# Relationship between demography and economic growth from the islamic perspective: a case study of Malaysia

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# Relationship between demography and economic growth from the islamic perspective: a case study of Malaysia

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**Abstract**: There have been various theoretical and empirical studies which analyze the relationship between demography and economic growth using different methodologies, which led to different results, interpretations and continuous debates. Demography as a statistical study of human population, has a significant impact on economic growth given certain area and period of time. This paper aims to include some of Islamic theory of demography and socio economics especially regarding family planning issue, along with other commonly used theories and bring them into the investigation of the long- and short- run relationship among demographic and socioeconomic variables in developing countries. Malaysia is used as a case study. This study, therefore, attempts to unravel the causality direction of demography and economic growth. We used annual data for the total fertility rate and infant mortality rate to represent demography, per capita gross domestic product and consumer price index to represent economic growth, and female labor participation along with female enrollment to secondary education percentage as links between demography and economic growth. Based on standard time series analysis technique, our findings tend to indicate the importance of female enrollment to education in finding a balance in the demography-growth nexus. The finding is important for the policymakers to choose the most suitable framework to model the economy related to changes in demography, health and fertility, education and labor employment.

**Keywords**: Demography, economic growth, VECM, VDC, Malaysia

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## 1. Introduction

Demography is a scientific study of the changing number of births, deaths, diseases, aging, migrations etc. in a community over a period of time. (Oxford Advanced Learner's Online Dictionary, 2015) In Greek, the term "*demos*" means "the people" and "*grapho*" means "description or measurement". Both these words have joined together to form the word "demography." The term "demography" is different from "population" in the sense that demography is the science of population. Demographers seek to understand population dynamics by investigating three main demographic processes: birth, migration, and aging (including death).

The Muslim population around the world are most likely to represent a certain understanding of demography regarding fertility among women, female education and female decision to participate in the labor work force rather than staying at home to raise children. The Islamic teaching followed by a significant number of Muslims around the world which sees family planning and birth control as a taboo, yet many Muslims in more developing countries are more open to accept family planning, birth control, and to let their female counterparts to further their studies in higher education and then participate in adding value to their house hold income.

This paper is an humble contribution to the debate about the relationships among demographic and socio-economic variables based on two theoretical point of view. Most Islamists believe both demographic and economic growth should have a positive relationship, while Malthusian model suggest a negative relationship.

We try to detect empirical evidence of these relationships in the Malaysian case, using a standard time series methodology and data of total fertility rate, infant mortality rate, gross domestic product, female labor participation and female education.

The main demographic indicators in most developed countries have changed in the last decades. The total fertility rate has dramatically decreased while the life expectancy has increased. The two factors have determined a significant deceleration in the speed of population's growth and have also altered the population's age structure, moving towards an aging population. The study is a small attempt to give an added value to the whole study in demography. Recent publications in the demography field indicates that the issue of ageing population has become a serious major concern among the demographers nowadays.

Malaysia is forecasted to have an ageing population by 2030 when 15% of its population are elderly. While in the mean times, studies show inadequacy of savings among the elderly and Malaysian households headed by the elderly experienced high incidence of poverty at 22.7%.[1]

The identification of the relationships between demographic, socio-economic and female accomplishment variables is fundamental to be able to assess and be ready to confront the consequences of these structural demographic changes in the future.

The aim of this paper is to provide an additional time series econometric evidence on the short run as well as the long run time series behaviour of demographic indicators and the economic growth for Malaysia. With the objective to research the relationships among these variables, we use the standard time series econometric tools. The complex interactions among the variables involved in fertility decisions suggest a modelling approach that allows all the variables to be endogenous, as in multivariate time series analysis. As for the causal treatment of non-stationary data, the key variables in fertility studies are either trended or follow long swings characteristic of non-stationary processes that must be differenced to become stationary.

The various views on the relationship between female education, female labor participation, infant mortality, fertility and economic growth do not explicitly define whether these variables should be treated as endogenous or exogenous to their models. Through Vector Error Correction Model technique in a multivariate analysis, we can clearly identify cointegration relationship and error correction terms, and distinguish between exogenous and endogenous variables.

The empirical discussion on the dynamic relationship between demographic indicators, female accomplishment and economic growth has yielded miscellaneous results. In this study, we also seek if causality exists along with the existence of common trends in the long run.

Economic-policy implications may vary depending on whether the changes in fertility rates are caused by changes in per capita gross domestic product or, vice versa. It is also important to specify the endogeneity or exogeneity nature of the variables to develop a theory that explains the economic growth especially in a more global environment today.

The conclusions drawn from the study of the time series, guide us to the best theoretical model to truly represent the economy: a model where both the economic growth and fertility rate are

[1] UNESCAP Report

determined by the female enrollment to education, or a model where the economic growth is determined by the quality of the population.

The structure of this paper is organized as follows. In the second section, we discusses a brief of the economic theories of fertility and reviews the main empirical studies. In Section 3, we present Muslim scholars' opinion regarding some related controversies on demography including family planning and female education. In Section 4, we briefly explain on the data used in the research and the methodology applied. Then in Section 5, we present the results of the empirical studies on stationarity of the variables, cointegration, causality, vector error correction models and the dynamics of the models based on the theoretical aspects. Finally, we conclude in section 6.

## 2. Literature Review

Most academic research done to explain the relationship between demographic and economic growth were based on a classical Malthusian model which was written by Malthus, T. R. (1798). The model highlights two main ideas which are the existence of some factor of production, such as land, which is in fixed supply, implying decreasing returns to scale for all other factors; and a positive effect of the standard of living on the growth rate of population. We could see, most of the governments around the world dealing with the problem of poverty, unemployment and economic underdevelopment in the country formulate their policies based on Malthusian model.

Becker, G. S. (1960) from "New Home Economics" who founded a theory on economic demography suggest that the fertility rate is a consequence of the demand for children. When price of children change, a positive income effect and a negative substitution effect must exist. As the result, factors affecting this price, specially female wages, become the main variables to predict the fertility behaviour.

A study written on the case of China and India by Lozeau, B. (2007) suggest that population growth can have several effects on the economic expansion and performance of a country. He found that both countries enjoy the same factor endowment, which is a large labour force, but it is the technological progress of the Chinese that has allowed them to better sustain the population growth of the last few decades and increase their per capita income.

While Abdul Fattah, F. et al (2012) empirical test result on China, Indonesia and Malaysia analyzed the relationship between demography and economic growth shows that fertility rate

jointly with civil liberty are positively related to economic growth, but have no significant effects on these developing nations. They found that the persistence of high fertility rate with element of greater openness are found to be significantly stimulating GDP in Indonesia.

While a study done by Alam S. (2003) on the case of Pakistan shows that in the short-run, the necessary condition of fertility decline may require an affordable but persuasive 'planned' family-planning program, few years of schooling, particularly female, supported by the political and social elite at all levels of that society, and adapting the socio-cultural realities of the vast masses of the people of that country.

As to test the significance of infant mortality rate on economic growth, Parr, N. & Ross, G's (2014) research applied on Australia shows the considerable social cost, in terms of the loss of discounted consumption per capita of improvements in mortality. While the effect of fertility, however, is rather inconclusive due to very sensitive to assumptions about the age-specific consumption needs of the population.

A wider range of empirical study done by Gobalasingham, K. (2013) on 150 countries found that the female literacy rate had a high impact on infant mortality rate, while GDP per capita is not significant to infant mortality rate.

The debate on female labor participation and female education's effect on both fertility and gross domestic product per capita is seen relevant to this study. Birdsall, N. (1998) concluded that an increase in education level translates into an increase in per capita income which has a negative correlation with fertility rates. She also finds through an empirical study that female education of over four years is has most consistent negative relationship to the fertility. But later, Lozeau (2007), finds that while education level is also shown to have a positive correlation with gross domestic product (GDP), the case of China and India shows a different scenario even though both enjoy a large labour force. Within the sphere of education, it is the gender gap in education that has hurt economic growth in India.

A similar study on demography-growth nexus done by Climent, F. & Meneu, R (2003) using the same methodology on Spain data sample, shows that total fertility rate response directly to a gross domestic product shock.

## 3. Family Planning from Islamic Perspective

As to begin the study, we would like to include several fundamentals regarding demographic expansion based on Islamic theoretical point of view. In the Holy Quran, Allah the Almighty revealed, "Kill not your children because of poverty – We provide sustenance for you and for them."[2] This Quranic verse indirectly indicates a positive relationship between demography and economic growth, as related to sins that been practiced by the Arabs society before Islam to kill their children for fear of poverty.

In a Hadith narrated by Ma'qil ibn Yasar, a man came to the Prophet (Peace be upon Him) and said: I have found a woman of rank and beauty, but she does not give birth to children. Should I marry her? He said: No. He came again to him, but he prohibited him. He came to him third time, and he (the Prophet) said: Marry women who are loving and very prolific, for I shall outnumber the peoples by you."[3] The hadeeth indicates the teaching of Prophet Muhammad that one of the main purposes of marriage between a male and a female is to have children and to expand the society and nation.

In Al-Hibri, A. Y. (1993) works on Family Planning from Islamic Jurisprudence Perspective, she stressed that Islam values the family and encourages procreation. But, some Muslims have concluded from these facts that Islam does not permit family planning. But their argument does not do justice to the complexity of the Islamic position and the totality of its teachings as to explain the established fact that the Prophet knew that some of his companions, including his cousin Ali, practices *al-'azl*[4] and yet he did not prohibit the practice.

Al-Ghazali (d. 1111) is one of the prominent classic scholar who propose family planning, yet he views that it is *makruh*[5] if practiced to avoid, for example, female offspring. He also supports contraception for reasons including protecting a woman from the dangers of childbirth, avoiding poverty, and even preserving a woman's beauty.

But yet, Islam does not prohibit family planning and birth control. There is a continuous debate among the Shariah scholars on this issues. A moderate view by Al-Banna, H. (1937) who attempt to balance between two extreme views among groups of scholars who view either

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[2] The Holy Qur'an, Surah Al-An'am 6: 151)
[3] Sunan Abu Dawud, Volume II, Chapter 12
[4] *Al-'azl* means coitus interruptus.
[5] *Makruh,* adjective meaning "disliked or disfavored". In Islamic Jurisprudence means, it is disfavored by the Shari'ah.

prohibition of family planning completely or to strictly control the number of birth and limit the number of children per family. He sees that based on Islamic teachings and texts, Islam encourages reproduction among humans, but scientific findings show that women who give a frequent birth will produce weak offspring. By controlling and planning birth will result stronger children. He suggested that an optimal gap between births is two years, so that the newborn will get enough nutrition from breastfeed to grow. A family still be able to continue reproducing and follow a family planning regime in the same time.

The International Islamic Fiqh Academy Fifth Conference (1988) concluded a few policy on family planning:

1. It is not permissible to any government to make a public law abridging the freedom of couples of childbearing.
2. Male and female sterilization to prevent pregnancy permanently are not permitted in Islam, except in the fatal cases confirmed through medical measures.
3. It is permissible to use temporal contraceptive method intended to space between periods of pregnancy, or stop it for a certain period of time if there is a need based on Shariah approval, according to the estimate of the married couple for mutual consultation and agreement, without any negative consequences, using only contraception methods legitimated by Shariah, and endanger existing pregnancy.

Al-Hibri, A. Y. (1993) mentioned that Islam permits a family to plan its growth rationally in order to avoid poverty, but this permission should not be distorted so as to discourage or deny poorer people or less technologically developed countries their right to propagation.

We can conclude that Islam encourage all Muslims – male and female - to further their studies and careers to the highest level as possible to make a successful living. But, in the meantime, they should not do anything that would harm their married life.

## 4. Empirical Model, Data Collection & Methodology

The demographic and macroeconomic variables used in the empirical analysis are: yearly data of the Total Fertility Rate (TFR), the Infant Mortality Rate (IMR), the Female Labor Participation (FLP), the Female Enrolment to Secondary Education (FSE) and the real per capita Gross Domestic Product (GDP).

| Variables | Description | Data Source |
|---|---|---|
| GDP | GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. | World Bank national accounts data, and OECD National Accounts data files. |
| TFR | Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates. | (1) United Nations Population Division. World Population Prospects,<br>(2) United Nations Statistical Division. Population and Vital Statistics Report (various years),<br>(3) Census reports and other statistical publications from national statistical offices,<br>(4) Eurostat: Demographic Statistics,<br>(5) Secretariat of the Pacific Community: Statistics and Demography Programme, and<br>(6) U.S. Census Bureau: International Database |
| IMR | Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year. | Estimates developed by the UN Inter-agency Group for Child Mortality Estimation (UNICEF, WHO, World Bank, UN DESA Population Division) at www.childmortality.org. |
| FLP | Labor force participation rate, female (% of female population ages 15+) (national estimate). Labor force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labor for the production of goods and services during a specified period. | International Labour Organization, Key Indicators of the Labour Market database. |
| FSE | Total female enrollment in secondary education, regardless of age, expressed as a percentage of the female population of official secondary education age. GER can exceed 100% due to the inclusion of over-aged and under-aged students because of early or late school entrance and grade repetition. | UNESCO Institute for Statistics |

*Table 1. Variables, descriptions and data sources.*

The methodology starts with the unit root tests of each variables using Augmented Dickey Fuller and Phillips-Perron techniques. The purpose of these test is to ensure that the data are fit to follow the required steps for the chosen model. The initial objective of the test is to affirm that the variables are non-stationary in the level form and stationary in the difference form. For the

stationary test, on the level form, only the GDP and CPI variables are expressed in logarithmic terms while other variables has already in their percentage values. Given the period and the frequency of the sample, the number of observations to carry out the study is quite small making the the cointegration technique seems to loses power. The Schwartz-Bayesian Criterion (SBC) and Akaike Information Criterion (AIC) are used to determine the optimal number of lags included in the test.

Second, the Granger causality test to examine a contrast if a variable causes or helps to predict better another one, based on Vector Autoregressive models (VAR). This technique investigates the interactions across the data, expressed as logarithmic differences, with the past values of the same variable and with those of the rest of variables. The detected causality relationships in the multivariate environment refers to a short run time horizon; then, we proceed to the study of the long run relationships to complete the analysis.

Third, we test the existence of cointegration relationship based on the Granger for the multivariate environment, among the six demographic and economic variables. The purpose of determining if two or more variables are following parallel growth paths, that is, if they present common trends in the long run. Then we used Johansen-Juselius Cointegration Test method that treats the estimation and test problems in cointegrated systems in a context of maximum likelihood under the normality assumption. This strategy is tested on the principle of the likelihood ratio, with the purpose of not only discerning if cointegration exists, but also to determine the cointegration range.

The purpose of the cointegration analysis is to examine the long-run theoretical or equilibrium relationship and to rule out spurious relationship among variables. What is behind this concept is the existence of economic forces that impede persistent deviations from the long run equilibrium conditions, although deviations can be observed in the short run. Most of the times, Economic theory suggests the existence of long run relationships among variables, although they can fluctuate individually outside of the equilibrium during some time. The economic models indicate that certain forces act to restore equilibrium and, therefore, some long run relationship should exist among the groups of variables.

Next, for the Fourth step, we apply Long Run Structural Model (LRSM) technique by subjecting the cointegrating estimated vectors to exactly identifying and over-identifying restriction based on the theory.

The Fifth step, if the previous tests shows a positive sign and found the existence of cointegration, Vector Error Correction Model (VECM) is estimated. VECM incorporates parameters that allow us to analyze the causality relationships without incurring in a specification error. We test the significance of the error correction term, using the weak exogeneity test to the significance, individually and combined, of the lagged explanatory variables, determining the short run causality among the time series.

For the Sixth step, using Vector Decomposition (VDC) technique, we rank the variables according their endogeneity and exogeneity condition, and their relative strength.

Finally, the dynamic properties of the multivariate system are investigated using the Impulse-Response Function (IRF) and Persistence Profile (PP) approaches. Both techniques are designed to map out the dynamic response path of a variable due to shock on another variable and give the information about how long it will take for the system to get back to equilibrium by using a system-wide shock.

## 5. Discussion of Empirical Results

### 5.1 Unit Root Test

#### 5.11 Augmented Dickey-Fuller Test:

| Variable | SBC | T- Statistic | Critical Value | Result |
|---|---|---|---|---|
| LGDP | 29.7858 | -2.165 | -3.5867 | Non-Stationary |
| TFR | 21.0441 | -1.970 | -3.5867 | Non-Stationary |
| IMR | -30.1156 | -1.376 | -3.5867 | Non-Stationary |
| FLP | -47.1609 | -2.935 | -3.5867 | Non-Stationary |
| FSE | -69.7232 | -2.089 | -3.5867 | Non-Stationary |

*Table 2: ADF Test results for variables in the level form.*

| Variable | SBC | T- Statistic | Critical Value | Result |
|---|---|---|---|---|
| ΔLGDP | 28.8417 | -4.8265 | -2.9798 | Stationary |
| ΔTFR | 19.0099 | -3.7276 | -2.9798 | Stationary |
| ΔIMR | -29.4944 | -5.2974 | -2.9798 | Stationary |
| ΔFLP | -47.8427 | -5.0182 | -2.9798 | Stationary |
| ΔFSE | -68.000 | -3.7186 | -2.9798 | Stationary |

*Table 2: ADF Test results for variables in the difference form.*

From the ADF Test, the results in Table 2 suggest that all the variables non-stationary at the level form and are integrated of order one i.e. stationary after first difference.

### 5.1.2 Phillip-Perron Test

| Variable | T- Statistic | Critical Value | Result |
|---|---|---|---|
| LGDP | -2.4352 | -3.5562 | Non-Stationary |
| TFR | -2.8866 | -3.5562 | Non-Stationary |
| IMR | -2.7034 | -3.5562 | Non-Stationary |
| FLP | -4.5259 | -3.5562 | Stationary |
| FSE | -1.5857 | -3.5562 | Non-Stationary |

*Table 3: Phillip-Perron Test result for variables in level form.*

| Variable | T- Statistic | Critical Value | Result |
|---|---|---|---|
| ΔLGDP | -9.3249 | -2.9798 | Stationary |
| ΔTFR | -8.7828 | -2.9798 | Stationary |
| ΔIMR | -6.1983 | -2.9798 | Stationary |
| ΔFLP | -7.3961 | -2.9798 | Stationary |
| ΔFSE | -4.9507 | -2.9798 | Stationary |

*Table 4: Phillip-Perron Test result for variables in difference form.*

The PP Test result suggest that all variables are non-stationary on their level forms except FLP. On the other hand, one their difference forms, all variables are stationary.

### 5.2 Optimal Lag Order of the VAR

Table 5 is the result of the optimal lag order selection. VAR order of 1 is selected based on the highest AIC.SBC is showing the same result of VAR order. Given a relatively small sample size (33) and the use of annual data, a lag length of 6 is used in the bounds test. Although Pesaran and Shin (1999) actually suggest a maximum of 2 lags, we have proceeded with 6 instead. The results of the bound test are given in Table 5. The critical values used in this paper are extracted from Narayan (2004).

| **Order** | **AIC** | **SBC** |
|---|---|---|
| 6 | 17.2674 | 10.3479 |
| 5 | 18.0141 | 11.7236 |
| 4 | 18.4800 | 12.8186 |
| 3 | 19.0951 | 14.0627 |
| 2 | 18.9997 | 14.5964 |
| **1** | **19.7201** | **16.9358** |
| 0 | 19.7152 | 16.5799 |

*Table 5: VAR order selection test.*

| Order | AIC | SBC | p-Value | Critical Value |
|---|---|---|---|---|
| 1 | **19.7201** | **16.9358** | [.402] | 5% |

### 5.3 Cointegration Test

#### 5.3.1 Johansen Method

| **Null** | **Alternative** | **Statistic** | **95% Critical Value** | **90% Critical Value** |
|---|---|---|---|---|
| **r = 0** | **r = 1** | **38.2443** | **37.86** | **35.04** |
| r<= 1 | r = 2 | 21.3963 | 31.79 | 29.13 |
| r<= 2 | r = 3 | 13.4763 | 25.42 | 23.1 |
| r<= 3 | r = 4 | 11.72 | 19.22 | 17.18 |
| r<= 4 | r = 5 | 5.3851 | 12.39 | 10.55 |

*Table 6: Maximum Eigenvalue Statistic Test.*

| Null | Alternative | Statistic | 95% Critical Value | 90% Critical Value |
|---|---|---|---|---|
| **r = 0** | **r>= 1** | **90.2220** | **87.1700** | **82.88** |
| r<= 1 | r>= 2 | 51.9777 | 63.0000 | 59.16 |
| r<= 2 | r>= 3 | 30.5814 | 42.3400 | 39.34 |
| r<= 3 | r>= 4 | 17.1052 | 25.7700 | 23.08 |
| r<= 4 | r = 5 | 5.38510 | 12.3900 | 10.55 |

*Table 7: Trace Statistic Test.*

Table 6 shows the Maximum Eigenvalue and Table 7 shows the Trace test, both from the Johansen & Juselius (1990) for the variables. Both statistic results reject the null hypothesis of no cointegrating equation. The null hypothesis of r = 0 is rejected at 5% significant level. This indicate the existence of a single cointegrating vector in the model, confirming the presence of a long-run stable linear equilibrium relationship among the variables.

### 5.4 Long Run Structural Model

| Variables | Panel A | Panel B |
|---|---|---|
| **LGDP** | .19745<br>( .41393) | -.0000<br>(*NONE*) |
| **TFR** | **1.000**<br>**(*NONE*)** | **1.000**<br>**(*NONE*)** |
| **IMR** | .059581<br>( .016664) | .057812<br>( .016573) |
| **FLP** | - .039367<br>( .022886) | - .049972<br>( .019038) |
| **FSE** | .026202<br>(0.0060611) | .024515<br>( .0059942) |
| **TREND** | .060068<br>( .021606) | .075415<br>( .0059175) |
| **LR Test Restriction Result** | | CHSQ(1) =<br>.51158 [ .474] |

*Table 8: LRSM exact- and over-identification test result*

Long Run Structural Model (LRSM) technique used to estimate theoretical cointegrating relation by imposing exact-identifying and over-identifying restrictions on those long-run relations based on theories and information found relevant for the studies.

For exact identification, TFR is treated as dependent variable being the focus of the study to determine its responsiveness on the changes on the GDP and other variables. The result of the exact identification is given in Panel A as Table 8.

Based on the result from exact-identification test, we restrict LGDP variable in over-identification test, which is not significant in previous identification test. As the result, p-value is more than 5%, indicate the null of the restriction cannot be rejected.

The LRSM test indicates LGDP variable is not significantly depending on TFR variable for long-run cointegration.

### 5.5 Vector Error Correction Model

| | **ΔGDP** | **ΔTFR** | **ΔIMR** | **ΔFLP** | **ΔFSE** |
|---|---|---|---|---|---|
| **Serial Correlation** | 2.2529<br>[.133] | 1.3383<br>[.247] | 1.3527<br>[.245] | 2.1753<br>[.140] | .50238<br>[.478] |
| **Functional Form** | 1.3901<br>[.238] | 1.3067<br>[.253] | .85215<br>[.356] | .0074717<br>[.931] | .20587<br>[.650] |
| **Normality** | 3.6401<br>[.162] | .82773<br>[.661] | 8.0002<br>[.018] | .62766<br>[.731] | 56.2290<br>[.000] |
| **Heteroscedasticity** | 3.4094<br>[.065] | 1.3803<br>[.240] | 2.5384<br>[.111] | .058183<br>[.809] | 1.1308<br>[.288] |
| **ECM(-1)** | -1.0478 | -1.1636 | -4.0218 | 2.3240 | .098960 |
| **P Values** | [.303] | [.254] | [.000] | [.027] | [.922] |
| **Interpretation** | **Exogenous** | **Exogenous** | **Endogenous** | **Endogenous** | **Exogenous** |

*Table 9: Error Correction Model test result.*

Error Correction Model technique used to determine the exogeneity and endogeneity of the corresponding dependent variables. The error correction term stands for the long-term relations among the variables in which at least one of the error correction term should be significant for the validity of the cointegrating relationship. The equation is insignificant when the P-Value is greater than 5%, implies that the corresponding dependent variables of suggested equation is exogenous[6]. If the equation is significant, or the P-Value is less than 5%, it implies that the corresponding

[6] Exogenous variable means the variable does not depend on the deviations of other variables. It is a leading variable among others.

dependent variable is endogenous[7]. It suggests that to bring about the long-term equilibrium among the cointegrating variables, the dependent variable bears the burden of short-run adjustment.

The P-Values from the result of the ECM test shows that ΔGDP, ΔTFR and ΔFSE are exogenous, while ΔIMR and ΔFSE are endogenous.

The diagnostic test for serial correlation, functional form and heteroscedasticity shows a healthy equation. However, both endogenous variables, ΔIMR and ΔFSE, might have normality problem. It means that the data set is not well-modeled by a normal distribution, and most likely it is not normally distributed for a random variables underlying. The problem occurred, most probably, due to the small size of data set.

Overall, the result above implies the need of other technique to achieve our study's objective, which to determine the relationship between gross domestic product and fertility rate. While ECM test implies that both variables, including the third variables observed, i.e. female education, are jointly exogenous, their degree of exogeneity and ranks are still unsolved.

### 5.6 Variance Decomposition Analysis

Variance Decomposition Analysis of Forecast Errors (VDC) consisted of Generalized and Orthogonalized Variance Decomposition techniques. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. In another word, using the analysis we can rank the variables based on their rate of exogeneity as to determine which variable leads others and which variables are the followers. The relative exogeneity or endogeneity of a variable can be determined by the proportion of the variance explained by its own past. The most exogenous variable of all is deemed to be explained mostly by its own shocks (and not by others).

[7] Endogenous variable means the variable does depend on the deviations of other leader variables. It is a follower variable among others.

### 5.6.1 Generalized Variance Decomposition

| Horizon | Variables | LGDP | TFR | IMR | FLP | FSE | Total |
|---|---|---|---|---|---|---|---|
| 1 | **LGDP** | 98.59% | 2.14% | 40.44% | 10.83% | 4.15% | 156.15% |
| | **TFR** | 3.37% | 98.74% | 31.37% | 0.49% | 5.06% | 139.03% |
| | **IMR** | 36.64% | 44.79% | 84.03% | 7.28% | 1.82% | 174.56% |
| | **FLP** | 13.01% | 2.89% | 0.96% | 93.88% | 2.24% | 112.97% |
| | **FSE** | 2.47% | 2.56% | 2.13% | 0.003% | 99.99% | 107.18% |
| 5 | **LGDP** | 95.40% | 0.82% | 38.50% | 7.71% | 6.53% | 148.96% |
| | **TFR** | 3.06% | 94.11% | 33.98% | 2.18% | 10.62% | 143.94% |
| | **IMR** | 29.54% | 54.16% | 64.18% | 13.02% | 3.77% | 164.66% |
| | **FLP** | 11.58% | 10.08% | 0.49% | 78.30% | 7.36% | 107.81% |
| | **FSE** | 2.40% | 2.34% | 2.07% | 0.001% | 99.97% | 106.80% |
| 10 | **LGDP** | 94.40% | 0.49% | 37.92% | 6.86% | 7.21% | 146.89% |
| | **TFR** | 3.06% | 94.11% | 33.98% | 2.18% | 10.62% | 143.94% |
| | **IMR** | 28.06% | 55.64% | 60.17% | 14.10% | 4.27% | 162.23% |
| | **FLP** | 11.07% | 12.48% | 0.35% | 73.08% | 9.05% | 106.03% |
| | **FSE** | 2.38% | 2.28% | 2.05% | 0.001% | 99.96% | 106.70% |
| 25 | **LGDP** | 93.71% | 0.26% | 37.52% | 6.27% | 7.69% | 145.44% |
| | **TFR** | 3.00% | 93.20% | 34.42% | 2.51% | 11.65% | 144.77% |
| | **IMR** | 27.17% | 56.52% | 57.76% | 14.75% | 4.57% | 160.76% |
| | **FLP** | 10.70% | 14.20% | 0.25% | 69.34% | 10.27% | 104.76% |
| | **FSE** | 2.37% | 2.24% | 2.04% | 0.001% | 99.96% | 106.62% |
| 50 | **LGDP** | 93.46% | 0.18% | 37.37% | 6.06% | 7.86% | 144.93% |
| | **TFR** | 2.98% | 92.86% | 34.58% | 2.63% | 12.03% | 145.08% |
| | **IMR** | 26.87% | 56.81% | 56.96% | 14.96% | 4.67% | 160.28% |
| | **FLP** | 10.56% | 14.83% | 0.21% | 67.97% | 10.71% | 104.29% |
| | **FSE** | 2.37% | 2.23% | 2.04% | 0.001% | 99.96% | 106.60% |

*Table 10: Generalised forecast error variance decomposition.*

| Horizon | LGDP | TFR | IMR | FLP | FSE |
|---|---|---|---|---|---|
| **1** | 4 | 3 | 5 | 2 | 1 |
| **5** | 4 | 3 | 5 | 2 | 1 |
| **10** | 4 | 3 | 5 | 2 | 1 |
| **25** | 3 | 4 | 5 | 2 | 1 |
| **50** | 3 | 4 | 5 | 2 | 1 |

*Table 11: Variables exogeneity ranking based on generalized forecast error variance decomposition.*

Based on previous VECM test result, the generalized forecast error decomposition gives us another insight on our quest in finding an answer to determine demography-growth nexus. The early horizons, i.e 1, 5 and 10 years, implies FSE as the most exogenous variable, followed by FLP and FSE. These variables, respectively are representing demography. While LGDP ranked as follower to those three demographic variables. At 25 and 50 years horizon, FSE and FLP remain the top exogenous variables, followed by LGDP as second runner-up. TFR was ranked at fourth place before IMR.

These result indicates that economic variables depends on demographic variables on short term. But, in long term relationship, TFR depends on LGDP.

### 5.6.2 Orthogonalized Variance Decomposition

| Horizon | Variables | LGDP | TFR | IMR | FLP | FSE | Total |
|---|---|---|---|---|---|---|---|
| 1 | **LGDP** | 98.59% | 0.48% | 0.15% | 0.30% | 0.48% | 100.00% |
| | **TFR** | 3.37% | 95.37% | 0.20% | 0.41% | 0.65% | 100.00% |
| | **IMR** | 36.64% | 32.33% | 22.17% | 3.40% | 5.47% | 100.00% |
| | **FLP** | 13.01% | 5.06% | 1.13% | 78.16% | 2.65% | 100.00% |
| | **FSE** | 2.47% | 1.77% | 0.04% | 0.001% | 95.59% | 100.00% |
| 5 | **LGDP** | 95.40% | 1.55% | 0.49% | 0.98% | 1.58% | 100.00% |
| | **TFR** | 3.14% | 92.21% | 0.75% | 1.50% | 2.41% | 100.00% |
| | **IMR** | 29.54% | 41.86% | 8.72% | 7.62% | 12.27% | 100.00% |
| | **FLP** | 11.58% | 14.48% | 0.54% | 64.03% | 9.38% | 100.00% |
| | **FSE** | 2.40% | 1.60% | 0.03% | 0.001% | 95.81% | 100.00% |
| 10 | **LGDP** | 94.40% | 1.89% | 0.60% | 1.19% | 1.92% | 100.00% |
| | **TFR** | 3.06% | 91.06% | 0.95% | 1.89% | 3.05% | 100.00% |
| | **IMR** | 28.06% | 43.46% | 6.37% | 8.47% | 13.64% | 100.00% |
| | **FLP** | 11.07% | 17.53% | 0.43% | 59.34% | 11.63% | 100.00% |
| | **FSE** | 2.38% | 1.55% | 0.03% | 0.002% | 95.87% | 100.00% |
| 25 | **LGDP** | 93.71% | 2.13% | 0.67% | 1.34% | 2.16% | 100.00% |
| | **TFR** | 3.00% | 90.21% | 1.09% | 2.18% | 3.52% | 100.00% |
| | **IMR** | 27.17% | 44.41% | 4.97% | 8.98% | 14.46% | 100.00% |
| | **FLP** | 10.70% | 19.72% | 0.35% | 55.99% | 13.25% | 100.00% |
| | **FSE** | 2.37% | 1.52% | 0.02% | 0.002% | 95.91% | 100.00% |
| 50 | **LGDP** | 93.46% | 2.21% | 0.70% | 1.39% | 2.24% | 100.00% |
| | **TFR** | 2.98% | 89.89% | 1.15% | 2.29% | 3.69% | 100.00% |
| | **IMR** | 26.87% | 44.73% | 4.51% | 9.15% | 14.74% | 100.00% |
| | **FLP** | 10.56% | 20.52% | 0.32% | 54.76% | 13.84% | 100.00% |
| | **FSE** | 2.37% | 1.51% | 0.02% | 0.002% | 95.93% | 100.00% |

*Table 12: Orthogonalized forecast error variance decomposition.*

| Horizon | LGDP | TFR | IMR | FLP | FSE |
|---|---|---|---|---|---|
| **1** | 1 | 3 | 5 | 4 | 2 |
| **5** | 2 | 3 | 5 | 4 | 1 |
| **10** | 2 | 3 | 5 | 4 | 1 |
| **25** | 2 | 3 | 5 | 4 | 1 |
| **50** | 2 | 3 | 5 | 4 | 1 |

*Table 13: Variables exogeneity ranking based on orthogonalized forecast error variance decomposition.*

The orthogonalized forecast error variance decomposition, on the other hand, implies LGDP as the most exogenous variable during the first year horizon. It is followed by FSE, TFR, FLP and IMR. But then, starting from the horizon of 5 to 50 years, LGDP ranked second most exogenous behind FSE. TFR ranked third, FLP fourth and IMR last.

The policy implications from these result suggest the importance of female education on economic growth for the long run. A shock on economic growth will result significant impact on total fertility rate and female labour participation.

## 5.7 Impulse Response Function

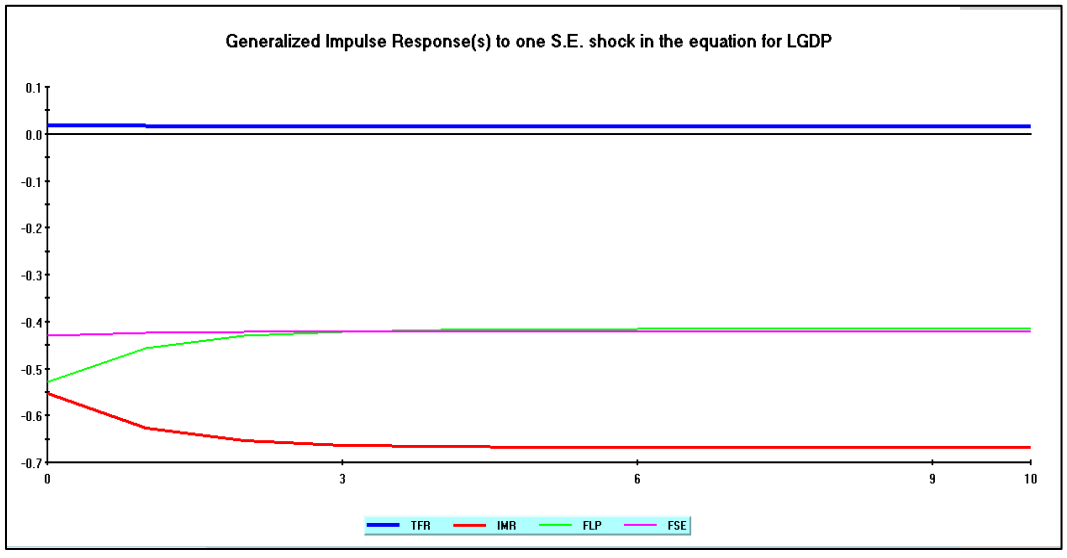

*Figure 1: Shock of LGDP on other variables (10 years period).*

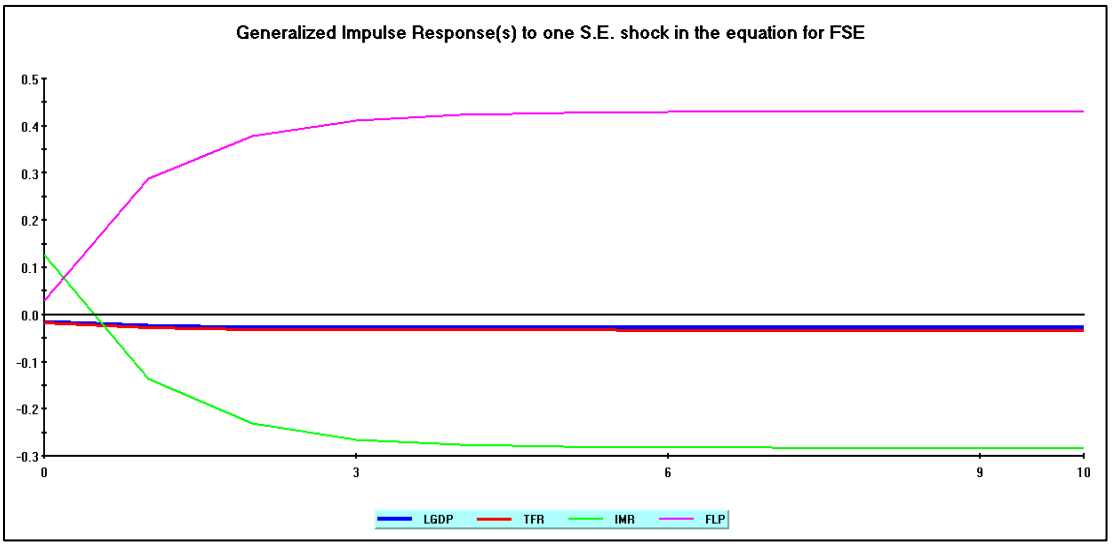


*Figure 2: Shock of FSE on other variables (10 years period).*

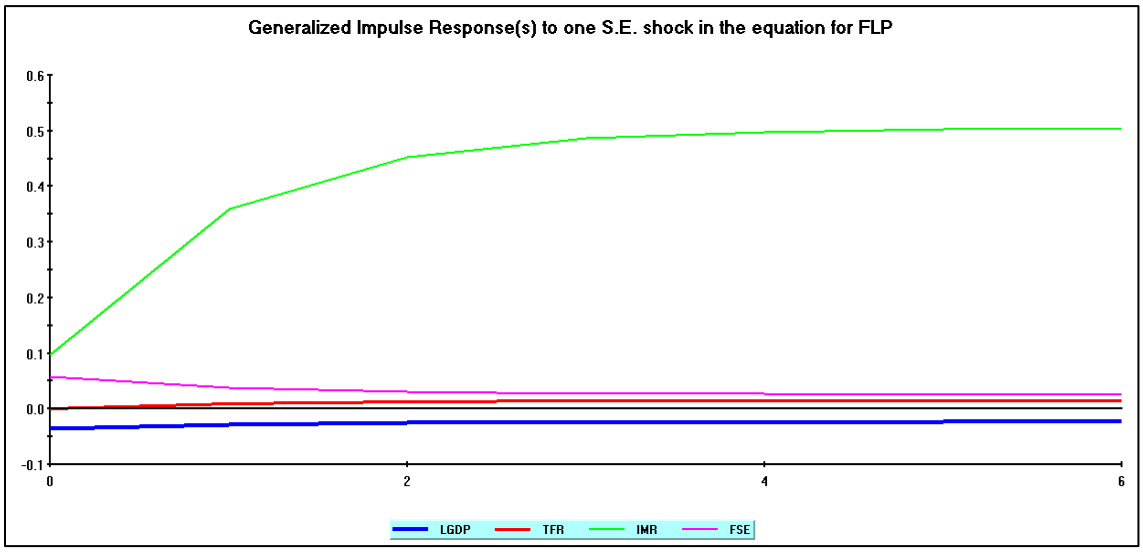


*Figure 3: Shock of FLP on other variables (6 years period).*

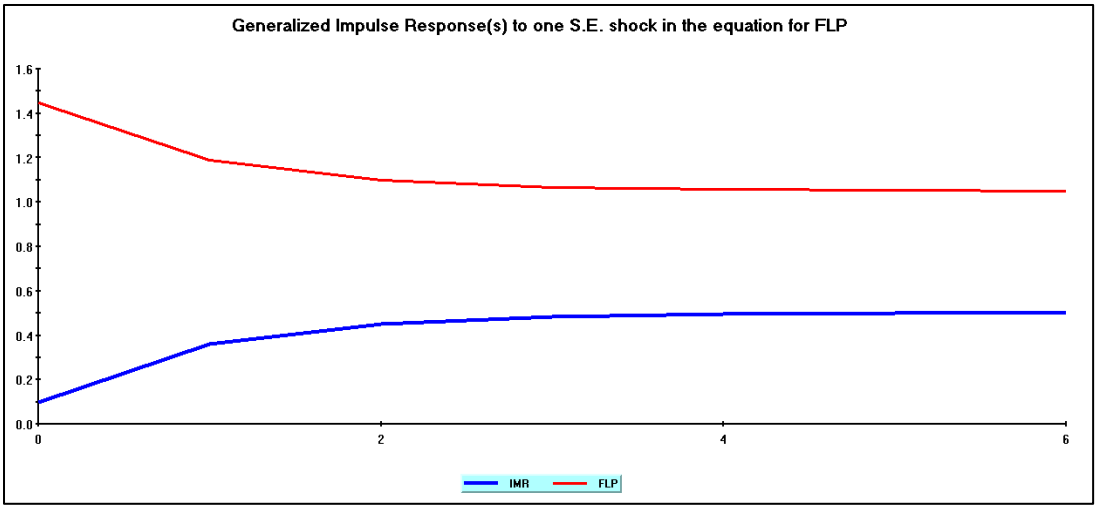


*Figure 4: Shock of FLP on IMR and FLP (6 years period).*

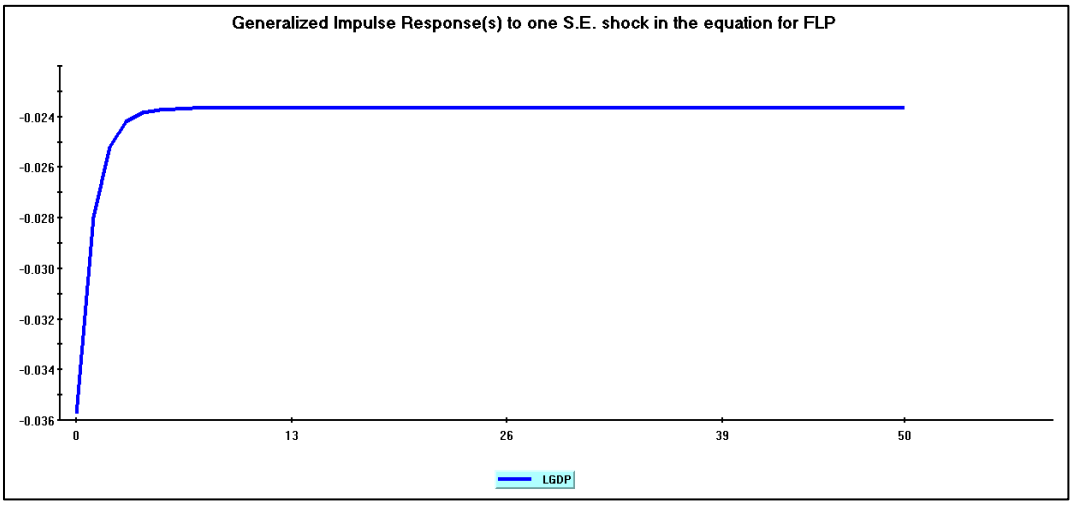


*Figure 5: Shock of TFR on LGDP (50 years period).*

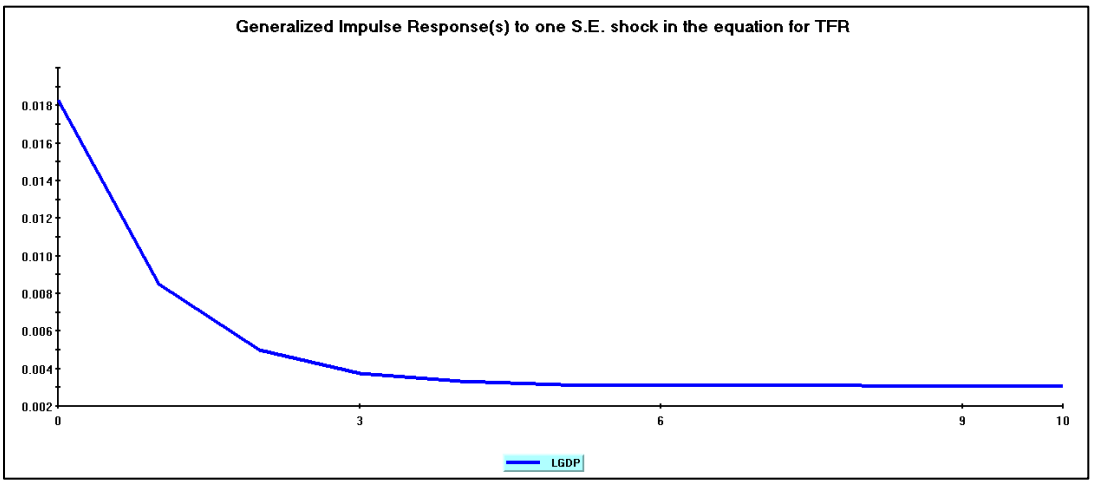


*Figure 6: Shock of TFR on LGDP (10 years period).*

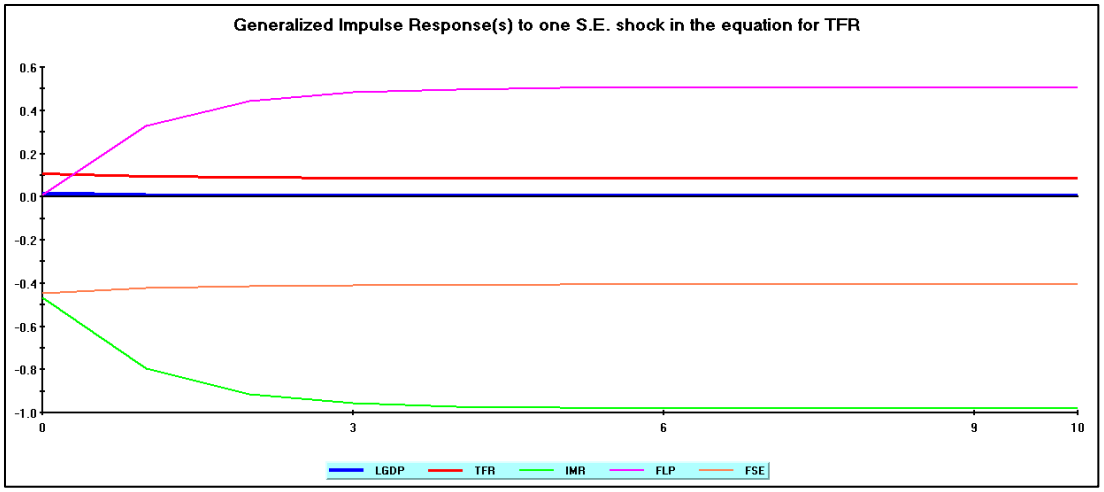


*Figure 7: Shock of TFR on other variables (10 years period).*

Based on Impulse Response Function analysis, we find out that shock on LGDP will result an increase on FLP and decrease on IMR during the first year before it goes to equilibrium. The shock however, does not have significant effect on other variables.

Shock on FSE on the other hand, shows a significant impact on FLP where it would has a positive impact while IMR line would have a decay.

A shock on FLP, would increase IMR, and LGDP in the same time. While, a shock on TFR will result a negative impact on LGDP and IMR, but a positive impact on FLP.

## 5.8 Persistence Profile

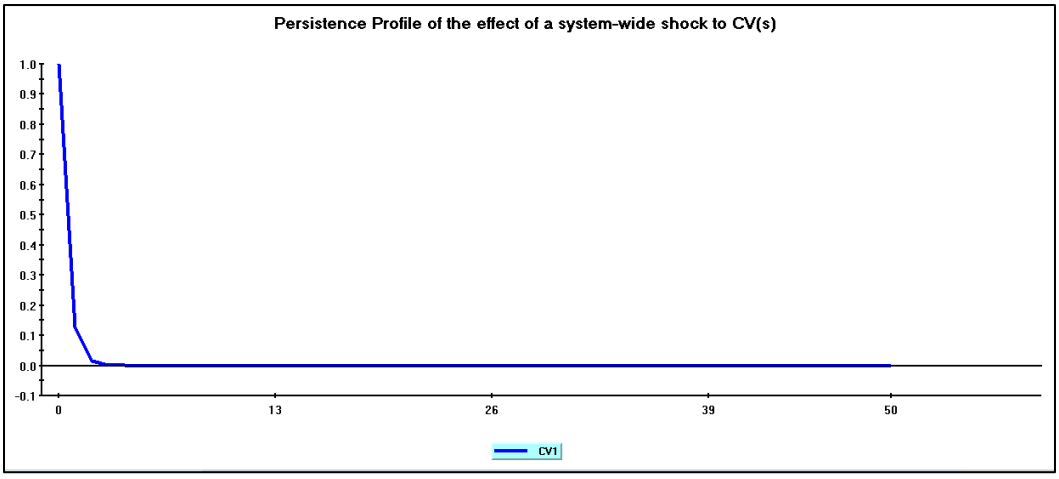


*Figure 8: Persistence profile (50 years period).*

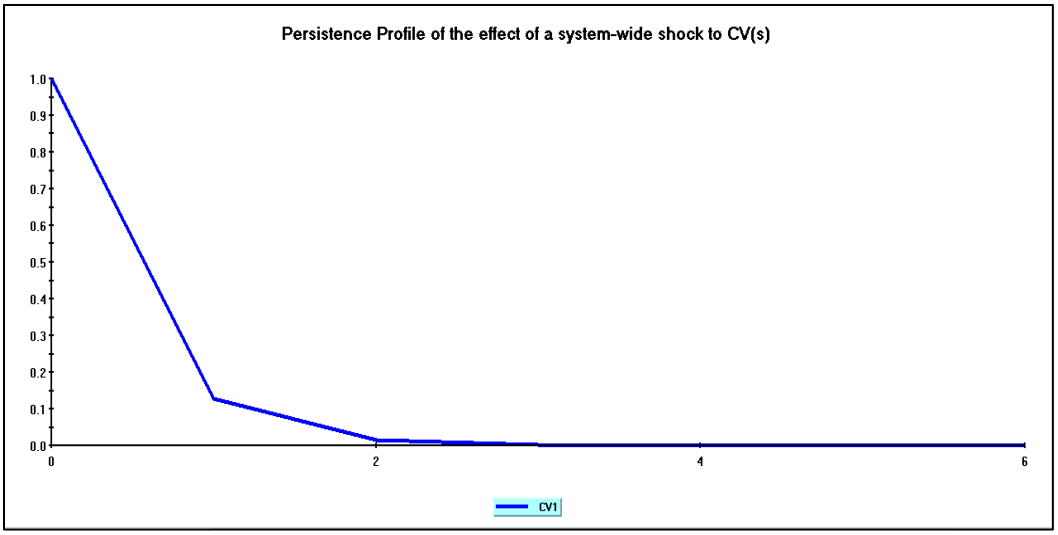


*Figure 8: Persistence profile (6 years period).*

The persistence profile shows the situation when the entire cointegrating equation is shocked widely. The result implies the time it would take for the shocked relationship to get back to equilibrium. The long-run relations is the focus instead of any specific variable. Figure 8 shows the persistence profile for the cointegrating relationship of our study. It shows that it would take approximately two years for the whole estimate to return to the equilibrium after a system-wide shock.

## 6. Conclusion and suggestion for future research

This work attempt an investigation on the demographic-growth nexus using gross domestic products per capita, total fertility rate, infant mortality rate, female participation in labour and female enrollment to secondary education, as the variables. The used Malaysian case, during the period of 1980-2012. In short, the existence of long run equilibrium relationships among them is studied, in a univariate and multivariate environment. At the same time, the endogenous or exogenous nature of the variables is examined, using a vector error correction model that considers the relationships in the short run and long run previously detected in the cointegration analysis.

The results can be summarized as follows: first, the existence of a long run relationship among the variables is statistically verified. Second, economic growth and female enrollment to education share the same result which are a positive impact on female labour participations and negative impact on infant mortality rate. Third, female labour participations however will benefit the economic growth but would result an increase on infant mortality rate. Lastly, total fertility

rate will enhance female participation in labour force, but a negative impact on GDP, even though female participation in the labour market would increase the economic growth.

The main findings of our study is the exogeneity character of female enrollment to education, gross domestic product per capita and total fertility rate. While the female education is the strongest independent variables among others in the demographic-growth nexus.

The policy implication of our analysis is the importance of female education to keep the long-term equilibrium of relationship between demographic and economic variables. Malaysia seems to maintain the economic growth, but in the same time preserving the fertility rate, as long as the policy makers give sufficient attention on the national education sector, especially for females. It is concluded that the balance between economic growth and demographic projections are determined by the quality of the population through female enrollment to the education.

Future works is suggested to expand the study on the relationship between the study and the emerging of ageing population in Malaysia. The issue has been the most concerned topic among the demographers around the globe.

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