's rural fertility trends were mostly responsible for the nation's population reduction between 1982 and 2008, demonstrating that official birth control initiatives had some influence, but were not the sole factor in reducing China's population growth. Besides, it has been suggested that urbanization will be the main cause of future drops in national fertility. Brinker and Amonker (2013) discovered that affluent countries or communities had low child demand, which led to low fertility. However, in developing countries, such as India, children have traditionally played significant roles in their parents' economic and old age security. Chandiok et al. (2016) argue that children are a major economic resource in many developing countries, in which children are categorized as a financial asset. This corresponds to Chani et al. (2012) who stated that some societies prefer low fertility rates and consider children as an economic liability.

Theoretically, urbanization is thought to have a detrimental effect on fertility (Chani et al., 2012). The expense of raising children in urban society is typically higher than in rural regions. Children probably contribute less to household production in urban regions than they do in rural areas, and the housing costs in urban are higher. There are differences between urban and rural populations' ideologies, worldviews, and attitudes toward family size. Additionally, urban residents can have easier access to modern health and birth control services. This helps urban women achieve their goal of having fewer children. The low fertility rate is required to replenish the population since improved health facilities in urban areas may also be related to declines in mortality rates. Therefore, it is believed that childbearing will become more expensive as urbanization increases. Urbanization indeed has a significant relationship with the total fertility rate.

Conceptual Framework



DATA AND METHODOLOGY

Data Collection

Based on the assessment of numerous previous literature, the variables listed in Table 1 are chosen for this study. In this study, secondary data will be used, which covers 32 years of Malaysia's annual data from 1990 to 2021 extracted from the World Bank Database. The data include proxies for total fertility rate (TFR), income (INC), female labor force participation (FLFP), female education (FE), household consumption expenditure (HCON), and urbanization (URB). Since the data for INC and HCON are large, both datasets need to be adjusted using a logarithmic transformation. Therefore, the logarithm of INC is represented by LINC, and the logarithm of HCON is represented by LHCON. The list of data selected is shown in Table 1.

Table 1: Summary of Variables

Variables		Data Description	Literature Reference
Dependent	Total fertility rate (TFR)	Fertility rate, total (births per woman)	Awas and Yussof (2017), Chandiok et al. (2016), Chani et al. (2012), Idris et al. (2018), Jemna (2015), Rayhan et al. (2018), Shariff and Jonedi (2020), Siah and Lee (2015), Zulqarnain and Yusuf (2022)
Independent	Income (INC)	Adjusted net national income per capita (current US$)	Chandiok et al. (2016), Tang and Tey (2017), Zulqarnain and Yusuf (2022)
	Female labor force participation (FLFP)	Labor force participation rate, female (%)	Awas and Yussof (2017), Chani et al. (2012), Rayhan et al. (2018), Shariff and Jonedi (2020), Siah and Lee (2015), Tang and Tey (2017), Zulqarnain and Yusuf (2022)
	Female education (FE)	School enrolment, secondary, female (% gross)	Awas and Yussof (2017), Chani et al. (2012), Rayhan et al. (2018), Shariff and Jonedi (2020), Siah and Lee (2015), Tang and Tey (2017),
	Household consumption expenditure (HCON)	Household final consumption expenditure (current US$)	Desta (2014), Idris et al. (2018), Zulqarnain and Yusuf (2022)
	Urbanization (URB)	Urban population (% of the total population)	Chani et al. (2012), Rayhan et al. (2018), Shariff and Jonedi (2020)

Autoregressive Distributed Lag (ARDL) Model

ARDL model is a cointegration method that helps in achieving the first and second objective in this study which is to examine the relationship of the short and long run between socio-demographic factors and fertility rates in Malaysia. This model is well-suited for analyzing variables with mixed orders of integration such as I(0) and I(1) and also applicable for the non-stationary time series. In a general-to-specific modeling framework, this model employs a sufficient number of lags to effectively capture the underlying data-generating process (Shrestha and Bhatta, 2018). The equation of the ARDL model is presented as follows:

$$\Delta TFR_t = \alpha_o + \sum_{i=1}^{k} \alpha_1 \Delta LINC_{t-i} + \sum_{i=0}^{k} \alpha_2 \Delta FLFP_{t-i} + \sum_{i=0}^{k} \alpha_3 \Delta FE_{t-i} + \sum_{i=0}^{k} \alpha_4 \Delta LHCON_{t-i} + \sum_{i=0}^{k} \alpha_5 \Delta URB_{t-i} + \beta_1 LINC_{t-1} + \beta_2 FLFP_{t-1} + \beta_3 FE_{t-1} + \beta_4 LHCON_{t-1} + \beta_5 URB_{t-1} + \varepsilon_t \quad (1)$$

where,

$\alpha_0 = intercept$ $\quad$ $\Delta = first\ difference\ operator$

$\alpha_i = short\ run\ coefficient$ $\quad$ $\varepsilon_t = error\ term$

$\beta_i = long - run\ coefficient$

The bounds test for cointegration is performed on Model (1) to test the validity of the long-run model. The hypothesis statement for this ARDL model is:

$$H_0: \beta_i = 0\ (no\ cointegration\ exist)$$
$$H_1: \beta_i \neq 0, (cointegration\ exist)$$

The existence of long-run cointegration relationship between variables is established by comparing the computed F-statistics with the bound critical value tabulated by Narayan (2005). If the null hypothesis, H_0 for this bound test is rejected when the computed F-statistics exceed the upper bound critical value, it suggests that there is cointegration and a long-term link between the variables (Pesaran et al., 2001). Shrestha and Bhatta (2018) also emphasized that through a simple linear transformation, the dynamic error correction model (ECM) can be obtained from ARDL. Similarly, the ECM combines short-term dynamics with long-term

equilibrium, ensuring the retention of long-term information and mitigating issues such as spurious relationships that arise from non-stationary time series data. The ECM can be formulated as below:

$$\Delta TFR_t = \alpha_o + \sum_{i=1}^{k} \alpha_1 \Delta LINC_{t-i} + \sum_{i=0}^{k} \alpha_2 \Delta FLFP_{t-i} + \sum_{i=0}^{k} \alpha_3 \Delta FE_{t-i} + \sum_{i=0}^{k} \alpha_4 \Delta LHCON_{t-i} + \sum_{i=0}^{k} \alpha_5 \Delta URB_{t-i} + \emptyset ECT_{t-1} + \varepsilon_t \quad (2)$$

The coefficient of error correction term (ECT), $\emptyset$ represents the speed of adjustment of short run equilibrium backs to its long-run equilibrium. The ECT value should be lower than 0 and significant to ensure that the series can change to its equilibrium.

Granger Causality Test

Granger causality test is employed to accomplish the third objective of this study which is to examine the causal relationship between each of the socio-demographic variables and total fertility rate. The function of this causality test is to verify the ability of one variable to forecast another variable. The direction of causality between two different variables can be unidirectional and bi-directional. The equations and hypotheses of this test can be represented as below, where the two variables are denoted as X and Y:

$$\Delta Y_t = \sum_{i=1}^{n} \alpha_i \Delta Y_{t-i} + \sum_{j=1}^{n} \beta_j \Delta X_{t-j} + u_{1t} \quad (3)$$

$$\Delta X_t = \sum_{i=1}^{n} \lambda_i \Delta X_{t-i} + \sum_{j=1}^{n} \delta_j \Delta Y_{t-j} + u_{2t} \quad (4)$$

H_0: There is no Granger causality between the dependent variable X, and the independent variable Y.
H_1: There is a Granger causality between the dependent variable X, and the independent variable Y.

To run this test, the F-statistics is used to indicate the causal effects of the variables. If the p-value of the F-test is less than 0.05, the null hypothesis, H_0 is rejected as the causal relationship is significant. Hence, the Granger causality between both variables exists.

RESULTS AND DISCUSSIONS

Table 2 shows the descriptive statistics of the variables used in this study. The data series consists of 192 total observations, where each variable has 32 observations. The mean and median of each variable indicate the average values of the data, while standard deviation, skewness, and kurtosis specify the dispersion of data points. Each of the variables is nearly symmetrical since its mean and median are relatively close. The average total fertility rate is 2.573, which indicates, on average, birth per woman is between 2 to 3 children with a standard deviation of 0.57. The average net national income per capita is 4,759.762 US$ while the average household consumption expenditure is 121.1379 million US$. On average, 45.83% of Malaysia's labor workforce is women with a standard deviation of 3.4%. About 79.89% of women enrol in secondary school with a variation of 7.9%. Lastly, the average population living in urban areas is 65.78% of the total population with a large standard deviation of 8.6%. This means that URB has the highest dispersion where the data points in the dataset are spread out widely from each other, and more volatile compared to other variables. For the skewness, it illustrates that TFR, INC, FLFP, and HCON are positively skewed while WE and URB have negative skewness.

Table 2: Descriptive Statistics

	TFR	INC	FLFP	FE	HCON (million)	URB
Mean	2.537094	4759.762	45.83269	79.89160	121.1379	65.78422
Median	2.298000	4061.874	43.72050	80.95609	85.09456	67.03850
Standard Deviation	0.570984	2354.522	3.407832	7.872328	81.97168	8.605830
Skewness	0.365386	0.174735	0.944430	-0.717227	0.49760	-0.365814
Kurtosis	1.564966	-1.70534	2.043327	2.088601	-1.39950	1.908175

The ADF test is the first step in the ARDL model where it is used to determine the stationarity of the variables. Columns 2, 3, and 4 in Table 3 show the p-values for the series in level, while columns 5, 6, and 7 show the p-values for the series after first differencing. There are two variables, TFR and URB that are stationary at level as the null hypothesis is rejected since the p-values are below the 5% significance level, which are 0.0284 and 0.0000 respectively. Meanwhile, the other four variables are stationary with intercept after the first difference, where the p-values are 0.0016 for LINC, 0.0001 for FE, and 0.0013 for LHCON, while FLFP is stationary with no trend and no intercept at a p-value of 0.0207. It is deduced that TFR and URB have the order of integration of I(0) while LINC, WE, LHCON, and FLFP have the order of integration of I(1). Thus, all variables can be included in the ARDL model as the ARDL model is only applicable for a series with the order of integration of I(1) and I(0).

Table 3: Augmented Dickey-Fuller Test

Series	*p*-value for Level (I(0)) :			*p*-value for First-difference (I(1)) :			Integration Order
	Intercept	*Trend and Intercept*	*None*	*Intercept*	*Trend and Intercept*	*None*	
TFR	0.5115	0.7475	0.0284	0.1972	0.3953	0.1667	*I(0)*
LINC	0.4505	0.6765	0.9947	0.0016	0.0078	0.0003	*I(1)*
FLFP	0.9676	0.4267	0.9571	0.0751	0.1256	0.0207	*I(1)*
FE	0.4132	0.6164	0.9205	0.0001	0.0008	0.0000	*I(1)*
LHCON	0.7981	0.7193	0.9996	0.0013	0.0078	0.0008	*I(1)*
URB	0.0000	0.1009	0.5868	0.8442	0.0000	0.4516	*I(0)*

To avoid misleading results and difficulties in interpreting the importance of the independent variables, it is crucial to perform the multicollinearity test. Table 4 presents the result of the multicollinearity test using the Variance Inflation Factor (VIF). Initially, there is a multicollinearity problem with the variables LINC and LHCON, where the VIF values are 18.2089 and 19.0255 respectively. Therefore, LHCON is omitted from the model to resolve the issue since it has the highest value of VIF. After excluding LHCON, the multicollinearity issue is nonexistent. Thus, following the adjustment, the model is robust and unbiased, making it reliable for use in the ARDL model.

Table 4: Multicollinearity Test

Multicollinearity	VIF before adjustment	VIF after adjustment
LINC	18.2089	1.51163
LHCON	19.0255	-
FE	1.65023	1.56507
FLFP	1.03529	1.03335
URB	1.192580	1.07739

Table 5 shows the result of the F-bound test approach to co-integration, to verify the existence of the long-run relationship between the dependent and its independent variables, at all significance levels. Given that the F-value of 10.16314 which exceeds the upper bound, I(1) at the significance levels of 1%, 2.5%, 5%, and 10%, the null hypothesis of no cointegration exist is rejected. This reflects that the total fertility rate (TFR), has a long-run relationship and is cointegrated with income (LINC), female labor force participation (FLFP), female education (FE), and urbanization (URB) from the year 1990 to 2021.

Table 5: ARDL Bound Test

Test Statistic	Value	Significance Level	*I(0)*	*I(1)*
***F*-statistic**	10.16314	**10%**	1.9	3.01
k	4	**5%**	2.26	3.48
		2.5%	2.62	3.9
		1%	3.07	4.44

The results of the ARDL (1,2,2,2,2) Model tabulated in Table 6 is the best-lagged model based on the smallest Akaike info criterion (AIC), which illustrates the long-run and short-run relationship to achieve the primary and secondary goals of this research. In light of the outcome, all independent variables, LINC, FLFP, FE, and URB are statistically significant at either 1%, 5%, or 10% significance levels in the short run. In the long run, the only variable that is insignificant is FE, whose p-value is greater than the significance level of 10%. The rate at which the short-run equilibrium is adjusted to the long-run equilibrium is represented by the error correction term (ECT). The coefficient ECT(-1) has a negative sign of -0.228354 and is significant at a 1% significance level, suggesting that nearly 23% of the discrepancy between the long run and the short run is corrected within a year.

Table 6: ARDL (1,2,2,2,2) Model

Long Run		Short Run	
Variable	**Coefficient**	**Variable**	**Coefficient**
LINC	0.666783**	D(LINC)	0.130944***
FLFP	0.033678***	D(LINC(-1))	0.047931
FE	-0.008131	D(FLFP)	0.004591
URB	-0.074885**	D(FLFP(-1))	-0.012687*
		D(FE)	0.001897
		D(FE(-1))	0.003831**
		D(URB)	0.227532***
		D(URB(-1))	-0.040422
		ECT (-1)	-0.228354***

**** indicates 1% significance, ** indicates 5% significance, * indicates 10% significance*

Referring to Table 6, LINC is positive and significantly related to TFR in both the short-run and long-run. This indicates that an increase of 1% in per capita income will increase the total fertility rate by 0.0013 in the short run and 0.0067 over the long run. This supported the findings from Zulqarnain and Yusuf (2022). People would feel comfortable expanding their families when they are financially stable and have better financial security when income is high. This happens as people can provide better healthcare, cleaner environments as well as enhanced nutrition to their families, therefore increasing birth and fertility rate. On the contrary, Idris et al. (2018) found that the inverted U-shaped curve existed where income and fertility were positively related in the short run and negatively related in the long run for the period 1975 to 2013. This may be due to inadequate access to financial resources that leads individuals to consider small family size as a choice to alleviate financial burdens and responsibilities (Zulqarnain and Yusuf, 2022).

FLFP is statistically significant and exhibits a positive relationship at lag 0 in the long run and an inverse relationship at the first lag in the short run with TFR. This means that a 1 unit increase in female labor force participation results in a 0.0337 unit increase in fertility in the long run and a 0.0127 unit decrease in fertility in the short run of lag 1, which supports the findings by Shariff and Jonedi (2020). In the short run, a higher percentage of women in the labor force results in lower fertility. However, over time, this link reverses because childrearing in a working environment can be challenging. Women would eventually be ready to have large families after they have achieved stability and flexibility in their careers. These findings supported the conclusion by Chandiok et al. (2016) that family size is influenced by the employment of the mother.

FE is found to be positive and significantly affecting TFR at the first lag in the short run but is insignificant on TFR at lag 0 in the long run. This reflects that an increase in female education will significantly increase TFR by 0.0038 within a short period of lag 1. This result supports Shariff and Jonedi (2020) who deduced that women's education positively affects fertility rate in the short run. This is in line with findings from Awad and Yussof (2017) and Chani et al. (2012) that female education has an opposite relationship with fertility in the long run. Initially, there is a positive relationship between female education and fertility as educated women would prefer to complete their studies before getting married. As time goes by, the advance in women's education tends to put off starting a family because they devote more time to their education and professions as they are more exposed to career opportunities due to high educational levels. Hence, it has led to a decline in the fertility rate.

URB and TFR have a significant positive correlation in the short run but are negatively significant in the long run. An increase in urban population can boost the fertility rate by 0.2275 in the short run and offset the fertility rate by 0.0749 in the long run. This outcome supported the conclusions by Chani et al. (2012) and Subramaniam and Mohd Saleh (2016) that long-term urbanization has a negative correlation with fertility rate. However, the short-term effect is the opposite. The younger population's migration to start new families in urban areas may be the cause of the favorable relationship observed in the short period as there are better education and job opportunities. Over time, the fertility rate is lower among the urban population since the living costs and childcare expenses in affluent communities are higher, compared to the rural areas.

After running the ADL model, the diagnostic checks are performed and the results are as shown in Table 7. This is to ensure that the outcomes from the selected ARDL model are valid and reliable. Since the p-values of heteroskedasticity and autocorrelation tests are greater than the significance level of 5%, the residual problems of heteroskedasticity and autocorrelation are absent. The Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ) demonstrated that the model is stable within a 5% significance level in long-run coefficients along with the short-run dynamics.

Table 7: Diagnostic Checks

Residual Diagnostic	*p*-value	Result
Heteroskedasticity test	0.3126	No heteroskedasticity problem
Serial Correlation test	0.8631	No autocorrelation problem
CUSUM	-	Stable
CUSUMSQ	-	Stable

The result of the Granger Causality test is tabulated in Table 8 to show the existence of the causal relationship between the dependent variable, TFR, and each of the independent variables. The p-values that are lower than 5% and 10% significance levels reject the null hypothesis of no Granger causality relationship between two variables. The result concludes that at 5% significance, URB does Granger Cause TFR while TFR does Granger Cause LINC. This shows that urbanization and income have a unidirectional relationship with fertility where the causality direction runs from urbanization to total fertility rate, and from total fertility rate to income. The unidirectional relationship between income and fertility corresponds to the study by Zulqarnain and Yusuf (2022). On the other hand, FE has a bidirectional relationship with fertility as FE does Granger Cause TFR at 5% significance and TFR does Granger Cause FE at 10% significance level. FLFP and TFR do not Granger Cause each other, which implies that the fertility rate will remain unchanged if the female labor force participation changes, and otherwise. This outcome supports the finding of Siah and Lee (2015) that women's employment has no causal relationship with fertility. The dependency of fertility on income, female education, and urbanization is in line with a study by Jemna (2015) who also concluded that a bidirectional causality existed between fertility and economic growth due to the enhancement of the socioeconomic factors such as household income, education level, and modernization.

Table 8: Granger Causality Test

Null Hypothesis	Observation	F-Statistic	Prob
LINC does not Granger Cause TFR	30	1.01877	0.3755
TFR does not Granger Cause LINC		5.21135	0.0128**
FLFP does not Granger Cause TFR	30	0.17167	0.8432
TFR does not Granger Cause FLFP		1.67671	0.2073
FE does not Granger Cause TFR	30	3.80151	0.0362**
TFR does not Granger Cause FE		3.01297	0.0672*
URB does not Granger Cause TFR	30	3.43830	0.0480**
TFR does not Granger Cause URB		1.25412	0.3027

*** indicates 5% significance, * indicates 10% significance*

CONCLUSION

The ARDL approach is applied in this study to examine the socio-demographic factors contributing to the decline of the total fertility rate in Malaysia and to examine their relationship in both the short-run and long-run. The Granger Causality test is employed to identify the causal relationship between fertility rate and income, female labor force participation, female education, household consumption expenditure, and urbanization. To avoid multicollinearity issues, household consumption expenditure is omitted from the model as it is highly correlated with income per capita. From the findings of the ARDL model, it is observed that income influenced the fertility rate positively in both the short run and long run. This finding suggests that higher income provides better access to nutritional foods, a healthy lifestyle, a clean environment, and affordable living, which in turn would increase birth and fertility rates. Female labor force participation influenced the fertility rate negatively in the short run but positively in the long run, while the reversed pattern is observed for urbanization. The result indicates that in early career development, women might refuse to have many children and defer childbearing due to work commitments. However, once they have established their career and have sufficient income, they are more ready to have more children. In terms of urbanization, there is a short-term favorable effect on the fertility rate as a result of the younger population migrating to urban areas due to better education and job opportunities. However, over time, the reversed effect on the fertility rate is observed due to the higher cost of living in urban areas than in rural areas. In other words, the higher cost of raising children in urban areas led to smaller family sizes. On the other hand, female education has a significant positive relationship with fertility rate in the short run but is insignificant in the long run. Prior research proved that female education has a significant relationship with fertility in both the short run and the long run. The inconclusive evidence from this study could be due to limitations in accessing the dataset of the most reliable proxy for women's education, which is the female tertiary school enrolment. The data of female secondary school enrolment used in this study might not be the best to represent the variable. From the Granger causality, it is found that urbanization and income have a unidirectional relationship where the causality direction runs from urbanization to total fertility rate and from total fertility rate to income. In addition, women's education has a bidirectional relationship, while female labor force participation has no causal relationship with fertility. In a nutshel, from the ARDL analysis, the national income, female employment, urbanization, and female education are among the factors that need to be focused on to uplift the national fertility rate. Female education although showing a positive short-run relationship using the ARDL model, the Granger causality test however shows that female education affected the fertility rate dually. Therefore, the effort for women's empowerment through education should be carefully designed to address the national birth and fertility rates issue.

Some policy recommendations can be offered to the Malaysian government through its agencies like the Ministry of Finance, the Ministry of Women, Family and Community Development, and the National Population and Family Development Board (LPPKN) to increase the total fertility rate. Firstly, the revision and restructuring of income tax are needed to consider more tax exemption for bigger family size, families with young children, and couples who undergo infertility treatments. Secondly, the promotion of flexible work arrangements especially for women is important to ensure work-family balance. Next, the maternity and paternity leave policies should be regularly enhanced to support new parents. In addition, clear education path and training programs should be introduced for enhancing women's empowerment skills and knowledge. Finally, development of more affordable housing options in urban areas and financial incentive for young families would be helpful and increase birth and fertility rate. These suggested interventions may also reduce the negative impact of aging population in Malaysia. Insurance corporations may work on new product development to support aged poopulation especially to secure for healthcare expenses. Private retirement scheme, retirement benefits, and pensions can also be adjusted to provide for longer term after retirement. Overall, this study may contribute to a better understanding and further research on fertility patterns in recent years by providing some insights to modify current policies or develop more effective interventions to cope with future demographic shifts.

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