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Female Labor Force Participation and Uganda's Economic Growth

[1]John Paul Apire, [2]Dickson Turyareeba, [2]Moni Anthony Olyanga, [2]Vincent Patsy Katutsi, [3]Benjamin Musiita*, [4]Anthony Wamala
[1]Ministry of Finance, Planning and Economic Development, Kampala, Uganda
[2]Makerere University Business School, Uganda
[3]Mbarara University of Science and Technology, Kampala, Uganda
[4]Makerere University, Kampala, Uganda
apirejohn@gmail.com, dturyareba@mubs.ac.ug, aolyanga@mubs.ac.ug, vkatutsi@mubs.ac.ug, *bmusiita@must.ac.ug, setlightpr@yahoo.com

Abstract: This comprehensive study explores the impact of various female labor force participation indicators on Uganda's economic growth, encompassing participation rate, educational levels, and fertility rate while considering confounding factors like capital formation and inflation. Utilizing a quantitative approach and a causal relationship research design, the study employs the ARDL (3, 3, 1, 1, 1, 2) model on quarterly data from 1990 to 2021. Results reveal a significant adverse short-term causal impact of the female labor force participation rate on economic growth, with no such effect in the long term. The educational levels and fertility rate exhibit statistically insignificant impacts in both short and long terms. The findings suggest a prevailing trend of female labor contributing predominantly to labor-intensive agriculture and the informal economy, without a noticeable shift to more lucrative sectors over the long run. Additionally, the study underscores the potential for short-term economic growth through birth control measures and policies enhancing physical capital stocks, contributing to our understanding of Uganda's economic progress within the neoclassical and U-shape development frameworks.

Keywords: *Female labor force, neoclassical growth theory, U-Shape development theory, economic growth, ARDL, Uganda.*

1. Introduction

Economic theories and empirical research have argued over the necessary conditions for the economic growth of a nation (Doré & Teixeira, 2023; Fankhauser & Jotzo, 2017). None of the theories and empirical studies in growth literature have denied the role of factor inputs in influencing variations in total output. Though growth literature lays down the growth theories that can provide a framework for modeling sources of cross-country variations in growth in GDP, the existing growth theories are not explicit on analysis of the influence of gender dimensions in the labor input variable in explaining variations in the growth of output. The growth accounting, as elucidated by Romer (1986), primarily seeks to decompose overall real-output growth into factors attributed to the expansion of capital input, the growth in labor input, and the advancement in total factor productivity, commonly known as the Solow residual. This residual gauges the rise in output that cannot be accounted for by the growth in inputs.

The growth accounting approach has limitations in disaggregating labor input by gender and discerning its contribution to output growth rates. Recent growth literature has incorporated the gender element in the labor variable, considering it a driving factor for output growth. Verick (2018), for example, contends that variations in economic growth, social standards, education levels, fertility rates, and availability of childcare and other services account for the large variation in female labor market participation among nations. Scholars express concern that understanding the impact of female labor force participation on economic growth is complex and reflects changes in the economic growth trajectory (Thaddeus et al., 2022). The limited available empirical data shows mixed results regarding the causal relationship between female labor force participation (FLF) and economic growth. One group of scholars reports a U-shaped association between female labor force participation and economic growth (e.g., Tam, 2011; Lechman & Okonowicz, 2013; Olivetti, 2013; Tsani et al., 2013; Lechman & Kaur, 2015, among others), while another group suggests a positive relationship (e.g., Na-Chiengmai, 2018; Dogan and Aky€uz, 2017; Lahoti & Swaminathan, 2013; Seguino, 2009, among others). Uganda has not received much attention in this area of study.

This research aims to contribute to this subject by incorporating the U-shaped development theory and adopting and modifying the Solow-style neoclassical model and its extensions to further investigate the impact of women's labor force participation on Uganda's economic growth, utilizing quarterly data for the period 1990-2021.

2. Empirical Evidence

Effect of Female Labor Force Participation Rate on Economic Growth

Thaddeus et al. (2022) examined a sample of 42 sub-Saharan African nations using yearly data from the World Bank development indicators. The study's goal was to look into how, between 1991 and 2019, the percentage of women in the workforce affected economic development. Cointegration analytical techniques were used in the study to examine the underlying link. In the investigation, the authors used Granger causality and the Autoregressive Distributed Lag model. The results pointed to a long-term, unidirectional causal relationship between economic growth and the female labor force in Sub-Saharan Africa. The causal relationship flowed from economic growth to the female labor force.

Khaliq et al. (2017) investigated the relationship between Pakistan's female labor force participation rate and economic growth using Error Correction Modeling and Johansen cointegration tests. Time series data covering the years 1990 to 2014 were used in the study. The study's findings supported the U-shaped link theory by showing that the variables had an inverse long-run relationship.

Using a modified version of Mankiw, Romer and Weil's (1992), Mankiw, Chiengmai (2018) and the traditional Solow's growth model, Na-Chiengmai (2018) examined the hypothesis that the female labor force participation rate—a measure of the proportion of women in the labor force—has a positive impact on economic growth. The study applied the OLS approach to a cross-section of 122 countries worldwide and the Autoregressive Distributed Lag (ARDL) methodology on a set of pooled time series data for five groups of countries between 1998 and 2016. The results validated the hypothesis about the positive contribution of the female labor force to growth, showing that the coefficients of the female labor force had a positive sign and were statistically significant in nearly all cases.

Lechman & Kaur (2015) investigated, in 162 different countries, the relationship between economic growth and the proportion of women in the labor force between 1990 and 2012. The source of the data was WDI 2013. The study estimated empirical models using panel estimation techniques and looked at two different sub-samples: one with 162 nations and the other with four income classes (low-income, lower-middle-income, upper-middle-income, and high-income). In all sub-samples, the study's results supported the hypothesis of a U-shaped relationship between female labor force participation and economic growth, despite large cross-country variable effects.

According to a study by Tandrayen-Ragoobur (2011), Mauritius's rate of economic growth and the labor force participation rate of women are positively correlated. The research indicated that married females had lower labor market participation rates, negatively impacting economic growth—a reflection of the positive relationship.

Level of education of female in employment and economic growth

A study by Verena et al*.* (2011) on Mauritius showed a positive correlation between female education and economic growth. The study looked into the things that motivate and dissuade female to work. Utilizing data from the 2006–2008 household census and employing the logistic regression modeling for Mauritius, Verena et al*.* (2011) found that their findings were consistent with earlier research for developing nations, which showed that female with higher levels of education are better able to contribute their skills for useful services. The study further showed that older female participates more actively, though this effect grows at a slower rate as female get older.

Syomwene and Kindiki (2015) employed a systematic literature review approach to study and discuss the relationship between female education and sustainable economic development in Kenya to find practical solutions to Kenya's development problems. The study's two main conclusions were that: (i) female education was one of the initiatives that could help Kenya achieve the MDGs; and (ii) female education could help Kenya achieve Kenya Vision 2030, which aims to make Kenya a newly industrializing, middle-income nation by 2030 that offers a high standard of living to all its citizens.

Oztunc et al. (2015) used panel regression analysis to examine the connection between female education and long-term economic growth in the Asia Pacific area. The study examined secondary data from Bangladesh, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand, and Vietnam, spanning the years 1990 to 2010. GDP was used to evaluate economic growth, while female enrollment in primary schools served as a proxy for education. The study found that the annual growth in per capita income was significantly influenced by the number of females enrolled in primary school.

Alaoui (2016) initiated a panel study focusing on Morocco, Algeria, Tunisia, and Egypt to examine the impact of female education on economic growth. Female education was assessed based on primary, secondary, and tertiary enrollments. The study's conclusions about the impact's direction on economic growth were not entirely consistent. Notably, the study indicated that whereas enrollment in primary and secondary schools was negatively correlated with economic growth, female tertiary education had a considerably favorable impact on the expansion of the economy. The study found that subject to the abolition of all forms of gender discrimination and a strong and high-quality institutional framework, female tertiary education was a major engine of economic growth and development.

Tansel and Güngör (2012) in their study examined the gender effects of education on economic development in Turkey. The study utilized province-level data collected over four time periods (i.e. 1975-1980, 1980-1985, 1985-1990 and 1990-2000) for the 67 provinces of Turkey. Estimation was done by Pooled Robust Regression and sensitivity analysis was accomplished by running OLS and 2SLS estimators. The study's primary conclusion was that, whereas male education generally had a positive or negligible impact, female education positively and considerably affected the steady-state level of labor productivity and, consequently, an increase in production.

Fertility rate and economic growth

Fertility is known to have an impact on the relationship between female labor force participation and overall economic growth. Diverse theories have been proposed by academics to explain the demographic shift and how it relates to economic growth, and there are conflicting opinions in the literature regarding how fertility affects growth. A panel dataset of 107 nations spanning the years 1960–1985 was used by Brander and Dowrick (1994) to investigate the impact of population increase and fertility on economic growth. According to the study, although traditional resource dilution was not apparent in the data, high birth rates seemed to hinder economic growth through investment effects and maybe "capital dilution." A noteworthy finding of the study was that a decrease in birth rates had a significant positive medium-term effect on per capita income growth through labor supply or "dependency" effects.

Er (2012) conducted a study using panel data estimation with fixed effects on 187 countries worldwide, representing different income levels during the study period 1998-2008. The aim was to determine which female indicators of education, employment, health, and political factors, measured through various sub-indicators, significantly affected economic growth. The study results revealed that different measurements, such as lower fertility, increased female employment, and greater female participation in parliament, were significant factors influencing the economic growth of a country.

Using panel data from the World Development Indicators (WDI) for more than 200 countries over a 50-year period, Ranganathan et al. (2015) treated economic growth and fertility decline as endogenous factors using a simultaneous system of equations in the change variables. They achieved this by combining cross-country data with a non-linear dynamic model. The purpose of the study was to investigate how demographic shifts affect economic growth. The findings showed that, although it had an indirect effect on child mortality, the fertility rate might affect economic growth. In particular, the results showed that the fertility rate was moderately GDP-dependent and fell in low-child mortality scenarios. GDP grew when fertility rates fell, and child mortality fell as GDP increased. The results further demonstrated that, in a concurrent system arrangement, economic growth affected the fertility rate through the intermediate variable of child mortality rather than having a direct effect on it.

Gaps identified in the reviewed literature

As a result, there is disarray in the literature review about the connection between economic growth and the rate of female labor force participation. Numerous indicators suggest that there are several connections between the rates and patterns of economic growth and women's labor force participation. The U-shaped theory is supported by some authors who find a negative association between the rate of female labor force participation and economic growth. Some scholars, however, claim that there is a positive correlation between these two characteristics. Furthermore, there is notably little data about the link under investigation, particularly in the context of Uganda. This study aims to contribute to the ongoing debate by exploring the connection between indicators of female labor force participation and Uganda's economic growth.

Theoretical Framework

The Solow-style neoclassical growth theory, which was first developed by Solow (1956) and later extended by Mankiw et al. (1992), and the U-shaped economic development theory, which was first demonstrated by Durand (1975) and popularized by Psacharopoulos & Tzannatos (1989), serve as the foundation for this study. The neoclassical growth model in the Solow school emphasizes how important capital accumulation is in determining the long-term pace of economic growth. On the other hand, as Verick (2018) points out, the U-shaped relationship theory suggests a U-shaped association between economic growth and female labor force participation.

The main idea in the neoclassical growth model is that technical progress is entirely exogenous to these models so that in reality economic growth is left unexplained (Solow and Swan, 1956), but can be accounted for in the Solow residual. The neoclassical growth model takes the following form:

$$Y(t) = A(t)K(t)^{\alpha}L(t)^{1-\alpha} \quad (1)$$

Where: Y is Income or the economy's Gross Domestic Product (GDP), A is a scaling factor or productivity parameter which reflects the state of technology, K is physical capital stock and L is the amount of labor stock in the economy.

Because of the dynamic relationship between labor and technology, the neoclassical production function is often re-stated as:

$$Y(t) = K(t)^{\alpha}[A(t)L(t)]^{1-\alpha} \quad (2)$$

In equation (2), the model now states that technology is labor augmenting and that workers' productivity depends on the level of technology.

The study aligns with the principles of neoclassical growth theory while incorporating elements from U-shaped development theory. The U-shaped theory posits that as countries undergo economic development, there is an initial decline in female labor force participation, followed by a subsequent increase. In the early stages of development, characterized by lower GDP per capita, females actively participate in economic activities, often in unpaid roles within family farms and businesses. At this initial phase, a low GDP per capita is positively correlated with a higher female labor force participation rate.

Our model incorporates the education level of female labor force participants as an extra characteristic, modeled after the neoclassical growth model extended by Mankiw, Romer, and Weil (1992), which acknowledged the importance of human capital in driving output growth. This effectively conveys the impact of female education on the increase in output. The modified version of equation (2) is then expressed as follows:

$$Y(t) = K(t)^{\alpha}\left[A(t)L_f(t)L_m(t)\right]^{\beta}H^{1-\alpha-\beta} \quad (3).$$

Where in equation (3), L_f represents female labor stock, L_m represents male labor stock, and H represents human capital, commonly measured by education level.

3. Method

Design: This study adopts a causal relationship research design. A time series multivariable regression model has been used as a tool to investigate the underlying relationships.

Data and sources: The World Bank Development Indicators Data Bank provided secondary time series data for the years 1990–2021, and the Uganda Bureau of Statistics (UBOS) provided supplementary data for this study. This study used the quadratic mean average method of converting low-frequency time series to high-frequency time series using Eviews9 to meet the recommended minimum number of time series observations of at least 50 observations for time series regressions (McCleary et al., 1980; Warner, 1998; Jebb et al., 2015). This conversion enabled the increase of time series observations from n = 32 with annual data to n = 128 with quarterly data.

Model Specification: The neoclassical growth theory, which was first developed by Solow (1956) and expanded upon by Mankiw, Romer, and Weil (1992), and the U-Shaped development theory, which was first demonstrated by Durand (1975) and made popular by Psacharopoulos & Tzannatos (1989), serve as the foundation for the empirical model for analysis in this research study.

Re-writing equation (3) in a general non-linear form, we have:

$$Y(t) = K(t)^{\alpha}\left[A(t)L_f(t)L_m(t)\right]^{\beta}H^{1-\alpha-\beta}\mu e^{u} \quad (4).$$

In equation (4), μ represents observable factors that influence Y that are not explicitly indicated in the extended neoclassical growth model and e is the Euler's constant. The rest of the variables are defined in equation (3).

In the empirical analysis, Y is measured by GDP (*GDP*); K is measured by gross capital formation (*gkf*); L_f is measured by total female labor force participation designated by (*tflfp*), L_m is measured by total male labor force participation designated by (*tmlfp*) and H is measured by total female labor force with basic education (*feduc*).

Introducing the variable notations in the empirical model, equation (4) becomes:

$$gdp(t) = gkf(t)^{\alpha}[tflfp(t)tmlf]^{\beta}feduc^{1-\alpha-\beta}\mu e^{u} \quad (5).$$

Letting $(1-\alpha-\beta) = \beta_3$ and taking natural logarithms in equation (5) while indicating a time indicator conventionally, we get a multivariate linear regression as follows:

$$lngdp_t = \alpha\, lngkf_t + \beta_1\, lntflfp_t + \beta_2\, lntmlfp_t + \beta_3\, lnfeduc_t + ln\mu + u_t lne \quad (6)$$

To avoid possible omitted variable bias, the study is based on empirical literature to further introduce additional variables in the empirical model such as total fertility rate (*fert)* and inflation, which are not explicitly indicated in the neoclassical growth model and its extensions and are not explicitly represented in the U-shaped development theory, but which have been linked as important factors that influence economic growth as provided by empirical evidence. These additional factors, together with a constant, are captured by μ in equations (5) and (6).

Incorporating the additional growth factors in our analysis, the empirical multiple linear regression for analysis is then expressed as:

$$lngdp_t = \delta + \alpha\, lngkf_t + \beta_1\, lntflfp_t + \beta_2\, lntmlfp_t + \beta_3\, lntflfeduc_t + \beta_4\, fert_t + \beta_5\, \text{inf}_t + u_t \quad (7).$$

Where:

$lngdp_t$ is the natural logarithm of GDP at time t; $lngkf_t$ is the natural logarithm of gross capital formation at time t,$lntflfp_t$ is the natural logarithm of total female labor force participation at time t; $lntmlfp_t$ is the natural logarithm of total male labour force participation at time t; $lntflfeduc_t$ is the natural logarithm of the total female labor force with basic education at time t; $fert_t$ is the average total fertility at time t; inf_t is the rate of inflation at time t; u_t is the error component in the time series empirical model; and δ is a constant.

Due to concerns about the high multicollinearity of the male labour force participation with female labour force participation and gross capital formation (Refer to Table 4), the variable male labour force was excluded from the model and the final empirical model became:

$$lngdp_t = \delta + \alpha\, lngkf_t + \beta_1\, lntflfp_t + \beta_2\, lntflfeduc_t + \beta_3\, fert_t + \beta_4 \inf_t + u_t \qquad (8)$$

Data Analysis

The study employs varied data analytical techniques, some of which explore the key descriptive statistics on model variables, others explore the time series data behavior for instance the unit roots tests, multicollinearity test and cointegration tests, and the other techniques are robustness tests after regression analysis such as the serial correlation test and normality of residuals test.

Model estimation techniques: Based on the unit root test results and the cointegration test results, this study employed the autoregressive distributed lags (ARDL) model to estimate the regression coefficients of the empirical model. The ARDL has been deemed appropriate because it accommodates series with mixed orders of integration, I (1) and I (0) variables under the conditions of the presence of cointegration. In addition, the ARDL model allows estimation with the presence of both the endogenous and exogenous variables in the model, thus the model controls for endogeneity concerns as the assumption of no autocorrelation in the error component is maintained (Pesaran et al., 2021). In fitting the ARDL model, the "logarithm of GDP" and the logarithm of gross fixed capital formation are treated as endogenous variables while the rest of the variables, namely: the "logarithm of female labour force participation", "logarithm of the female labor force with basic education", fertility" and "inflation" are treated as exogenous variables.

4. Results

The descriptive statistics on all model variables

The study generates the key descriptive statistics on all the model variables in their original units of measurement. Given that the model variables in this study are quantitative and continuous, the key descriptive statistics of interest are the mean, minimum, maximum values as well as the standard deviation and number of observations for each of the model variables. The estimates of the descriptive statistics are displayed in Table 1 as indicated below.

Table 1: Descriptive statistics on all model variables (1990q1-2021q4)

Variable name	Obs	Mean	Minimum	Maximum	Std. Dev.
Gross Domestic Product (current US$, billion)	128	16.68	2.83	41.74	12.69
Gross capital formation (current US$, billion)	128	4.05	0.45	10.13	3.46
Female labour force participation (count)	128	4,938,541	2,804,985	8,640,011	1,633,561
Male labour force participation (count)	128	5,303,764	3,154,765	8,780,223	1,583,231
Female labour force with basic education	128	3,288,992	1,039,669	4,496,817	1,205,264
Fertility, total(births per woman)	128	6.19919	4.54625	7.06403	0.79271
Inflation, GDP deflator (annual %)	128	11.51991	-5.99676	90.35822	17.8866

Source: Author's compilation

The descriptive statistic in Table 1 indicates over the study period, the mean gross domestic product was approximately $.16.7 billion with a standard deviation of approximately $12.7 billion. The maximum gross domestic product recorded over the study period was approximately $ 41.7 billion while the minimum Gross Domestic Product recorded over the study period was approximately $ 2.83 billion. It is observed that Uganda's Gross Domestic Product recorded standard deviation, which was not far from the mean value, giving a coefficient of variation of approximately 76 percent which is higher than the acceptable level of 10 percent.

This result suggests high variability in the gross domestic product over the study period. The high variability in Uganda's GDP could be explained by various growth episodes Uganda has registered over the study period.

The descriptive statistics indicate that the mean gross capital formation over the study period was approximately $ 4.05 billion with a standard deviation of approximately $ 3.46 billion, the maximum gross capital formation was approximately $ 10.1 billion and its minimum was approximately $ 0.45 billion.

The mean female labor force participation stock was approximately 4.93 million people (which was less than the mean male labor force participation stock of 5.30 million people), the maximum female labor force participation stock was approximately 8.64 million people (less than the maximum male labor force participation stock of 8.78 million people) while the minimum female labor participation stock was approximately 2.80 million people.

The descriptive statistics in Table 1 further indicate that the mean female labor force with basic education was approximately 3.29 million people, the maximum female labor force with basic education was approximately 4.50 million people while the minimum female labor force with basic education was approximately 1.04 million people.

The average fertility per woman was 6 live births, the maximum fertility was 7 live births while the minimum fertility was 4 live births. Inflation (annual change in GDP deflator) averaged 11.52 percent over the study period, the maximum inflation rate was 90.36 percent while the minimum inflation rate was -5.99 percent.

Unit root test results on all model variables

The study employed the Augmented Dickey-Fuller (ADF) test to assess the stationarity status of the time series variables and determine the order of integration in the empirical model. In the ADF unit root test, the selection of lag order was guided by Schwarz's Bayesian Information criteria (SBIC). Table 2 provides a summary of the unit test results.

Table 2: Unit root test results

	Variable in Levels			**Variable in first Difference**			**Order of Integration**
Variable	**Lags**	**ADF Z(t) statistic**	**Prob. for Z(t)**	**Lags**	**ADF Z(t) statistic**	**Prob. for Z(t)**	
Logarithm of GDP	2	-0.84	0.8066	4	-3.46***	0.009	I(1)
Logarithm of gross capital formation	2	-0.89	0.7922	4	-3.55***	0.0067	I(1)
Logarithm of female LF participation	2	2.67	0.9991	1	-2.26**	0.0129	I(1)
Logarithm of male LF participation	2	-0.80	0.9661	1	-3.62**	0.0285	I(1)
Log. of female LF with basic education	2	-1.85	0.3563	4	-3.94***	0.0018	I(1)
Fertility	3	1.07	0.9950	3	-3.75**	0.0194	I(1)
Inflation	2	-5.13***	0.0000	-	-	-	I(0)

Source: Author's compilation. **p<0.05; *** p<0.01

According to Table 2's ADF unit root results, the estimated Z(t) statistics do not reject the null hypothesis that these variables are non-stationary at the 5 percent significance level for all variables except inflation. However, when these variables are first differences and the ADF unit root test is applied to them, the estimated Z(t) statistics reject the null hypothesis that these variables become stationary at the 5 percent significance level. For the variable "inflation", the estimated Z (t) statistic rejects the null hypothesis of having a unit root in levels at a 5 percent level of significance. These unit root test results suggest that the variable inflation is integrated of order zero, I (0) while the rest of the variables are integrated of order one, I (1). The mixed orders of integration of the time series variables imply the choice of model estimation procedure. For instance, under conditions of cointegrating relationship, mixed orders of integration of the time series variables suggest that the ARDL could be the most appropriate estimation procedure to adopt.

Cointegration test results

The study utilizes the Johansen and Juselius cointegration test (Johansen & Juselius, 1990). This study's methodology makes it possible to estimate and provide the statistics needed to determine how many cointegrating equations there are in a vector error correction model (VECM) for the given relationship in the cointegration test. Schwarz's Bayesian information criteria (SBIC) serve as a reference for lag selection in the cointegration test. The analysis counts the number of cointegrating equations, 'r,' in a VECM that represents the underlying relationship using the "trace" statistic. There are only 'r' cointegrating relations, according to the null hypothesis of the trace statistic. Table 3 presents a summary of the Johansen cointegration test results, as follows:

Table 3: The cointegration test results

Maximum rank	Eigen Value	Trace statistic	Critical value (5%)
0	-	128.5752	94.15
1	0.29440	84.6389	68.52
2	0.21995	53.3411	47.21
3	0.18456	27.6338*	29.68
4	0.12452	10.8774	15.41
5	0.05616	3.5954	3.76
6	0.02813	-	-

Source: Author's compilation.

Table 3 displays the results of the cointegration test. The trace statistic indicates that there are more cointegrating relations in the empirical model than r = 3, which refutes the null hypothesis. This means that the model has four cointegrating relations, which the cointegration test discovers. The conclusion from the cointegration test conducted is that the Johansen test detects the presence of cointegration in the model being estimated.

The empirical existence of cointegrating linkages has implications for estimation. The cointegration-based estimate method explicitly used in this work is the autoregressive distributed lag (ARDL) model, which considered model variables with mixed orders of integration.

Multicollinearity checks among the independent variables in the model

The study checks for multicollinearity among the explanatory variables in the empirical model which is to be estimated using regression analysis. Thus, the multicollinearity check is conducted on the log-transformed variables (except inflation). A correlation coefficient of 0.8 in absolute terms would be indicative of highly collinear regressors (Gujarati, 2009). Table 4 shows the correlation matrix which indicates the estimated simple correlation coefficients, alongside their respective probability values, between the explanatory variables in the empirical model.

Table 4: Correlation matrix among the independent variables in the empirical model
(P-values in parentheses)

Variable	1	2	3	4	5	6
Logarithm of gross capital formation	1.000000 -----					
Logarithm of female labour force participation	0.7536*** (0.0000)	1.000000 -----				
Logarithm of male	0.8560***	0.8999***	1.000000			

labour force participation	(0.0000)	(0.0000)	-----			
Logarithm of female with basic education	0.7428***	0.7334***	0.8351***	1.000000		
	(0.0000)	(0.0000)	(0.0000)	-----		
Fertility	-0.9022***	-0.9684***	-0.7669***	-0.681541	1.000000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	-----	
Inflation	-0.2215**	-0.304101	-0.302455	-0.368648	0.249413	1.000000
	(0.0120)	(0.0005)	(0.0005)	(0.0000)	(0.0045)	-----

Source: Author's compilation. ***p<0.01; **p<0.05; * p<0.1
1=Logarithm of gross capital formation; 2= Logarithm of female labor force participation; 3 = Logarithm of male labor force participation; 4= Logarithm of female labor force with basic education; 5= Fertility; 6 = Inflation.

The estimated pairwise correlation coefficients between the independent variables, as summarized in Table 4, indicate that the variable "logarithm of male labour force participation" is highly linearly correlated with variables; logarithm of gross fixed capital formation (r = 0.8560, p = 0.0000), logarithm of female labour force participation (r = 0.8999, p = 0.0000) and logarithm of a female with basic education (r = 0.8351, p = 0.000). This high correlation implies that the inclusion of the variable "logarithm of male labour force participation" together with the logarithm of gross fixed capital formation, the logarithm of the female labour force and the logarithm of a female with basic education in the same linear regression model would cause high multicollinearity in the model and this may jeopardize the efficiency of model estimates.

By estimating the VIFs of the independent variables, the study conducted additional analysis regarding the degree of linear relationships among the independent variables. Following the OLS estimation, the VIFs were estimated. Table 5 shows a summary of VIFs when all the model-independent variables are included and Table 6 shows a summary of VIFs when one of the model-independent variables (i.e. Logarithm of the male labor force) is excluded.

Table 5: Variance Inflation Factors of the model-independent variables (all the independent variables included)

Variable Name	VIF	1/VIF
Logarithm of male labour force participation	140.30	0.007128
Logarithm of female labour force participation	123.76	0.008080
Logarithm of gross capital formation	14.08	0.071023
Logarithm of female with basic education	12.46	0.080257
Fertility	2.28	0.438596
Inflation	1.29	0.775194
Mean VIF	**40.03**	

Source: Compiled by the author

It can be observed that the VIFs in Table 5 are exceedingly high for variables: Logarithm of male labor force participation, the Logarithm of female labour force participation, the Logarithm of gross capital formation and the logarithm of a female with basic education. For each of these independent variables, the estimated VIF well exceeds the maximum acceptable level of the VIF of 10. Additionally, the mean VIF (Mean VIF = 40.03) is more than 10. The VIF summary estimated in Table 6 indicates that the "Logarithm of male labor force participation" has the highest VIF (VIF = 140.30), which is exceedingly above the unacceptable level of VIF. When the "logarithm of male labor force participation" is excluded among the independent variables and VIF is re-estimated, the following results show up:

Table 6: Variance Inflation Factors of the model-independent variables (Logarithm of male labour force participation excluded)

Variable Name	VIF	1/VIF
Logarithm of female labour force participation	9.74	0.102669
Logarithm of gross capital formation	8.57	0.116686
Logarithm of female with basic education	4.62	0.21645

Fertility	1.25	0.8
Inflation	1.05	0.952381
Mean VIF	**5.05**	

Source: Author's compilation

In Table 6, the estimates of the VIFs of the individual independent variables are less than 10. The mean VIF (Mean VIF=5.05) is now in acceptable range. In consideration of the high linear correlation caused by the "logarithm of male labor force participation" with other independent variables in the model and its very high VIF, this study excluded it (i.e. the study excluded, the variable "logarithm of male labor force participation") from the final model (equation 8) for estimation on concerns of causing multicollinearity problem in the empirical model.

Regression estimates

The variables in the empirical model have varied orders of integration, and the relationship being modeled has cointegration; these findings lead the study to employ the autoregressive distributed lag (ARDL) model for model estimation. I allowed SBIC to choose the lags in the ARDL model for both the autoregressive terms in the dependent variable and the lagged terms in the independent variables. The ARDL model may show the adjustment parameter/equilibrium error as well as the short- and long-term regression coefficients. Table 7 displays the summary of ARDL estimates, which includes estimates of equilibrium error, short-run and long-run coefficients, their respective standard errors and probability values as well as relevant post-estimation diagnostic test results.

Table 7: ARDL (3, 3, 1, 1, 1, 2) regression estimates

	Coef.	**Std. Err.**	**probability**
Adj. parameter (ECT_{t-1})	-0.16407***	0.037424	0.000
Long-run Coefficients			
(Logarithm of gross capital formation)$_t$	0.76281**	0.438594	0.028
(Logarithm of female LF participation)$_t$	0.55721	0.707672	0.433
(Logarithm of female LF with basic education)$_t$	0.17997	0.151356	0.237
(Fertility)$_t$	0.01879	0.228436	0.935
(Inflation)$_t$	-0.00004	0.001022	0.966
Short-run Coefficients			
Δ(Logarithm of GDP)$_{t-1}$	0.59104***	0.083464	0.000
Δ(Logarithm of GDP)$_{t-2}$	0.23611***	0.085301	0.007
Δ(Logarithm of gross capital formation)$_t$	0.10474**	0.047994	0.031
Δ(Logarithm of gross capital formation)$_{t-1}$	-0.0993*	0.053725	0.068
Δ(Logarithm of gross capital formation)$_{t-2}$	-0.10826**	0.053493	0.046
Δ(Logarithm of female LF participation)$_t$	-5.98783**	2.390460	0.014
Δ(Logarithm of female LF with basic education)$_t$	0.09918	0.094218	0.295
Δ(Fertility)$_t$	-1.09043**	0.444616	0.016
Δ(Inflation)$_t$	0.00176***	0.000289	0.000
Δ(Inflation)$_{t-1}$	-0.00124***	0.000333	0.000
Constant	-0.28616	2.215683	0.897
Diagnostics			
Adj. R-squared = 0.7617			
Ramsey RESET test for omitted variables			
Ho: The Model has no omitted variables			
Prob > F = 0.3344			
Pesaran, Shin and Smith (2001) bounds test			
Ho: No level of relationship			
prob > t for I(0) variables = 0.006			
prob > t for I(1) variables = 0.030			
Breusch–Godfrey LM test for autocorrelation			

Ho: No autocorrelation in the fitted residuals
Prob > chi2 = 0.112
Jarque-Bera normality test
Ho: The fitted residuals are normally distributed
Prob > chi2 = 0.227

Source: Compiled by the author after ARDL estimation. **p<0.05; *** p<0.01

Explanatory Power of the estimated model: The ARDL (3, 3, 1, 1, 1, 2) in Table 7 regression estimates indicate an explanatory power of the fitted regression, as measured by the adjusted R-Square, of approximately 0.76, implying that the fitted ARDL (3, 3, 1, 1, 1, 2) provided approximately 76 percent explanatory ability. This study considers this as a commendable explanatory power of the estimated egression where the included explanatory variables jointly explain up to 76 percent of what accounts for variations in the logarithm of gross domestic product for Uganda.

Omitted variables test: Under the null hypothesis that the estimated model has no omitted variables bias, the F-statistic from the RAMSET Reset omitted variables test does not reject the null hypothesis because its corresponding probability value is greater than the 0.05 significance level (Prob > F = 0.3344). The implication is that the estimated ARDL (3, 3, 1, 1, 1, 2) model does not suffer from the omitted variable bias.

No level relationship test: After model estimation, the study conducted the Pesaran, Shin, and Smith (2001) bounds test under the null hypothesis that there is no level relationship model for I (0) and I (1) variables respectively. Results in Table 4.5 indicate that the estimated t-statistics reject the null hypothesis at a 5 percent level for both I (0) and I (1) variables respectively [prob > t =0.006 for I(0) variables and prob > t = 0.030 for I (1) variables] , confirming the presence of cointegration between the logarithm of gross national product and I (0) and I (1) variables.

Autocorrelation test: The Chi-square statistic from the Breusch–Godfrey LM test for autocorrelation does not reject the null hypothesis of no autocorrelation in the residuals produced from the estimated ARDL (3, 3, 1, 1, 1, 2) model. This is because the Chi-square probability (p = 0.112) exceeds the 0.05 significance level. This result suggests that the residuals from the estimates regression are not autocorrelated which renders the estimates consistent.

Normality of the residuals test: Under the null hypothesis that the estimated residuals are normally distributed, the Chi-square statistic produced from the Jarque-Bera normality test does not reject the null hypothesis at a 5 percent level of significance (p> Ch2 = 0.227). This result suggests that the ARDL (3, 3, 1, 1, 1, 2) estimates are valid for statistical inference.

The estimated coefficient of the error correction

The ARDL (3, 3, 1, 1, 1, 2) in Table 4.7 regression estimates indicate that the estimate of the error correction term or the adjustment parameter is negative and statistically significant at 5 percent testing level (Coef. of ECT_{t-1} is -0.16407, p=0.000). The negative sign is consistent with a priori expectations. The statistical significance shows that the model converges to its long-run equilibrium value, which is further evidence of the presence of cointegration in the model. This result thus suggests that there is the presence of a long-run causal relationship in the model.

The effect of the female labor force on Uganda's economic growth

The variable "female labor force participation in employment" has been used as a proxy for the Female labor force participation rate. The short-run regression estimates indicated a negative and statistically significant coefficient on the logarithm of female labor force participation while the long-run regression estimates indicated a positive and statistically insignificant coefficient on the logarithm of female labor force participation. This result suggested that the rate of female labor force participation in employment has a significant causal effect on Uganda's economic growth in the short run but does not have a long-run causal effect.

We urge that the negative and statistically short-run regression coefficient on the female labor force participation could be explained by a number of factors: firstly, the disaggregation of the labor stock input into the components of the female and male labor force could have made the disaggregated variables to have a negative relationship with total output, arising from the possibility of "poorly measured" labor input variable due to disaggregation; secondly, borrowing from the rudiments of the U-shape theory of development, the negative coefficient on female labor force participation could be consistent with the stylized argument that at the initial stages when a country is struggling to grow (say in the short run), female mainly work in subsistence agriculture or home-based production whose output is not captured in national accounting. As a country develops, economic activity shifts from subsistence agriculture to industry. But in Uganda's context, possibly more male labor force as opposed to female labour force get employed in the industrial sector, as more female remain and are more engaged in home-based subsistence activities (Verick, 2014). In the medium term, as the country exhibits some structural transformation and as more female are engaged in subsistence, growth emerges from other factors other than increased female labor force participation in employment. The negative causal effect of female labor force participation on growth in GDP has been reported in other related studies (e.g. Olivetti, 2013; Tsani et al*.,* 2013; Lechman & Kaur, 2015; Khaliq et al*.,* 2017) whose study results showed that the coefficients of the female labor force had a negative sign and was statistically significant in almost every case, confirming the hypothesis of the negative effect of the female labor force on growth.

The effect of the level of education of female in employment on Uganda's economic growth

Due to a lack of comprehensive education statistics on the Ugandan labor force, this study employed the stock of females in the labor force with basic education (female working-age population with basic education) as a proxy for female education. According to the "Education and Mismatch Indicators Database" (EMI) (2023), basic education includes primary education or lower secondary education by the International Standard Classification of Education. The study's findings showed that the variable "logarithm of female labor force with basic education" had an estimated coefficient that was positive in the short and long terms, and statistically insignificant at the 5 percent significance level. This outcome is consistent with the null hypothesis that was put to the test. The results show that there is no long-term or short-term impact of the proportion of low-educated female labor force participants on Uganda's economic growth. Based on these findings, the study concludes that Uganda's economic growth is unaffected by the proportion of female labor force participants with only a primary or lower secondary education. The study applies the positive sign on the coefficient and attributes the "statistical insignificance" to data problems: first, it was only data on a female in the labor force with basic education that was available for the period under study- there were quite many missing observations on other education levels in the data banks. Thus "female education in the labor force with basic education" could have been a poor proxy for the female level of education that made the coefficient statistically insignificant. Additionally, Uganda is still struggling to meet sustainable development goal number four of "ensuring inclusive and equitable quality education and promote lifelong learning opportunities for all". There are still gender disparities in terms of access to education as well as employment in Uganda. Female/Girl children are a more vulnerable gender. Though, Uganda recognizes that education is crucial for both building human empowerment, and delivering economic progress, there are still challenges that inhibit human capital development, particularly female which may have a detrimental effect on the overall growth and development of Uganda. The Office of the Prime Minister (2020) outlines poor quality and efficiency of primary education and limited systemic capacity in the education sector as some of the challenges. Consequently, labor force attainment of basic education perhaps by both genders may still have no or limited effect on Uganda's economic growth.

The findings from this study do not tally with the findings of related studies, for instance results from this study conflict with the findings of Oztunc et al*.* (2015) who found that female education as measured by female primary school enrollment was a significant factor for annual per capita income growth in the Asia Pacific region. Nevertheless, a study by Alaoui (2016) in Morocco, Algeria, Tunisia and Egypt found that female education as measured by primary and secondary female school enrolments was negatively linked to economic growth.

The effect of fertility on Uganda's economic growth on Uganda's economic growth

The study's estimates showed that, in the short term, there was a negative and statistically significant coefficient on the fertility variable, and, in the long term, there was a positive and statistically insignificant coefficient. According to these estimations, the fertility rate has no long-term impact on Uganda's economic growth but has a short-term, negative, and large causal influence. Theoretical literature demonstrates how fertility affects female labor force participation, which in turn influences economic growth. Consistent with the theoretical argument, it's noticed that the signs on the short-run and long-run coefficients on the female labor force participation and fertility variables respectively match. The negative short-run causal effect of fertility on Uganda's economic growth could be explained by the fact that many of the employed young female who have given birth tend to be given short-term maternity leave from employment which temporarily reduces the total labor supply. The same effect is observed even in informal employment where the female who is due to give birth withdraws labor temporarily. The temporal/short-run reduction in labor supply, as more working female temporarily get out of active labor on maternity leave, could have a negative effect on the output of goods and services, and this could bring about a negative effect on aggregate output. As maternity leave is over, breastfeeding mothers return to employment, but as it was with the female labor force in employment, they will have an insignificant effect on overall output. This renders the high fertility to have a negative short-run effect on aggregate supply and an insignificant influence on GDP growth in the long run.

In terms of short-run effects, findings from this study are consistent with the findings of Brander and Dowrick (1994) who found that high birth rates appeared to reduce economic growth, attributing it to investment effects and "capital dilution". This study's findings also concur with the findings of Er (2012) who concluded from his study findings that less fertility was significant in influencing economic growth.

5. Conclusion

Based on the statistically significant coefficients, and the study objectives, estimates from the ARDL (3, 3, 1, 1, 1, 2) regression model indicate that female labor force participation rate in the employed female labor force has a significant negative short-run causal effect but does not show any long run effect on Uganda's economic growth; the level of female education in the employed female labor force has no short run and long run causal effect on Uganda's economic growth while the female fertility rate has negative short-run causal influence but shows no long-run causal effect on Uganda's economic growth.

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