Economic Growth-Female Labour Force Participation Nexus: An Empirical Evidence for Pakistan

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1. INTRODUCTION

Economic literature shows significant attention towards the role played by female labour force in the economic development of nations. The structural changes of economies from agriculture to industrial and services sector reduce the female labour force participation in case of developing nations. The activities of female labour force increases in the later stage of economic development due to increase in education and dynamics of economic activity. As the size of the economy expands females have easier and better access of jobs thus are encouraged to become economically active, it leads to increase female participation in the productive activities. The participation of female labour force is desirable for both equity and efficiency reasons. The equity aspect shows that the women's participation in the labour market ultimately improves their relative economic position, increase the overall economic efficiency by enhancing the development potential of the country. Moreover, the increasing integration of women in the economy helps in reducing gender disparities in education, improving maternal health, increasing sectoral share of female employment in different sectors of the economy, demonstrating the hidden contribution of women as unpaid family worker especially in agriculture sector. According to the modernisation theorists, economic development is positively associated with female labour force participation through change in the occupational structure and increase in educational opportunities along with the household responsibilities. The modernisation process is linked with increased demand for labour, a general social acceptance of women's education and employment as well as lower fertility [Heckman (1980); Standing (1981); Bauer and Shin (1987)]. A body of theoretical and empirical literature provides evidence that female labour force participation has a positive and strong relationship with economic growth [Tansel (2002) and Fatima and Sultana (2009)].

Pakistan is going through a demographic transition where the proportion of productive young persons is increasing. It is in fact the demographic dividend for future development of Pakistan. The economic development of the country reveals the fact that

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both male and female are contributing in the market activities. It is evident from various studies, as in the early phases of economic development the female participation increases specially as unpaid family worker in the agriculture sector. Later, their employment increases in the manufacturing and services sector. As female's education improves so do their opportunities in the services sector. Education not only guarantees higher income but also provide opportunities in the labour market. Therefore, there exist a strong causality between female labour force participation and the level of economic development.

The objective of the study is to investigate the relationship between female labour force participation and the level of economic development of Pakistan for the period of 1980–2010. ARDL technique will be applied to study the short run and long run relationship between female labour force and economic development.

Rest of study is organised as follows: Section 2 describes theoretical and empirical review of literature. Section 3 explains analytical frame work, modelling and data sources. Section 4 discusses the Methodology, Section 5 dilates upon the empirical results, Section 6 elucidates the VECM Granger Causality Analysis and Section 7 presents the conclusion and policy implication.

2. THEORETICAL AND EMPIRICAL REVIEW OF LITERATURE

The relationship between female labour force and economic development is an empirical issue discussed both in time series and cross country literature.

Mincer (1962), Killings worth and Heckman (1986) and Goldin (1994; 1995) deliver a theoretical exposition of the stages of economic development.

Goldin (1994) revealed that the labour supply of married women is U-shaped as the countries move on the path of development. Initially the female labour supply decreases as then later on it increases. This U-shaped relationship between female labour force participation and economic development is also evident through the histories of recently advanced countries. The author employed the data of more than 100 countries and the history of United States is used to expose the U-shaped female labour supply curve. In the initial stages of development less educated women are only and mostly work in the household, agriculture sector and in the family farm with which a strong social stigma exists. With the over all development, women becomes more educated and there exist more job opportunities for white-collar jobs for females specially of secondary education level, for which no social stigma exists. With the introduction of new technologies and the expansion of the markets family income rises so the rate of female participation in the labour market declines while their domestic activities increase. The reduction in the female labour supply owes to an income effect but ultimately the substitution effect dominates the income effect at some point in time. Goldin (1995) explores the U-pattern hypothesis by employing data for 180 countries for the period 1985 and taken real GDP per capita as a measure of development. The falling portion of the U-shaped curve shows the existence of the poorest countries of the world while the wealthier nations are on the rising portion and the middle income countries are at the bottom. Mammen and Paxson (2000) explores evidence of the U-shaped curve using the cross country data for 90 countries for the years 1970,1975,1980 and 1985. The authors finds a U-pattern, the richest and the poorest countries represents more than 50 percent

participation rates and 35 percent for the middle income countries which is in line with the findings of Goldin (1995). Tansel (2002) affirms the U-shaped hypothesis between economic development and female labour supply for Turkey. The author used the time series data and considers its cross-provincial factors to determine the female participation rate. Using data for 67 provinces for three different points in time i.e. 1980, 1985 and 1990. The findings are positive and strong effect on female labour supply while negative effect on unemployment. Onzur Cakir (2008) focuses the effects of economic development on female labour supply using time series data from 1980–2000 in Turkey. The study incorporates 5 different models to measure different determinants of female labour supply. The study concludes that Turkey is experiencing the declining portion of U-shaped curve but it is expected that the country will move to the rising portion of U-shaped curve in the future. Fatima and Sultana (2009) finds the U-pattern relationship between female labour force participation and economic development using cross-sectional data for 4 provinces with respect to regions (urban/rural) are pooled for three periods 1992-93, 1996-97 and 2001-2002 using a fixed effect test and affirms the U-shaped existence in Pakistan. The authors used household expenditure on fuel consumption to measure the level of economic development as the data on GDP are not available at the provincial level. Sanjukta (2010) revisits the U-shaped hypothesis for 172 countries from 1990 through 2007, with the total observations 3060 for the South Asia and South East Asia. The study concludes that both the regions are on the falling portion of the U-curve. Roughly, the South Asian countries are below the U-curve while the South East Asian countries are slightly above the curve with Pakistan having the lowest female labour supply and countries like Cambodia and Vietnam having the highest female participation rates.

The pattern and amplitude of the U-shaped trend varied between countries and periods of time. The U-shaped curve for the female labour force participation specially during the process of economic development is not agreed by all the researchers. Standing (1978) stressed that the factors of female labour supply is too complicated and complex to be explained by the U-shaped hypothesis. Such as Durand (1975:150)[1] finds that in the case of developing countries, the U-shaped phenomenon is not a general trend of female labour supply. Economic development can have positive and negative effect on female labour supply depending on the share of female participation rate employed in the growing and expanding sector. Steel (1981:163)[2] argues that in the 1960s, as Ghana modernised its economy in terms of rapid manufacturing employment but does not experience the U-shaped curve for female participation rate in fact the female labour supply rose because of industrialisation.

3. ANALYTICAL FRAMEWORK, MODEL AND DATA SOURCES

This study explores the relationship between economic growth and female labour force participation. So, this study expects that better economic conditions encourage women to enter the labour market for earnings. According to Kuznets (1955) economic

[1]Durand (1975) *The Labour Force in Economic Development*. Princeton: Princeton University Press (seen in "Economic Development and Female Labour Force Participation in Turkey: Time-series Evidence and Cross-Province Estimates", Tansel (2005).

[2]Steel (1981) Females Small Scale Employment under Modernisation in Ghana. *Economic Development and Cultural Change* 30, 153–167 [seen in Tansel (2005)].

progress measured by income per capita, first increases inequality but as the benefits from development is accrued and spread in the society the disparities starts declining. Goldin (1994) and Mammen and Paxson (2000) reveal that there is a U-shape relationship between female labour force and economic growth with the view that developing countries are mostly agrarian in nature where the contribution of females in the fields are dominant. The females in these poor countries are burden laden as they contribute not only in the fields but are also involved in rearing and bearing of children and in domestic chores. Due to industrialisation, there is an expansion in the manufacturing sector with the introduction of the technologies, the family income rises so that female labour force participation squeezes. This is said to be an unearned income effect that reduces the female labour supply.

3.1. The Model

On the basis of theoretical literature and empirical studies we use the GDP and its square for the estimation of U-shaped relationship between female labour supply and economic development. Based on the general form of U-shaped relationship between female labour force participation and economic growth is modelled as follows:

$$FP_t = f(Y_t, Y_t^2) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

Where, FP is female labour force participation and Y is level of economic development. We have converted the both series into per capita before taking natural log of female labour force participation and economic development. It is pointed by Ehrlich (1975, 1996) and Cameron (1994) that adoption log-linear specification is better option for empirical analysis. The log-linear specification provides reliable, efficient and unbiased results. So, the log-linear specification is as following:

$$\ln FP_t = \alpha_1 + \alpha_Y \ln Y_t + \alpha_{Y_t^2} \ln Y_t^2 + \varepsilon_i \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

where $\ln FP_t$, $\ln Y_t$, $\ln Y_t^2$ and ε is natural log of female labour force participation per capita, natural log of real GDP per capita, squared of natural log of real GDP per capita and is residual term supposed to be independently, identically and normally distributed.

3.2. Data Sources

The study covers the period of 1980–2010. The data on female labour force participation is collected from web page of International Labour Organisation (ILO). The World Development Indicators (CD-ROM, 2011) have sourced to collect data on real GDP per capita.

4. METHODOLOGICAL FRAMEWORK AND EMPIRICAL RESULTS

This study use time series data, which always show some trends that's why the properties of stationarity are necessary. Stationarity properties of the macroeconomic variables can be investigated by applying a variety of unit root tests which are available in applied economics. We use following unit root tests; ADF by Dickey and Fuller (1979), P-P by Philips and Perron (1988) and Ng-Perron by Ng-Perron (2001). The explanation of all tests is given below:

4.1. ADF Unit Root Test

Extensive empirical research is available, where researchers have used ordinary least squared (OLS) method to investigate the relationship between macroeconomic series. The problem with OLS procedure is that it is supposed that residual term is normally distributed and has zero mean and finite constant. This implies that without examining unit root properties of the variables, OLS provides misleading empirical evidence which may be useless for policy analysis. It is necessary to test the integrating order of the series while investigating cointegration relationship between the variables. We start from widely used unit root test i.e. Augmented Dickey-Fuller developed by [Dickey and Fuller (1981)] which can be applied if residual term seems to be time variant. The knowledge about unit root properties is necessary to make times series reliable and efficient. The estimable equation is modelled as following:

$$\Delta Y_t = \beta_1 + \beta_2 T + \delta Y_{t-1} + \alpha_j \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_i \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3)$$

Where Δ is difference operator and ε is residual term following the assumption of normality.

$$\Delta Y_t = (Y_t - Y_{t-1}), \Delta Y_{t-1} = (Y_{t-1} - Y_{t-2}), \ \Delta Y_{t-2} = (Y_{t-2} - Y_{t-3}) \text{ etc.}$$

The main objective here is to test whether δ is equal to zero or not. The critical T-statistics are generated by Dickey and Fuller (1979) to examine unit root problem. The series Y is said to be stationary, if the estimate of δ is less than tabulated T-statistics.

4.2. Philips and Perron Unit Root Test

ADF unit root test is applicable when there is serial correlation and heteroskedasticity is found between error terms. ADF unit root test is parametric test and different in nature from Philips and Perron unit root test. Philips and Perron (1988) unit root test is non-parametric test. PP does not consider if there is any serial correlation in test regression while ADF test follows serial correlation. The empirical equation is modelled as following:

$$\Delta Y_t = \beta^1 D_t + \theta Y_{t-1} + \varepsilon_i \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (4)$$

Where ε is assumed to be stationary at level with heteroskedasticity. Phillips and Perron (1988) unit root test solves the problem of serial correlation and heteroskedasticity by revising the T-statistics $t_{\pi=0}$ and $T\hat{\pi}$. These revised statistics, are renamed as Z_t and Z_π, given by:

$$Z_t = \left(\frac{\hat{\sigma}^2}{\hat{\lambda}^2}\right)^{1/2} . t_{\pi=0} - 1/2 \left(\frac{\hat{\lambda}^2 - \hat{\sigma}^2}{\hat{\lambda}^2}\right) . \left(\frac{T.SE(\hat{\pi})}{\hat{\sigma}^2}\right)$$

$$Z_\pi = T\hat{\pi} - 0.5 \times \left(\frac{T^2.SE(\hat{\pi})}{\hat{\sigma}^2}\right) \times (\hat{\lambda}^2 - \hat{\sigma}^2)$$

These terms such as $\hat{\sigma}^2$ and $\hat{\lambda}^2$ are variance parameters.

$$\sigma^2 = \lim_{T \to \infty} T^{-1} \sum_{t=1}^{T} E[u_t^2]$$

$$\lambda^2 = \lim_{T \to \infty} \sum_{t=1}^{T} E[T^{-1} S_T^2]$$

Where, $ST = \sum_{t=1}^{T} u_t$. The least square residual u_t seems to be consistent with σ^2 and estimates u_t and $\hat{u}_t$ of Newey-West long run variances are consistent with λ^2. Following the null hypothesis of $\pi = 0$, Z_t and Z_π in PP unit root test do have normal distribution as the ADF unit root test has. The PP unit root test selects appropriate lag (bandwidth) by itself endogenously. The PP unit root test considers heteroskedasticity of residual terms while doing analysis. It is pointed out by Dejong, *et al.* (1992) and Harris (2003) that these unit root tests have poor size and power properties. So results provided by these tests are not reliable and efficient for small samples. ADF and PP unit root tests seem to over-reject the null hypotheses when it is true and accept it when it is false. Ng-Perron (2001) developed a test statistics wherein GLS is applied to de-trend the series D_t^d. The critical values of the tests are based on those of Philip-Perron (1988) Z_α and Z_t statistics, Bhargava (1986) R_1 statistics, and Elliot, Rotherberg and Stock (1996). The following annotations are used:

$$k = \sum_{t=2}^{T} (D_{t-1}^d)^2 / T^2 \qquad \cdots \qquad \cdots \qquad \cdots \qquad \cdots \qquad \cdots \qquad \cdots \qquad (5)$$

The de-trended GLS tailored statistics is given by:

$$MZ_a^d = (T^{-1}(D_T^d)^2 - f_\circ)/(2k)$$

$$MZ_t^d = MZ_a \times MSB$$

$$MSB^d = (k / f_\circ)^{1/2}$$

$$MP_T^d = \left\{ (\overline{c}^2 k - \overline{c} T^{-1}(D_T^d)^2 / f_\circ, \, and, (\overline{c}^2 k + (1-\overline{c})T^{-1}(D_T^d)^2 / f_\circ \quad \cdots \qquad \cdots \qquad (6) \right.$$

All these econometric tests do not contain any information about the structural break points of the time series. Therefore, these tests yield biased and spurious results due to the absence of information about structural break points occurred in the time series.

4.3. Zivot-Andrews Unit Root Test

The drawback about the absence of structural break points has been removed by Zivot-Andrews (1992) by developing three new econometric models. These econometric models are very useful in investigating the stationarity properties of the macroeconomic variables in the presence of structural break points in the series. These models allow (i) a one-time change in variables at level form, (ii) a one-time change in the slope of the trend component i.e. function, and (iii) a model has one-time change both in intercept and trend function of the variables to be used for empirical propose. Zivot-Andrews (1992) adopted three models to check the hypothesis of one-time structural break in the series as follows:

$$\Delta x_t = a + ax_{t-1} + bt + cDU_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (7)$$

$$\Delta x_t = b + bx_{t-1} + ct + bDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (8)$$

$$\Delta x_t = c + cx_{t-1} + ct + dDU_t + dDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \qquad \ldots \qquad \ldots \qquad \ldots \quad (9)$$

In the above equation dummy variable is represented by DU_t showing mean shift occurred at each point with time break, while trend shift variables is shown by DT_t.[3] So,

$$DU_t = \begin{cases} 1..if\ t > TB \\ 0..if\ t < TB \end{cases} \text{ and } DU_t = \begin{cases} t - TB..if\ t > TB \\ 0..if\ t < TB \end{cases}$$

The null hypothesis of unit root break date is $c = 0$ which indicates that series is not stationary with a drift not having information about structural break point while $c < 0$ hypothesis implies that the variable is found to be trend-stationary with one unknown time break. Zivot-Andrews unit root test fixes all points as potential for possible time break and does estimate through regression for all possible break points successively. Then, this unit root test selects that time break, which decreases one-sided t-statistic to test $\hat{c}(= c - 1) = 1$. Zivot-Andrews intimate that in the presence of end points, asymptotic distribution of the statistics is diverged to infinity point. It is necessary to choose a region where end points of sample period are excluded. Further, Zivot-Andrews suggested the trimming regions i.e. (0.15T, 0.85T) are followed.

To examine long run relationship between the variables of interest, there are numerous cointegration approaches available in existing literature. For example, Engle and Granger (1987) based on two-step procedure, Johansen (1988), Johansen and Juselius (1990) based on full information maximum likelihood and, Stock and Watson (1993) based on dynamic ordinary least square require that all the series should be integrated at same order of integration. These cointegration approaches do not have good power properties for small sample and require large sample data for efficient and reliable empirical evidence [Gonzalo and Lee (1998)]. These tests seem produce misleading results regarding cointegration if series are integrated at I(1) or I (0) in the system [Cheung and Lai (1993)]. Moreover, critical values developed by Johansen co-integration approach are not suitable [Turner (2009)].

4.4. The ARDL Bounds Testing Approach to Cointegration

The autoregressive distributed lag modelling or the ARDL bounds testing approach developed by Pesaran, *et al.* (2001) is superior to traditional cointegration approaches due to numerous aspects. For example, the ARDL bounds testing approach is suitable to apply for long run relationship between the variables if the variables are found to be stationary at level or 1st difference. The bounds testing approach to cointegration is suitable for small sample. In the presence of some endogenous variables, the ARDL

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[3]We used Model-4 for empirical estimations following Sen (2003).

bounds testing provide efficient long run estimates with valid t-statistics. The bounds approach to cointegration also seems to combine short run dynamics with long run equilibrium path having long run information following unrestricted error correction model (UECM). The UECM is modelled as following:

$$\Delta \ln FP_t = \vartheta_1 + \vartheta_T T + \vartheta_Y \ln Y_{t-1} + \vartheta_{Y^2} \ln Y_{t-1}^2 + \vartheta_{FP} \ln FP_{t-1} + \sum_{j=1}^{q} \vartheta_j \Delta \ln FP_{t-j}$$

$$+ \sum_{k=0}^{r} \vartheta_k \Delta \ln Y_{t-k} + \sum_{l=0}^{r} \vartheta_l \Delta \ln Y_{t-l}^2 + \varepsilon_i \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (10)$$

Where difference operator is indicated by Δ, T is trend variable and ε is residual term assumed to have normal distribution with finite variance and zero mean. Next step is to compute the ARDL F-statistic to examine whether cointegration between the variables exists or not. Appropriate lag order of is necessary to choose because value of F-statistic varies with lag order. We use Akaike Information Criteria (AIC) to choose suitable lag length. We apply F-test developed by Pesaran, *et al.* (2001) to examine the joint significance of estimates of lagged level of the series. The null hypothesis of no co-integration is $H_0 : \vartheta_Y = \vartheta_{Y^2} = \vartheta_{FP} = 0$ and hypothesis of co-integration is $H_0 : \vartheta_Y \neq \vartheta_{Y^2} \neq \vartheta_{FP} \neq 0$. Two asymptotic such as upper critical bound (UCB) and lower critical bound (LCB) have been generated by Pesaran, *et al.* (2001). We accept the hypothesis of cointegration if computed F-statistic is more than upper critical bound. The hypothesis of cointegration is rejected once lower critical bound is more than our computed F-statistic. We cannot make decision about cointegration if computed F-statistic is between upper and lower critical bounds. We utilize critical bounds developed by Narayan (2005) because these are suitable for small sample i.e. T = 30 to T = 80. It is pointed by Narayan (2005) that critical -bounds provided by Pesaran, *et al.* (2001) are downwards and may produce misleading results. The diagnostic tests have also been conducted to test the problem of normality, serial correlation, autoregressive conditional heteroskedasticity, white heteroskedasticity and specification of the ARDL bound testing model. Once long run relationship between economic development and female labour force participation is established then it is necessary to find short run impact of economic development on female labour force participation in case of Pakistan. In doing so, we apply error correction method (ECM). The empirical equation of ECM is modelled as follows:

$$\Delta \ln FP_t = \delta_{\circ 1} + \sum_{i=1}^{l} \delta_{FP} \Delta \ln FP_{t-i} + \sum_{j=0}^{m} \delta_Y \Delta \ln Y_{t-j} + \sum_{k=0}^{n} \delta_{Y^2} \Delta \ln Y_{t-k}^2$$

$$+ \vartheta ECM_{t-1} + \varepsilon_i \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \quad (11)$$

Where, ECM_{t-1} is lagged error term. ϑ is estimate of lagged error term captures the speed of adjustment from short run towards long run equilibrium path. Here, we say that differenced of female labour force participation is explained by differenced of linear (non-linear) term of real GDP per capita plus lagged error term and stochastic term.

4.5. Error Correction Model: Short-Run

Once long run relationship between economic development and female labour force participation is established then it is necessary to find short run impact of economic development on female labour force participation in case of Pakistan. In doing so, we apply error correction method (ECM). The empirical equation of ECM is modelled as follows:

$$\Delta \ln FP_t = \delta_{o1} + \sum_{i=1}^{l} \delta_{FP} \Delta \ln FP_{t-i} + \sum_{j=0}^{m} \delta_Y \Delta \ln Y_{t-j} + \sum_{k=0}^{n} \delta_{Y^2} \Delta \ln Y_{t-k}^2$$

$$+ \vartheta ECM_{t-1} + \varepsilon_i \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (12)$$

Where ECM_{t-1} is lagged error term. ϑ is estimate of lagged error term captures the speed of adjustment from short run towards long run equilibrium path. Here, we say that differenced of female labour force participation is explained by difference of linear (non-linear) term of real GDP per capita plus lagged error term and stochastic term. We have conducted diagnostic tests to test the CLRM assumptions such as normality of error term, serial correlation, autoregressive conditional heteroskedasticity, white heteroskedasticity and specification of short model. The reliability of short run estimates is investigated by applying the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq) suggested by Pesaran and Shin (1999).

4.6. The VECM Granger Causality Test

We should apply the vector error correction model (VECM) to investigate causal relationship between the variables once co-integration relationship exists between the series. It is argued by Granger, (1969) that the VECM is an appropriate approach to examine causality between the variables when series are integrated at I (1). The empirical equation of the VECM Granger causality approach is modelled as following:

$$(1-L)\begin{bmatrix} \ln FP_t \\ \ln Y_t \\ \ln Y_t^2 \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} b_{11i}b_{12i}b_{13i} \\ b_{21i}b_{22i}b_{23i} \\ b_{31i}b_{32i}b_{33i} \end{bmatrix} \times \begin{bmatrix} \ln FP_{t-1} \\ \ln Y_{t-1} \\ \ln Y_{t-1}^2 \end{bmatrix}$$

$$+ \begin{bmatrix} \alpha \\ \beta \\ \delta \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \qquad \dots \quad (13)$$

Where (1–L) indicates difference operator and lagged residual term is indicated by ECT_{t-1} which is obtained from long run relationship while $\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}$, and ε_{5t} are error terms. These terms are supposed to be homoscedastic i.e. constant variance. The statistical significance of coefficient of lagged error term i.e. ECT_{t-1} using t-statistic shows long run causal relationship between the variables. The short run causality is shown by statistical significance of F-statistic using Wald-test by incorporating differenced and lagged differenced of independent variables in the model. Moreover, joint significance of lagged error term with differenced and lagged differences of independent variables provides joint long-and-short runs causality. For example,

$b_{12,i} \neq 0 \forall_i$ implies that economic growth Granger-causes female labour supply and economic growth is Granger-caused by female labour supply shown by $b_{21,i} \neq 0 \forall_i$.

We have conducted diagnostic tests to test the CLRM assumptions such as normality of error term, serial correlation, autoregressive conditional heteroskedasticity, white heteroskedasticity and specification of short model. The reliability of short run estimates is investigated by applying the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq) suggested by Pesaran and Shin (1999).

5. EMPIRICAL RESULTS

Our empirical discussion starts from descriptive statistics and correlation matrix. The results are reported in Table 1. The results specify that all the series have been normally distributed. The mean is and variance is constant of the residual terms of the series. The correlation matrix reveals that there is a positive and strong correlation exists between economic development and female labour force participation in case of Pakistan.

Table 1

Descriptive Statistics and Correlation Matrix

Variables	$\ln FP_t$	$\ln Y_t$	$\ln Y_t^2$
Mean	1.4293	10.1256	102.5631
Median	1.3353	10.1501	103.0261
Maximum	1.9675	10.4512	109.2295
Minimum	1.1656	9.7734	95.5200
Std. Dev.	0.2309	0.1872	3.7915
Skewness	1.1060	–0.0125	0.0217
Kurtosis	3.1213	2.2586	2.2571
Jarque-Bera	6.3398	0.7107	0.7152
Probability	0.0420	0.7009	0.6993
Observations	31	31	31
$\ln FP_t$	1.0000		
$\ln Y_t$	0.8689	1.000000	
$\ln Y_t^2$	0.8732	0.9999	1.0000

Source: Author's Estimation.

The next step is to test the unit root properties of female labour force participation and economic development, in doing we have applied ADF [Dickey and Fuller (1979)], PP [Philips and Perron (1988) and Ng-Perron (2001)] unit root tests. Although, the ARDL bounds testing approach to cointegration is flexible whether variables are integrated at I (0) or I (1) or I (0)/ I (1). But it is important to have information about the unit root properties of the variables. The assumption of the ARDL bound testing approach is that the series under investigation should be integrated at I (0) or I (1). If any variable is found to be stationary beyond that order of integration, then process of computing the ARDL F-statistic becomes unusable. Just to ensure that none of the variables is stationary at 2nd difference. The results of ADF, PP and Ng-Perron unit root tests are detailed in Table 2.

Table 2

Unit Root Analysis

Variables	ADF Unit Root Test		PP Unit Root Test		Ng-Perron Unit Root Test			
	T-statistic	Prob. value	T-statistic	Prob. value	MZa	MZt	MSB	MPT
lnFP_t	−1.3747 (1)	0.8463	−0.8427 (3)	0.9459	−4.2816 (1)	−1.2598	0.29425	19.4041
ln$Y_{t|}$	−1.9645 (1)	0.5946	−1.8076 (3)	0.6749	−8.3933 (1)	−2.0322	0.2421	10.9069
lnY_t^2	−1.9268 (1)	0.6140	−1.7576 (3)	0.6988	−8.5504 (1)	−2.0455	0.2392	10.7288
ΔlnFP_t	−4.8335 (1)*	0.0032	−5.7271 (3)*	0.0004	−34.7297 (2)*	−4.1629	0.1198	2.6465
ΔlnY_t	−3.5666 (0)***	0.0514	−3.5324 (3)***	0.0551	−84.1507 (5)*	−6.486	0.07708	1.0838
ΔlnY_t^2	−3.5464 (0)***	0.0536	−3.5111(3)***	0.0575	−82.9746 (5)*	−6.4408	0.07762	1.09913

Source: Author's Estimation.

Note: *, ** and *** indicate significant at 1 percent, 5 percent and 10 percent levels respectively. Optimal lag order for ADF and bandwidth for PP unit root tests is determined by Schwert (1989) formula. Optimal lag order of the variables is given in small parentheses.

The results indicate that female labour participation per capita and real GDP per capita have unit root problem at level with constant and trend. Both series are stationary at 1st difference indicated by statistics of ADF, PP and Ng-Perron unit root tests. This shows that series have same order of integrated i.e. (1). The problem with these unit root tests is that they do not have information about structural break stemming in the series. In such an environment, application of these tests provides unreliable and biased results. Baum (2004) forced to apply structural break unit root test to examine unit root properties of the variables. The reason is that misleading results about order of integration of the variables would be helpful for policy-makers in articulating comprehensive economic policy. To overcome this objection, we choose to apply Zivot-Andrews [Zivot and Andrews (1992)] structural break unit root test which allows having information about the unknown structural break point stemming in the time series.

The results are reported in Table 3. The results indicate that variables do have unit root problem at level with a structural break both in intercept and trend. The both variables are found to be stationary at 1st difference. This implies that the variables are integrated at I (1). The unique integrating properties of the both series leads us to implement the ARDL bounds testing approach to cointegration examining the long run relationship between female labour force participation per capita and real GDP per capita over the study period in case of Pakistan. An appropriate lag order of the variables is needed to apply the ARDL bounds testing. Various lag length criterion are available indicated in Table 3.

Table 3

Zivot-Andrews Structural Break Unit Root Test

Variables	At Level		At 1st Difference	
	T-statistic	Time Break	T-statistic	Time Break
lnFP_t	−3.963 (0)	1996	−5.678 (0)*	1997
lnY_t	−3.629(1)	1997	−5.632(0)*	2004
lnY_t^2	−3.667(1)	1997	−5.623(0)*	2004

Source: Author's Estimation.

Note: *represents significant at 1 percent level. Critical T-values are −5.57 and −5.08 at 1 percent and 5 percent levels respectively. Optimal lag order of the variables is given in small parentheses.

We followed Akaike information criteria to select appropriate lag length. It is pointed by Lütkepohl (2006) that AIC has superior power properties for small sample data compared to any lag length criterion. Our decision about leg length is based on the minimum value of AIC. The results are reported in Table 4. It is found that we cannot take lag more than 1 in such small sample data.

Table 4

Lag Length Selection

| | VAR Lag Order Selection Criteria | | | | | |
Lag	LogL	LR	FPE	AIC	SC	HQ
0	113.3788	NA	9.92e-08	−7.612329	−7.470884	−7.568030
1	245.0620	227.0401*	2.11e-11*	−16.07324*	−15.50747*	−15.89605*
2	252.8795	11.86094	2.34e-11	−15.99169	−15.00158	−15.68160

Source: Author's Estimation.
* Indicates lag order selected by the criterion.   LR: sequential modified LR test statistic (each test at 5 percent level).
FPE: Final prediction error.   AIC: Akaike information criterion.
SC: Schwarz information criterion.   HQ: Hannan-Quinn information criterion.

The next step is to estimate the ARDL F-statistic to examine the existence of cointegration between female labour force participation and real GDP per capita over the study period of 1980-2010 in case of Pakistan. The results of the ARDL F-statistic are reported in Table 5.

Table 5

The ARDL Co-integration Analysis

Estimated Model	$FP_t = f(Y_t, Y_t^2)$	
Optimal Lag Structure	(1, 1, 1)	
F-statistics	11.017*	
Significant Level	Critical Values $(T = 31)^{\#}$	
	Lower Bounds, $I(0)$	Upper Bounds, $I(1)$
1 percent	7.763	8.922
5 percent	5.264	6.198
10 percent	4.214	5.039
R^2 0.5582		$ADj - R^2$ 0.2983
F-statistics 2.1481***		DW Test 1.9727
$\chi^2NORMAL$ 3.0576 (0.2167)		$\chi^2SERIAL$ 1.2057 (0.3268)
χ^2ARCH 0.0372 (0.8478)		χ^2WHITE 0.9252 (0.5782)
$\chi^2REMSAY$ 0.4396 (0.5166)		

Note: * and *** show significant at 1 percent and 5 percent levels respectively. We have used critical bounds developed by Narayan (2005). χ^2NORM is for normality test, $\chi^2SERIAL$ for LM serial correlation test, χ^2ARCH for autoregressive conditional heteroskedasticity, χ^2WHITE for white heteroskedasticity and $\chi^2REMSAY$ for Resay Reset test. In parenthesis p-values is given.

The results indicate that our computed F-statistic i.e. 11.017 is greater than upper critical bounds at 1 percent level of significance once we used real GDP per capita (squared of real GDP per capita) is used as forcing variable. This confirms the existence of cointegration between the variables. This shows that there is a long run relationship between female labour force participation and economic development over the period of 1980-2010 in case of Pakistan. Furthermore, the model of ARDL bounds testing has passed the assumptions of CLRM such as error term is normally distributed. There is no existence of serial correlation between the variables and residual term. No evidence is found for autoregressive conditional heteroskedasticity and same inference can be drawn for white heteroskedasticity. The statistic of Ramsey reset test shows that model is well articulated.

The existence of long run relationship between the variables leads us to examine long run impact of independent variables on dependent variable. The empirical evidence of marginal impact of economic development on female labour force participation is reported in Table 7. Our results show that both linear and non-linear terms of real GDP per capita are statistically significant at 1 percent level of significance. This finding validates the existence of U-shaped relationship between female labour force participation and economic development. It is noted that a 1 percent rise in economic growth is linked with –60.1726 percent decline in female labour force participation shown by estimate of linear term while positive sign of non-linear (squared) term of real GDP per capita indicates the joining point of female labour force participation and real GDP per capita with a rise economic growth to higher levels. The estimate of non-linear term of real GDP per capita is 3.0191.

Table 7

Long Run OLS Analysis

Dependent Variable = $\ln FP_t$ [4]				
Variable	Coefficient	Std. Error	T-Statistic	Prob. value
Constant	301.0709*	47.3969	6.3521	0.0000
$\ln Y_t$	–60.1726*	9.3234	–6.4539	0.0000
$\ln Y^2_t$	3.0191*	0.4584	6.5862	0.0000
R-squared	0.9536	Adj. R-squared	0.9483	
Durbin-Watson	1.5883	F-statistic	178.4347*	
$\chi^2 SERIAL$ 1.7708 (0.1676)		$\chi^2 ARCH$ 0.0010 (0.9739)		
$\chi^2 WHITE$ 0.2348 (0.7922)		$\chi^2 REMSAY$ 0.5310 (0.4724)		

Source: Authors' estimation.

Note: *shows significance at 1 percent level. $\chi^2 SERIAL$ is for normality test, $\chi^2 SERIAL$ for LM serial correlation test, $\chi^2 ARCH$ for autoregressive conditional heteroskedasticity, $\chi^2 WHITE$ for white heteroskedasticity and $\chi^2 REMSAY$ for Resay Reset test. In parenthesis p-values is given.

This shows that initial level of economic growth lowers the demand for female labour force and demand for female labour force increases at higher level of economic development after the threshold point. The threshold point Rs 21597 real per capita GDP

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[4]We have used AR (1) process to remove autocorrelation in the model. The estimate of AR (1) is 0.3573 and it is statistically significant at 5 percent level.

and Pakistan achieved this point in 1987.[5] These findings are consistent with Pampel and Tanaka, (1986); Tansel (2002) and Fatima and Sultana (2009). All these studies support that the coefficient of the level of income per worker was negative and significant but that of its square is positive and significant.

The results show that female labour force participation is 95.36 percent explained by real GDP per capita and squared of real GDP per capita and rest is by other factors included in residual term. Overall model is significant shown by F-statistic. There is no evidence of autocorrelation as indicated by Durban Watson test. The diagnostic tests show that there is no evidence of serial correlation between the variables used in the model. The evidence of autoregressive conditional heteroskedasticity is not found and same view is about the white heteroskedasticity. The model is well specified reported by estimate of Ramsey reset test.

The next step is to examine the short run impact of economic development on female labour force participation in case of Pakistan. For this purpose we have used error correction method (ECM). The results are reported in Table 8. It is found from our analysis that U-shaped relationship between economic development and female labour force participation also exists in Pakistan. The linear and non-linear (squared) of real GDP per capita have negative and positive according to expectations and it is statistically significant at 10 percent level of significance. The short run coefficients are smaller than log run estimates. This confirms that our results are reliable and efficient.

Table 8

Short Run OLS Analysis

Dependent Variable = $\Delta \ln FP_t$				
Variable	Coefficient	Std. Error	T-Statistic	Prob. value
Constant	0.0122	0.0127	0.9635	0.3441
$\Delta \ln Y_t$	−25.6126***	13.5074	−1.8961	0.0691
$\Delta^{\ln} Y^2_t$	1.2978***	0.6614	1.9620	0.0605
ECM_{t-1}	−0.5980*	0.1368	−4.3698	0.0002
R-squared	0.3771	Adj. R-squared		0.3052
Durbin-Watson	1.5507	F-statistic		5.2480*
Diagnostic Tests				
$\chi^2 SERIAL$	1.9049 (0.1706)	$\chi^2 ARCH$	0.1142	(0.7380)
$\chi^2 WHITE$	0.2509 (0.9539)	$\chi^2 REMSAY$	0.1620	(0.6906)
CUSUM	Unstable (5%)	CUSUMsq	Stable (5%)	

Source: Author's Estimation.

Note: * and *** represent significant at 1 percent and 10 percent levels respectively. $\chi^2 NORM$ is for normality test, $\chi^2 SERIAL$ for LM serial correlation test, $\chi^2 ARCH$ for autoregressive conditional heteroskedasticity, $\chi^2 WHITE$ for white heteroskedasticity and $\chi^2 REMSAY$ for Resay Reset test. In parenthesis p-values is given.

The estimate of error correction term i.e. ECM_{t-1} has negative sign and it is statistically significant at 1 percent level of significance. The coefficient of ECM_{t-1} shows the speeds of adjustment from short run towards long run equilibrium path. If speed of

[5]The long span of data may change that threshold point.

adjustment is higher then greater would be correction in deviations from short run towards long run [Banerjee, *et al.* (1993)]. It is also pointed by Bannerjee, *et al.* (1998) that we can validate our established long run relationship between the variables through the statistical significance of error correction term. The coefficient of ECM_{t-1} is –0.5980 and it is statistically significant at 1 percent level of significance. This confirms our long run established relationship between economic development and female labour force participation in case of Pakistan.

Moreover, our results show that deviation is female labour force participation from short span of time to long run is précised by 59.80 percent every year. This speed of adjust is fast and indicates that adjustment process would take 1 year and 7 months in case of Pakistan for female labour force participation model. The empirical evidence of diagnostic checks shows no indication of serial correlation, autoregressive conditional heteroskedasticity, white heteroskedasticity and functional form of short run model is well specified.

Table 9

Error Correction Model

Dependent Variable = $\Delta \ln FP_t$

Variable	Coefficient	Std. Error	T-Statistic	Prob. value
Constant	0.0122	0.0127	0.9635	0.3441
$\Delta \ln Y_t$	–25.6126***	13.5074	–1.8961	0.0691
$\Delta^{\ln} Y^2_t$	1.2978***	0.6614	1.9620	0.0605
ECM_{t-1}	–0.5980*	0.1368	–4.3698	0.0002
R-squared	0.3771			
Adj. R-squared	0.3052			
Durbin-Watson	1.5507			
F-statistic	5.2480*			
Diagnostic Tests				
F-statistic	**Prob. value**			
$\chi^2 SERIAL$	1.9049	0.1706		
$\chi^2 ARCH$	0.1142	0.7380		
$\chi^2 WHITE$	0.2509	0.9539		
$\chi^2 REMSAY$	0.1620	0.6906		
CUSUM	Unstable	5%		
CUSUMsq	Stable	5%		

Source: Author's estimation.

Note: * and *** represent significant at 1 percent and 10 percent levels respectively. $\chi^2 NORM$ is for normality test, $\chi^2 SERIAL$ for LM serial correlation test, $\chi^2 ARCH$ for autoregressive conditional heteroskedasticity, $\chi^2 WHITE$ for white heteroskedasticity and $\chi^2 REMSAY$ for Resay Reset test.

The stability of long run and short run estimates has been tested by applying the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq) are applied. It is suggested by Pesaran and Shin (1999) to apply these tests. The null hypothesis of both CUSUM and CUSUMsq may be accepted that if plots of both tests are moving between critical limits. The null hypothesis is "regressions equation is correctly specified" [Bahmani-Oskooee and Nasir (2004)].

Fig. 1. Plot of Cumulative Sum of Recursive Residuals
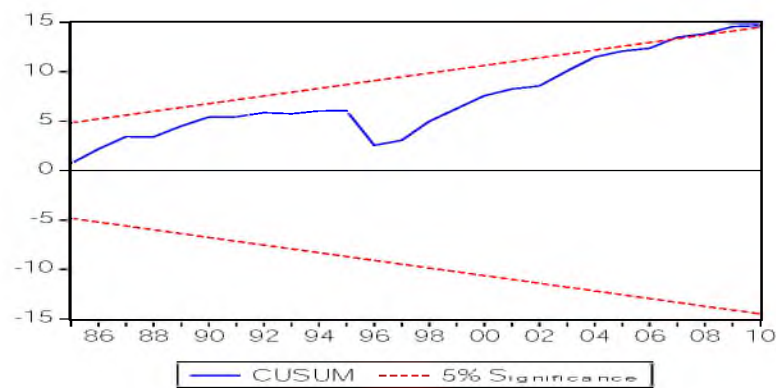
The straight lines represent critical bounds at 5 percent significance level.

The results of both CUSUM and CUSUMsq tested are reported in Figures 1 and 2. The plot of CUSUM test crosses upper critical limit after 2008 may be showing the impact of regime shift from dictatorship to democracy (structural break).

Table 10

Chow Forecast Test

Chow Forecast Test: Forecast from 2008 to 2010			
F-statistic	0.1519	Probability	0.9273
Log Likelihood Ratio	0.5887	Probability	0.8990

Source: Author's estimation.

Leow (2004) noted that we should not reply graphs. Graphs do not provide reliable results. That's we have applied Chow forecast test to observe the significance of structural break in case of Pakistan in 2008. The results of Chow Forecast Test do not seem to show any structural break in the country confirmed by F-statistic.

Fig. 2. Plot of Cumulative Sum of Recursive Residuals
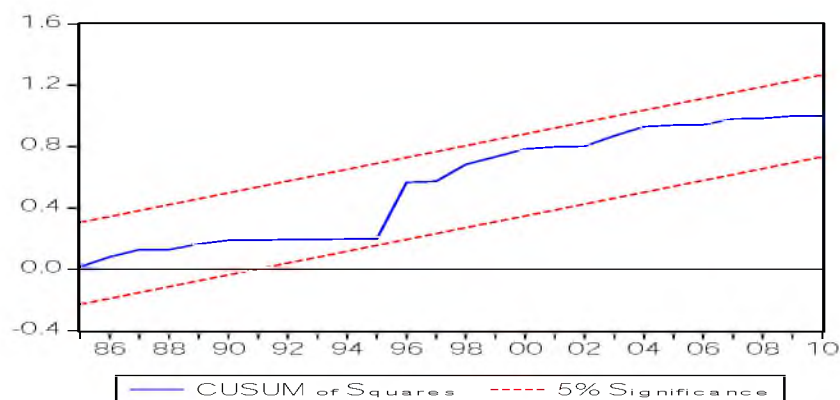
The straight lines represent critical bounds at 5 percent significance level.

The CUSUMsq test shows that graph does not seem to cross lower and upper critical limits. So, we can conclude that long and short runs estimates are reliable and efficient.

6. THE VECM GRANGER CAUSALITY ANALYSIS

It is pointed by Granger (1969) that the VECM Granger causality should be applied to investigate the causal relationship between the variables if variables are co-integrated for long run relationship and order of integration of series is I(1). The exact detection of causal relationship between the variables would help us in knowing about which factor is causing female labour supply. Our analysis validated the co-integration between economic growth and female labour supply which further leads us to apply the VECM Granger causality to test the existence of causal relationship between said variables. The results of the VECM Granger causality are reported in Table 10. The convergence is high in female labour supply (–0.7026) equation.

Table 10

The VECM Granger Causality Analysis

| | Direction of Causality | | | | | | |
| | Short Run | | | Long Run | Joint Long-and-Short Run Causality | | |
Dependent Variable	$\Delta \ln FP_{t-1}$	$\Delta \ln Y_{t-1}$	$\Delta \ln Y_{t-1}^2$	ECT_{t-1}	$\Delta \ln FP_{t-1}$, ECT_{t-1}	$\Delta \ln Y_{t-1}$, ECT_{t-1}	$\Delta \ln Y_{t-1}^2$, ECT_{t-1}
$\Delta \ln FP_t$	–	2.3952 [0.1145]	2.5369*** [0.1020]	–0.7026* [–3.9983]	–	6.5988* [0.0024]	6.6430* [0.0023]
$\Delta \ln Y_t$	0.4151 [0.6651]	–	4.5472** [0.0141]	–	–	–	–
$\Delta \ln Y_t^2$	0.4204 [0.6617]	4.5467** [0.0143]	–	–	–	–	–

Source: Author's estimation.
Note: * and ** show significance at 1, and 5 percent levels respectively.

The results show that in long run, unidirectional causality is found running from economic growth to female labour supply. Similarly, economic growth Granger causes female labour force participation in short run. This further provides support for the existence of U-shaped curve between economic growth and female labour supply over the study period. The joint significance of short-and-long runs also reveals the robustness of short run and long run causality results.

7. CONCLUSION AND POLICY IMPLICATIONS

This study deals with the empirical investigation of relationship between economic development and female labour force participation in case of Pakistan over the period of 1980–2010. Unit root tests such as ADF, PP and Ng-Perron as well as Zivot-Andrews structural break unit root test have been applied to test the stationarity properties of the variables. The ARDL bounds testing approach to co-integration is implemented to examine cointegration for long run relationship between economic development and female labour force participation. Our results confirm long run and U-shaped association between both variables long run as well as in short run in case of Pakistan. Pakistan is

undergoing on the severe economic crisis that has produced a lot of social and economic problems within the country. Due to which the marginalised segment of the population which is in the form of women and children have become more actively associated in the marginalised activities. The participation of female is understated due to the exclusion of marginal activities and the invisible contribution of women in the economy. In case of Pakistan, it is desirable as well as the need of the day to narrow the gap between men and women through providing equal opportunities to females in terms of better market opportunities, better wages, more job opportunities etc. From the view point of equity and efficiency, their integration into the economy is desirable. The causality reveals the unidirectional causality running from economic growth to female labour force participation in long run.

There is a strong link between economic growth and female labour supply so that the policy-makers should concentrate on increasing and improving female's education and skills. The adoption of gender specific wage laws may be reduced the earning gap between both the genders. Moreover, measures to improve the employment opportunities along with the expansion of the manufacturing and industrial sector will contribute to increase the female labour supply. The policy-makers should focus on cottage industries where the role and participation of females can easily be increased due to our cultural and traditional skills. To encourage the female labour supply in the labour market the government must provide child care subsidies specially in the form of day care centres, pri-school education etc., which may ultimately supports the females and encourage them to participate in the economic activities.

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