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Factors Affecting Fertility – New Evidence from Malaysia

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Abstract. This research paper investigates long and short term determinants of fertility rates in Malaysia based on basic macroeconomic variables for the period 1980-2014 using Auto Regressive Distributed Lag (ARDL) method. The study reveals that over a long term period, all the selected variables (GDP, infant mortality rate, females' education and employment) have had significant and negative impact on total fertility rates. Whilst during the short term period, only the infant mortality rate has had a positive impact. Since population growth is partly determined by fertility rates, efforts to increase population in Malaysia should consider factors that affect those rates.

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1. Introduction

Demographic trends in most developing economies, including Malaysia, experienced a few decades of rapid population growth followed by slower growth as the economy advanced, which is frequently referred to as demographic transition (Gavin et al., 2009). A key feature of demographic transition is that, after an initial increase, the natural rate of population growth typically falls in association with reductions in mortality and fertility rates (Cervellati, Sunde, 2011). The most debated question is probably whether the fertility decline is primarily caused by declining mortality; or whether declining fertility is due to the rise in income and technological advancements. The earlier view is frequently linked to demographers, but the latter is mostly associated with the view of economists. Nevertheless, the debate on whether the consequence of the observed decline in fertility on population growth is beneficial or detrimental to economic growth continues (Acemoglu, Johnson, 2007; Cervellati, Sunde, 2011).

Malaysia is one of the countries whose demographic transition closely resembled the demographic trends of many Asian countries, i.e. trends including decreases in both fertility and infant mortality rates. During the period between 1960 and 2010, fertility rates in Malaysia declined from 6.3 to 2.6 live births per woman, representing a decline of 59%. The total fertility rates in Malaysia were greater than other Asian countries, such as India which recorded a 53% decline in fertility rates between 1960 and 2000. Meanwhile, the standard criteria adopted for the onset of demographic transition is a decline in fertility rate of only 10% (Masih, Masih, 2000). Narayan (2006) compares the demographic transition of Taiwan with India and China. The study found that while the demographic transition in India and China is associated with the backdrop of poor socioeconomic structures, the demographic transition in Taiwan is marked by a remarkable fall in infant mortality rates. In Malaysia, similar to Taiwan, declining fertility rates are associated with the same pattern of decline in infant mortality rates, which fell from 6.4% in 1960 to 0.5% in 2010, representing a 92% decline in infant mortality rates.

In Malaysia, studies on fertility are still very limited, especially with regards to time series frameworks investigating the main determinants affecting the trends. For instance, Mason and Palan (1981) investigate the relationship between female work and fertility using a multivariate analysis of cross sectional data from the 1974 Malaysian Fertility and Family Survey. Similarly, Ying (1992) utilises primary data to investigate the differences in fertility between the three principal ethnic groups in Malaysia (ethnic Malay, ethnic Indian and ethnic Chinese). The present study attempts to contribute to extant empirical studies on the determinants of the fertility by examining fertility rates in Malaysia. While the present study follows the theoretical explanations and methodology of Narayan (2006), a modified proxy is utilised in the present study to examine the determinants of fertility rates in the Malaysian context. Narayan (2006) utilised the labour share of females in the labour force and the secondary school enrolment of females, alongside other variables, as the main determinants of fertility rates in Taiwan. Since share of females in the labour force also includes unemployed females, which is likely to have a different implication on fertility rates, the present study utilises female employment to reflect the actual value of the opportunity cost of female employment. In addition, instead of relying only on 'sub-education' levels (i.e. secondary school), the present study extends female gross enrolment to include the gross enrolment at all education levels combined.

Moreover, no attempt has been made, thus far, to model the determinants of fertility rates using time series data through cointegration and an error correction framework in the context of Malaysia. Given the importance of fertility and its implications for population growth and economic development, it is imperative to understand the determinants of fertility changes in Malaysia over time. In light of this, the aim of this paper is to present an econometric model that examines the determinants of fertility rates in Malaysia for the period between 1980 and 2010 (1). Since various factors affect fertility rates over time, it is necessary to identify factors that have significant influences on the trend which will likely result in several policy implications.

Henceforth, the paper is organised as follows. In the next section, the Malaysian demography and economic context is surveyed, followed by a review of theoretical observations in section three. Section four elaborates on the model specification, the definition of the variables measurements and estimation procedures. Section five examines the results, followed by a presentation of the conclusions in the final section.

2. Malaysia's Demographic and Economic Context

Immediately after achieving independence in 1957, Malaysia's population grew at a relatively high rate of over 3% between the 1960s and 1970s. Based on World Bank data, the demographic trends are as follows: infant mortality rates were high, approaching 6.4% in 1960; fertility was over six children per woman; and life expectancy exceeded 59 years. Additionally, almost 30% of the population was illiterate (40% of women versus 22% of men) at the end of the 1970s. However, in recent years, the population growth rate has reduced to only 1.6%, especially in 2010 (World Bank database). The low population growth is partly due to the relatively lower reduction in the crude birth growth rate of -51% compared to reduction in the crude death growth rate of -55% during the period between 1960 and 2010. The low birth growth rate is consistent with the observed decline in fertility rates, from 6.3 to 2.6 children per woman during the same period. Fertility rates have currently approached the minimum population replacement threshold level of approximately two children per woman (Espenshade et al., 2003). Given the positive correlation between infant mortality and fertility rates, the reduction in fertility rates has led to similar reductions in infant mortality rates, from 6.43% in 1960 to 0.56% in 2010.

Demographic transition in a country is associated with evidence of female empowerment. The female gross enrolment ratio increased at all education levels, from 52.1% in 1970 to 78.4% in 2010. Additionally, the gender parity index at all education levels, combined during the same period, demonstrating a narrowing of the gap between male and female enrolment, as the index shifted from 0.93 in 1980 to 1.05 in 2005. Moreover, the average years of schooling for females over 15 increased from 0.821 to 9.920 during the period between 1960 and 2010 (Barro, Lee, 2010). Although the share of females in the labour force showed a slight improvement during the same period, from 42.9% in 1980 to 46.1% in 2010, the number of employed females increased from 1.59 million to 4.02 million between 1980 and 2010, representing a growth rate of 153%. The most important observation on female employment is that the labour share of females in the agriculture sector decreased from 43.8% in 1980 to less than 10.0% in 2010. In contrast, their labour in the manufacturing and services sectors increased from 20.0% to 23.0% and 36% to 70%, respectively, during the same period. Clearly, improvements in the education of females plays a significant role in changing the structure of female employment hence results in the shifting of female employment towards modern sectors.

Theoretically, demographic transition highlights the importance of a country's economic performance in explaining population trends. In terms of economic growth for the last 50 years (1960-2010), the Malaysian per capita gross domestic product (GDP) (constant 2000 US$) increased from US$847 to US$5365, representing a growth rate of more than 500%. The initial examination of the aforementioned socioeconomic factors appears to indicate the existence of a positive correlation between these factors and declining fertility rates in Malaysia. More specifically, decreases in infant mortality rates, improvements in the education of females and employment and economic growth may be responsible for the decrease in fertility rates.

3. Theoretical Explanation and Literature Review

Theoretically, from a demographic perspective, the decline in fertility rates is strongly correlated with declines in infant mortality rates. However, from the economic perspective, a decline in fertility rates might also be associated with other factors resulting from economic expansion and technological change. With regard to the demographic perspective, several refinements of demographic transition theory have been proposed in an attempt to explain the impact of infant mortality rates on fertility rates (Rustein, Medica, 1975; Scrimshaw, 1978; Ritcher, Adlakha, 1989). Generally, there are four possible channels through which child mortality may affect the level of fertility: biological, replacement, insurance and societal response effects (Preston, 1978; Chaudhury, 1982; El Deeb, 1988). All of these effects are positive in the sense that declines in infant mortality rates result in a decline in fertility rates. The biological effects refer to the minimisation of the period of breastfeeding, leading to an abridged postpartum amenorrhea, consequently, birth interval (Syamala, 2011). The replacement effect is the attempt of parents to have further births to compensate for the death of a child. Insurance effects, or holding effects, refer to the response of fertility rates to expected mortality rates of offspring. This response is primarily dependent upon the view of parents regarding the level of mortality in their community or country. Societal response effects are associated with the volitional behaviour of women, which stem from the prevalent cultural norms, customs and taboos within a given society (Singarimbum, Hull, 1977). In contrast, another argument exists which indicates that increasing infant mortality rates discourage child birth. In other words, increasing infant mortality rates will result in decreasing, rather than increasing, total fertility rates (Narayan, 2006; Narayan, Peng, 2006).

From the economic perspective, infant mortality rates fall due to an increase in industrialisation and urbanisation which, in turn, raises literacy and living standards and improves medical practices. The decline in infant mortality rates leads to a subsequent decline in fertility rates (Chowdhury, 1988). However, the crucial challenge for the economist is to clarify the observed negative correlation between income and fertility without abandoning the assumption of children as 'normal goods'. One common element among fertility rates is that the generally positive income effect is dominated by an accompanying negative substitution effect. Theories differ with respect to the motivation of the substitution effect. Becker (1960) contributes two theories concerning total fertility rates based upon the new household economics approach. The first theory is based upon time allocation, whereby children are considered to be more time-intensive than other consumption goods (Becker, 1960). The second theory is based upon quantity-quality trade-off preferences and argues that households prefer to substitute fertility with child expenditure as income rises (Becker, 1960; Becker, Lewis, 1973). The cost of raising a child must be weighed against the income foregone from working. The argument points to the fact that income increases tend to reduce fertility rates because rising incomes mean children are needed less as producer goods and investment goods because income increases allow greater access to capital markets.

In addition to income and infant mortality rates, other factors affect fertility rates. According to Narayan (2006), certain factors are essential to initiate a decline in fertility rates, including the participation of women in the work force, family planning, female schooling and the average age of women at first marriage. For instance, an increase in the female education level is expected to reduce fertility rates. Through education, information about family planning may encourage attempts to control childbearing via a wide range of contraceptive methods. Apart from deliberate fertility control, education may also affect the supply of living children through the provision of better health services. Education may directly change attitudes, values and beliefs toward those that are comfortable with small family norms and childrearing that is relatively costly to parents in terms of both time and money (Weinberg, 1987).

An increase in the share of females in the labour force is also likely to have a negative effect on fertility rates (Brewster, Rindfuss, 2000; Lehrer, Nerlove, 1986). Generally, female employment is argued to be inversely related to fertility due to the presumed conflict between the employment and reproductive roles of women (Becker, 1992; Rindfuss, Brewster, 1996; Standing, 1983). The conflict between the roles of mother and worker is argued to stem from the separation of the home and the workplace, the nature of employment and social norms regarding the roles of men and women (Mason, Palan, 1981; Rindfuss, Brewster, 1996). In particular, such a conflict is exacerbated during the period of childbearing (Collier et al., 1994). The inverse relationship between fertility rates and employment rates emerge when economic and social life is structured in such a way that it is difficult to combine both childbearing and employment (United Nations, 1987). Moreover, it is theoretically assumed that fertility rates among wage employees are lower than that of non-wage working women and others (Kollehon, 1984). Thus, it is crucial to examine employed females, rather than the share of females in the labour force.

4. Model Specification and Estimation Procedures

4.1. The model

In the present study, a model for the determinants of fertility rates in Malaysia has been constructed following Masih and Masih (1999, 2000); Narayan and Peng (2006); Narayan (2006); and Frini and Muller (2012) utilising the following equation:

$$\ln F_t = \beta_0 + \beta_1 \ln IM_t + \beta_2 \ln Y_t + \beta_3 \ln FE_t + \beta_4 \ln FEM_t + \omega_{it} \quad (1)$$

Where, ln is the natural logarithm, F is total fertility rate (children per woman), Y is real per capita GDP (local currency), IM is infant mortality rate (per 1,000 live births), FE is female gross enrolment at all education levels combined, FEM is the female employment, μt is the error term, t represents the time period, and β_1, β_2 β_3 and β_4 are the coefficients to be estimated. The review of the literature has indicated that several other factors affect fertility rates. Given the small sample size of the present study, incorporating too many variables is likely to have implications on the degrees of freedom, which would affect the findings (for example, Narayan, Peng, 2007; Frini, Muller, 2012). All data regarding the abovementioned variables were obtained from the World Bank Development indicators database.

4.2. Estimation procedures

The present section explains the estimation procedures utilised, which include stationary and cointegration tests. The explanation also provides justification regarding the analysis performed in the present study.

4.2.1. Stationary Test

Since the present study follows the Auto Regressive Distributive Lag (ARDL) approach, the first step is to ensure that all the variables satisfy ARDL requirements. One of the basic requirements of ARDL is that the order of the integration between the variables must not exceed one (e.g. no variables are at I(2)). If the order of integration of any of the variables is greater than one, for example I(2), then the critical bounds provided by Pesaran et al. (2001) and Narayan (2005) are not valid (Ozturk, Acaravic, 2011; Shahbaz et al., 2011). The critical bounds are computed on the basis that the variables are I(0) or I(1). For this purpose, testing for unit root is necessary to ensure that all variables satisfy the underlying assumptions of ARDL. The bounds testing approach is applied to test for cointegration before proceeding to the estimation stage. The data series is tested for stationarity using the Augmented Dickey Fuller (ADF) and Philip-Perron (PP) tests to assess the order of integration. The ADF test and the PP test are commonly used methods of investigating the presence of a unit root in single time series.

4.2.2. Cointegration Test

The present paper employs the ARDL procedure, or bounds testing procedure, proposed by Pesaran et al. (2001). ARDL has certain econometric advantages in comparison to other cointegration procedures. The advantages include its ability to (i) avoid endogeneity problems and problems associated with the inability to test hypotheses for the estimated coefficients in the long run associated with the Engle Granger method, (ii) estimate long and short run parameters of the model simultaneously, (iii) to assume all variables are endogenous, (iv) relieve the burden of pre-testing of unit roots by employing an econometric methodology, irrespective of whether the tested variables are I(0), I(1), or fractionally integrated; and (v) be applied to small samples. Recent studies suggest that estimates using either the Engle and Granger or Johansen and Juselius (1990) methods of cointegration are not robust for small sample sizes (see for example, Mah, 2000; Tang and Nair, 2002). However, Pesaran and Shin (1999) show that the bounds test procedure is robust in small sample sizes.

The ARDL modelling approach was originally introduced by Pesaran and Shin (1999) and later extended by Pesaran et al. (2001). Basically, the ARDL approach to cointegration involves two steps for estimating long run relationships (Pesaran et al., 2001). The first step is to investigate the existence of a long run relationship among all variables in the equation under estimation, which is generally known as the bounds test. If there is an evidence of long run relationships (cointegration) between variables, the second step is to estimate the long and short run models.

Thus, the bound test is applied to unrestricted error correction model (UECM) frameworks in Equation (1). Here, it is important to recognise that it is possible and practical in the ARDL approach to consider all the variables as dependent variables. However, because the specific objective of the present study is to examine the main determinants of the total fertility rate, the fertility rate variable is only of interest when considered as a dependent variable. According to the Pesaran et al. (2001), the UECM framework derived from Equation (1) takes the following form:

$$\Delta \ln F_t = a_1 + \sum_{i=1}^{p} \beta_1 \Delta \ln F_{t-i} + \sum_{i=0}^{p} \beta_2 \Delta \ln IM_{t-i} + \sum_{i=0}^{p} \beta_3 \Delta \ln Y_{t-1} + \sum_{i=0}^{p} \beta_4 \Delta \ln FE_{t-i} + \sum_{i=0}^{p} \beta_5 \Delta \ln FEM_{t-1} + \delta_1 \ln F_{t-1} + \delta_2 \ln IM_{t-1} + \delta_3 \ln Y_{t-1} + \delta_4 \ln FE_{t-1} + \delta_5 \ln FEM_{t-1} + \omega_i \quad (2)$$

Where all the variables are previously defined, Δ is the first difference operator, p is optimal lag length, the residuals are assumed to be normally distributed and white noise. In this equation, the F-test is utilised to examine whether long run equilibrium relationships exist between the variables by testing the significance of the lagged level variables. In the process of testing it is important to determine the cointegration of the variables in order to identify the order of the lags on the first differentiated variables. Bahmani et al. (2000) suggests that the results of the first step are usually sensitive to the order of the VAR. Thus, the present study imposes different lags order on the first difference of each variable for the stated equation and computes the F-statistic for the joint significance of the lagged level of variables. The computed F-statistics for each order of lags, together with the critical value of the F-tests, are used for testing for the existence of long run relationship. The H0 of no cointegration is given by $\delta_i = 0$.

The F-test has a non-standard distribution that depends on (i) whether the variables included in the model are I(0) or I(1); (ii) the number of regressors; and (iii) whether the model contains an intercept and/or a trend. Given the relatively small sample size in the present study (31 observations), the critical values used are as reported by Narayan (2005), which are based upon small sample sizes between 30 and 80. Two sets of critical values are generated: one set refers to the I(1) series and the other to the I(0) series.

Critical values for the I(1) series are referred to as the upper bound critical values, while the critical values for I(0) series are referred to as the lower bound critical values. If the F-test statistics exceed their respective upper critical values, evidence of a long run relationship between the variables exists, regardless of the order of integration of the variables. If the test statistics are below the lower critical values, the null hypothesis of no cointegration cannot be rejected. If the test statistics lie between the bounds, a conclusive inference cannot be made without knowing the order of integration of the underlying regressors. In the event the F-statistic falls between the lower bound and the upper bound critical values, considering the t-test corresponding to the ECT is recommended. If the value of the F-statistic is negative and significant, the result suggests the existence of cointegration among the variables (Bannerjee et al., 1998; Mosayeb, Mohammad, 2009).

The second step is only performed if a long run relationship is found to exist in the first step (Marashdeh, 2005). If either the F-statistics or the t-tests of the ECT_{-1} show evidence of a long run relationship (cointegration) between the variables in the above equation, the next step is to estimate the long and short run relationships. Theoretically, if a long run relationship exists between the variables, an error correction representation exists as well. The existence of a cointegration relationship implies that the selected explanatory variables are the long run forcing variables for the dependent variables (Pesaran, Pesaran, 1997). Equation 3, below, represents the long run model:

$$\ln F_t = a_1 + \sum_{i=1}^{p} \alpha_1 \ln F_{t-1} + \sum_{i=0}^{p} \alpha_2 \ln IM_{t-i} + \sum_{i=0}^{p} \alpha_3 \ln Y_{t-i} + \sum_{i=0}^{p} \alpha_4 \ln FE_{t-i} + \sum_{i=0}^{p} \alpha_5 \ln FEM_{t-i} + \omega_{it}. \quad (3)$$

In the third and final step, we obtain the short run dynamic parameters by estimating an error correction model (ECM) associated with the long run estimates in Equation 3 above. Thus, from equation 3, the ECM specification takes the following form:

$$\Delta \ln F_t = \phi_1 + \sum_{i=1}^{p} \gamma_1 \Delta \ln F_{t-i} + \sum_{i=0}^{p} \gamma_2 \Delta \ln IM_{t-i} + \sum_{i=0}^{p} \gamma_3 \Delta \ln Y_{t-i} + \sum_{i=0}^{p} \gamma_4 \Delta \ln FE_{t-i} + \sum_{i=0}^{p} \gamma_5 \Delta \ln FEM_{t-i}$$
$$+\theta\, ECT_{t-1} + \upsilon_{1t} \quad (4)$$

Here γ_{th} are the short run dynamic coefficients of the model's convergence to equilibrium and θ is the speed of adjustment. To ascertain the goodness of fit of the ARDL model, relevant diagnostic tests and stability tests are conducted.

5. Results and Discussion

5.1. Unit Root Test

The results of the tests shown in Table 1 indicate that the null hypothesis (H_0 = the series has a unit root) cannot be rejected as levels (I(0)) for all variables are at 1% and 5% significance level, except for female education (FE) and female employment (FEM) in which the null hypothesis is rejected.

Table 1. Unit root test-Variables at level (I(0))

Variables	With trend		Without trend	
	ADF	PP	ADF	PP
LnF	-2.04 [0.54]	-3.00 [0.14]	-1.25 [0.64]	2.75 [1.00]
LnY	-1.57 [0.78]	-1.58 [0.70]	-0.60 [0.86]	-0.60 [0.86]
LnIM	-2.25 [0.64]	-2.25 [0.64]	-7.86*** [0.000]	-7.86*** [0.000]
LnFE	-3.62** [0.042]	-3.62** [0.042]	-1.55 [0.50]	-1.08 [0.71]
LnFEM	-3.01 [0.14]	-3.01 [0.14]	-1.88 [0.34]	-1.88 [0.34]

Explanation: (***) and (**) indicate significance at 1% and 5%levels, respectively. Figures in brackets represent the p value.

Source: author's calculation

Nevertheless, the difference of the remaining variables is stationary at I(1), as indicated in Table 2. Therefore, the null hypothesis is rejected and subsequently, it is possible to conclude that all variables are integrated at different orders, i.e. I(0) and/or I(1).

Table 2. Unit root test-Variables at first difference

Variables	With trend		Without trend	
	ADF	PP	ADF	PP
LnF	0.88 [0.99]	0.82 [0.99]	-2.99** [0.041]	-3.09** [0.031]
LnY	-4.42*** [0.001]	-4.42*** [0.001]	-4.50*** [0.001]	-4.50*** [0.001]
LnFEM	-6.35*** [0.000]	-14.21*** [0.000]	-5.88*** [0.000]	-6.66*** [0.000]

Explanation:(***) and (**) indicate significance at the 1% and 5% levels, respectively. Figures in brackets represent the p value.

Source: author's calculation

The results of the unit root tests, either at level or at first difference, suggest the absence of I(2) variables among those selected, which is preconditioned using the ARDL framework. Thus, the results of the unit root test affirm the need to test for cointegration among these variables. The next step is to test whether a long run relationship exists between the variables.

5.2 Cointegration Test

To test whether a long run relationship exists between the variables, Equation (2) is utilised to estimate the different lags length by computing the F-statistics. Table 3 shows that a long run relationship exists between the variables under lag two, where the F-statistics reject the null hypothesis of no cointegration between the variables. Pesaran and Pesaran (1997) argue the existence of cointegration implies that selected explanatory variables are long run forcing variables for the dependent variable. In the present case, it is possible to conclude that the long run forcing variables for fertility in Malaysia during the period between 1970 and 2010 include all of the underlying variables: economic growth, infant mortality, female education and female employment.

Table 3. Bound tests Results

Lag length	The F-statistic	Conclusion
1	3.20	No cointegration
2	6.22**	Cointergration exists
3	2.31	No cointegration

Explanation: a – The lower/upper critical value for the F-test (unrestricted intercept and no trend) with four variables (k=4) are (5.33-7.06) (3.71-5.02) and (3.008-4.15) with 1%, 5% and 10% significance levels, respectively; b – The critical value is obtained from Narayan (2005) p. 1988.; c – (**) denotes significance at the 5% level.

Source: author's calculation

Since the cointegration relationship is detected, the next step is to examine the pattern of the long and short run relationships among the variables. The long run effect of the independent variables on economic growth is obtained using the ARDL procedure indicated in Equation (3). To test for robustness, the ARDL analysis will be estimated using both the Schwarz Bayesian Criterion (SBC) and the Akaike Information Criterion (AIC). The results in Table 4 show that both criteria (SBC and AIC), suggest evidence of the robustness of the analysis since the two tests produce identical results.

The results from the table indicate that a 1% increase in infant mortality rates is expected to reduce fertility rates by approximately 22% in the long run. The result is in sharp contrast to the expected positive influence of the infant mortality rates on fertility rates, as discussed in extant literature. Although the findings of Narayan (2006) and Narayan and Peng (2007) demonstrate the negative influence of infant mortality rates on fertility rates in the cases of Taiwan and Japan, respectively, the influence appears statistically insignificant. However, Narayan and Peng (2006) and Frini and Muller (2012) find significant and positive impacts of infant mortality rates on total fertility rates in China and Tunisia, respectively. The mixed findings may be due to the differences in (i) the methodology issues (ii) the time period covered by respective studies and (iii) variations regarding the proxies used as determinants affecting fertility rates. The best explanation, in relation to the present case examining Malaysia, is that increasing infant mortality rates may discourage having more children, as suggested by Narayan (2006) and Narayan and Peng (2006).

Table 4. Long run relationship for dependent variable LnF

Explanatory variables	SBC ARDL(2,2,2,0,0)	AIC ARDL(2,2,0,2,0)
LnIM	-0.22 [2.68] **	-0.22 [2.68] **
LnY	-0.08 [2.12] **	-0.08 [2.12] **
LnFE	-0.30 [2.14] **	-0.30 [2.14] **
LnFEM	-0.60 [4.71] ***	-0.60 [4.71] ***
constant	8.44 [6.48] ***	8.44 [6.48] ***
Diagnosis tests		
Serial Correlation	1.33 (0.26)	1.33 (0.26)
Functional Form	1.85 (0.19)	1.85 (0.19)
Normality	0.81 (0.67)	0.81 (0.67)
Heteroskedasticity	0.04 (0.84)	0.04 (0.84)
CUSUM	Stable	Stable
CUSUMSQ	Stable	Stable

Explanation: a – Serial correlation is the F- statistics of Breusch-Godfrey serial correlation LM test. B: Functional form is F- statistics of Ramsey's RESET test using the square of the fitted values. Normality is LM-statistics of skewness and kurtosis of residuals for normality test. Heteroskedasticity is F-statistics of white Heteroskedasticity test. CUSUM; Cumulative Sum of Recursive Residuals is the stability test of the long run coefficients together with the short run dynamics, based on Pesaran and Pesaran (1997). CUSUMSQ; Cumulative Sum of Squares of Recursive Residuals is the stability test of the long run coefficients together with the short run dynamics; b – The absolute value for t-statistic in [ ] and probability for F-statistic in ( ); c – (***) and (**) denotes significance at the 1% and 5% levels, respectively.

Source: author's calculation

The results also show that the elasticity of fertility rates, with respect to income, is negative and statistically significant in the long run. More specifically, an increase in income by 1% is expected to reduce fertility rates by approximately 10% in the long run. The findings support the note made by Becker (1960), who points out that an increase in incomes will tend to reduce fertility rates because rising income means children are needed less as producer goods and investment goods because increased income allows greater access to capital markets. In addition, the results also support the findings of Narayan and Peng (2006) in the case of China. However, these findings contrast with those of Firin and Muller's (2012), which detect the significant and positive impact of per capita income on fertility rates in Tunisia.

As previously reported in the Table (4), female education has a negative and statistically significant impact on total fertility rates in the long run. The result indicates that a 1% increase in the female gross enrolment at all education levels combined is likely to reduce total fertility rates by approximately 30%. The finding confirms previous observations on the negative relationship between female education and fertility rates. In Malaysia, the decreasing trends in fertility rates during the period between 1970 and 2010 are associated with an increase in the gross enrolment ratio of females at all education levels combined, from 50% in 1970 to 76% in 2010. The finding is similar to those of Narayan (2006); Narayan and Peng (2006; 2007) who found a negative correlation between female education and fertility rates in the cases of Taiwan, China and Japan.

Female employment variables appear to be the most influential variable over the fertility rates in Malaysia in the long run, at the 1% level. The results show that a 1% increase in female employment will result in an approximately 60% decrease in the total fertility rates over time. The finding is consistent with the fact the tendencies or opportunities to have children decline as women devote more time to work. In Malaysia, although the share of females in the labour force show a slight increase from 42 to 46% during the period 1980-2010, female employment figures increase by 153% between 1980 and 2010, from 1.59 to 4.02 million.

Previous studies also found similar results for other countries. e.g. Masih and Masih (1999) show that a 1% increase in the share of female in the labour force reduced fertility rates by 0.05% in Thailand, whilst Narayan and Peng (2006) found that the same increase mentioned previously reduced fertility rates in China by approximately 1.4% in the long run. Furthermore, Narayan (2006) and Narayan and Peng (2006) arrived at the same conclusion, in which a 1% increase in the share of females in the labour force is expected to reduce fertility by 80% and 1.37% each in the long run in the case of Taiwan and China, respectively. In Malaysia, the multivariate analysis of the 1974 Malaysian Fertility and Family Survey conducted by Mason and Palan (1981) found that an inverse relationship between women's work and fertility occurred only when there were serious conflicts between working and caring for children. The results from the diagnosis tests suggest that the model passes all necessary tests. Specifically, the normality test cannot reject the null hypothesis since the estimated residuals are normally distributed and the standard statistical inferences (i.e. t-statistic, F-statistic, and R-squares) are valid. Moreover, the results for the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) also indicate that the regression coefficients are generally stable over the study period. The stability of the CUSUM and CUSUMQ also provide further evidence of the robustness of the model.

The short run analysis is reported in Table 5, obtained by estimating Equation 4. The results show that 99% of the variation in the total fertility rates in Malaysia is explained by the selected explanatory variables. Moreover, all underlying explanatory variables have a significant impact on fertility rates, as reflected by the significance level of F-statistic values. The impact of each selected variable on fertility rates is marginal in the short run, irrespective of sign, compared with long term results. Two important observations have been made in relation to the above results. First and contrary to findings in relation to China (Narayan, Peng 2006), an increase in infant mortality rates will result in a decrease in fertility rates over time in Malaysia. Second, an increase in the infant mortality rates will result in an increase in fertility rates in Malaysia in the short term.

The findings imply that, in the short run, an increase in infant mortality rates will lead to an increase in fertility rates due to the replacement effect. However, such an increase in infant mortality rates will lead to a decrease in total fertility rates, as infant mortality rates may discourage attempts to have children. The principal distinctions between the present study and that by Narayan and Peng (2006) examining China are (i) the use of different methodological approaches, as Johansen (1988) and Johansen and Juselius (1990) procedures are employed in the case China, (ii) the study in China covers the period between 1952 and 2000, and (iii) the utilisation of different proxies as determinants of total fertility rates.

Table 5. The Short Run Analysis for the dependent variable ΔLnF

Explanatory variables	SBC ARDL(2,2,2,0,0)	AIC ARDL(2,2,0,2,0)
$\Delta LnIM_t$	0.02 [1.35]	0.02 [1.35]
$\Delta LnIM_{t-1}$	0.03 [2.24] **	0.03 [2.24] **
ΔLnY_t	-0.003 [2.10] **	-0.003 [2.10] **
$\Delta LnFE_t$	-0.01 [2.05] **	-0.01 [2.05] **
$\Delta LnFEM_t$	-0.008 [2.16] **	-0.008 [2.16] **
$\Delta LnFEM_{t-1}$	0.007 [2.66] **	0.007 [2.66] **
Constant	0.32 [6.35] ***	0.32 [6.35] ***
ECM_{-1}	-0.04 (11.18) ***	-0.04 (11.18) ***
R^2	0.99	0.99
R^{-2}	0.99	0.99
F-statistic	523.24 (0.000) ***	523.24 (0.000) ***

Explanation: a - .The absolute values for t-statistics are in [ ], and the probability values for F-statistics are in ( ); b - (***) and (**) denotes significance at the 1% and 5% levels, respectively.

Source: author's calculation

The explanation regarding the long run effects of income and female education on fertility rates is essentially the same. The only difference is that the impact of female education on fertility rates is marginal in the short run when compared with long run effects. The findings of short run significant impacts of income and female education on fertility rates support the findings of Masih and Masih (1999); Narayan and Peng (2006); Narayan (2006); Narayan and Peng (2007); and Firin and Muller (2012) in the cases of Thailand, China, Taiwan, Japan and Tunisia, respectively. The second observation relates to the marginal impact of female employment on fertility rates. The results show that a one time lag increase in female employment is expected to boost fertility rates, but the current increases in female employment are likely to reduce total fertility rates. In this regard, the one time lag positive impact of female employment on fertility rates reflects an adjustment period. In other words, the expected negative impact of female employment on fertility rates takes a longer period to manifest itself in a decrease in fertility rates, as shown in the long run results presented in Table 4.

The most important finding relates to the coefficient of the lagged error term (ECM_{-1}). The negative sign and the magnitude of this coefficient reported by both criteria (SBC and AIC) suggests a low rate of adjustment for fertility variables in the long run equilibrium relationship. The coefficient of -0.04 implies that if fertility rates deviate from the long run relationship in the current year, the chosen explanatory variables interact together and, on average, correct 0.04% of the disequilibrium in the following year. Furthermore, the significance of the ECM_{-1} coefficient shows evidence of causality in at least one direction.

Since the examination of the pattern of the long run causality relationship between the variables is also of interest, the Wald-test for the non-causality relationship is applied in Equation (4), following Ozturk and Acaravci (2011); Odhiambo (2009); and Shahbaz *et al.* (2011). The null hypothesis (H0) for the test is as follows:

$$\gamma_2 = \theta = 0; \gamma_3 = \theta = 0; \gamma_4 = \theta = 0; \gamma_5 = \theta = 0 \quad (5)$$

The rejection of the null hypothesis implies the existence of a strong long run causality relationship running from a particular variable to fertility rates. Table 6 shows that in a strong causality relationship flows between each of the underlying explanatory variables and fertility rates (F) in the long run.

Table 6. Wald test for long run causality relationship

The Null hypothesis	SBC	AIC
ΔLnY;ECM-1→ΔlnF (H0; $\gamma_2 = \theta = 0$)	125.10*** [0.000]	125.10*** [0.000]
ΔLnIM; ECM-1→ΔlnF (Ho: $\gamma_3 = \theta = 0$)	130.2*** [0.000]	130.2*** [0.000]
ΔLnFE; ECM-1→ΔlnF (Ho: $\gamma_4 = \theta = 0$)	125.27*** [0.000]	125.27*** [0.000]
ΔLnFEM; ECM-1→ΔlnF (Ho: $\gamma_5 = \theta = 0$)	126.94*** [0.000]	126.94*** [0.000]

Explanation:a - probability value of F-statistic in [ ]; b - (***) denotes significance at the 1% level.

Source: author's calculation

5.3. Variance Decomposition Analysis

A variance decomposition (VD) analysis reveals the percentage of forecast error variance for each variable that is due to its own innovations and shocks to the other system variables. The variance decompositions utilised in the present study are estimated by disturbing each underlying variable in the estimated system by one standard deviation. Following the disturbance, the forecast error variance of any variable is decomposed into the proportion attributed to each of the random shocks. Table 7 shows the variance decomposition up to 10 years for the model under examination. The table shows that, on average, over a 10-year horizon, approximately 33% of the variations in the forecast errors for fertility rates can be explained by innovations to the fertility rates. A shock in income and female employment explains, on average, 34% and 76% of the variance in fertility rates, respectively. The most important observation is that the power of shock in fertility rates to explain the variance in fertility rates diminishes over time. In other words, 86% of the variation in fertility rates is attributed to shocks to fertility rates after two years (short term). However, only 33% of such variation is explained by shocks to fertility after 10 years (long term), with the remaining 67% being explained jointly by all explanatory variables. From the policy implication point of view, the findings suggest that economic growth, infant mortality rates, female employment and education jointly explain a large proportion of fertility rates in Malaysia in the long run. As a whole, the results of the long run analysis, long run causality and the variance decomposition analysis are consistent and support each other.

Table 7. Variance decomposition analysis

Horizon	LF	LY	LR	LEM	LGR
0	1.00000	0.029020	0.043133	0.44499	0.031764
1	0.92225	0.017963	0.084432	0.63542	0.073652
2	0.86004	0.028849	0.081367	0.73825	0.070669
3	0.76369	0.066186	0.048960	0.78227	0.043196
4	0.65252	0.12395	0.029404	0.80607	0.030434
5	0.55383	0.18517	0.017657	0.80673	0.023825
6	0.47792	0.23879	0.011272	0.79694	0.020591
7	0.42312	0.27852	0.0074276	0.78540	0.018519
8	0.38477	0.30611	0.0051353	0.77701	0.017477
9	0.35686	0.32496	0.0036106	0.76977	0.016470
10	0.33469	0.33969	0.0026022	0.76216	0.015384

Source: author's calculation

6. Conclusion

The principal objective of the present study is to investigate the main determinants of total fertility rates in Malaysia during the period between 1980 and 2014. The underlying variables used in the present study are per capita GDP; infant mortality rate; and female employment and education. The variables are selected based upon a review of extant literature and utilised to explain the fertility rates in Malaysia using the ARDL procedure. The results show that all selected variables have statistically negative impacts on total fertility rates in the long run. Meanwhile, the analysis shows that Granger causality exists between the variables and total fertility rates in the short run, with the exception of female employment. The Wald test for causality relationships detects strong long run causality relationships running from each of the underlying variables to fertility rates.

The overall findings of the study indicate that demographic and socioeconomic factors are the main source of the observed declining trend in total fertility rates in Malaysia. In regard to demographic factors, improvements made in the provision of health care services and decreases in infant mortality rates, have significantly reduced fertility rates. Whilst with regards to socioeconomic factors, increases in income; education enrolment of females; and female employment reduce the fertility rates in Malaysia. Thus, if Malaysia aims to increase the size of its population, special policies must be designed to encourage an increase in family size, for instance by restructuring the tax for households with relatively large family sizes; offering child benefits; and providing childbearing and childrearing assistance for employed women. Nonetheless, further studies are needed to explain whether the decline in fertility rates is also attributable to other factors. Specifically, further factors to be considered in relation to fertility rates should include the impact of abortions; the mean age of marriage among women; the use of contraception; poverty; and urbanisation, as such factors are considered as possible determinants in previous studies.

Note

(1) Although the data on the fertility rate; infant mortality rate; per capita income; and female education are only available for Malaysia since the 1960s, the data on share of females in the labour force and female employment is only available from 1980.

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