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Fertility in Sixty-Four Developing and Developed Countries: The Role of Financial Development

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Abstract

This study examined the relationship between financial development and fertility in 64 countries between 2001 and 2015. This comprehensive analysis allowed inputs for development planning. The dynamic panel GMM analysis was used to develop models for fertility-financial development analysis, controlling for other variables, such as per capita income, infant mortality rate, female education, and urbanization. Results showed that financial development has a non-linear inverted U-shaped relationship with total fertility rate in developing countries, but a non-linear U-shaped association in developed countries. Based on the findings, this study offers some imperative policy recommendations.

Keywords

Financial development; fertility; non-linear relationship; dynamic panel GMM analysis; developing and developed countries

Introduction

Fertility levels have been declining steadily since the 1960s in most developing countries when they started to introduce family planning programs. However, fertility levels remained high in Africa. Globally, fertility rates had declined from an average of five children per woman in the period 1950-1955 to 2.5 children between 2010 and 2015 (United Nations, 2017). Fertility decline occurred concurrently with rapid financial development. The 'remarkable' increase in household purchasing power and financing consumption has led to the rapid growth of credit and inter-temporal trade for households and firms (Filoso & Papagni, 2015). Growth in international trade has increased the production of skill-intensive high-tech industrial products (Zakaria, Fida, Janjua & Shahzad, 2016), affecting the demand for labor, which in turn resulted in a decline in fertility rates.

Many past studies have suggested financial development has a significant impact on fertility rates (Basso, Bodenhorn & Cuberes, 2014; Boldrin, De Nardi & Jones, 2005; Cigno & Rosati, 1992; 1996; Filoso & Papagni, 2015; Habibullah, Farzaneh & Din, 2016; Idris, Habibullah & Din, 2018; Lehr, 1999; Lim, Lai & Tang, 2019; Rammohan, 2001; Steckel, 1992; Zakaria et al., 2016). The inverse relationship between financial development and fertility is well established (Basso et al., 2014; Boldrin et al., 2005; Lehr, 1999; Rammohan, 2001; Steckel, 1992; Zakaria et al., 2016). However, Idris, Habibullah, and Din (2018) postulated that financial development has different effects on fertility. Leibenstein (1957) and Becker (1960) suggested a link between consumer behavior and childbearing, and whereby the demand for children depends on the utility and cost incurred in having an additional child. According to consumer behavior theory, an increase in income corresponds with improved living standards, and this, in turn,

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leads to an increase in demand for consumer goods from parents. However, the demand from parents tends to fall as households become wealthier when income elasticity of child quantity is low, and income elasticity of child quality is high. This proposition is known as "quality-quantity tradeoff" (Becker, 1960). Caldwell's (1976) old-age security hypothesis suggested that children are like assets that allow parents to enjoy consumption over their lifetime in the absence of capital markets that permit inter-temporal lending and borrowing. Hence, countries with a weak financial system would have higher fertility as parents depend on their children to support them during their old age. On the other hand, a developed capital market allows households to borrow resources from banks and subsequently reduces parents' incentives to have more children. The complete substitutability hypothesis posited that the financial market is a substitute for children (Cigno, 1993; Filoso & Papagni, 2015; Lehr, 1999). According to this hypothesis, demand for children would be reduced if the returns from childbearing and childrearing are lower than those of investments in the financial markets.

A previous study found that financial development tends to increase fertility in developed countries, but it has a reverse effect in developing countries (Habibullah et al., 2016). There were only two studies that showed a non-linear relationship (an inverted U-shaped curve) between economic development and fertility in the context of Malaysia (Idris et al., 2018; Tang & Tey, 2017). The non-linear impact of financial development on fertility, however, remains unexplored. The current study, therefore, attempts to fill this gap by examining non-linearity in fertility-financial development nexus through an econometric analysis of data gleaned from 64 countries over 15 years. The study objective was to assess the linkages between financial market development and fertility in developing and developed countries.

Fertility levels in many developing countries have fallen below replacement levels in recent years, and this has given rise to concerns related to the ageing population and labor shortage. Hence, a comprehensive analysis of the forces influencing fertility is vital for inputs in development planning. This study differed from earlier studies that used conventional analysis in building the models for fertility-finance analysis, such as panel analysis with fixed and/or random effect (Basso et al., 2014; Habibullah et al., 2016) and vector autoregressive (VAR) model (Lehr, 1999; Maksymenko, 2009). Instead, the current study used dynamic panel GMM analysis to address simultaneity bias and country-specific effects (Law, Kutan & Naseem, 2018). Detailed evaluation on non-linear effects of financial development on fertility was carried out separately for developed and developing countries, controlling for per capita income growth rate, infant mortality rate, female secondary school enrollment, and urbanization.

Data, Empirical Model and Methodology

Data

This study used a balanced panel data gleaned from 41 developing[i], and 23 developed[ii] countries (see Table 1). The analysis uses data from World Development Indicators (WDI) and Financial Structure Database (FSD) of the World Bank for the period 2001-2015. The sampled countries and period selected were based on the availability of female secondary school enrollment data. The period of study was averaged into three-year intervals, with a maximum of five observations for each country: between 2001 and 2003, 2004 and 2006, 2007 and 2009,

[i] Excluding the least developed countries.
[ii] Classifications of country development are based on IMF (2017).

2010 and 2012, and 2013 and 2015. The full sample period (2001-2015) produced too many instruments without averaging the period, which in turn produced a biased GMM estimator, and hence, three-year intervals were used as a basis of analysis. This averaging process was based on GMM analysis that required a large number of countries (N), and a short period (t).

Table 1: List of sampled countries (Sample period: 2001-2015)

41 developing countries	Albania, Armenia, Belarus, Belize, Bolivia, Bulgaria, Cameroon, Colombia, Costa Rica, Cote d'Ivoire, Croatia, Dominican Republic, Ecuador, El Salvador, Georgia, Ghana, Guatemala, India, Indonesia, Jamaica, Kazakhstan, Kyrgyz Republic, Lebanon, Macedonia, FYR, Malaysia, Mauritius, Mexico, Moldova, Mongolia, Panama, Philippines, Romania, Samoa, Serbia, South Africa, St. Lucia, St. Vincent and the Grenadines, Suriname, Thailand, Turkey, West Bank and Gaza.
23 developed countries	Australia, Austria, Belgium, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States.

Empirical Model

This study examined the linkages between financial development (FD) and total fertility rate (TFR). The selection of financial development indicators was based on earlier studies on economic research (Idris et al., 2018; Law et al., 2018; Zakaria et al., 2016). The indicators included liquid liabilities (LLY), private sector credit (PRC), and domestic credit to the private sector (DOC). Liquid liabilities (LLY) measure the overall size of financial intermediaries relative to the size of the economy. Private sector credit (PRC) refers to the value of financial intermediary credits to the private sector. Domestic credit to the private sector (DOC) incorporates the credit provided by the banking sector to the private sector, as well as to the public sector (Law et al., 2018).

Variables, such as per capita income growth, infant mortality rate, female secondary school enrollment, and percent urban population, have been widely used in fertility studies (Agyei-Mensah & Owoo, 2015; Basso et al., 2014; Caldwell & Caldwell, 2003; Fenge & Scheubel, 2017; Filoso & Papagni, 2015; Idris et al., 2018; Tang & Tey, 2017; Zakaria et al., 2016) and were used as control variables in the present study. The empirical specification of panel data setting for this study is shown as equation (1).

$$\mathrm{lnTFR}_{it} = \alpha \mathrm{lnTFR}_{it-1} + B_1 \mathrm{lnFD}_{it} + B_2 \mathrm{lnX}_{it} + v_i + \varepsilon_{it} \quad (1)$$

where i is country index, t is time index, lnTFR is the logarithm of total fertility rate, FD is a vector of financial development indicators comprising liquid liabilities (LLY), private sector credit (PRC), and domestic credit to the private sector (DOC), X is a vector of controls (per capita income growth, infant mortality rate, female secondary school enrollment, and percent urban population), v_i is the unobserved country-specific effect term, and ε_{it} is the error term. Except for per capita income growth, all other explanatory variables were transformed into natural logarithms for interpretation convenience. Table 2 presents the variables used in this study.

Table 2: List of variables

Variables	Description	Unit of measurement	Source
TFR	Total fertility rate	Children per woman	WDI
LLY	Liquid liabilities	% of GDP	FSD
PRC	Private sector credit	% of GDP	WDI
DOC	Domestic credit to the private sector	% of GDP	WDI
Growth	Real GDP per capita growth	Annual %	WDI
Mortality	Infant mortality rate	Per 1,000 live births	WDI
Education	Female secondary school enrollment rate	% of gross enrollment, secondary	WDI
Urban	Urbanization	% of the total population	WDI

The non-linearity concept used in this study was derived from the inverted U-shaped relationship between fertility and economic development (instead of financial development) as proposed by Dahan and Tsiddon (1998). As costs of childrearing are measured in terms of parents' foregone earnings, affluent (educated) parents tend to have lower fertility due to higher net return to education of the child is relative to that of the poor (uneducated) parents. Poor (uneducated) parents are willing to forgo large family size if they foresee a higher net return to education. Hence, when the overall level of education increases, fertility declines, and income distribution becomes more equal while output per capita increases. Since the poor (uneducated) parents have a growing weight in the economy in the early phase, and a decreasing weight in the later phase, the economy-wide average fertility rate first increases and subsequently decreases. Nevertheless, the U-shaped relationship between fertility and economic/financial development remains an exploratory subject.

This study investigates the differing non-linearity effect of financial development on fertility rate using empirical evidence from developing and developed countries. The squared term of financial development (FD^2) was added to the model specification to capture the non-linear effect (e.g., U-shaped or inverted U-shaped). The inclusion of the squared term of financial development in the model specification is shown as equation (2).

$$\mathrm{lnTFR_{it}} = \alpha \mathrm{lnTFR_{it-1}} + \mathrm{B_1 lnFD_{it}} + \mathrm{B_2 lnFD_{it}^2} + \mathrm{B_3 lnX_{it}} + \mathrm{v_i} + \varepsilon_{\mathrm{it}} \qquad (2)$$

If B_1 and B_2 coefficients are negative and positive, respectively, and both are statistically significant, this indicates a U-shaped relation between financial development and fertility. The U-shaped relation implies financial development suppresses fertility at an early stage; however, fertility levels rise after financial development achieves a certain threshold.

In contrast, if B_1 and B_2 coefficients are positive and negative, respectively, and both are statistically significant, this implies an inverted U-shaped relationship. The inverted U-shaped relation implies financial development increases fertility at an early stage; however, after a certain threshold, it reduces fertility levels.

Methods

This study uses the dynamic panel system generalized method-of-moments (system GMM) estimators proposed by Blundell and Bond (1998). Data were analyzed using Stata version 14, based on the xtabond2 command. This method assumes there is no autocorrelation in the idiosyncratic errors. There is an initial condition the panel-level effects be uncorrelated with the first difference of the first observation of the dependent variable. The system GMM estimator also benefits from additional instruments that are orthogonal to the error term and are obtained from the lagged values of the endogenous lagged dependent variable. This approach has been found to yield more unbiased estimates (Oikarinen & Engblom, 2016).

The system GMM estimator is consistent in parameter estimates, and it is unbiased compared with the pooled least square (OLS), within groups (fixed effects) and different GMM estimators. Furthermore, the system GMM can handle endogeneity because it provides more efficient estimates than the fixed effects or different GMM models (Law et al., 2018).

The GMM estimators consist of two variants: the one-step and two-step estimators. The two-step estimator is efficient relative to the one-step estimator because it uses optimal weighting matrices. However, its application to a sample with a small cross-section dimension may lead to biased standard errors, biased estimated parameters (Windmeijer, 2005), and a weakened over-identification test (Bowsher, 2002). Roodman (2009) showed that the cause of these problems is instrument proliferation or having too many instruments. This study adopted a sufficient cross-section sample from both developing and developed countries, and therefore, the dimensionality of the instrumental variable matrix was reduced. The instrumental variables used in this study included a lagged dependent variable, mortality rate, and time dummies.

The two-step system GMM estimator was used to examine the non-linear effect of financial development on fertility. The consistency of GMM estimator depends on two specification tests, namely the Hansen *J* test of too many instruments and autocorrelation test in the disturbances (Arellano & Bond, 1991). Failure to reject the null hypothesis for the Hansen *J* test indicates no instruments proliferation. For the autocorrelation test, one should not reject the absence of the second-order autocorrelation (AR(2)). This study employed Windmeijer's finite sample correction for the variance of linear two-step GMM estimators to address the severe downward bias in standard errors (Windmeijer, 2005) and to ensure the standard errors are robust. Before the GMM estimation, Cook's distance outlier test and winsorize technique were used to remove the outliers inherent in the data.

Results

Descriptive statistics

Table 3 is the descriptive statistics of the study variables. The average fertility rate for the full sample is 2.2 children per woman. The total fertility rate in developing countries averages 2.5 children per woman, compared with 1.7 in developed countries. Additionally, the fertility rate in developing countries is more varied compared with that of developed countries, as indicated by the higher standard deviation. The financial development indicators suggested developed countries exhibited higher liquid liabilities (LLY), private sector credit (PRC), and domestic credit to the private sector (DOC) compared with developing countries.

Table 3: Descriptive statistics

Variables	Mean	Std.dev	Skewness	Kurtosis	Jarque-Bera test statistic	Obs
Full sample						
TFR	2.221	0.948	1.655	5.477	683.819 (0.000)	960
LLY	67.381	44.762	1.597	6.046	779.196 (0.000)	960
PRC	67.206	48.766	1.087	4.248	251.522 (0.000)	960
DOC	68.716	51.388	1.104	3.915	228.375 (0.000)	960

Variables	Mean	Std.dev	Skewness	Kurtosis	Jarque-Bera test statistic	Obs
Growth	2.359	3.585	0.206	5.991	364.619 (0.000)	960
Mortality	16.209	16.749	2.179	8.591	2,005.174 (0.000)	960
Education	97.729	24.045	0.059	5.127	181.589 (0.000)	960
Urban	64.294	17.105	-0.385	2.829	24.829 (0.000)	960
Developing countries						
TFR	2.511	1.040	1.208	3.861	168.611 (0.000)	615
LLY	51.138	37.556	2.610	12.261	2,896.144 (0.000)	615
PRC	40.523	25.897	1.059	3.652	126.044 (0.000)	615
DOC	43.434	31.615	1.377	4.730	271.211 (0.000)	615
Growth	3.138	3.755	-0.197	4.896	96.044 (0.000)	615
Mortality	23.244	17.311	2.004	7.325	890.990 (0.000)	615
Education	81.675	18.682	-1.327	5.057	288.877 (0.000)	615
Urban	56.141	14.680	-0.406	3.036	16.902 (0.000)	615
Developed countries						
TFR	1.705	0.370	1.526	6.423	302.470 (0.000)	345
LLY	96.337	41.902	1.442	4.636	157.962 (0.000)	345
PRC	109.582	45.107	0.982	4.565	90.677 (0.000)	345
DOC	118.973	47.021	0.627	3.485	25.999 (0.000)	345
Growth	0.971	2.764	0.939	17.256	2,972.127 (0.000)	345
Mortality	3.669	0.993	0.827	4.161	58.689 (0.000)	345
Education	112.435	19.516	1.429	4.385	145.109 (0.000)	345
Urban	78.829	10.013	-0.146	2.377	6.811 (0.033)	345

Notes: [a] *All statistics are based on original data values.*
[b] *Values in parentheses are p-values.*
[c] *Sample period: 2001-2015. TFR denotes total fertility rate, LLY denotes liquid liabilities, PRC denotes private sector credit, DOC denotes domestic credit to the private sector, Growth denotes real GDP per capita growth rate, Mortality denotes infant mortality rate, Education denotes female secondary school enrollment, and Urban denotes urban population.*

Table 4 shows the correlation between the variables used in the analysis. Financial development indicators, as represented by the liquid liabilities (LLY), private sector credit (PRC), and domestic credit to the private sector (DOC), were negatively associated with total fertility rate (TFR) in the full sample, as well as in both developing and developed countries. In contrast, infant mortality was found to be positively correlated with fertility. The per capita income growth (Growth), female secondary school enrollment (Education), and urban population (Urban) were found to have a negative correlation with the fertility rate in the full sample and developing countries, but the reverse is true in developed countries.

Table 4: Correlations

Variables	TFR	LLY	PRC	DOC	Growth	Mortality	Education	Urban
Full sample								
TFR	1.000							
LLY	-0.353	1.000						
PRC	-0.414	0.657	1.000					
DOC	-0.426	0.700	0.909	1.000				
Growth	-0.031	-0.274	-0.302	-0.313	1.000			
Mortality	0.782	-0.436	-0.485	-0.538	0.124	1.000		
Education	-0.578	0.287	0.472	0.460	-0.117	-0.731	1.000	
Urban	-0.326	0.349	0.383	0.454	-0.177	-0.490	0.567	1.000
Developing countries								
TFR	1.000							
LLY	-0.215	1.000						

Variables	TFR	LLY	PRC	DOC	Growth	Mortality	Education	Urban
PRC	-0.336	0.728	1.000					
DOC	-0.295	0.592	0.924	1.000				
Growth	-0.207	-0.199	-0.182	-0.168	1.000			
Mortality	0.756	-0.291	-0.382	-0.270	-0.075	1.000		
Education	-0.630	0.064	0.239	0.255	0.086	-0.747	1.000	
Urban	-0.174	0.119	-0.031	-0.036	0.057	-0.231	0.214	1.000
Developed countries								
TFR	1.000							
LLY	-0.219	1.000						
PRC	-0.101	0.436	1.000					
DOC	-0.060	0.482	0.789	1.000				
Growth	0.053	-0.148	-0.208	-0.206	1.000			
Mortality	0.143	-0.131	-0.232	0.035	0.097	1.000		
Education	0.160	-0.138	-0.036	-0.187	0.041	-0.094	1.000	
Urban	0.477	-0.073	-0.097	-0.018	0.002	-0.133	0.500	1.000

Note: [a] All statistics are based on original data values. Sample period: 2001-2015.

Dynamic Panel System GMM Estimation

Table 5 presents the non-linear relationship between financial development and fertility estimated from equation (2). Results suggest all three financial development indicators (liquid liabilities, private sector credit, and domestic credit to the private sector) and the respective square term are significant determinants of fertility in the full sample, as well as in developing and developed countries. Outliers inherent in the data were removed using Cook's distance, and the results from winsorization (as presented in the Appendices) show the robustness of the results to outliers.

Post-estimation diagnostic test suggests all the models are valid. As such, the Hansen *J* test is not rejected at the 5% level, and this indicates the validity of instruments used in each model. Similarly, failure to reject the null hypothesis of Arellano-Bond statistic for error autocorrelation indicates the absence of error correlation in all the models. The coefficient of the lagged dependent variable ($lnTFR_{it-1}$) in each of the model is less than unity, which fulfills the properties for a dynamic model (Keele & Jelly, 2005).

In the full sample, the coefficient of each financial development indicator in models 1-3 is positive, but its square term is negative. The change in the sign indicates financial development and fertility has a non-linear inverted U-shaped relationship, in which the former increases the fertility rate up to a turning point, after which it depresses the fertility rate. The turning point is the highest for liquid liabilities (lnLLY) (51.80% of GDP), and the lowest for private sector credit (lnPRC) (24.68% of GDP). Domestic credit to the private sector (lnDOC) has the most substantial effect on fertility (due to the smallest p-values), with a turning point of 34.14% of GDP.

Notably, in developing countries, the coefficient of each financial development indicator in models 4-6 is positive, but its square term is negative. The change in the sign shows the relationship between financial development and fertility follows a non-linear inverted U-shaped dynamic, as indicated in the full sample results. The turning points in these models ranged between 26.58 and 32.10% of GDP. Liquid liabilities (lnLLY) has the most substantial effect on fertility in developing countries, with a turning point of 32.10% of GDP.

In the developed countries, models 7-9 show the coefficient of each financial development indicator is negative, but its square term is positive. The change in the sign suggests a non-linear relationship, depicted by a U-shaped. Financial development suppresses fertility rate up to the turning point after which it has a positive effect on the fertility rate. The turning points varied widely across the models, ranging from 93.97 to 178.57% of GDP. The liquid liability (lnLLY) indicator has the most substantial effect on fertility in developed countries, with a threshold point of 118.51% of GDP.

Table 5: Results of non-linear relationship between financial development and fertility

Variables	Dependent variable: $\ln TFR_{it}$								
	Full sample			Developing countries			Developed countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-1.664*	0.273	-0.359	-0.971**	-0.597	-0.352	1.639	1.256	4.949*
	(0.055)	(0.459)	(0.338)	(0.023)	(0.348)	(0.335)	(0.491)	(0.662)	(0.076)
$\ln TFR_{it-1}$	0.975***	0.929***	0.945***	0.948***	0.984***	0.924***	0.689***	0.791***	0.891***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\ln LLY_{it}$	0.432**	-	-	0.533***	-	-	-2.434**	-	-
	(0.039)			(0.001)			(0.019)		
$\ln LLY_{it}^2$	-0.055**	-	-	-0.077***	-	-	0.255**	-	-
	(0.032)			(0.001)			(0.016)		
$\ln PRC_{it}$	-	0.121*	-	-	0.310***	-	-	-1.522**	-
		(0.076)			(0.005)			(0.032)	
$\ln PRC_{it}^2$	-	-0.019**	-	-	-0.047***	-	-	0.147**	-
		(0.011)			(0.003)			(0.040)	
$\ln DOC_{it}$	-	-	0.386***	-	-	0.438***	-	-	-2.637*
			(0.005)			(0.007)			(0.094)
$\ln DOC_{it}^2$	-	-	-0.055***	-	-	-0.066***	-	-	0.290*
			(0.002)			(0.003)			(0.095)
$Growth_{it}$	-0.007*	-0.002	-0.004*	-0.002	0.006	0.004	-0.014	-0.005	0.002
	(0.072)	(0.419)	(0.089)	(0.407)	(0.184)	(0.313)	(0.352)	(0.494)	(0.591)
$\ln Mortality_{it}$	0.026	-0.037*	-0.032**	-0.002	0.001	-0.001	0.200**	0.121**	-0.026
	(0.382)	(0.050)	(0.027)	(0.911)	(0.997)	(0.973)	(0.018)	(0.024)	(0.488)
$\ln Education_{it}$	0.156	-0.088	-0.053	0.020	0.024	-0.056	0.444	0.241	-0.157**
	(0.192)	(0.114)	(0.333)	(0.747)	(0.835)	(0.431)	(0.430)	(0.417)	(0.016)
$\ln Urban_{it}$	0.021	0.021	0.016	0.004	-0.004	-0.018	0.449	0.346	0.423
	(0.555)	(0.445)	(0.373)	(0.825)	(0.889)	(0.537)	(0.362)	(0.344)	(0.144)
Hansen *J* test	18.74	23.47	27.32	19.29	29.96	26.54	1.29	4.11	5.16
	(0.539)	(0.434)	(0.243)	(0.736)	(0.365)	(0.543)	(0.936)	(0.533)	(0.396)
AR(2)	-1.53	0.51	0.83	-1.62	0.86	0.89	0.02	-0.21	-1.27
	(0.125)	(0.613)	(0.408)	(0.105)	(0.387)	(0.375)	(0.980)	(0.835)	(0.204)
No. instrument	30	32	32	32	37	37	15	17	15
No. country	64	64	64	41	41	41	23	23	23
No. lag	3	3	3	3	2	2	4	2	2
FD turning point (%)	51.80	24.68	34.14	32.10	26.58	28.13	118.51	178.57	93.97

Notes: [a] *The different lag length is used in each model to pass the Hansen J test and AR(2).*
[b] *Sargan test is not required as the standard error estimates are robust (Ibrahim, 2019).*
[c] *Values in parentheses are p-values. Sample period: 2001-2015, 3-year averaged.*
[d] **, **, and *** denote statistical significance at 10%, 5%, and 1% levels respectively.*

Conclusion

This study explores empirically the potential relationship between fertility and financial development using data from 64 countries between 2001 and 2015. Although the determinants of fertility have been extensively discussed in earlier studies, this study contributes to the literature on the relationship between financial development and fertility based on a dynamic panel data model. Results of this study are consistent with those of earlier ones that provide ample evidence of the significant relationship between financial development and fertility (Basso et al., 2014; Boldrin et al., 2005; Cigno & Rosati, 1992; 1996; Filoso & Papagni, 2015; Habibullah et al., 2016; Idris et al., 2018; Lehr, 1999; Lim et al., 2019; Rammohan, 2001; Steckel, 1992; Zakaria et al., 2016). However, this study has pointed out that the fertility rate is non-linearly associated with financial development in both developing and developed countries. Effects of financial development on fertility are different in developed and developing countries. In developing countries, financial development contributes to higher fertility. However, greater financial development (i.e., after the threshold point) tends to lower fertility (an inverted U-shaped relationship). In contrast, a U-shaped relationship is observed in developed countries, in which a higher level of financial development (i.e., after the threshold point) is associated with higher fertility. The roles of per capita income, infant mortality rate, female secondary school enrollment, and urban population were not discussed in this study as these control variables were not the primary focus of this study.

This study draws attention to some policy concerns. The non-linearity effect of financial development on fertility suggests developing countries should expand the size of financial intermediaries relative to the size of their economy by improving their banking system. Access to financial products, such as deposits and loans, will result in increased household wealth, thereby reducing the desire for children as their old-age security. In the low-resource developing countries, it is crucial to slow down the rapid population growth and break the vicious cycle of poverty, especially in African countries where the fertility rates are still very high.

From another perspective, increased expenses for children's education and childcare expenses imply that every additional child incurs additional expenditure, and this is more pronounced in developed countries where the cost of living and raising a child is much higher than that in developing countries. Population ageing and low fertility in the developed countries have prompted the policymakers to incorporate population policies in development planning. The results of this study suggest that the central banks in developed countries should revise their high-interest rates. A lower real cost of borrowing is expected to reduce the budget constraints of households in raising a child, such as the cost of an educational loan, and lower cost of children will likely boost the fertility level. However, the situation may vary from country to country in the developing as well as developed regions. Future research should explore the relationship between financial development and fertility at the country level to facilitate the planning of effective national population and economic/financial development programs.

This study has several limitations. First, the time frame of the data used is relatively short (15 years) due to the unavailability of data for longer time frames. Additionally, this study only focused on the indicators of financial development, which are liquid liabilities, private sector credit, and domestic credit to the private sector. There is a need to explore other indicators, such as government regulation on borrowing, education insurance, stock market, and unit trust development in future work. Detailed analyses are important to assess the differential effects of various financial development measures on fertility. The interaction between per capita income and financial development was not considered in the current analysis as the paper focused only on the impact of financial development on fertility. There is a need for future research to investigate the moderating effect of per capita income growth on the relationship between financial development and fertility rate.

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Appendices

Table A: Robustness check with winsorization (1st and 99th percentiles)

Variables	Dependent variable: $\ln TFR_{it}$								
	Full sample			Developing countries			Developed countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-0.397	-0.191	0.156	-0.537	-0.195	0.060	7.522***	1.516	-0.059
	(0.234)	(0.515)	(0.504)	(0.163)	(0.700)	(0.899)	(0.005)	(0.578)	(0.980)
$\ln TFR_{it-1}$	0.946***	0.967***	0.938***	0.919***	0.921***	0.891***	0.983***	0.849***	0.733***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\ln LLY_{it}$	0.219*	-	-	0.362**	-	-	-2.779***	-	-
	(0.081)			(0.024)			(0.005)		
$\ln LLY^2_{it}$	-0.032**	-	-	-0.051**	-	-	0.293***	-	-
	(0.047)			(0.020)			(0.006)		
$\ln PRC_{it}$	-	0.176***	-	-	0.263**	-	-	-1.565**	-
		(0.004)			(0.027)			(0.027)	
$\ln PRC^2_{it}$	-	-0.025*	-	-	-0.044**	-	-	0.149**	-
		(0.000)			(0.015)			(0.041)	
$\ln DOC_{it}$	-	-	0.211***	-	-	0.386*	-	-	-1.914**
			(0.007)			(0.057)			(0.021)
$\ln DOC^2_{it}$	-	-	-0.031***	-	-	-0.061**	-	-	0.190**
			(0.001)			(0.033)			(0.025)
$Growth_{it}$	-0.005**	0.001	0.001	-0.005	-0.002	-0.001	0.004	-0.043***	0.061**
	(0.072)	(0.637)	(0.882)	(0.105)	(0.353)	(0.991)	(0.525)	(0.000)	(0.041)
$\ln Mortality_{it}$	-0.008	-0.029**	-0.039***	0.007	-0.006	-0.020	0.099**	0.078***	0.097
	(0.520)	(0.034)	(0.000)	(0.617)	(0.837)	(0.478)	(0.038)	(0.000)	(0.151)
$\ln Education_{it}$	0.021	0.001	-0.064	-0.016	0.014	-0.068	-0.172***	0.162	0.359
	(0.652)	(0.987)	(0.198)	(0.600)	(0.864)	(0.370)	(0.000)	(0.263)	(0.291)
$\ln Urban_{it}$	0.002	-0.006	-0.018	0.005	-0.038	-0.050	-0.063	0.411**	0.729***
	(0.960)	(0.779)	(0.419)	(0.808)	(0.339)	(0.152)	(0.693)	(0.044)	(0.007)
Hansen *J* test	56.02	43.31	49.52	21.44	31.06	30.70	1.69	1.05	3.46
	(0.259)	(0.332)	(0.144)	(0.554)	(0.314)	(0.331)	(0.890)	(0.959)	(0.629)
AR(2)	-1.58	-0.02	0.02	-1.33	0.48	0.48	0.26	0.60	0.64
	(0.113)	(0.983)	(0.981)	(0.184)	(0.628)	(0.631)	(0.796)	(0.545)	(0.520)
No. instrument	61	50	50	32	37	37	14	14	14
No. country	64	64	64	41	41	41	23	23	23
No. lag	2	2	2	3	2	2	4	2	2
FD turning point (%)	31.22	34.97	28.95	35.20	19.97	23.18	115.54	189.70	155.40

Notes: [a] *The different lag length is used in each model to pass the Hansen J test and AR(2).*
[b] *Sargan test is not required as the standard error estimates are robust (Ibrahim, 2019).*
[c] *Values in parentheses are p-values. Sample period: 2001-2015, 3-year averaged.*
[d] **, **, and *** denote statistical significance at 10%, 5%, and 1% levels respectively.*

Table B: Robustness check with winsorization (5th and 95th percentiles)

Variables	Dependent variable: $\ln TFR_{it}$								
	Full sample			Developing countries			Developed countries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-0.288	0.151	0.166	-0.841**	-0.121	-0.195	2.887*	0.376	5.262
	(0.426)	(0.613)	(0.620)	(0.038)	(0.826)	(0.753)	(0.067)	(0.851)	(0.329)
$\ln TFR_{it-1}$	0.946***	0.961***	0.934***	0.936***	0.917***	0.895***	0.919***	0.795***	0.604***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
$\ln LLY_{it}$	0.232*	-	-	0.517**	-	-	-1.405***	-	-
	(0.088)			(0.025)			(0.007)		
$\ln LLY_{it}^2$	-0.034*	-	-	-0.073**	-	-	0.151**	-	-
	(0.061)			(0.023)			(0.010)		
$\ln PRC_{it}$	-	0.133**	-	-	0.314**	-	-	-0.887	-
		(0.044)			(0.037)			(0.124)	
$\ln PRC_{it}^2$	-	-0.019**	-	-	-0.051**	-	-	0.079	-
		(0.018)			(0.016)			(0.166)	
$\ln DOC_{it}$	-	-	0.247**	-	-	0.404**	-	-	-4.367*
			(0.026)			(0.041)			(0.066)
$\ln DOC_{it}^2$	-	-	-0.036**	-	-	-0.064**	-	-	0.436*
			(0.011)			(0.019)			(0.079)
$Growth_{it}$	-0.005**	0.002	-0.001	-0.003	0.001	-0.001	-0.004	-0.013***	-0.096**
	(0.022)	(0.584)	(0.817)	(0.289)	(0.980)	(0.743)	(0.809)	(0.000)	(0.010)
$\ln Mortality_{it}$	-0.012	-0.037***	-0.039***	-0.002	-0.018	-0.013	0.068**	0.103***	0.048
	(0.419)	(0.006)	(0.004)	(0.943)	(0.556)	(0.667)	(0.035)	(0.006)	(0.514)
$\ln Education_{it}$	0.001	-0.052	-0.091**	-0.017	-0.010	-0.029	0.046	0.214	0.839
	(0.977)	(0.132)	(0.042)	(0.662)	(0.896)	(0.704)	(0.760)	(0.276)	(0.176)
$\ln Urban_{it}$	-0.007	-0.007	-0.006	0.016	-0.044	-0.045	0.019	0.245**	0.407*
	(0.862)	(0.866)	(0.888)	(0.621)	(0.282)	(0.385)	(0.903)	(0.040)	(0.053)
Hansen *J* test	56.59	50.00	48.11	18.69	32.22	29.91	7.66	2.60	0.69
	(0.243)	(0.134)	(0.177)	(0.719)	(0.266)	(0.368)	(0.176)	(0.761)	(0.984)
AR(2)	-0.70	-0.15	0.16	0.17	0.64	0.64	0.48	0.59	1.24
	(0.486)	(0.877)	(0.876)	(0.862)	(0.524)	(0.521)	(0.631)	(0.554)	(0.215)
No. instrument	61	50	50	32	37	37	16	15	15
No. country	64	64	64	41	41	41	23	23	23
No. lag	2	2	2	3	2	2	2	2	2
FD turning point (%)	31.93	31.70	29.66	35.01	21.79	23.86	106.09	-	149.78

Notes: [a] *The different lag length is used in each model to pass the Hansen J test and AR(2).*
[b] *Sargan test is not required as the standard error estimates are robust (Ibrahim, 2019).*
[c] *Values in parentheses are p-values. Sample period: 2001-2015, 3-year averaged.*
[d] **, **, and *** denote statistical significance at 10%, 5%, and 1% levels respectively.*