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IMPACT OF DEMOGRAPHIC CHANGES ON INFLATION IN PAKISTAN

ATIF ALI JAFFRI, FATIMA FAROOQ AND FAISAL MUNIR*

Abstract. This study empirically investigates the impact of demographic changes on inflation in Pakistan for the period 1988-2014. The study has used population growth (PG) rate and proportion of middle age working population (MAWP) as indicators of demographic change, and estimated two separate models using these proxies. Based on unit root tests, the study has applied Autoregressive Distributive Lag (ARDL) model. The findings of the study show that PG and MAWP have positive and negative impact on inflation in Pakistan, respectively. The validity of results is supported by standard diagnostic tests and results are found consistent with recent empirical evidence for other countries. No previous empirical study for Pakistan on the subject exists; thus, highlighting the contribution of this study in the literature. The study suggests that demographic factors along with traditional macroeconomic determinants of inflation must be considered for designing effective policies to control inflation in Pakistan.

Keywords: Inflation, Demographic change, Population growth, Autoregressive Distributive Lag model

JEL classification: E31, J11

I. INTRODUCTION

Macroeconomic performance of an economy is determined through several macroeconomic indicators like inflation, growth rate, balance of payment,

*The authors are, respectively, Associate Professor/Chairman, Department of Economics, University of Gujrat, Gujrat (Pakistan); Assistant Professor, School of Economics, Bahauddin Zakariya University, Multan (Pakistan); and M. Phil. Scholar, Department of Economics, University of Gujrat, Gujrat (Pakistan).
Corresponding author e-mail: fatimafarooq@bzu.edu.pk

and unemployment rate. Controlling inflation is considered an important goal of macroeconomic policy formulation by policy makers and academia. A large body of empirical and theoretical literature is available on determinants of inflation. Empirical literature on determinants of inflation is vast showing determents range from monetary, fiscal, external and real sector variables (Ahmed *et al.*, 2014; Bashir *et al.*, 2011; Khan and Gill, 2010). Further, studies have confirmed that social sector variables also significantly affect inflation rate (Bhattacharya, 2014; Andersson *et al.*, 2009; Lim and Papi, 1997). Recent literature has identified that demographic factors also affect inflation in countries experiencing demographic transition (Yoon *et al.*, 2014; Anderson *et al.*, 2013).

The concept of "demographic change" refers to a population's age structure adjusting to changes in living situations (Linz and Stula, 2010). The literature suggests that working age population, growth in old age dependency, fertility rate, crude birth rate, crude death rates and population growth are frequently used indicators of demographic change (Weber, 2009).

Studies have developed the link between the size and alignment of population structure and macroeconomic outcomes. The channels through which demographic changes affect an economy usually include savings and investment, labor market choices, aggregate demand and aggregate supply reactions. Life Cycle Hypothesis suggested that people in middle working age (40 to 64 years) are net savers while retirees and the youth are relatively more dis-savers, thus, rise in proportion of middle age working population leads toward decrease in demand-pull inflation (Imam, 2013).

There are many empirical studies conducted to find the impact of demographic changes on inflation. Young working age population is more inflationary as compared to old working age population (Juselius and Takáts, 2015). Lindh and Malmberg (2000) examine the hypothesis that net savers dump down inflation and with empirical evidence of panel study they find that population aging leads toward net saving and low inflation. On the other hand, youth population leads towards high consumption and high inflation. The same question is also addressed in recent studies which confirm a significant relationship between demographic changes and macroeconomic indicators, particularly, inflation (Yoon *et al.*, 2014).

Pakistan is sixth most populous country in the world and currently passing through demographic transition. Pakistan has experienced slowdown in population growth over the last four decades declining from 3.32 percent in 1980s to 1.8 percent in 2015. Age composition shows that 41 percent population is under 15 years and 3.2 percent population is above 65 years.

Thus, 55.8 percent population is working age population, and the proportion of middle age working population (40-64 years) is 18 percent and expected to increase in coming years. The growing proportion of middle age working population has important macroeconomic implications particularly for inflation. Only few studies have investigated the implications of demographic changes on macroeconomic indicators like current account balance and economic growth in Pakistan (Jaffri *et al.*, 2012; Iqbal *et al.*, 2015). No previous study has estimated the impact of demographic changes on inflation in Pakistan. So the current study is important to fulfill the gap in the existing literature by investigating the empirical relationship between demographic factors and inflation in Pakistan.

In the remaining part of the paper, Section II provides review of literature and Section III discusses methodology and the results of the study. Finally, conclusion and implications of the study based on empirical findings are given in Section IV.

II. LITERATURE REVIEW

Although theoretical literature on demographic determinants of inflation is scarce, empirical literature on the subject is growing and a large number of empirical studies for developed countries have been conducted. Stevenson (2013) explored the drivers of inflation theoretically by incorporating demographic variables in the analysis. According to the argument of the study, Life Cycle Hypothesis (LCH) is a powerful framework to understand the relationship between age structure and inflation. The impact of demographic changes on inflation has been empirically examined for single and cross-countries including OECD, Japan, China, Korea and USA. Anderson *et al.* (2013) have examined the relationship between population aging and inflation in Japan. They have used the global integrated fiscal and monetary model (GIMF) for estimating the impact of demographic changes on inflation and conclude that population aging is significantly deflationary. Bullard *et al.* (2012) find that young cohorts expect high wages with high levels in consumption pattern and they prefer relatively low interest rates, this may cause in upward pressure on inflation. In contrast older population is less active in consumption and they spend more on medical and leisure that may cause saving behavior and leading toward low inflation. Imam (2013) finds that increase in older age population would lead toward weakening the monetary policy effectiveness. Juselius and Takáts (2015) have investigated that population age group of 15 to 35 is positively associated with inflation and age group of 40 to 64 is significant in decreasing inflation. Lindh and Malmberg (2000) have estimated that more

savers (old age population) are negatively and significantly correlated with inflation, and net consumers (young working age population) are positively and significantly correlated with inflation. Yoon *et al.* (2014) have found that population growth, working age population, and share of population aged over 65 years are significantly affecting inflation.

In case of Pakistan, literature is mostly on traditional macroeconomic determinants of inflation. Ahmed *et al.* (2014) have found that exchange rate, money supply, indirect tax and government borrowings are significant drivers of inflation in Pakistan. Bashir *et al.* (2011) have found that in the long-run inflation is significantly determined by money supply, gross domestic product, government revenue, imports and government expenditures. Other studies like Khan and Gill (2010) and Khan *et al.* (2007) elaborate that broad money, exchange rate, current account balance, gross domestic product, government revenue and expenditure, output gap, unemployment and oil prices are the determinants of inflation in Pakistan. Jaffri *et al.* (2012) have found that in case of Pakistan, increase in population growth is negatively and significantly affecting current account balance.

From above discussed literature it is found that demographic factors are taking vital place in macroeconomic analysis with special focus to inflation in developed countries. However, in developing countries particularly in Pakistan the literature on determinants of inflation is focused only to traditional macrocosmic factors. So, there is gap in existing literature and the study is an effort to fill the existing gap on the subject.

III. METHODOLOGY AND RESULTS

The study has developed two models to determine the impact of demographic changes on inflation in Pakistan following Yoon *et al.* (2014):

$$INF_t = \alpha_1 + \alpha_2 PG_t + \alpha_3 RGDP_t + \alpha_4 TOT_t + \alpha_5 M2_t + \mu \qquad \text{(I)}$$

$$INF_t = \beta_1 + \beta_2 MAWP_t + \beta_3 RGDP_t + \beta_4 TOT_t + \beta_5 M2_t + \mu \qquad \text{(II)}$$

To capture demographic changes in above models the study has used population growth (PG) rate and middle age working population portion (MAWP). MAWP is defined as the proportion of middle aged population (40-64) in total population. The study has used annual change in Consumer Price Index (CPI) to calculate inflation (INF). Control variables in both models are real growth in gross domestic product (RGDP), changes in terms of trade (TOT) and money supply growth (M2). The theoretical channels are given below:

PG is an important determinant of inflation in the literature having positive impact on inflation. Bullard *et al.* (2012) elaborate that PG potentially increases the consumption and creates upward pressure on aggregate demand which leads toward inflation.

Juselius and Takáts (2015) elaborate the importance of MAWP in inflation determination by examining the consumption behavior in different age structures and argued that MAWP is net saver and bring down inflation.

TOT is projected to decrease inflation under a flexible exchange rate system by adjusting the real exchange rate. Further, high change in TOT reduces investment by creating uncertainty. This will cause aggregate demand to fall, which will reduce inflation (Desormeaux *et al.*, 2010).

TABLE 1

Unit Root Tests

Variable	Augmented Dickey-Fuller Test Results				Decision
	At level		At first difference		
	Intercept	Trend and intercept	Intercept	Trend and Intercept	
INF	–2.377[0] (0.157)	–2.317[0] (0.411)	–6.256[0] (0.000)***	–6.144[0] (0.000)***	I(1)
PG	–3.356[2] (0.023)**	–0.536[2] (0.974)	—	—	I(0)
M2	–3.582[0] (0.013)**	–3.549[0] (0.054)*	—	—	I(0)
TOT	–1.133[0] (0.598)	–2.087[0] (0.528)	–6.221[0] (0.000)***	–6.307[0] (0.000)***	I(1)
MAWP	–2.759[3] (0.079)*	–2.636[5] (0.269)	—	—	I(0)
RGDP	–4.252[4] (0.003)***	–3.938[4] (0.027)**	—	—	I(0)

***, ** and * indicate stationarity at 1%, 5% and 10% level of significance, respectively.

Real GDP growth can have both positive and negative effects on inflation. According to the quantity theory of money, as output increases,

inflation decreases and vice versa. This implies that income affects inflation negatively (Ayyoub *et al.*, 2011). On the other hand, when income rises, the demand for money will also increase. As a result, the interest rate will rise, thereby increasing inflation (Patra and Sahu, 2012).

The theoretical relationship between money supply and inflation is clearly determined in quantity theory of money. Therefore, the study expects the money supply to have a positive effect on inflation.

Time series data of Pakistan spanning from 1988 to 2014 was obtained from *World Development Indicators* (2015) and Pakistan Bureau of Statistics (PBS). The study used data for PG and MAWP from United Nations World Population Prospects (2015).

To check stationarity, Augmented Dickey-Fuller (ADF) test has been applied to avoid spurious results. Results of ADF test determined that INF and TOT are I(1) and PG, MAWP, RGDP and M2 are I(0). Thus, variables used in the model are combination of I(1) and I(0) variables and there is no variable integrated of order I(2). Therefore, following Pesaran *et al.* (2001) the study has applied ARDL approach of cointegration to test the short-run and long relationship between demography and inflation.

Step one in ARDL approach is to apply unrestricted VAR model and use Schwarz Information Criteria (SIC) and Akaike Information Criterion (AIC) for the optimum lag selection. The results of SIC and AIC in our study show that 3 lags are optimal for both models to run ARDL model.

In the second step, to check whether variables hold long-run and short-run relationship to each other the study applied Bounds test through estimating following models.

$$\begin{aligned} DINF_t = {} & \alpha_1 + \alpha_{2i}\sum_{i=1}^{3} DINF_{t-i} + \alpha_{3i}\sum_{i=0}^{3} DPG_{t-i} + \alpha_{4i}\sum_{i=0}^{3} DTOT_{t-i} \\ & + \alpha_{5i}\sum_{i=0}^{3} DM2_{t-i} + \alpha_{6i}\sum_{i=0}^{3} DRGDP_{t-i} + \alpha_7 INF_{t-1} + \alpha_8 PG_{t-1} \\ & + \alpha_9 TOT_{t-1} + \alpha_{10} M2_{t-1} + \alpha_{11} RGDP_{t-1} + \varepsilon_t \end{aligned} \quad \text{(I)}$$

$$\begin{aligned} DINF_t = {} & \beta_1 + \beta_{2i}\sum_{i=1}^{3} DINF_{t-i} + \beta_{3i}\sum_{i=0}^{3} DMAWP_{t-i} + \beta_{4i}\sum_{i=0}^{3} DTOT_{t-i} \\ & + \beta_{5i}\sum_{i=0}^{3} DM2_{t-i} + \beta_{6i}\sum_{i=0}^{3} DRGDP_{t-i} + \beta_7 INF_{t-1} + \beta_8 MAWP_{t-1} \\ & + \beta_9 TOT_{t-1} + \beta_{10} M2_{t-1} + \beta_{11} RGDP_{t-1} + \varepsilon_t \end{aligned} \quad \text{(II)}$$

In the next step, Wald test (F-test) is applied to test following hypothesis:

Model I

H_0: $\alpha_7 = \alpha_8 = \alpha_9 = \alpha_{10} = \alpha_{11} = 0$ (No cointegration exists among variables)

H_1: $\alpha_7 \neq \alpha_8 \neq \alpha_9 \neq \alpha_{10} \neq \alpha_{11} \neq 0$ (There is cointegration)

Model II

H_0: $\alpha_7 = \alpha_8 = \alpha_9 = \alpha_{10} = \alpha_{11} = 0$ (No cointegration exists among variables)

H_1: $\alpha_7 \neq \alpha_8 \neq \alpha_9 \neq \alpha_{10} \neq \alpha_{11} \neq 0$ (There is cointegration)

Wald test results from Model I show that the value of F-calculated is 44.887 and probability value is 0.021 which allows to reject H_0 in Model I, thus, concluding existence of cointegration among the variables. Similarly, for Model II F-calculated value is 12.58 is greater than F-critical from Pesaran *et al.* (2001), thus, cointegration among variables of Model II exists.

TABLE 2

Long-Run Results (Model I)
Dependent Variable: INF

Variable	Coefficient	Std. Error	t-statistic	Prob.
C	0.05	3.8539	0.01	0.9890
INF(–1)	0.45***	0.1217	3.70	0.0015
PG	3.54**	1.4639	2.42	0.0260
RGDP	–0.18	0.2255	–0.78	0.4463
TOT	–0.06**	0.0303	–2.16	0.0440
M2	0.18**	0.0723	2.44	0.0247
DUM2008	12.54***	2.1016	5.97	0.0000
Diagnostics				
R-squared	0.86	F-statistic		19.92
Adjusted R-squared	0.82	Prob (F-statistic)		0.0000

NOTE: ***, **, * indicate significance of coefficients at 1%, 5% and 10% level of significance, respectively.

Table 2 shows that PG and M2 have positive and significant coefficients at 5% level of significance, whereas, coefficients of TOT and RGDP are

negative. Long-run results indicate that on average one percentage point increase in PG leads to 3.54 percentage point increase in inflation in Pakistan. Dummy variable (DUM2008) to capture the impact of 2008 global economic crisis has positive and significant impact on inflation in Pakistan. R-squared is 0.8628; this means that about 86 percentage variation in inflation is due to explanatory variables used in the model. F-statistic is 19.92 with probability of 0.0000 which confirms overall significance of the model.

TABLE 3

Short-Run Model (Model I)
Dependent Variable: DINF

Variable	Coefficient	Std. Error	t-statistic	Prob.
C	–1.52***	0.5036	–3.01	0.0083
DINF(–1)	–0.30***	0.0937	–3.15	0.0061
DPG	–100.70**	44.6585	–2.25	0.0385
DPG(–1)	208.01**	76.6290	2.71	0.0153
DPG(–2)	–130.74***	40.4027	–3.23	0.0052
DRGDP	–0.14	0.1700	–0.84	0.4129
DTOT	–0.12***	0.0388	–3.11	0.0067
DM2	0.13*	0.0658	1.94	0.0706
ECM(–1)	–0.52**	0.2101	–2.50	0.0238
DUM2008	12.75***	2.0279	6.29	0.0000
Diagnostics				
R-squared	0.87	F-statistic		12.0913
Adjusted R-squared	0.80	Prob (F-statistic)		0.0000

NOTE: ***, **, * indicate level of significance at 1%, 5% and 10% respectively

Table 3 shows that the coefficient of ECM_{t-1} is negative and significant having t-statistic 2.50 which reconfirms the long-run relationship between PG and INF. R-squared is 0.87 and F-statistic is 12.09 with probability 0.000. The model was selected based on general to specific methodology of selection of lags of explanatory and dependent variable. Table 4 shows the results of diagnostic tests including Breusch-Godfrey Serial Correlation LM

Test, heteroskedasticity Test of Breusch-Pagan-Godfrey, Jarque-Bera Test of normality, and Ramsey RESET Test. The probability value of all test statistics is greater than 0.05; thus, existence of no serial correlation, no heteroscedasticity, normality of residuals and correct specification of model is confirmed. Stability of parameters is further tested through CUSUM and CUSUMSQ test. Figure 1 shows that coefficients of estimated Model I are stable.

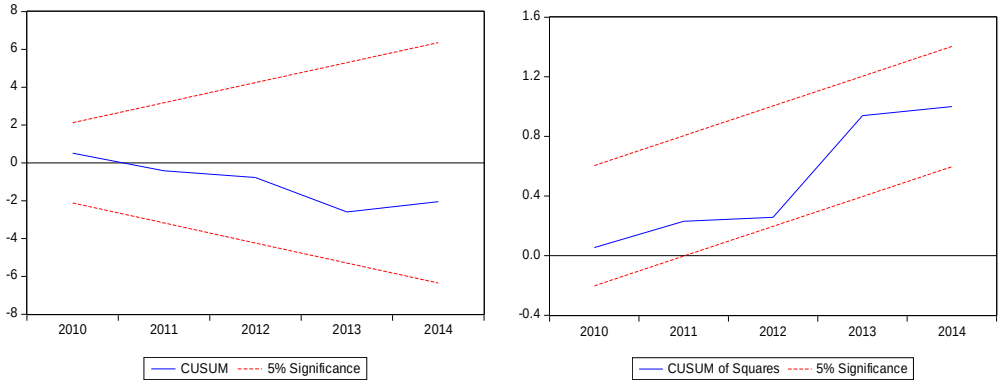
TABLE 4

Diagnostic Tests for ECM Model I

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	0.0853	Prob.	0.7742
Obs*R-squared	0.1470	Prob. Chi-Square	0.7014
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.3416	Prob.	0.9468
Obs*R-squared	4.1913	Prob. Chi-Square	0.8984
Jarque-Bera Test of Normality			
Jarque-Bera	0.5201	Prob.	0.7709
Ramsey RESET Test			
t-statistic	0.9210	Prob.	0.3716
F-statistic	0.8482	Prob.	0.3716

FIGURE 1

CUSUM and CUSUMSQ Tests for ECM Model I



Estimation results of long-run relationship between MAWP and INF in Pakistan are given in Table 5. Results show that MAWP affects inflation significantly and negatively. RGDP, TOT and M2 also affect INF significantly in the long-run. Consistent with long-run Model I, DUM2008 has positive and significant impact on inflation in Pakistan.

TABLE 5

Long-Run Results (Model II)
Dependent Variable: INF

Variable	Coefficient	Std. Error	t-statistic	Prob.
C	71.54***	17.92	3.99	0.0007
MAWP	–2.67***	0.87	–3.06	0.0059
GDP	–0.44*	0.24	–1.83	0.0816
TOT	–0.23***	0.05	–4.87	0.0001
M2	0.16*	0.09	1.81	0.0845
DUM2008	7.56**	2.68	2.82	0.0102
Diagnostics				
R-squared	0.7286	F-statistic		11.27
Adjusted R-squared	0.6640	Prob (F-statistic)		0.0000

NOTE: ***, **, * indicate level of significance at 1%, 5% and 10%, respectively.

For short-run model, ECM error term was calculated from estimated long-run model and unit root test was applied to confirm stationarity of the series. Table 6 shows that coefficient of ECM(–1) is –0.71 with t-statistic –3.37 and probability 0.0036. It reconfirms the long-run relationship given in Table 5. R-square is 0.8447 which means the explained variation in the model due to independent variables is 84% and F-statistic is 11.56 with probability of 0.0000 which confirms overall significance of the model.

Table 7 presents results of standard diagnostic tests to check serial correlation, heteroskedasticity and normality of residuals along with correct specification of the model. The probability values of all test statistics are greater than 0.05, thus, existence of no serial correlation, no hetero-scedasticity, normality of residuals and correct specification of the model is confirmed.

TABLE 6

Short-Run Results (Model II)
Dependent Variable: DINF

Variable	Coefficient	Std. Error	t-statistic	Prob.
C	0.20	0.4127	0.47	0.6421
DINF(–1)	–0.19*	0.1033	–1.83	0.0842
DMAWP	–10.48***	3.4889	–3.00	0.0080
DRGDP	0.22	0.1933	1.14	0.2687
DTOT	–0.17***	0.0418	–4.17	0.0006
DM2	0.06	0.0640	0.87	0.3934
DM2(–1)	0.08	0.0586	1.42	0.1741
ECM(–1)	–0.71***	0.2112	–3.37	0.0036
DUM2008	10.27***	2.2025	4.66	0.0002
Diagnostics				
R-squared	0.8447	F-statistic		11.5614
Adjusted R-squared	0.7716	Prob (F-statistic)		0.0000

NOTE: ***, **, * indicate level of significance 1%, 5% and 10%, respectively.

TABLE 7

Diagnostic Tests for ECM Model II

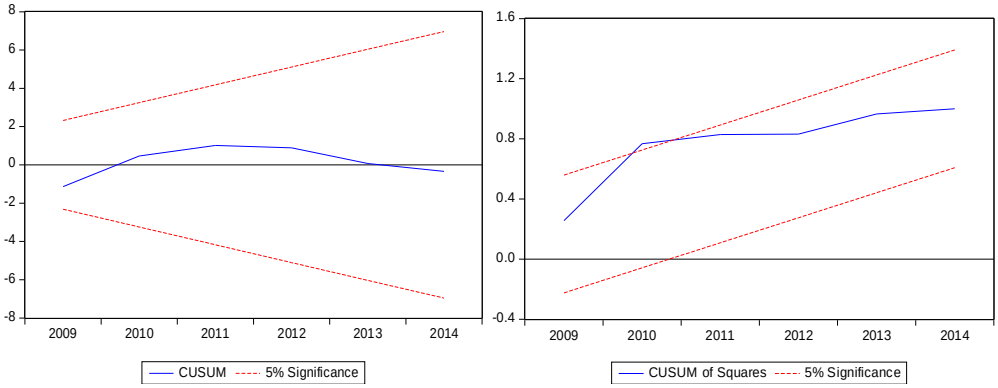
Breusch-Godfrey Serial Correlation LM Test			
F-statistic	0.3104	Prob.	0.5851
Obs*R-squared	0.4948	Prob. Chi-Square	0.4818
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.6184	Prob.	0.7511
Obs*R-squared	5.8612	Prob. Chi-Square	0.6628
Jarque-Bera Test of Normality			
Jarque-Bera	0.3287	Prob.	0.8484
Ramsey RESET Test			
t-statistic	0.5897	Prob.	0.5636
F-statistic	0.3478	Prob.	0.5638

Tests critical values are compared at 5% level of significance.

Stability of parameters is tested through CUSUM and CUSUMSQ test. Figure 2 shows that parameters are stable at 5% level of significance.

FIGURE 2

Stability Test for Short-Run ECM Model II



IV. CONCLUSION

The study has examined the relationship between demographic changes and inflation in Pakistan applying ARDL approach of cointegration for the period of 1988 to 2014. The study developed two separate models for two indicators of demographic change (PG and MAWP) following Yoon *et al.* (2014). The study used RGDP, TOT and M2 growth as control variables in both models.

Estimation results show that PG and MAWP have positive and negative effects on inflation, respectively. Negative and significant coefficients of lagged ECM terms in both short-run models reconfirm long-run relationships. Validity of empirical results has been confirmed through applying standard diagnostic tests. The study concludes that along with traditional macroeconomic factors demographic factors are also important determinants of inflation in Pakistan. Thus, policy makers should also consider demographic factors for designing effective policies to control inflation in Pakistan.

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