Demography India
Vol. 51, No. 1 (2022), pp. 126-143 ISSN 0970-454X

Cointegration and Causality between Fertility and Female Labour Force Participation in India

Balhasan Ali* [1] **and Preeti Dhillon**[2]

Abstract: This article investigates the co-integration and causality between total fertility rate and female labour force participation rate in India. Using time series data from 1983-2018, this study finds the long-run co-integration between female labour force participation rate and total fertility rate, and both influences each other through interaction effect of female age at first marriage, per capita gross domestic product and infant mortality rate. However, there is no causal relationship between fertility and female labour force participation in India. This study concludes that fertility decline alone could not able to increase female labour force participation in India.

Keywords: female labour force, fertility, cointegration, causality, time series, India

Introduction

It is assumed that low fertility would ensure greater participation of women as workers. The size of birth cohorts decides the youth dependency ratios and influenced the work participation rate of women. Fertility decline can affect female labour force participation (Ahn and Mira, 2002; Jaumotte, 2003; Adsera, 2004; Bloom et al., 2009), and working women has low fertility rate as compared to non-working women (Del Boca, 2002; Engelhardt et al., 2004; Subramaniam et al., 2018). Moreover, many developed countries have experienced an enormous decline in fertility rate with an increase in female labour force participation, founded significant inverse relationship between these two factors (Engelhardt et al., 2004; Mishra & Smyth, 2010; Narayan, & Smyth; 2006). The shift in the fertility rate in these countries is largely attributed to increasing female labour force participation (Hartani et al., 2015; Nam, 2010; Ahn & Mira; 2000; Del Boca, 2002; Jaumotto; 2003).

Theoretically, causation between two variables can have a bidirectional or unidirectional relationship. An increase in the female labour force can bring down fertility, and vice-versa. However, the major issue here is that studies that have assessed the correlation do not showcase the causation effect. Moreover, in macroeconomics, variables mostly reflect their past behaviour and produce dynamic and autoregressive processes. It is possible that two factors could be highly associated, but have no causality between the two (Granger, 1969; Granger, 1974; Granger, 1988). Another issue is that the statistic assumption of the econometric model which applies correlation-based approaches replicate a one-period relative stationary framework. These are inappropriate approaches because the effect of demographic and economic factors is not instantaneous. Cheng (1996a) notes that fertility and FLPR should not only be seen as a dynamic process but as an autoregressive process because these variables showed their past behaviour. Therefore, to capture the past behaviour of fertility and

---

*Corresponding Author

[1] Doctoral candidate, International Institute for Population Sciences, Mumbai. E-mail: alihasancs92@gmail.com

[2] Assistant professor, International Institute for Population Sciences, Mumbai, Email: pdhillon.iips@gmail.com

female labour force participation and to overcome the above-discussed issues, this study employs the autoregressive process using the ARDL approach (Pesaran et al., 2001).

Concurrent review of literature indicates that there are comparatively few studies on the causal direction between fertility and female labour force participation, and have so far shown mixed results. Most of the studies having applied the granger causality model found unidirectional causality from fertility to female labour force participation in the short-run (Cheng, 1996b; Cheng et al., 1997). Cheng (1996a) found unidirectional causation in female Labour force participation and fertility in the African-American population from 1954 to 1992. However, few studies also found the bidirectional causality in the short run between fertility and female Labour force participation (Michael,1985; Klijzing et al., 1988).

The determinants of female labour force participation and fertility have been discussed by Becker’s New Home Economics model (Becker, 1960), the Role Incompatibility hypothesis (Bowen and Finegan, 1969; Mason and Palan, 1981). and the Societal Response hypothesis (Narayan and Smith, 2006). The New Home Economics model stresses that fertility decisions are a function of individual preference and the opportunity cost of childbearing and rearing (Becker, 1960). Further, Role Incompatibility Approach articulates that there is an inverse relationship between female employment and fertility, only in a condition where the trade-off between mother’s duty and work is not accommodated duly (Mason and Palan, 1981). Using micro-level data, several studies suggest that women with more children spend less time in the labour market (Lehrer and Nerlove, 1986; Spitze, 1988). On the other hand, the societal response hypothesis suggests that societal response such as changing attitude and behaviour towards the female workers and working mothers, availability of child care and paid maternity leave reduces the incompatibility between female work participation and childbearing. The recent findings from OECD countries revealed that with low fertility rates, low female work participation supports the societal response theory (Brewster and Rindfuss, 2000; Rindfuss et al., 2000). Narayan and Smith (2006) using Australian annual data from 1960 to 2000 found that fertility and infant mortality showing granger cause female labour force participation in long and short-run periods. Further, the literature on the relationship between female labour force participation and fertility from developed countries shows that the impact of fertility is complicated by the endogeneity of fertility and resulting in identifying the direction of causality (Hartani et al., 2015; Siah and Lee, 2014). However, most of the research suggests that there is complex causality between female Labour force participation and fertility (Hartani et al., 2015; Siah and Lee, 2014; Salamaliki et al., 2012; Mishra and Smith, 2010; Cheng et al., 1997).

In the Indian context, since the early 1990s, the fertility rate has been declining, and it reached 2.18 per woman in 2016 (IIPS& ICF, 2017). Several works indicate that increasing age at marriage, better accessibility, and availability of family planning programmes, low infant mortality, high enrolment of girls in secondary and higher education, and increasing per capita income are contributors to fertility decline in India (Arokiasamy,2009; Das Gupta & Mari Bhat, 1997). However, it is quite shocking that female workforce participation is a continuous decline 1990s (except 2004-05), and, only 17.5 percent of women were in the labour force in 2018 (PLFS, 2019; see the NSSO various round reports). The literature on female labour force participation suggests that an increase in educational attainment, higher remunerations of the male member of the household discourages female's economic participation, accompanied by the absence of the certain level of skill sets discourages and eliminates them from engaging into work in India (Bhalla & Kaur, 2011; Mazumdar & Neetha, 2011; Mehrotra & Parida, 2011). Long term trends show that female labour force participation rates in India have been puzzling, and, fertility decline would bring down the participation of women in the workforce (Afridi et al., 2018; Andres et al., 2017; Kapsos et al., 2014).

Conceptually, the observed trend of declining fertility and female labour force participation is characterised by an interaction between the several economic, social, and demographic changes overtime. However, in the case of India, continuous decline in female labour force participation and fertility also going to cross the replacement level fertility shows the contradictory situation and questions the general assumption about the relationship between female labour force participation and fertility. Although the above question is significant, the already documented shreds of evidence do not signify the relationship of both in India.

Though there are a few studies in India, which examines the relationship between fertility and female labour force participation rate at a regional level; the causality between fertility and female labour force participation rate has not been examined extensively. Although the existing pieces of evidence have been showing puzzling conclusions, the study does require a revamp in the methodological area. Also, several studies indicate causality between female labour force participation and fertility if there is any confounding factor which can affect both at the same point of time (Hartani et al., 2015; Siah and Lee, 2014; Salamaliki et al., 2012; Mishra and Smith, 2010). Therefore, this study assessed the causal relationship and co-integration between fertility and female labour force participation rate in India.

Materials and Methods

Data source

This study used multiple data set for analysis. Unit level data for female labour force participation rate (FLPR) has been derived from various successive rounds of Employment-Unemployment survey of (1983, 1987/88, 1993/94, 1999/2000, 2004/05, 2009/10, 2011/12), Periodic labour Force survey (2017-18) and, we have also exponentially interpolated this estimate to make it annual time series data. We have derived data for infant mortality rate and fertility rate from Sample

Registration System, Registrar General of India (1983-2018). Further, for per capita gross domestic product (PGDP) at a constant price (base year: 2011-12), data has been derived from the Reserve Bank of India (1983-2018) database. For the female age at first marriage, this study derived data from the census (1981, 1991, 2001, and 2011) and NFHS-4 (2015-16). The above datasets are either quinquennial or decadal. To make it annual time series data, we interpolated the data. AFM has been interpolated to use linear interpolation method. This study has considered time (in years) from 1983 to 2018 for this analysis.

The rationale for the choice of the variables

As mentioned in the background, the suggested causal relationship between fertility and female labour force participation is less explicit in Becker's New Home Economics theory or the theory of incompatibility. Additionally, these theories do not specify the direction of causality between female labour force participation rate (FLPR) and total fertility rate (TFR). Instead, these theories consider fertility rate and female labour force participation rate as being an endogenous factor in the microeconomic model, and both are caused by common exogenous factors, such as the social norms, unemployment rate, female wage rate, age at marriage, infant mortality rate, per capita gross domestic product, household status, and male labour force participation. However, on the other hand, several studies also argue that fertility behaviour and FLPR are an outcome of a sequential decision process overtime rather than being a product of a concurrent decision problem, the relationship between two may not be influenced by other confounding factors (Engelhardt et al., 2004).

The present study aimed to check the robustness of the association of TFR and FLPR by adding as confounding variable in the econometric model. This study used infant mortality rate (IMR), age at first marriage (AFM), per capita gross domestic product (PGDP) as a confounding factor. In literature, the high infant mortality rate in developing countries has been assumed as a major cause of high fertility rates. In contrast, IMR is declining in India due to better nutrition, Maternal and Child Healthcare services, and better accessibility and availability of affordable lifesaving medicine. So, the falling infant mortality is the resultant of a decline in fertility rate in India. Hence, there is a need to distinguish between the cost of childbearing and rearing during the life span, understanding the phenomenon of opportunity cost in both situations. So, there is a possibility that the changes in IMR and TFR can simultaneously influence the labour force participation of women.

Further, female age at first marriage is considered mainly to be an outcome of female enrolment in secondary and higher education. Employment opportunities for the more educated women are higher than for the less educated women. Further, girl's enrolment in higher secondary and higher education delay their marriage resulting in having fewer children and tend to pursue their productive career and employment. Again, per-capita-gross domestic product (PGDP) is a product of the total economic activities taking place in the country. The growth of GDP boosts the economy and helps to create new employment opportunities to expand the labour market, which can affect TFR as well as FLPR. The inclusion of these factors captures the effect of social, demographic, and economic changes overtime as suggested by the literature on the relationship between TFR and FLPR.

Analytical approach

This study is based on annual time series data from 1983 to 2018. To check the basic properties of time series data, the following methods have been used:

Unit-root tests

Unit root tests are used for stationarity in time series. A time series has stationarity if a shift in time doesn't cause a change in the shape of the distribution; unit-roots are one cause for non-stationarity. A series is said to be stationary if the mean and auto covariance of the series do not depend on time. For the stationarity check, this paper used the Augmented Dickey-Fuller (ADF) Test (Dickey and Fuller, 1979) and Phillip-Perron (PP)Test (Phillips and Perron, 1988).

Augmented Dickey-Fuller (ADF) Test: The Augmented Dicky Fuller test constructs a parametric correction for higher-order correlation by assuming that y series follows an AR (p) process and adding p lagged difference terms of the dependent variable y:

$$\Delta y_t = \alpha y_{t-1} + x_t'\delta + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \cdots + \beta_p \Delta y_{t-p} + v_t$$

Phillip-Perron (PP)Test: Phillips and Perron (1988) proposed an alternative method of controlling for serial correlation when testing for a unit root (see Phillips and Perron, 1988). Further, Time series is stationary if p-value is less than 0.05 significance level for the t-test calculated by employing ADF test and PP test in this study.

Model specification:

Model I:

$$FLPR_t = f(TFR_t, \quad AFM_t, \quad IMR_t, \quad LPGDP_t) \ldots\ldots\ldots \tag{1}$$

$$FLPR_t = \alpha_1 + \alpha_2 TFR_t + \alpha_3 AFM_t + \alpha_4 IMR_t + \alpha_5 LPGDP_t + \mu_t \quad \ldots\ldots\ldots \tag{2}$$

Model II:

$$TFR_t = f(FLPR_t, \quad AFM_t, \quad IMR_t, \quad LPGDP_t) \ldots\ldots\ldots \tag{3}$$

$$TFR_t = \alpha_1 + \alpha_2 FLPR_t + \alpha_3 AFM_t + \alpha_4 IMR_t + \alpha_5 LPGDP_t + \mu_t \quad \ldots\ldots\ldots \tag{4}$$

Where,

$$FLPR_t = Female\ Labour\ Force\ Participation\ Rate$$

$$TFR_t = Total\ Fertility\ Rate$$

$$AFM_t = Female\ Age\ at\ \ First\ Mrriage$$
$$IMR_t = Infant\ Mortality\ Rate$$
$$LPGDP_t = Log\ of Per\ Capita\ Gross\ Domestic\ Product$$
$$\mu_t = Error\ term$$
$$t\ = time\ period\ (in\ years)$$

Autoregressive Distributed Lag (ARDL) bound test approach for testing co-integration

This study applies the ARDL bound test approach (Pesaran et al., 2001) to test the co-integration for FLPR and TFR. ARDL has some advantages over other co-integration methods such as Johansen and Granger. It can estimate the long-run and short-run dynamics simultaneously and can control the endogeneity. ARDL can be applied Irrespective of I (0), I (1) or a mixture of both levels. It is worth concluding that all the variables used in this study are integrated into one order. However, ARDL bound testing co-integration can be applied for the same order of integration of each variable, we found that if any of the series is greater than of order I (2), then calculated F statistics was invalid. The ARDL test is more efficient in a small sample size. The ARDL bound test estimates the unconditional error correction model (UECM) which is models as follows:

$$\Delta FLPR_t = \delta_1 + \partial_1 TFR_{t-1} + \partial_2 AFM_{t-1} + \partial_3 IMR_{t-1} + \partial_4 LPGDP_{t-1} + \sum_{i=1}^{q} \rho_i \Delta FLPR_{t-i} + \sum_{i=1}^{q} \alpha_i \Delta TFR_{t-i} + \sum_{i=1}^{q} \beta_i \Delta AFM_{t-i} + \sum_{i=1}^{q} \gamma_i \Delta IMR_{t-i} + \sum_{i=1}^{q} \pi_i LPGDP_{t-i} + \varepsilon_t \quad \dots\dots\dots.(5)$$

Where Δ is the first difference operator, δ_1 is a constant term, L implies that variable has been transformed in the natural log,ε_t is error term (residual) which assumed to be normally distributed, $\boldsymbol{\partial_1}$, $\boldsymbol{\partial_2}$, $\boldsymbol{\partial_3}$, $\boldsymbol{\partial_4}$ are long term parameters, and $\boldsymbol{\rho_i}$, $\boldsymbol{\alpha_i}$, $\boldsymbol{\beta_i}$, $\boldsymbol{\gamma_i}$, $\boldsymbol{\pi_i}$ are short-run parameters for Model I.

The null hypothesis of no co-integration of the model I is: $\boldsymbol{H_0\colon \partial_1 = \partial_2 = \partial_3 = \partial_4 = 0}$, and the alternative hypothesis: $\boldsymbol{H_1\colon \partial_1 \neq \partial_2 \neq \partial_3 \neq \partial_4 \neq 0}$ implies co-integration.

$$\Delta TFR_t = \delta'_1 + \partial'_1 FLPR_{t-1} + \partial'_2 AFM_{t-1} + \partial'_3 IMR_{t-1} + \partial'_4 LPGDP_{t-1} + \sum_{i=1}^{q} \rho'_i \Delta TFR_{t-i} + \sum_{i=1}^{q} \alpha'_i \Delta FLPR_{t-i} + \sum_{i=1}^{q} \beta'_i \Delta AFM_{t-i} + \sum_{i=1}^{q} \gamma'_i \Delta IMR_{t-i} + \sum_{i=1}^{q} \pi'_i LPGDP_{t-i} + \varepsilon'_i \quad \dots\dots.\dots.(6)$$

Where Δ is the first difference operator, $\boldsymbol{\delta'_1}$ is a constant term, L implies that variable has been transformed in the natural log, $\boldsymbol{\varepsilon'_i}$ is error term (residual) which assumed to be normally distributed, $\boldsymbol{\partial'_1}$, $\boldsymbol{\partial'_2}, \boldsymbol{\partial'_3}, \boldsymbol{\partial'_4}$ are long term parameters, and $\boldsymbol{\alpha'_i}$, $\boldsymbol{\rho'_i}$, $\boldsymbol{\beta'_i}$, $\boldsymbol{\gamma'_i}$, $\boldsymbol{\pi'_i}$are short-run parameters for Model II. The null hypothesis of no co-integration of model II is: H_0: $\boldsymbol{\partial'_1 = \partial'_2 = \partial'_3 = \partial'_4 = 0}$, and the alternative hypothesis: H_1: $\boldsymbol{\partial'_1 \neq \partial'_2 \neq \partial'_3 \neq \partial'_4 \neq 0}$ implies co-integration.

Accordingly, if F-statistics value is less than the lower bound critical value, then the null hypothesis of no co-integration will be accepted; and if F-statistics value is greater than the upper bound critical value, the null hypothesis of no co-integration will be rejected. The result will be inconclusive if F-statistics falls within the critical values of the upper and lower bound. After the establishment of co-integration, the conditional ERDL long-run model for $FLPR_t$ and TFR_t can be estimated as (Eq.7 & Eq.8):

$$FLPR_t = \alpha_1 + \sum_{i=1}^{q} \delta_1 FLPR_{t-i} + \sum_{i=1}^{q} \delta_2 TFR_{t-i} + \sum_{i=1}^{q} \delta_3 AFM_{t-i} + \sum_{i=1}^{q} \delta_4 IMR_{t-i} + \sum_{i=1}^{q} \delta_5 LPGDP_{t-i} + \varepsilon_t \qquad \ldots\ldots\ldots.(7)$$

$$TFR_t = \alpha'_1 + \sum_{i=1}^{q} \delta'_1 TFR_{t-i} + \sum_{i=1}^{q} \delta'_2 FLPR_{t-i} + \sum_{i=1}^{q} \delta'_3 AFM_{t-i} + \sum_{i=1}^{q} \delta'_4 IMR_{t-i} + \sum_{i=1}^{q} \delta'_5 LPGDP_{t-i} + \varepsilon'_i \qquad \ldots\ldots\ldots.(8)$$

This involves selecting the orders of ARDL $(q_i , q_2 , q_3 , q_4 , q_5)$ model using Schwarz information criterion (SIC) and HAC (Newey-West) coefficient covariance matrix. Further, for the short-run dynamic parameters, an error correction model will be estimated with the long-run estimates. The equations (Eq.9 & Eq.10) for $FLPR_t$ and TFR_t are specified as below:

$$\Delta FLPR_t = \mu + \sum_{i=1}^{q} \rho_i \Delta FLPR_{t-i} + \sum_{i=1}^{q} \alpha_i \Delta TFR_{t-i} + \sum_{i=1}^{q} \beta_i \Delta AFM_{t-i} + \sum_{i=1}^{q} \gamma_i IMR_{t-i} + \sum_{i=1}^{q} \pi_i LPGDP_{t-i} + \varphi ECM_{t-1} + \varepsilon_t \qquad \ldots\ldots\ldots.(9)$$

Where $\rho, \alpha, \beta, \gamma, \pi, \varphi$ are short-run coefficients to equilibrium, and ECM_{t-1} is the error correction term indicates the speed of adjustment back to long-run equilibrium after a short run shock.

$$\Delta TFR_t = \mu_t + \sum_{i=1}^{q} \rho_i' \Delta TFR_{t-i} + \sum_{i=1}^{q} \alpha_i' \Delta FLPR_{t-i} + \sum_{i=1}^{q} \beta_i' \Delta AFM_{t-i} + \sum_{i=1}^{q} \gamma_i' IMR_{t-i} + \sum_{i=1}^{q} \pi_i' LPGDP_{t-i} + \varphi' ECM_{t-1} + \varepsilon_i' \quad \ldots\ldots\ldots.(10)$$

Where $\boldsymbol{\rho_i'}$, $\boldsymbol{\alpha_i'}$, $\boldsymbol{\beta_i'}$, $\boldsymbol{\gamma_i'}$, $\boldsymbol{\pi_i'}, \boldsymbol{\varphi'}$ are short-run coefficients to equilibrium, and ECM_{t-1} is the error correction term indicates the speed of adjustment back to long-run equilibrium after a short run shock.

Granger causality test

To assess the direction of causality between these selected variables, we used Granger causality test proposed by Granger (1969) which is a time series data-based approach to determine causality between two variables (see Granger, 1969; Engle and Granger, 1987).The Granger (1969) approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation. y is said to be Granger-caused by x if x helps in the prediction of y if the coefficient of lagged x's is statistically significant. The bivariate form of Granger Causality test for all possible pairs of (x, y) series in the group is following to assess the direction of Granger cause between for both model:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \cdots + \beta_l x_{t-l} + \varepsilon_t \quad \ldots\ldots\ldots.(11)$$

$Where, l = lag\ length, t = time\ period, \varepsilon_t = error\ term$

In equa.11, the null hypothesis is x does not Granger cause y.

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \cdots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \cdots + \beta_l y_{t-l} + u_t \quad \ldots\ldots\ldots.(12)$$

$Where, l = lag\ length, t = time\ period, \varepsilon_t\ and\ u_t = error\ term$

In equa.12, the null hypothesis is y does not Granger cause x.

In our study, we employ the Granger causality test to assess the direction and causal relation among fertility, female labour force participation rate, female age at first marriage, infant mortality rate, and per capita GDP.

Results

Descriptive statistics of female labour force participation rate (FLPR), total fertility rate (TFR), female age at first marriage (AFM), infant mortality rate (IMR), per capita gross domestic product (PGDP) variables is presented in Table 1. On average the FLPR in India was 26.2 percent during 1983-2018.For the same period, the average TFR was 3.16 per woman, and the IMR was 65.7

per 1000 live births. The mean AFM for the females was 20 years. Furthermore, the average per capita GDP for India was 50537 INR during 1983-2018.

Table 1: Descriptive statistics of FLPR, TFR, AFM, IMR, LPGDP

Indicators	Mean	Max.	Min.	Std. Dev.	Sample Size (Years)
FLPR	26.2	29.4	17.5	3.62	36
TFR	3.16	4.5	2.12	0.70	36
AFM	20.1	21.6	18.5	0.93	36
IMR	65.7	105.0	32.0	21.1	36
PGDP	50537	105688	24105	23756	36

The trend shown in Figure 1 for annual years between 1983 and 2018in India revealed that 28.7 percent of women were working in 1983, which reduced to only 17.5 percentage of women in 2017-18. About 11.2 percent points in FLPR has dropped between 1983 and 2018. A continuous decline in FLPR has been observed in India except 2004-05 (29.4%). Figure 2 showed a continuous decline of TFR in India and demonstrated that TFR declined from 4.5 children per woman in 1983 to 2.12 in 2018.

Figure (1) & (2). Trends of female labour force participation rate and fertility rate in India, 1983-2018

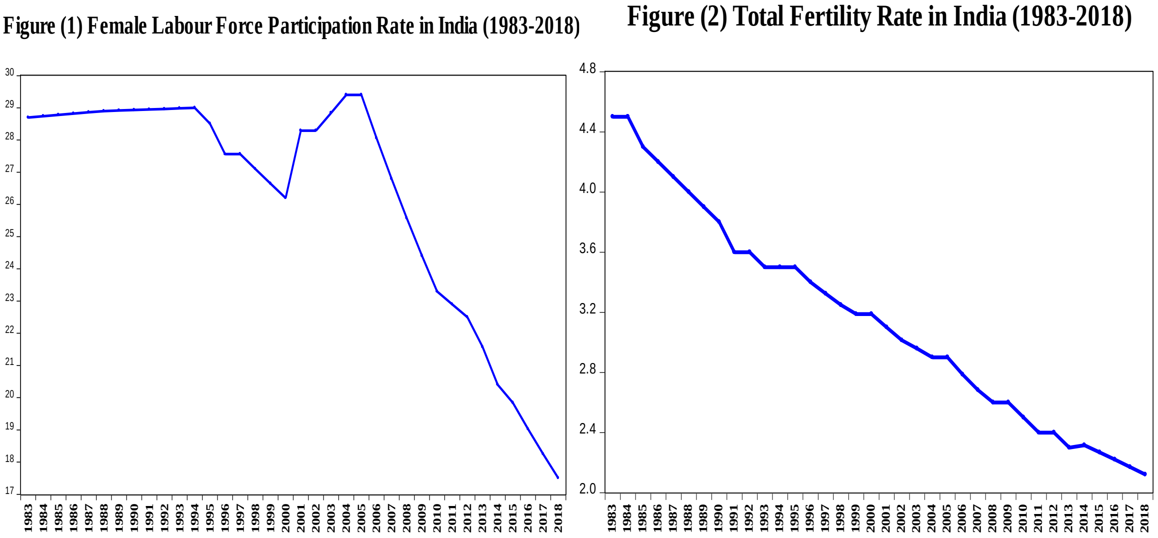

Figure (1) Female Labour Force Participation Rate in India (1983-2018)

Figure (2) Total Fertility Rate in India (1983-2018)

The stationary properties of the selected variables were checked by applying the ADF and PP unit root test (Table 2). The table 2 show the t-test for female labour force participation rate (FLPR), total fertility rate (TFR), female age at first marriage (AFM), infant mortality rate (IMR), per capita gross domestic product (PGDP). Findings portray that at level, t-test is not significant, and p-value is more than 0.05 significance level. However, at first difference, p-values for t-test of all selected variables are less than 0.05. In both unit root test, at first difference, t-test is highly significant and suggesting absence of unit root problems in these data series. Hence, all the selected variables were non-stationary in levels I (0) but at first difference became stationary, i.e., I (1).

Table 2: Unit root test for time series stationarity check

	ADF test					**PP test**			
	at level		**at first difference**			**at level**		**at first difference**	
	t-test	**prob. Value**	**t-test**	**p. Value**		**t-test**	**prob. Value**	**t-test**	**p. Value**
FLPR	-0.05	0.99	-3.89	0.02	FLPR	-0.66	0.97	-3.99	0.02
TFR	-2.17	0.49	-8.06	0.00	TFR	-1.96	0.60	-7.96	0.00
AFM	-1.61	0.76	-4.62	0.00	AFM	-1.91	0.63	-4.63	0.00
IMR	-4.58	0.00	-6.26	0.00	IMR	-2.65	0.26	-6.25	0.00
LPGDP	-1.98	0.58	-5.32	0.00	LPGDP	-1.27	0.87	-9.12	0.00

The bound co-integration test among all variables is presented in Table 3whichshowed the calculated F-statistics and diagnostic test for model I and model II. The calculated F-statistics were(6.36 in model I) and (7.73in model II) higher than upper critical bound at 5% and 1% significance level. The value of F-statistics indicated the presence of co-integration among variables and confirmed long-run relationship.

Table 3: ARDL bound test to co-integration

Model I: $\boldsymbol{FLPR = f\ (TFR, AFM, IMR, LPGDP)}$		**Model II:** $\boldsymbol{TFR = f\ (FLPR, AFM, IMR, LPGDP)}$	
F-Statistics	6.36	F-Stat.	7.73
5% critical value bounds		5% critical value bounds	
I (0)	*I (1)*	*I (0)*	*I (1)*
2.86	4.01	2.86	4.01
1% critical value bounds		1% critical value bounds	
I (0)	*I (1)*	*I (0)*	*I (1)*
3.74	5.06	3.74	5.06

The estimated long-run coefficients of ARDL are presents in Table 4. The result of model I showed that TFR and per capita GDP were negatively and significantly associated with the FLPR, as one child per woman increase in TFR was followed with 8.5% decline in FLPR. In addition, 10,000 INR increase in PGDP lead to28.4% points decline in FLPR in India. This finding indicates that income and fertility, both had the role in decline in the FLPR in India. The results of model-II revealed that IMR and PGDP were positively and significantly related to the fertility rate in the long term. The results showed that IMR and PGDP had significant and positive effect on the levels of TFR. However, FLPR did not show the effect on fertility. The diagnostic test statistics indicated that long-run estimates passed all the tests, and both models were reliable and stable in the long-run. The estimates of the Ramsey RESET test indicated that the model specification for TFR and FLPR is correctly specified, and there was no evidence of serial autocorrelation, heteroscedasticity, and the value of $R^2$was very 99% showing the goodness of fit of both models.

Table 4: ARDL bound test for long run results

Model I			**Model II**		
$FLPR = f\ (TFR, AFM, IMR, LPGDP)$			$TFR = f\ (FLPR, AFM, IMR, LPGDP)$		
Regressor	Coefficient	t-statistics	Regressor	Coefficient	t-statistics
TFR	-8.465**	-2.36	FLPR	0.003	0.52
AFM	1.615	0.93	AFM	-0.08	-1.24
IMR	-0.129	-0.82	IMR	0.037***	8.78
LPGDP	-28.38***	-6.31	LPGDP	0.519**	2.34
Constant	332.347***	36.95	Constant	-3.156	-1.11
Diagnostic Test			**Diagnostic Test**		
R^2	0.99		R^2	0.99	
Adjusted R^2	0.99		Adjusted R^2	0.99	
D-W stat.	1.844		D-W stat.	-3.89	
F-stat.	309.88		F-stat.	964.54	
Ramsey RESET test	8.11 (0.00)		Ramsey RESET test	0.39(0.71)	
Heteroskedasticity (ARCH) test	25.12 (0.00)		Heteroskedasticity (ARCH) test	0.68(0.40)	
J-B Normality value	2.54 (0.28)		J-B Normality value	0.27 (0.87)	
Breusch-Godfrey Serial correlation LM test	28.79 (0.00)		Breusch-Godfrey Serial correlation LM test	7.43(0.00)	

Note: Values in brackets are *p* values ** and *** denote significance at 5% and 1% levels, respectively

The empirical findings of the short-run analysis are presented in Table 5. The results of model I reveal that the female AFM was positively and significantly associated with FLPR in the short-run. Results from model II suggested that the female AFM had a significant and negative effect on TFR in the short-run. Decline in IMR contributed to a decline in TFR. however, at 1 and 2 lag period, IMR was negatively associated with TFR. Findings of model II also suggested that one- and three-years lag of PGDP had contributed to decline in TFR. Both the model passed all the diagnostic test successfully for short-run estimates and showed robustness of the models. The estimates of the Ramsey RESET test indicated that the model specification for TFR and FLPR was correctly specified for the short-run, and there was no evidence of serial autocorrelation, heteroscedasticity, the value of R^2 indicated that the model was a good fit and free from specification error.

Table 5: ARDL bound test for short run results

Model I			**Model II**		
$\Delta FLPR = f\ (\Delta TFR, \Delta AFM, \Delta IMR, \Delta LPGDP)$			$\Delta TFR = f\ (\Delta FLPR, \Delta AFM, \Delta IMR, \Delta LPGDP)$		
Regressor	Coefficient	t-statistics	Regressor	Coefficient	t-statistics
$\Delta FLPR_{t-1}$	0.438***	4.11	ΔAFM	-0.242***	-4.27
$\Delta FLPR_{t-2}$	0.463***	4.32	ΔAFM_{t-1}	-0.191***	-2.99
ΔTFR	1.077	0.93	ΔAFM_{t-2}	-0.357***	-5.77
ΔAFM	5.972***	6.65	ΔAFM_{t-3}	-0.235***	-3.12
ECM_{t-1}	-0.251***	-6.87	ΔIMR	0.004**	1.71
			ΔIMR_{t-1}	-0.009***	-2.81
			ΔIMR_{t-2}	-0.009	-3.90
			$\Delta LPGDP$	0.011	0.01
			$\Delta LPGDP_{t-1}$	-1.233***	-5.23
			$\Delta LPGDP_{t-2}$	-0.184	-0.61
			$\Delta LPGDP_{t-3}$	-1.083***	-4.22
			ECM_{t-1}	-0.642	-7.71
Diagnostic Test			**Diagnostic Test**		
$R^2$0.76			$R^2$0.85		
Adjusted $R^2$0.72			Adjusted $R^2$0.78		
F-stat	17.3(0.000)		F-stat	7.4 (0.000)	
D-W stat	1.844		D-W stat	2.37	
Heteroscedasticity (ARCH) test	0.91(0.82)		Heteroscedasticity (ARCH) test	3.91(0.42)	
Breusch-Godfrey Serial Correlation LM test	12.81(0.002)		Breusch-Godfrey Serial Correlation LM test	15.86(0.01)	
Ramsey RESET test	0.247(0.62)		Ramsey RESET test	1.686(0.22)	

Note: Values in brackets are *p* values ** and *** denote significance at 5% and 1% levels, respectively

Figure 3 and Figure 4 show that the plots of the cumulative sum (CUSUM) and the cumulative sum of square (CUSUM of the square) were between critical boundaries at 5% level of significance for Model I. These tests were developed by Brown et al. (1975) to see the consistency of the parameters for both models.

Figure (3) & (4): Stability test for Model I

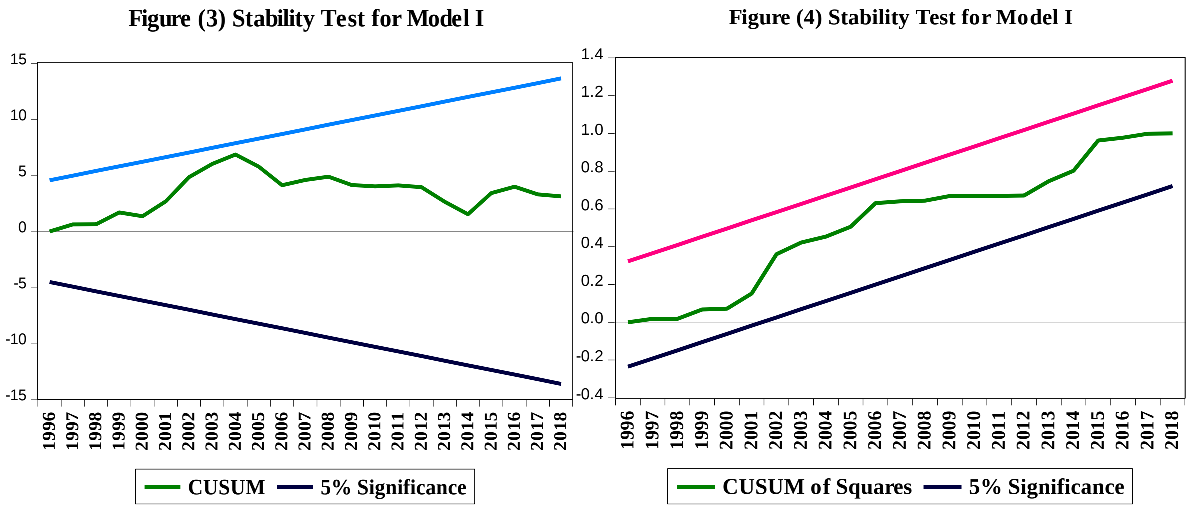

Figure (3) Stability Test for Model I

Figure (4) Stability Test for Model I

Figure 5 and Figure-6 depicted the plots of cumulative sum (CUSUM) and the CUSUM of square were between critical boundaries at 5% level of significance for Model II. These tests suggested that the stability property and reliability of parameters in both the long and short-run for the model I and II. These tests also confirmed that both models appeared to be steady and specified appropriately.

Figure (5) & (6): Stability test for Model II

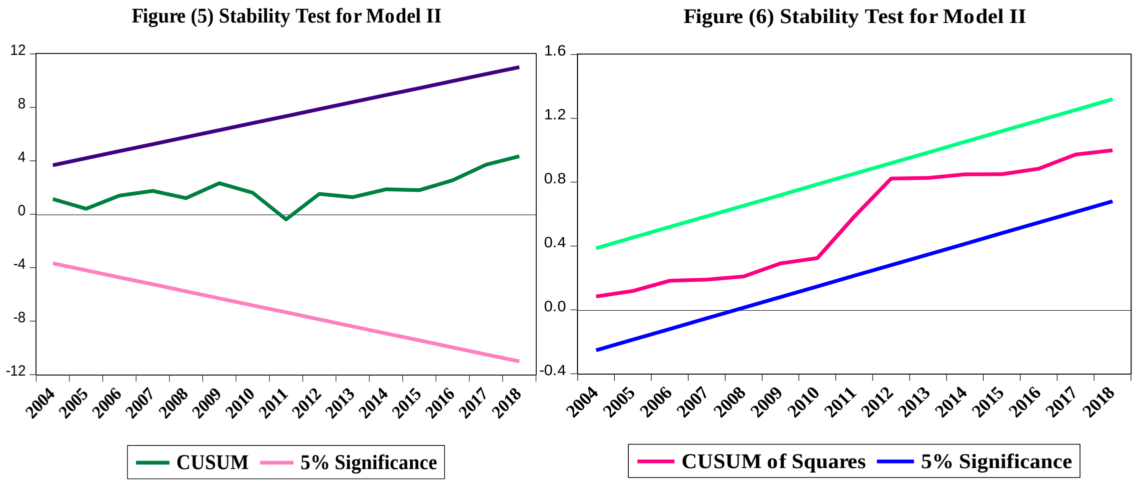

Figure (5) Stability Test for Model II

Figure (6) Stability Test for Model II

The findings of Granger causality test shown in Table 6 for Model I and II revealed that there was a unidirectional causality running from female age at first marriage and Per capita GDP to female labour force participation rate in model I. Further, model II showed that there was a unidirectional causality running from the female age at first marriage, infant mortality rate, and per capita GDP to total fertility rate. However, both the model indicated that there was no causality between FLPR and TFR.

Table 6: Granger Causality analysis

Model I			Model II		
Granger Causality	**F-Stat.**	**Prob.**	**Granger Causality**	**F-Stat.**	**Prob.**
TFR→FLPR	3.46	0.07	FLPR → TFR	0.07	0.79
AFM→FLPR	5.06**	0.03	AFM→ TFR	5.13**	0.01
IMR→FLPR	3.36	0.07	IMR→TFR	2.63	0.08
LPGDP→FLPR	5.58**	0.02	LPGDP→TFR	3.91**	0.03
FLPR→AFM	0.21	0.65	TFR→AFM	0.88	0.43
FLPR→IMR	0.83	0.35	TFR→IMR	3.74**	0.04
FLPR→LPGDP	1.58	0.22	TFR→LPGDP	1.19	0.32

Note: ** denote significance at 5% levels

Conclusions

The question of whether fertility decline leads FLPR in India, but also the effect of increment in female age at first marriage, infant mortality rate, and per capita GDP has been examined through the TFR-IMR-FLPR-AFM-PGDP over last three decades (1983-2018). Although most of the literature has shown that any change in fertility directly affects the FLPR. However, the theory provides a conflicting indication of the relationship between female labour force participation and fertility. The empirical evidence from developed countries revealed mixed results on the relationship between fertility and labour force participation of women (Hartani et al., 2015; Siah and Lee, 2014; Salamaliki et al., 2012; Mishra and Smith, 2010). In the context of India, both FLPR and fertility are on a continuous decline challenging the established theory that low fertility leads to more participation of women in the labour market.

To the best of our knowledge, this is first study in context of India which investigate the cointegration and causality between fertility and female labour force participation using ARDL bound test approach. Our study contributes in current debate of fertility declines as well as declining female labour force participation in India. The current scenario of fertility and FLPR in India reveals a puzzling situation as both are declining over the last three decades. Our findings do not support the becker’s new home economics theory, societal response theory and role incompatibility hypothesis as both fertility and FLPR are at continuous decline despite the fact that India has achieved much progress towards economic growth, girl’s higher enrolments in secondary and higher education, improvement in reproductive health, good employment opportunities and investment in skills generation among youth and women. The findings of this study indicate that fertility declines do not directly affect the FLPR, and controlling and reducing TFR is not the sufficient measure to increase labour force participation of women. The study shows that delay in women’s marriage age and high economic growth might be helpful to increase FLPR in India.

Our study does not find any evidence that fertility declines helps women to participate in labour market as FLPR is at its lowest point (17.5 percent) in 2018. This could be possible due to the India’s traditional employment system and structural employment problems. Turning back to the literature, our findings support the role of falling infant mortality, increasing household income and delay in women’s marriage age in reducing fertility. Additionally, the findings also indicate that massive increment in per capita GDP and delay age at marriage impact FLPR in long run periods. The findings reveal long run cointegration between female labour force participation and fertility in India. However, we do not find any evidence of granger cause between fertility and female labour force participation in India.

The results of the present study supported that the female age at first marriage and per capita GDP affect both fertility and FLPR, and in long-run TFR and FLPR, both influence each other. However, the findings indicate that there is no evidence of Granger causality between FLPR and fertility rates.Further, the findings from possible linkage among TFR-IMR-FLPR-AFM-per capita GDP are significant. Although the fertility has been decliningdue to increased awareness, accessibility, and availability of family planning programmes of government of India(Bhalla & Kaur, 2011; Mazumdar & Neetha, 2011; Mehrotra & Parida, 2011; Afridi et al., 2018; Andres et al., 2017; Kapsos et al., 2014; Arokiasamy,2009; Das Gupta & Mari Bhat, 1997). However, this decline is not accompanied by an increase in the participation of women in thelabour market. The empirical results of this study and the existingliterature (Bhalla & Kaur, 2011;Arokiasamy,2009; Bloom et al., 2009) suggested that higher enrolment of girls in secondary and higher education, increase in age at first marriage, falling infant mortality rate and speedy economic growth has led to demographic, social, and economic change in India resulting in fertility decline. However, these factors could not increase female labour force participation, and over the last three decades, India experienced a huge drop in work participation of women indicates conflicting trends.

India has experienced massive increase in per capita GDP, increase in girl’s enrolment in secondary and higher education, and declining fertility and mortality rates in last thirty years. However, during the same period, there has been persistent fall in women’s work participation. Policy makers must give attention on delaying female age at marriage, increasing public works programs for women, incentives at workplace to join, improving per capita income, and Government should focus on women’s social and economic welfare, and reproductive health through investment in women’s education and skills especially vocational and technical training. Societal norms and attitudes can employ a significant influence to increase female participation in labour market in India. In addition, changing perceptions regarding gender roles and providing better opportunity to women can be agenda to increase women’s economic activity and employment outcome in India.

Funding

This study is not funded by any institutions.

Conflicts of interest

There is no conflict of interest.

Availability of data and material

All the data has been obtained from database of National sample survey, sample registration survey, Registrar General of India and Reserve Bank of India which is online available.

Software

EVIEWS 10 version and STATA 16 has been used for analysis.

Acknowledgments

The author is thankful to the International Institute for Population Sciences (IIPS), Mumbai and the UCSD Center on Gender Equity and Health (GEH), San Diego, USA to provide travel grants to present earlier version of this paper in Population association of America (PAA 2020) under the GENDER (Gender Equity and Demography Research) Project. This research article is part of the author's PhD dissertation, and the author would like to thank Dr. Preeti Dhillon for her guidance with this research piece.

References

Afridi, Farzana, Taryn Dinkelman, and Kanika Mahajan, 2018, "Why are fewer married women joining the work force in rural India? A decomposition analysis over two decades." *Journal of Population Economics* 31(3): 783-818.

Ahn, Namkee, and Pedro Mira, 2002, "A note on the changing relationship between fertility and female employment rates in developed countries." *Journal of population Economics* 15(4): 667-682.

Andres, Luis Alberto, Basab Dasgupta, George Joseph, Vinoj Abraham, and Maria Correia, 2017, "Precarious drop: Reassessing patterns of female labor force participation in India." *World Bank Policy Research Working Paper* 8024.

Arokiasamy, P, 2009, "Fertility decline in India: Contributions by uneducated women using contraception." *Economic and Political Weekly 44*(30): 55-64.

Becker, Gary S, 1960 "An economic analysis of fertility." In *Demographic and economic change in developed countries*, pp. 209-240. Columbia University Press.

Bhalla, Surjit, and Ravinder Kaur, 2011, "Labour force participation of women in India: some facts, some queries."

Bloom, David E., David Canning, Günther Fink, and Jocelyn E. Finlay. "Fertility, female labor force participation, and the demographic dividend." *Journal of Economic growth 14*(2): 79-101.

Bowen, William G., and T. Aldrich Finegan,1969, *The economics of labor force participation*. Princeton University Press.

Brewster, Karin L., and Ronald R. Rindfuss, 2000, "Fertility and women's employment in industrialized nations." *Annual review of sociology 26*(1): 271-296.

Brown, Robert L., James Durbin, and James M. Evans, 1975, “Techniques for testing the constancy of regression relationships over time." *Journal of the Royal Statistical Society: Series B (Methodological) 37*(2): 149-163.

Cheng, Benjamin S, 1999, "Cointegration and causality between fertility and female labor participation in Taiwan: A multivariate approach." *Atlantic Economic Journal* 27(4): 422-434.

Cheng, Benjamin S., Robert C. Hsu, and Qiyu Chu,1997, "The causality between fertility and female labour force participation in Japan." *Applied Economics Letters* 4(2):113-116.

Cheng, Benjamin S, 1996a, "The causal relationship between African American fertility and female labor supply: Policy implications." *The Review of Black Political Economy* 25(2): 77-88.

Cheng, Benjamin S, 1996a, "An investigation of cointegration and causality between fertility and female labour force participation." *Applied Economics Letters* 3(1): 29-32.

Das Gupta, Monica, and P. N. Mari Bhat, 1997, "Fertility decline and increased manifestation of sex bias in India." *Population studies* 51(3): 307-315.

Del Boca, Daniela, 2002, "Low fertility and labour force participation of Italian women: evidence and interpretations." *OECD Labour Market and Social Policy Occasional Papers*, No. 61. OECD Publishing, Paris.

Desai, Sonalde, 2010, "The other half of the demographic dividend." *Economic and political weekly 45*(40): 12-14.

Dickey, David A., and Wayne A. Fuller,1979, "Distribution of the estimators for autoregressive time series with a unit root." *Journal of the American statistical association* 74(366a): 427-431.

Engelhardt, Henriette, Tomas Kögel, and Alexia Prskawetz,2004, "Fertility and women's employment reconsidered: A macro-level time-series analysis for developed countries, 1960–2000." *Population studies 58*(1): 109-120.

Engle, Robert F., and Clive WJ Granger,1987, "Co-integration and error correction: representation, estimation, and testing." *Econometrica: journal of the Econometric Society* 55 (2): 251-276.

Granger, Clive WJ,1969, "Investigating causal relations by econometric models and cross-spectral methods." *Econometrica: journal of the Econometric Society* 37(3): 424-438.

Granger, Clive WJ,1988, "Some recent development in a concept of causality." *Journal of econometrics 39*(1-2): 199-211.

Granger, Clive WJ, and Paul Newbold,1974, "Spurious regressions in econometrics." *Journal of econometrics* 2(2): 111-120.

Hartani, Nira Hariyatie, Nor Aznin Abu Bakar, and Muhammad Haseeb, 2015, "The nexus between female labor force participation and female total fertility rate in selected ASEAN countries: panel cointegration approach." *Modern Applied Science* 9(8): 29.

International Institute for Population Sciences (IIPS) and ICF, 2017, National Family Health Survey (NFHS-4), 2015-16: India. Mumbai: IIPS.

International Institute for Population Sciences (IIPS),and Macro International,2007, National Family Health Survey (NFHS-3), 2005-06. India. Mumbai: IIPS.

Jaumotte, Florence,2003, "Female labour force participation: past trends and main determinants in OECD countries." OECD Countries. OECD Working Paper No. 376.http://dx.doi.org/10.2139/ssrn.2344556

Kapsos, Steven, Evangelia Bourmpoula, and Andrea Silberman,2014, "*Why is female labour force participation declining so sharply in India?*." No. 994949190702676. International Labour Organization.

Klijzing, Erik, Jacques Siegers, Nico Keilman, and Loek Groot,1988, "Static versus dynamic analysis of the interaction between female labour-force participation and fertility." *European Journal of Population* 4(2): 97-116.

Lehrer, Evelyn, and Marc Nerlove,1986, "Female labor force behavior and fertility in the United States." *Annual review of sociology* 12(1): 181-204.

Mason, Karen Oppenheim, and V. T. Palan,1981, "Female employment and fertility in peninsular Malaysia: The maternal role incompatibility hypothesis reconsidered." *Demography 18*(4):549-575.Mazumdar, Indrani, and Neetha N, 2011,"Gender Dimensions: Employment Trends in India, 1993- 94 to 2009-10."*Economic and Political Weekly*XLVI (43): 118-26.

Mehrotra, Santosh, and Jajati K. Parida,2017, "Why is the labour force participation of women declining in India?." *World Development* 98: 360-380.

Michael, Robert T,1985, "Consequences of the rise in female labor force participation rates: questions and probes." *Journal of Labor Economics* 3(1) Part 2: S117-S146.

Mishra, Vinod, and Russell Smyth,2010, "Female labor force participation and total fertility rates in the OECD: New evidence from panel cointegration and Granger causality testing." *Journal of Economics and Business* 62(1): 48-64.

Nam, Kigon,2010, "The Effect of Having More Children on Women's Labour Force Participation in Korea: An Analysis Using Instrument Variables." *Labour 24*(3): 333-356.

Narayan, Paresh Kumar, and Russell Smyth, 2006, "Female labour force participation, fertility and infant mortality in Australia: some empirical evidence from Granger causality tests." *Applied Economics* 38(5): 563-572.

Pesaran, M. Hashem, Yongcheol Shin, and Richard J. Smith, 2001, "Bounds testing approaches to the analysis of level relationships." *Journal of applied econometrics 16*(3): 289-326.

Phillips, Peter CB, and Pierre Perron. 1988. "Testing for a unit root in time series regression." *Biometrika* 75(2): 335-346.

PLFS, 2019, Periodic Labour Force Survey in India, 2017–18. New Delhi, Department of Statistics, Government of India.

RBI, 2020, Handbook of Statistics on the Indian Economy. Reserve Bank of India. https://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications

RGI, 2020, Sample Registration of Births & Deaths in India 1983-2018. Compendium of India's Fertility and Mortality Indicators. Sample Registration System (SRS), Office of Registrar General, India. SRS Analytical Series.http://censusindia.gov.in/2011-Common/Sample_Registration_System.html

RGI, 2011, Census of India. F-series. Office of Registrar General, India. http://censusindia.gov.in/Meta-Data/metadata.htm#/tab5

Salamaliki, Paraskevi K., Ioannis A. Venetis, and Nicholas Giannakopoulos, 2013, "The causal relationship between female labor supply and fertility in the USA: updated evidence via a time series multi-horizon approach." *Journal of Population Economics 26*(1): 109-145.

Siah, Audrey KL, and Grace HY Lee, 2015, "Female labour force participation, infant mortality and fertility in Malaysia." *Journal of the Asia Pacific Economy 20*(4): 613-629.

Spitze, Glenna. "Women's employment and family relations: A review." *Journal of Marriage and the Family* 50(3):595-618.

Subramaniam, Thirunaukarasu, Nanthakumar Loganathan, and Evelyn S. Devadason, 2018, "Determinants of female fertility in ASEAN-5: Empirical evidence from bounds cointegration test." *The Singapore Economic Review 63*(03): 593-618.