KER
Kashmir Economic Review
Since 1984

KASHMIR ECONOMIC REVIEW

Volume 32, Issue 1 **June 2023**

ISSN (Print): 1011-081X **ISSN (Online): 2706-9516**

Articles

Kashmir Institute of Economics
University of Azad Jammu and Kashmir, Muzaffarabad, Pakistan
www.ker.org.pk

Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

Kashmir Economic Review (KER) is published biannually by Kashmir Institute of Economics in the spring and autumn since 1984. The Editorial Board is responsible for the final selection of the content of the journal and reserves the right to reject any material deemed inappropriate for publication. Articles presented in the journal do not represent the views of the University of Azad Jammu & Kashmir. Responsibility for the opinions expressed and the accuracy of facts published in articles and reviews rests solely with the author(s).

Correspondence

All correspondence should be directed to the Managing Editor.
Email: m.jamil@ajku.edu.pk; managing.editor@ker.org.pk
Phone: +92-331-2331079
Postal Address: Dr. Muhammad Jamil, Managing Editor, Kashmir Economic Review (KER), Kashmir Institute of Economics, University of Azad Jammu & Kashmir, King Abdullah Campus, Muzaffarabad, Pakistan.

Copy Rights

Indexing by HEC

HEC Recognized, Category “Y”

Subscription Rates

Pakistan	**South Asian Countries**
Pak Rs. 300 a copy	Pak Rs. 600 a copy
Pak Rs. 500 a year	Pak. Rs. 1000 a year
Other Countries	
US$ - 20 a copy	US$ - 30 a year

Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

Editorial Board

Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

Advisory Board

Indexing and Listing

EconBiz	ECONBIZ Find Economic Literature.
Google Scholar	Google Scholar
HEC-Pakistan	HEC Higher Education Commition of Pakistan
Index Copernicus	INDEX COPERNICUS INTERNATIONAL
J-Gate	J-Gate
National Library of Australia	NATIONAL LIBRARY OF AUSTRALIA
Print Archive and Preservation Registry	PAPR PRINT ARCHIVES PRESERVATION REGISTRY
Repindex	repindex
World Catalogue	WorldCat

Disclaimer

The contents of this "journal" are writers' personal views. The statements, facts and opinions by the authors in the Kashmir Economic Review do not imply the official policy of the Kashmir Institute of Economics or university of Azad Jammu & Kashmir or editors.

Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

Contents

Kashmir Economic Review, Volume 32, Issue 1, June 2023

Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

Deficit Spending, Inflation & Output Growth: Does Source of Spending Matter?

ABSTRACT

A government's choice of a source for 'deficit financing' has both economic and political consequences. In recent decades, academics and policymakers have leaned more in favor of bond financing as opposed to monetization. The reasons for this shift, in the latter, range from being politically motivated and inflationary to counter-productive, while the former, as a market-based solution to fiscal discipline and stability. The objective of this paper is to investigate whether different sources of finance for the government's deficit spending have any bearing on the macroeconomic outcomes i.e., inflation and output growth in the case of Pakistan. A structural vector autoregressive (SVAR) model is built with key economic variables, to calculate impulse responses to monetized and bond-financed deficit spending. The evidence shows that, although both monetized and bond-financed deficit spending have inflationary consequences, they improve output growth. Moreover, to fund the government's deficit spending, picking either monetization or bond financing over the other does not provide substantial benefits in terms of macroeconomic outcomes. The robustness of these results is substantiated by the evidence from the QQ approach as well.

AUTHORS

Adeel Ahmed Sheikh *
PhD Scholar, Pakistan Institute of Development Economics, Islamabad, Pakistan.
Author's Contributions: 1,2,3,4,5,6
aahmedsheikh87@gmail.com
https://orcid.org/0000-0002-3545-6628

Wasim Shahid Malik
Economic Advisor Wing, First Floor, S-Block, Pak Secretariat, Islamabad, Pakistan.
Author's Contributions: 1,4
wsmalick@gmail.com
https://orcid.org/0000-0003-0684-4610

Keywords
Deficit, Inflation, Output, Quantile-on-Quantile (QQ) Method, Structural Vector Autoregressive (SVAR)

JEL Classification
E40, E62, E35, E1

Please cite this article as:
Sheikh, A. A. & Malik, W. S. (2023). Deficit Spending, Inflation & Output Growth: Does Source of Spending Matter? *Kashmir Economic Review*, 32(1), 1-18.

*** Correspondence author**

Author's contribution in the article: 1- Conceived and designed the analysis, 2- Reviewed and compiled the literature, 3- Collected the data, 4- Contributed data or analysis tools, 5- Performed the analysis, 6- Wrote the paper, 7- Financial support for the conduct of the study, 8-Other

1. INTRODUCTION

Even though the fiscal view of inflation and output growth is highly contested in academic discourse, it holds special importance in the case of developing countries. This is because developing countries, generally, are weak at raising taxes and foreign assistance (Alesina & Drazen, 1989; Cukierman et al., 1992) to finance their spending and thus keep engaging in deficit financing to meet their expenses.

There are two ways a government can finance its deficits i.e., either through monetization1 or bond financing2. From a monetarist point of view, there is a consensus in the literature that excessive monetization of a government's debt by its central bank is inflationary because it creates high-powered money and inflation is always and everywhere a monetary phenomenon (Friedman, 1989). But a similar argument is not made when a government borrows from the private funds market i.e., mainly banks. The explanation for this behavior is in the orthodox understanding of the way money supply is created in the economy through a multiplier model and the way banks behave as financial intermediaries in an economy. A government borrowing from a private bank is not assumed to be inflationary because it "crowds out" the private funds market the possibility of a buildup of excessive money stock, and consequently inflation, is very low. However, the argument that governments running deficits persistently will eventually have to finance them through monetization, even if they are initially bond-financed weakens the premise along with the argument that the money supply is not exogenous but endogenous to the financial requirements of the fiscal authorities (Sargent & Wallace, 1981). As far as output growth is concerned, excessive borrowing by the government can severely crowd out private borrowing to the level that it hurts private investment plans and thus output growth in the economy, however, negative impacts on output growth can be mitigated with a growth-oriented deficit spending. Therefore, the choice of the source of financing deficit spending is material to macroeconomic outcomes and policy formation.

Pakistan is a developing economy and has faced moderately high inflation and low output growth for the past two decades. Historically, the government has maintained a substantial footprint, and consequently, sizable deficit spending, financed both through the central bank and the private funds market to support the economy. Motivation for this study comes from the recent central bank independence, essentially putting an end to the monetization of deficits. This move is aimed at providing a market-based solution to discipline deficit spending. The present literature, in the case of Pakistan, does not provide information as to either the impact or relative importance of the sources of deficit financing on macroeconomic outcomes such as inflation and output growth.

The main objective and contribution of this study is to investigate how monetization and bond-financing of government deficits affect inflation and output growth in the economy. The discussion over respective impacts carries over to the argument of whether it makes 'a difference' for the macroeconomic outcomes if one source of deficit financing is picked over the other. This study then discusses whether measures such as central bank independence, in hopes of subjecting deficit spending to 'market discipline' prove to be effective or not. This study proceeds by building a context for the analysis by elaborating on the theoretical background of the problem and then uses the structural vector autoregressive (SVAR) modeling approach to find the impacts. The robustness of the results is established through the QQ method.

2. CONCEPTUAL FRAMEWORK

Theoretical arguments both in classical and Keynesian traditions have historically advocated in favor of monetization e.g., during the Great Depression the argument by the early classicists that money should be

[1] Monetization is the term used when government borrows directly through its central bank.

[2] Bond-finance is the term used when government borrows from the funds market.

created under a policy of "full-reserve banking" by the government or the central bank (Fischer, 1936). A variant of the monetization argument has recently been revived under the 'Modern Monetary Theory' (MMT) (Wray, 2012) which argues that the sovereign currency-issuing state or its central bank is the ultimate creator of the money and hence there are no limits to their power to spend for full employment. The added benefit of the monetization arrangement is that governments own their central banks to whom they issue their debt therefore, no liability to the public exists and the government stands to earn, as profit, whatever interest it pays to its central bank (Turner, 2014; Johnston & Pugh, 2014). Monetization over time, however, is increasingly been seen as synonymous with inflation in the economics literature.

With the emergence of the "New Macroeconomic Consensus", its prescriptions around monetary policy make targeting a certain inflation rate the key objective and views operational independence of the central bank as a means of achieving the credibility necessary to complete that objective. Monetization was thus stopped because if the government were to demand that the central bank keep monetizing its deficits it would not have been possible for the central bank to be independent. Even though, post 1970s, central banks have become more and more "independent", there have been critiques that, central banks, instead of becoming truly independent, have worked either in favor of the financial sector over the productive sector (Epstein, 1992; Posen, 1998; Ingham, 2004) or towards its power and influence (Goodman, 1991; Werner, 2003).

The question that presents itself is how money creation by the government or its central bank comes to be seen as inflationary. Or if we look at the question from the perspective of the government's sources of finance for its deficit, we can say how monetization came to be seen as inflationary and how the shift toward bond financing occurred.

Historically, instances, where large amounts of money have been created as a result of monetization, parallel with a drop in productivity levels, are seen during war times (Pigou, 1941; Davies, 2002) that persist in post-war times as well. In a bid to attract similar action from the government during the Great Depression, Keynes tries to draw similarities between wartime needs and an economy in depression to justify monetization-based spending. Even though Lerner (1943) tries to draw attention to the ability of a sovereign state with its own fiat currency to manage levels of money to create employment and use tax to withdraw money from different sectors of the economy to control inflation, yet eventualities of monetization-based spending, especially in terms of spending, didn't become mainstream economic theory until monetarist counterrevolution.

There was never any dispute among economists on the valid options available to a government in terms of financing its deficits i.e., monetization and bond finance. Even the classical pro-market economists e.g., (Fischer, 1936; Simons, 1941) have preferred monetization over bond financing for the former is more stable than the latter. Classical economists in the 'Chicago Plan' went as far as branding credit creation by private banks to be damaging and unstable for the economy and to be completely abolished with a 100% reserve ratio (Douglas et al., 1939). These prescriptions, although much debated, were never actually implemented in their original essence yet the period between the Great Depression and 1970s, which can arguably be termed as the era of Keynesian "fiscal dominance", saw a growth in private bank money creation constrained by a set of various regulations.

The causes of "great inflations" in the 1970s are much contested even today but are often attributed to the inability of the Keynesian paradigm to explain them and the re-emergence of the monetarist paradigm for simply sighting the correlation between money supply and inflation as its evidence (Friedman, 1963). Friedman (1962) thus marks, in a manner, the beginning of the movement away from monetization towards the public sector bond finance by arguing in favor of a fixed rate of growth for money because of the ability of the government to cause inflationary episodes by tinkering with the monetary policy and generating business cycles. This stance was well received by the politicians as well as the economists at that time.

The rise of the neoclassical paradigm made up of rational agents with perfect foresight and choices leading to a demand-supply equilibrium and long-term neutrality of money (Sargent & Wallace, 1975; Lucas, 1972) once again opens the debate on the mode of financing of government's deficits. In these rational expectation models, both modes of deficit financing are taken under consideration i.e., money financing and bond financing. In the case of bond financing, the government is assumed to be competing with the private sector in the money market for loanable funds thus raising interest rates and slowing down economic activity i.e., crowding out but since that ends in net resource transfer from the private sector to the public sector it is considered less inflationary in the sense that private sector has a decreased ability to create demand. In the case of money-financing, all money is assumed to be printed by the central bank, and the change in money supply is directly proportional to the base money and hence inflation because there is no resource transfer involved.

More specifically, Cagan (1956) and Dornbusch (1992) argue that under the assumption of rationality, there would be a need for more and more inflationary financing of monetized deficits because agents, for higher returns, will keep preferring non-monetary assets over real money balances. Even if those deficits are bond financed, expanding deficits will eventually have to be serviced through monetization because of the exploding interest cost (Sargent et al. 1981). The problem, however, is that even though mild inflation has a growth potential the rational agent can expect it and re-negotiate contracts, and a government that is looking to exploit this dynamic will either have to exceed the agent's expectation or revert to a rule for optimal monetary policy. This argument flows naturally towards central bank independence and hence the prohibition of money financing of government deficits. The question of the source of funding deficits, thus, becomes important as whether a growth-targeted government spending will bear fruit or whether it will prove only inflationary in the end. There have been some studies that have empirically tested the correlation between fiscal deficits and inflation (King & Plosser, 1985; Barnhart & Darrat, 1988; Lin & Chu, 2013) but have failed to establish a significant connection between the two regardless of the deficit being funded through money or bond financing.

The sources of finance for government's deficits have received renewed attention in the past two decades especially during post-GFC and post-Covid times with some economists even going as far as drawing comparisons with the post-war period (Draghi, 2020). Today, we see money financing coming up in the discussions as a valid tool for macro-management (Agur et al., 2022; Buetzer, 2022) of aggregate demand and the price level while stabilizing financial markets (Constancio, 2018) and ensuring smooth functioning of capital markets (Gabor, 2021; Hauser, 2021) at a time when bond-financing is not a pretty option for governments due to high debt levels and a possibility of a potential crowding out. The relevance of this discussion in Pakistan's context highlights that present conditions have exerted a very high cost of bond financing on the government's deficit but since the recent independence legislation, it has been legally barred from having its debt monetized which hampers its ability to make necessary expenditures in a time of crisis.

In the case of Pakistan, inflation has been studied mainly as a monetary phenomenon (Kemal, 2006; Khan & Schimmelpfennig, 2006; Qayyum, 2006). Output has also been similarly linked to monetary growth (Malik & Khawaja, 2006; Qayyum, 2006) but these studies do not analyze the impact of fiscal development on inflation and output growth. There are, however, few studies (Shabbir et al., 1994; Chaudhary et al., 1995; Agha & Khan, 2006; Jalil et al., 2014; Iqbal et al., 2017) that do look at inflation and output growth from the perspective of fiscal developments. However, these studies tend to pick fiscal deficits in the aggregate and do not take deficit spending and money creation from the perspective of the sources of these deficits and their impacts on macroeconomic outcomes. In this study, we intend to fill this gap from a policy perspective.

3. ECONOMETRIC METHODOLOGY

Policy analysis in the 80's took a turn from the standard axiomatic-deductive approach towards a-theoretical approach such as vector autoregressive (VAR) models (Sims, 1980). The reason for this shift, as Lucas (1976) points out, is the failure, of economic models and their assumptions regarding exogeneity and endogeneity of variables, in predicting the future. Sims' proposed solution to this problem is to drop all structural as well as exogeneity assumptions. The study intends to make the model truly empirical in the sense that patterns emerge purely out of data rather than any economic prejudice.

The way patterns emerge out of a VAR model is through impulse responses (IR). IR, simply, is the response of a system to the shock in one of its variables. But, in principle, this is a causal question requiring causal sequencing. The absence of causal sequencing is the weakness that becomes the source of initial criticism of VAR analysis for not being able to answer policy-related questions (Leamer, 1985; Sargent, 1984). To tackle this weakness, more sophisticated approaches have been developed, since, Sims (1986), Bernanke (1986), and Blanchard & Watson (1986) to answer this criticism. More than three decades of innovations have brought VAR analysis many steps further ahead from its ability to merely forecast.

This study constructs a six-variable structural vector autoregressive (SVAR) model with the objective the objective of answering policy-related questions on the impact of monetized and bond-financed deficit spending on inflation and output growth.

$$BX_t = B_0 + \sum_{i=1}^{P} C_i X_{t-i} + \grave{o}_t \quad (1)$$

the set of contemporaneous coefficients is represented by the matrix$B$, a vector of constants by B_0, lagged coefficients of i^{th} order by C_i, and vector of variables by X i.e., $X_t = [\pi_t, y_t, fbcb_t, fbpb_t, er_t]$. The index of consumer prices is represented by π_t, output by y_t, market interest rate by i_t, monetized deficit spending by $fbcb_t$, bond-financed deficit spending by $fbpb_t$, and exchange rate by er_t. $\grave{o}_t$ is the vector of exogenous structural shocks that are contemporaneously and serially uncorrelated with constant variance and a zero mean.

The SVAR model in Equation (1) is transformed into a reduced-form VAR in Equation (2) to make it empirically testable:

$$X_t = A_0 + \sum A_i X_{t-i} + e_t \quad (2)$$

The elements of e_t are one step ahead of forecast errors. These forecast errors may be contemporaneously correlated but are serially uncorrelated with constant variance and zero mean. A more convenient representation of reduced-form VAR in Equation (2) is given in Equation (3) with moving averages using lag operators:

$$X_t = B(L)e_t \quad (3)$$

The resultant vector moving average (VMA) model in Equation (3), can then be written in terms of structural shocks in Equations (4) and (5) as:

$$X_t = B(L)S\grave{o}_t \quad (4)$$

$$X_t = \phi(L)\grave{o}_t \quad (5)$$

ϕ in Equation (5), is the representation of impulse response functions (IRF).

3.1 Identifying Restrictions

The standard way to estimate a reduced-form VAR model e.g. in Equation (2) is through the use of the ordinary least squares (OLS) method. The issue, however, with estimating such a model, is that the problem of identification must be resolved ahead of estimation. 'Identification' necessitates the imposition of a minimum number of restrictions on the structural parameters. One way of achieving that, among others, is through the use of the 'Cholesky decomposition' method for structural model identification (Enders, 2004). The exact identification of the SVAR model in this study requires $(n^2 - n)/2$ restrictions to be placed, where, n is the number of variables in the SVAR model. With $n = 6$, a minimum of 15 restrictions must be placed on structural parameters.

For contemporaneous responses, output is allowed to respond only to its shock. The reason is that the response in output is lagged in response to shocks in other variables (Christiano et al., 1999; Kim & Roubini, 2000). Exchange rate is allowed to respond to all variables in the model as it adjusts promptly to any economic developments. The inflation rate responds contemporaneously to all other variables in our model except the exchange rate. The reason is that the domestic prices eventually adjust to changes in the exchange rate but not in the same period (Goldberg & Knetter, 1996). Moreover, (Choudhary et al., 2016) and (Malik et al., 2008) present evidence for less than sticky prices in Pakistan that indicates a rather prompt response to economic developments. Market interest rate is used to represent market conditions as it responds to the movement in government securities in the secondary market and even the issue of new government debt in the market in liquidity management operations. Market interest rate is allowed to respond to monetized and bond-financed deficit spending and its lag but not to inflation and exchange rate movements.

Monetized deficit spending is allowed to respond to its shock and output while bond-financed deficit spending is allowed to respond to monetized deficit spending besides its shock and output. The reason for this setup is that government spending is budgeted in advance and is directed towards expenditures that are related to development expenditures or government operations therefore, it doesn't make sense for it to contemporaneously respond to interest rate, inflation, or exchange rate in the current period. Our analysis takes deficit spending by the government as a policy variable in the Keynesian fashion a government may choose to spend more in a recession and less in a boom making perfect sense for the budgetary spending to respond contemporaneously to output. Lastly, bond-financed deficit spending is allowed to respond contemporaneously to monetized deficit spending because, in countries where central banks have not been fully independent in the past (such as Pakistan), governments have monetized deficits rather easily. This completes the identification requirements for our VAR model and its final representation in matrix form is given by Equation (6).

$$\begin{bmatrix} e_{y_t} \\ e_{FBCB_t} \\ e_{FBPB_t} \\ e_{i_t} \\ e_{\pi_t} \\ e_{ER_t} \end{bmatrix} = \begin{bmatrix} c_{11} & 0 & 0 & 0 & 0 & 0 \\ c_{21} & c_{22} & 0 & 0 & 0 & 0 \\ c_{31} & c_{32} & c_{33} & 0 & 0 & 0 \\ c_{41} & c_{42} & c_{43} & c_{44} & 0 & 0 \\ c_{51} & c_{52} & c_{53} & c_{54} & c_{55} & 0 \\ c_{61} & c_{62} & c_{63} & c_{64} & c_{65} & c_{66} \end{bmatrix} \begin{bmatrix} \grave{o}_{y_t} \\ \grave{o}_{FBCB_t} \\ \grave{o}_{FBPB_t} \\ \grave{o}_{i_t} \\ e_{\pi_t} \\ e_{ER_t} \end{bmatrix} \quad (6)$$

3.2 Data & Construction of Variables

Quarterly data on all variables is used in the empirical analysis for the period 2005:3 to 2020:2 for Pakistan3. Real gross domestic product (RGDP) is used as a measure of output and broadly as a measure of overall economic activity. RGDP in annual frequency is converted into quarterly frequency by applying estimated quarterly weights from Kemal & Arby (2004)[4]. The same weights are used in this study following the Nasir & Malik (2011) arguments highlighting negligible variability in quarterly weights to justify their use. Furthermore, necessary seasonal adjustments are made with the X12 method. Quarterly RGDP is converted into its year-on-year percentage form to construct the series for output growth in quarterly frequency.

Quarterly data on monetized deficit spending (FBCB) and bond-financed deficit spending (FBPB) is taken in quarterly frequency as 'quarter-end stocks'. This data is subsequently converted into year-on-year percentages to construct the series of growth rates in monetized deficit spending and growth rates in bond-financed deficit spending. Moreover, data on consumer prices is taken in the form of a consumer price index (CPI) at a quarterly frequency. CPI is converted into inflation (INFCPI) by taking the year-on-year percentage change.

Karachi-interbank-offered-rate (KIBOR) is used as the market interest rate as the representative rate for the price of money in the economy in the quarterly frequency as well. Although evidence in the literature suggests the use of money market rates (Bernanke & Mihov, 1998; Clarida et al., 1999; Svensson, 2002; Taylor, 1993; Thorbecke, 1997) and even discount rates for policy analysis, to the extent of this study the interest rate is not the concern of policy but the representation of the overall market behavior as a response to changing economic conditions. Therefore, using a discount rate, which is set by the central bank and is susceptible to prolonged rigidity or fixation, is not an appropriate measure to be used in this analysis as opposed to a money market rate that does respond to economic developments. The exchange rate (ER) is also used at a quarterly frequency in its year-on-year percentage change form to represent appreciation and depreciation in the exchange rate.

Data on RGDP, CPI, and ER is sourced from the Pakistan Bureau of Statistics (PBS) and that of FBCB, FBCP, and KIBOR from quarterly reports of the SBP. KIBOR along with year-on-year percentage change in RGDP, CPI, FBCB, FBPB, and ER are non-stationary at level but stationary at first difference. We are, thus, confronted with a choice to use the non-stationary variables either at level or at first difference. Non-stationary variables are used in the level form owing to the caution leveled by (Sims, 1980; Sims et al., 1990) against using variables in different forms.

4. RESULTS AND DISCUSSION

The direction of impact of FBCB and FBPB on inflation and output growth is calculated through impulse response functions (IRF) with variable sequencing developed in section 0. These IRFs are presented in Figure 1. The bottom panel of Figure 1 shows that both FBCB and FBPB have inflationary consequences. In the case of FBCB, results find support in the standard theory in terms of its inflationary impact. However, in the case of FBPB, the evidence challenges the standard explanation of a resource transfer from the private to the public sector. This result also raises questions on the orthodox understanding of the creation and dynamics of money in the modern banking setup. This is because the inflationary consequence of FBPB may very well be due to additional high-powered money being created in the banking system. This money created is not destroyed by a subsequent bond sale to the banking sector.

[3] Period is not extended before 2005 for data limitation on interest rate and beyond 2020 for large exogenous shocks to economic variables due to CoVID-19.
[4] Estimated for the period 1974-2004.

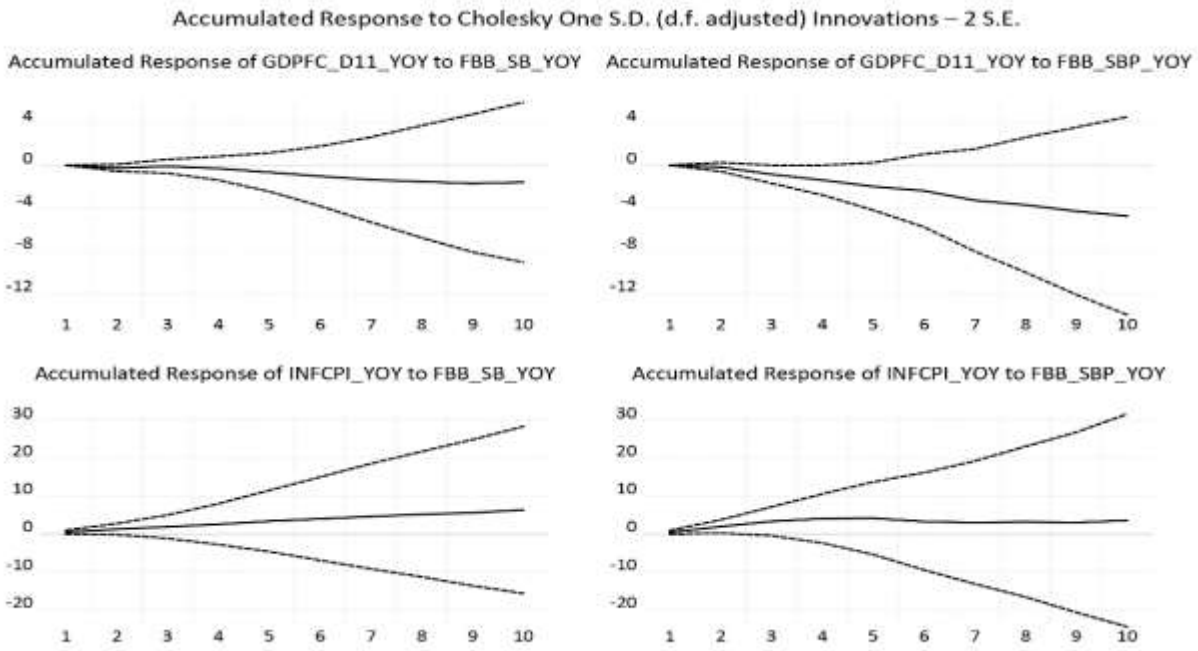


Figure 1: *Impact of FBPB on output growth (top-left) and inflation (bottom-left) & Impact of FBCB on output growth (top-right) and inflation (bottom-right). Source: Author's Estimations [Cholesky Ordering: Output Growth, FBCB, FBPB, Interest Rate, Inflation, and Exchange Rate]*

The top panel of Figure 1 shows a negative contemporaneous movement in output to FBCB as well as FBPB however in the case of FBCB, negative response is found to be significant. These results of a negative response in output to deficit spending are not plausible for the simple fact that, theoretically, the government budget multiplier is non-negative. Data suggests that, in the case of Pakistan, these results should strictly be seen in the context of the relationship between deficit spending and output growth, which shows a counter-cyclical trend (Iqbal & Zahid, 1998; Iqbal et al., 2017) and a pro-cyclical trend only when the business cycle is in the boom phase.

However, in light of the counter-cyclical trend (see Appendix A1) between deficit spending and output growth, IRFs are re-estimated with a control variable that accounts for the state of the economy. The results are presented in Figure 2. The top panel from Figure 2 shows that the state of the economy is accounted for, both FBCB and FBPB carry a positive impact on output growth while its inflationary characteristics stay intact. Thus, results from Figure 2 present a better understanding of the facts compared to results from Figure 1.

Variance decomposition is calculated to see how much variability is caused in output growth and inflation over time due to changes in FBCB and FBPB. The results are presented in **Error! Reference source not found.**. FBPB carries a larger initial impact on inflation compared to FBCB. However, the impact of FBCB has a larger but comparable impact on inflation over longer horizons compared to FBPB. Over a time horizon of ten quarters, the impact of FBPB tends to die down by fifty percent but the impact of FBCB first shows a rising trend but then falls towards the end of the horizon.

As already discussed, in Pakistan, the relationship between deficit spending to output growth is counter-cyclical in that most of this spending comes at a time when the economy is in the downturn part of the cycle. When we control for this behavior with the introduction of a control variable that accommodates this dynamic, the pattern becomes clear. FBCB carries a larger impact on output growth compared to FBPB.

Table 1 shows that on a time horizon of ten quarters, the impact on output growth tends to rise for both FBCB and FBPB, however, the former carries a stronger impact than the latter. See (Appendix A2) for more details on IRFs.

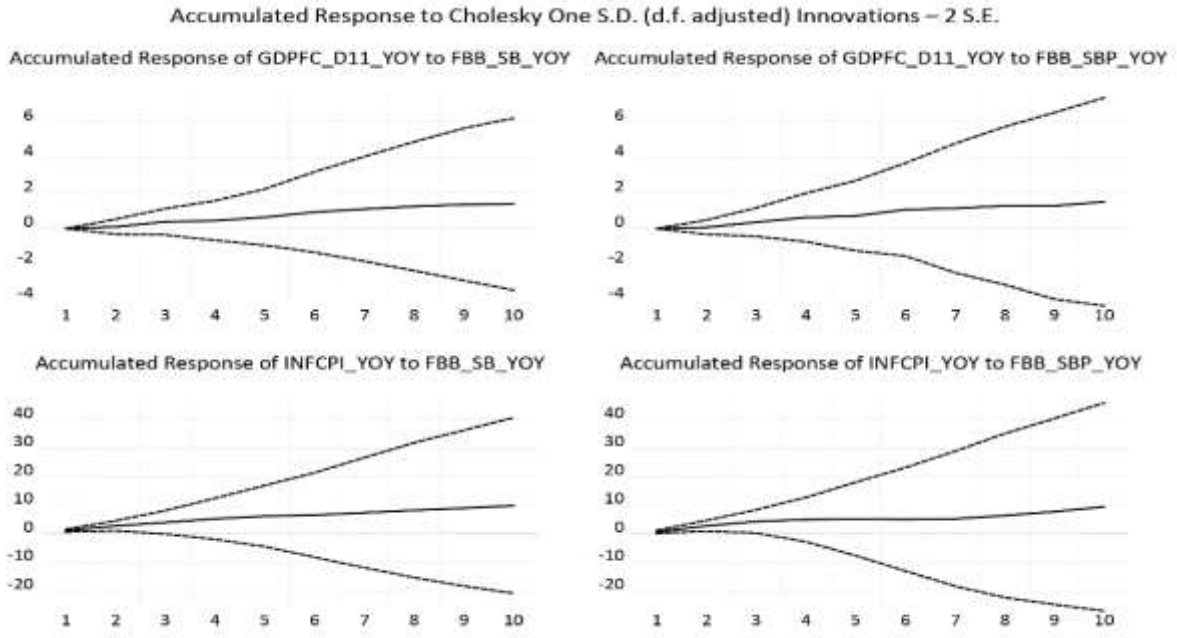


Figure 2*: Impact of FBPB on output growth (top-left) and inflation (bottom-left) & Impact of FBCB on output growth (top-right) and inflation (bottom-right). Source: Author's Estimations [Cholesky Ordering: Output Growth, FBCB, FBPB, Interest Rate, Inflation, and Exchange Rate]*

Table 1*: Variance Decomposition of the Impact of FBPB and FBCB on output growth and inflation.*

	RGDP			INFCPI		
Horizon	S.E.	FBPB	FBCB	S.E.	FBPB	FBCB
1	0.618	0.000	0.000	18.340	29.304	9.651
4	0.956	9.993	17.265	36.950	20.549	22.400
7	1.332	13.607	16.680	66.681	18.009	16.063
10	1.418	13.680	18.160	78.848	15.115	19.181

Note: full form of the abbreviations used in the table: output growth (RGDP), inflation (INFCPI), bond-financed deficit spending growth (FBPB), monetized-deficit spending growth (FBCB)

Results in our model are not specific to a particular Cholesky ordering. In an alternate ordering, we allow output to contemporaneously respond to FBCB and FBPB and we also assume that the funds market adjusts fully to any changes in the economic variables. We find that results from our alternate ordering (see Appendix 0) are consistent with results from our original model.

4.1 Robustness Check

To establish the robustness of the results presented in **Error! Reference source not found.** section 4, we employ a non-parametric approach called the quantile-on-quantile (QQ) method developed by Sim & Zhou (2015) to study the relationship between FBCB and FBPB on inflation and output growth.

4.1.1 QQ Method

The basic quantile regression equation that models the effect of an independent variable (X) i.e., FBCB and FBPB on a dependent variable (Y) i.e., inflation and output growth under the QQ approach is given as:

$$Y_t = \beta^{\theta}(X_t) + u_t^{\theta} \tag{7}$$

where t represents the time and θ represents the θ^{th} quantile of the conditional distribution of the dependent variable and u_t^{θ} the quantile residual term. As we lack prior information as to the relationship between our independent and dependent variables thus the function $\beta^{\theta}(\cdot)$ is unknown. To estimate Equation 7, we use a local linear regression in the neighborhood of X^t to establish a relationship between θ^{th} quantile of Y and τ^{th} quantile of X. We use first-order Taylor expansion to define a regression function around X^t because we know that $\beta^{\theta}(\cdot)$ is unknown to us, as follows:

$$\beta^{\theta} X_t \approx \beta^{\theta} X^t + \beta^{\theta}(X^t)(X_t - X^t) \tag{8}$$

β^{θ} is the partial derivative of the independent variable and has an interpretation like the slope coefficient in linear regression. It follows from Equation (8) that θ and τ both are dual indexed parameters and that $\beta^{\theta}(X^t)$ and $\beta^{\acute{\theta}}(X^t)$ are functions of τ and θ thus we can write:

$$\beta^{\theta}(X^t) \approx \beta_0(\theta, \tau) + \beta_1(\theta, \tau)(X_t - X^{\tau}) \tag{9}$$

where β^{θ} and $\beta^{\acute{\theta}}$ are written as $\beta_0(\theta, \tau)$ and $\beta_1(\theta, \tau)$ respectively. Substituting Eq (9) into Eq (7) gives us Eq (10).

$$Y_t = \beta_0(\theta, \tau) + \beta_1(\theta, \tau)(X_t - X^{\tau}) + u_t^{\theta} \tag{10}$$

Eq (10) represents the relationship between θ^{th} quantile of Y with τ^{th} quantile of X because both β_0 and β_1 are indexed in θ and τ at the same time which may vary as quantiles, both of Y and X changes. As distributions of both Y and X are linked to each other it establishes for us the dependence structure as well. In the end, we estimate the following minimization problem:

$$min_{b_0 - b_1} \sum_{i=1}^{n} \rho_0 \left[Y_t - b_0 - b_1(X_t - X^{\tau}) K\left(\frac{F_n(X_t) - \tau}{h}\right) \right. \tag{11}$$

where ρ_0 represents the quantile loss function, $K(\cdot)$ represents the kernel function and h represents the bandwidth parameter. This minimization problem estimates the local estimates for β_0 and β_1 as b_0 and b_1.

4.1.2 Data & Variables

Key variables in this part of the analysis are the same as the ones provided in section 3.2 i.e., RGDP, INFCPI, FBCB, and FBPB (re-named FBSB) except for market interest rate and exchange rate which have not been taken. Data on all the variables have been taken on a monthly frequency for the period 2005:1 to 2019:12. Monthly data for the large manufacturing index (LSMI) has been used in place of RGDP. All variables are used in the form of year-on-year growth rates.

4.1.3 Results

FBCB and FBPB act as policy variables because it is eventually the government's decision to respond to any economic scenario. The intention of this analysis with this approach is to see how FBCB and FBPB affect inflation and output growth in the economy. Results are presented in Fig 3 and Fig 4.

Results from Fig 3 show that as we move from lower to higher quantiles of FBCB the resultant impact on inflation remains strong and positive. A very similar pattern emerges with the quantiles of FBPB and their impact on inflation. We conclude from this pattern that deficit spending, be it monetized or bond-financed has inflationary consequences in Pakistan. Results from Fig 3 are interesting in the sense that a positive relationship between FBPB and inflation is seen. Middle to high quantiles of inflation (0.4 – 0.9) show a strong and positive relationship with low to high quantiles of deficit spending (0.1 – 0.8). Unlike the case of FBCB, the impact doesn't have a secular positive impact i.e., for lower quantiles of inflation, the effect tends to go in the opposite direction. However, middle to higher quantiles of inflation respond positively to all quantiles of FBPB.

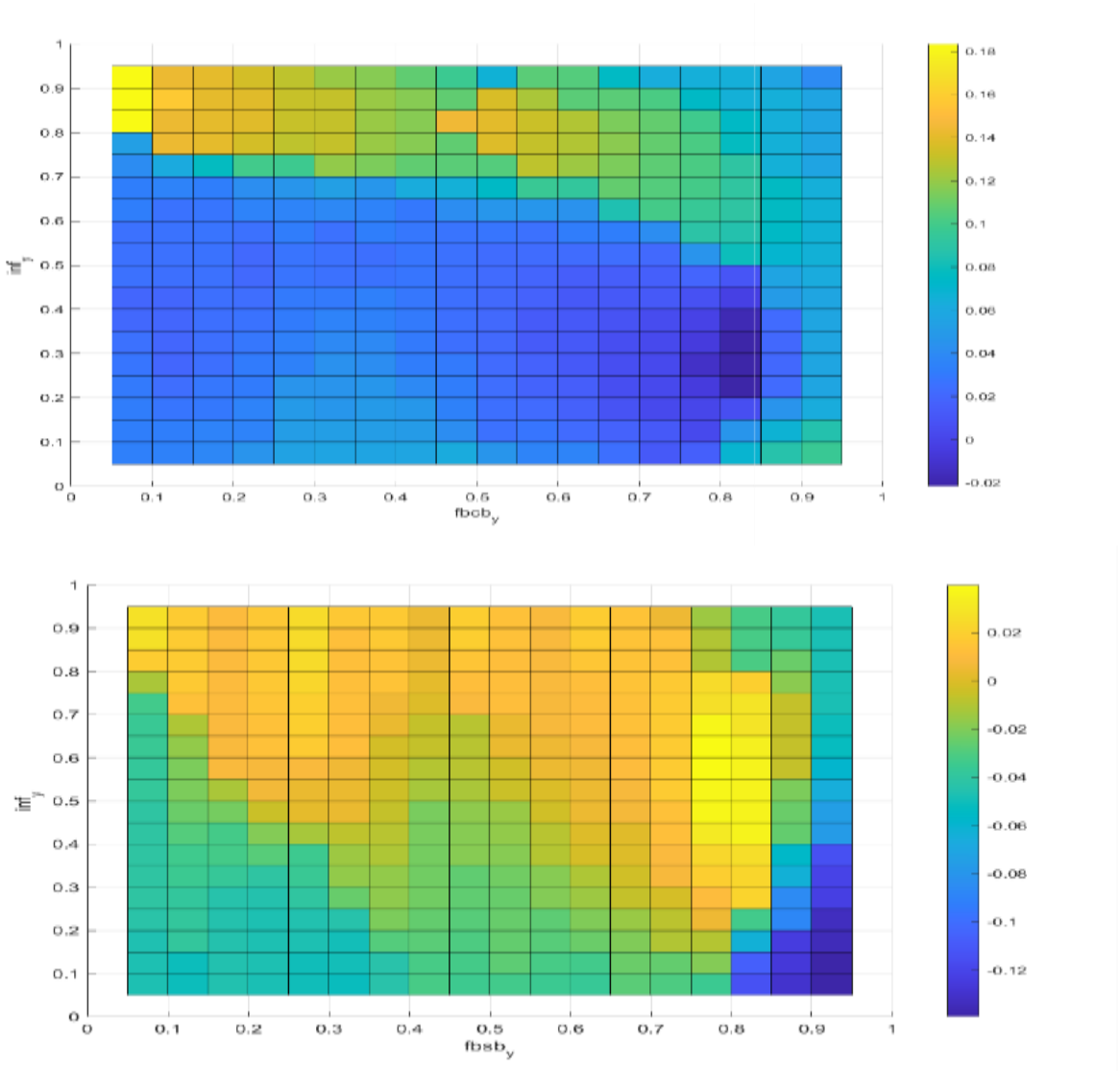


***Fig 3**: Impact of FBCB (top) and FBSB (bottom) on Inflation. (Source: Author's Estimations)*

Results presented in Fig 4 show that there is a predominantly negative relationship between FBPB and output growth but there is a positive relationship between lower to middle quantiles of LSMI (0.1 – 0.5) and middle to higher quantiles of FBCB (0.5 – 0.9). This result also supports our result and argument from our previous analysis that in times of recession or low output growth, there is a higher level of FBCB to boost economic activity. It is important to note here that we cannot control the state of the economy and hence are unable to separate the business cycle impact from the impact of deficit spending.

In summary, the consistency of the results from the QQ method establishes the robustness of the results from the SVAR analysis presented in section 4.

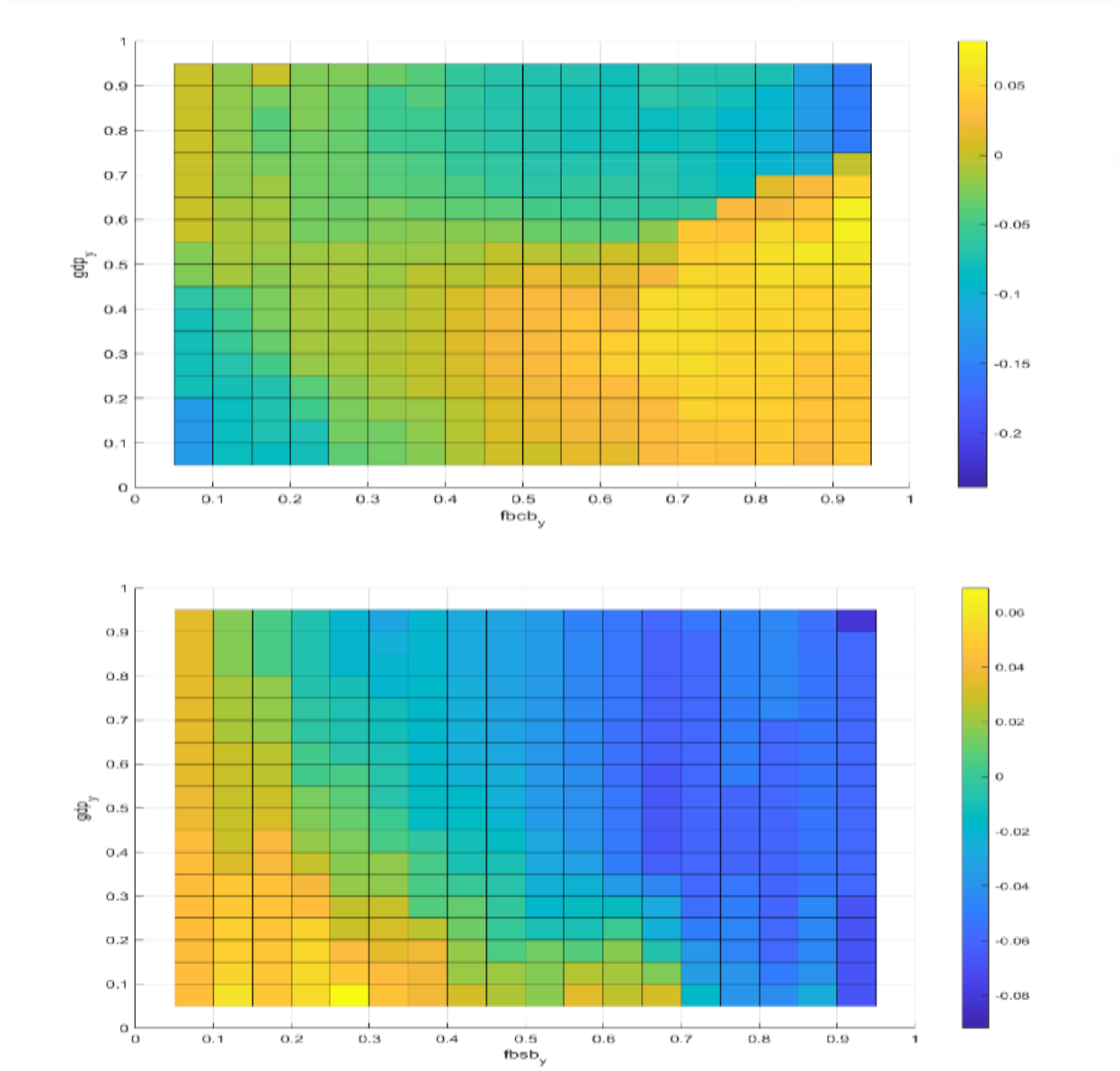


Fig 4*: Impact of FBCB (top) and FBSB (bottom) on Output Growth. (Source: Author's Estimations)*

5. CONCLUSION AND POLICY IMPLICATIONS

The objective of this study is to find how monetized and bond-financed deficit spending impacts macroeconomic outcomes i.e., inflation and output growth in Pakistan. The main hypothesis is that it should not matter whether a government's deficit spending is monetized or bond-financed because, eventually, both lead to the creation of high-powered money and are therefore, inflationary. Also, the government sector being a substantial part of aggregate demand, deficit spending by the government should generally raise output growth. To test these hypotheses, a six-variable SVAR model is constructed to represent the linkages in the economy. Data on output growth, monetized and bond-financed deficit spending, interest rate, inflation, and exchange rate are used in quarterly frequency as well in monthly frequency for the period 2005:3 to 2020:4.

This study initially finds a negative impact of both monetized and bond-financed deficit spending on output growth. However, data shows that GoP has historically engaged in deficit spending more heavily at times when the economy is at the lower end of the business cycle. To have a clearer understanding of the relationship between deficit spending and output growth, an appropriate variable control variable is introduced to account for this pattern. Subsequent analysis shows that deficit spending from both sources has a positive relationship with output growth, supporting the theoretical understanding. Also, both monetized and bond-financed spending are found to have inflationary consequences. This study finds that, in the case of Pakistan, bond financing does not offer any substantial benefits over monetization of deficit spending in terms of macroeconomic outcomes i.e., inflation and output.

A host of studies in the fashion of 'money-inflation-output' modeling has been done in Pakistan that use an aggregate measure of money such as broad money (M2) to represent monetary growth and aggregate budget deficits with somewhat similar results. However, the hazard of using an aggregate measure such as M2 or budget deficit is that it becomes very difficult to answer policy-related questions, especially the type that this study endeavors to answer. This study traces monetary growth back to one of its sources i.e., deficit spending, and divides it further into its sub-sources i.e., monetization and bond-financing.

The results of this study provide policy-relevant insights into Pakistan's current context. GoP has recently passed legislation in favor of the independence of SBP. This move essentially cuts off one of the two sources for the government to finance deficits. The idea behind this move is to discourage political business cycles, subject the government to a degree of fiscal discipline to achieve lower inflation, and higher output growth, and control monetary growth by clamping down on the creation of high-powered money. The implied assumption, however, is two-fold: one, that bond financing leads to resource transfer from the private to the public sector, and two, deficit spending ends up in the productive real sector. The results of this study indicate that these assumptions do not fit, at least in Pakistan's context. Results also hint that if bond-financing of government deficits does not result in any substantial benefits over monetization in terms of macroeconomic outcomes, then it warrants an investigation perhaps into the makeup of the spending rather than its source.

Acknowledgment
The authors acknowledge the comments made by the reviewers and members of the editorial board on the earlier version of this manuscript.

Funding Source:
The author(s) received no specific funding for this work.

Conflict of Interests:
The authors have declared that no competing interests exist.

REFERENCES

Abbas, F., & Hiemenz, U. (2011). Determinants of public health expenditures in Pakistan. *ZEF-Discussion Papers on Development Policy*, 158.

Agha, A. I., & Khan, M. S. (2006). An empirical analysis of fiscal imbalances and inflation in Pakistan. *SBP Research Bulletin*, 2(2), 343-362.

Agur, M. I., Capelle, M. D., Dell'Ariccia, M. G., & Sandri, M. D. (2022). Monetary Finance: do not touch, or handle with care? (Departmental Paper DP/2022/001). Washington, D.C.: International Monetary Fund. IMF Departmental Paper.

Alesina, A. F., & Drazen, A. (1989). Why are stabilizations delayed? In: National Bureau of Economic Research Cambridge, Mass., USA.

Barnhart, S. W., & Darrat, A. F. (1988). Budget deficits, money growth and causality: Further OECD evidence. *Journal of International Money and Finance, 7*(2), 231-242.

Bernanke, B. S., & Mihov, I. (1998). Measuring monetary policy. *The Quarterly Journal of Economics, 113*(3), 869-902.

Bernanke, B. S. (1986). Alternative explanations of the money-income correlation. *National Bureau of Economic Research.* Cambridge, Mass.

Blanchard, O. J., & Watson, M. W. (1986). Are business cycles all alike? In *The American Business Cycle: Continuity and Change.* 123-180. University of Chicago Press.

Buetzer, S. (2022). Advancing the Monetary Policy Toolkit through Outright Transfers. *IMF Working Papers,* Article 2022/087.

Cagan, P. (1956). The monetary dynamics of hyperinflation. In *Friedman, M., Ed., Studies in the Quantity Theory of Money.* The University of Chicago Press, Chicago, 25-17.

Chaudhary, M. A., Ahmad, N., & Siddiqui, R. (1995). Money Supply, Deficit, and Inflation in Pakistan [with Comments]. *The Pakistan Development Review*, 34(4), 945-956.

Choudhary, M. A., Faheem, A., Hanif, M. N., Naeem, S., & Pasha, F. (2016). Price setting & price stickiness: a developing economy perspective. *Journal of Macroeconomics, 48,* 44-61.

Christiano, L. J., Eichenbaum, M., & Evans, C. L. (1999). Monetary policy shocks: what have we learned and to what end? *Handbook of Macroeconomics, 1,* 65-148.

Clarida, R., Gali, J., & Gertler, M. (1999). The science of monetary policy: a new Keynesian perspective. *Journal of Economic Literature, 37*(4), 1661-1707.

Constancio, V. (2018). *Completing the Odyssean Journey of the European Monetary Union* [Presentation]. ECB Colloquium on "The Future of Central Banking" Frankfurt.

Cukierman, A., Web, S. B., & Neyapti, B. (1992). Measuring the independence of central banks and its effect on policy outcomes. *The World Bank Economic Review*, 6(3), 353-398.

Davies, G. (2002). *History of Money (3rd ed.). University of Wales Press.*

Dornbusch, R. (1992). Lessons from experiences with high inflation. *The World Bank Economic Review, 6*(1), 13-31.

Douglas, P. H., Fischer, I., Graham, F. D., Hamilton, E. J., King, W.I., & Whittlesey, C. R. (1939). *A program for monetary reform.* Colorado.

Draghi, M. (2020). We face a war against coronavirus and must mobilise accordingly. *Financial Times, 25*(3).

Enders, W. (2004). Applied time series econometrics (2nd Ed). In: *Wiley Series in Probability and Statistics, John Wiley & Sons, Hoboken.*

Epstein, G. (1992). Political economy and comparative central banking. *Review of Radical Political Economics, 24*(1), 1-30.

Fischer, I. (1936). 100% money and the public debt. *Economic Forum,* 406-420.

Friedman, M. (1962). Should there be an independent monetary authority? *In search of a monetary constitution,* 219-243. Harvard University Press.

Friedman, M. (1963). Price determination in the United States treasury bills market: A comment. *The Review of Economics and Statistics*, 318-320.

Friedman, M. (1989). Quantity theory of money. In Money (pp. 1-40). Springer.

Gabor, D. (2021). *Revolution without Revolutionaries: Interrogating the New Politics of Monetary Financing.* [Policy Brief]. Finanzwende and Heinrich Boell Stiftung.

Goldberg, P. K., & Knetter, M. M. (1996). Goods prices and exchange rates: what have we learned? *National Bureau of Economic Research.* Cambridge, Mass.

Goodman, J. B. (1991). The politics of central bank independence. *Comparative Politics*, *23*(3), 329-349.

Hauser, A. (2021). *From Lender of Last Resort to Market Maker of Last Resort via the Dash for Cash: Why Central Banks Need New Tools for Dealing with Market Dysfunction* [Presentation]. Reuters, London.

Ingham, G. (2004). The nature of money. *Economic Sociology: European Electronic Newsletter*, *5*(2), 18-28.

Iqbal, N., ud Din, M., & Ghani, E. (2017). The fiscal deficit and economic growth in Pakistan: new evidence. *The Lahore Journal of Economics*, *22*, 53-72.

Iqbal, Z., & Zahid, G. M. (1998). Macroeconomic determinants of economic growth in Pakistan. *The Pakistan Development Review*, 125-148.

Jalil, A., Tariq, R., & Bibi, N. (2014). Fiscal deficit and inflation: New evidences from Pakistan using a bounds testing approach. *Economic Modelling*, 37, 120-126.

Johnston, A., & Pugh, T. (2014). The law and economics of quantitative easing. *Sheffield Institute of Corporate and Commercial Law Working Paper Series.*

Kemal, M. A. (2006). Is inflation in Pakistan a monetary phenomenon? *The Pakistan Development Review*, 213-220.

Kemal, A., & Arby, M. F. (2004). Quarterisation of annual GDP of Pakistan. *Pakistan Institute of Development Economics.*

Khan, M. S., & Schimmelpfennig, A. (2006). Inflation in Pakistan: Money or wheat?

King, R. G., & Plosser, C. I. (1985). Money, deficits, and inflation. *In Carnegie-Rochester conference series on public policy*, *22*, 147-195. North-Holland.

Kim, S., & Roubini, N. (2000). Exchange rate anomalies in the industrial countries: a solution with a structural var approach. *Journal of Monetary Economics*, *45*(3), 561-586.

Leamer, E. E. (1985, January). Vector autoregressions for causal inference? In *Carnegie-Rochester conference series on public policy*, *22*, 255-304). North-Holland.

Lerner, A. P. (1943). Functional finance and the federal debt. *Social research*, 38-51.

Lin, H. Y., & Chu, H. P. (2013). Are fiscal deficits inflationary? *Journal of International Money and Finance*, *32*, 214-233.

Lucas Jr, R. E. (1972). Expectations and the neutrality of money. *Journal of economic theory*, *4*(2), 103-124.

Lucas Jr, R. E. (1976, January). Econometric policy evaluation: A critique. In *Carnegie-Rochester conference series on public policy*, *1*, 19-46). North-Holland.

Malik, W. S., & Khawaja, M. I. (2006). Money, Output, and Inflation: Evidence from Pakistan [with Comments]. *The Pakistan Development Review*, 1277-1286.

Malik, W. S., Satti, A. u. H., & Saghir, G. (2008). Price setting behavior of Pakistani firms: evidence from four industrial cities of Punjab. *The Pakistan Development Review*, 247-266.

Nasir, M., & Malik, W. S. (2011). The contemporaneous correlation of structural shocks and inflation-output variability in Pakistan. *The Pakistan Development Review*, 145-162.

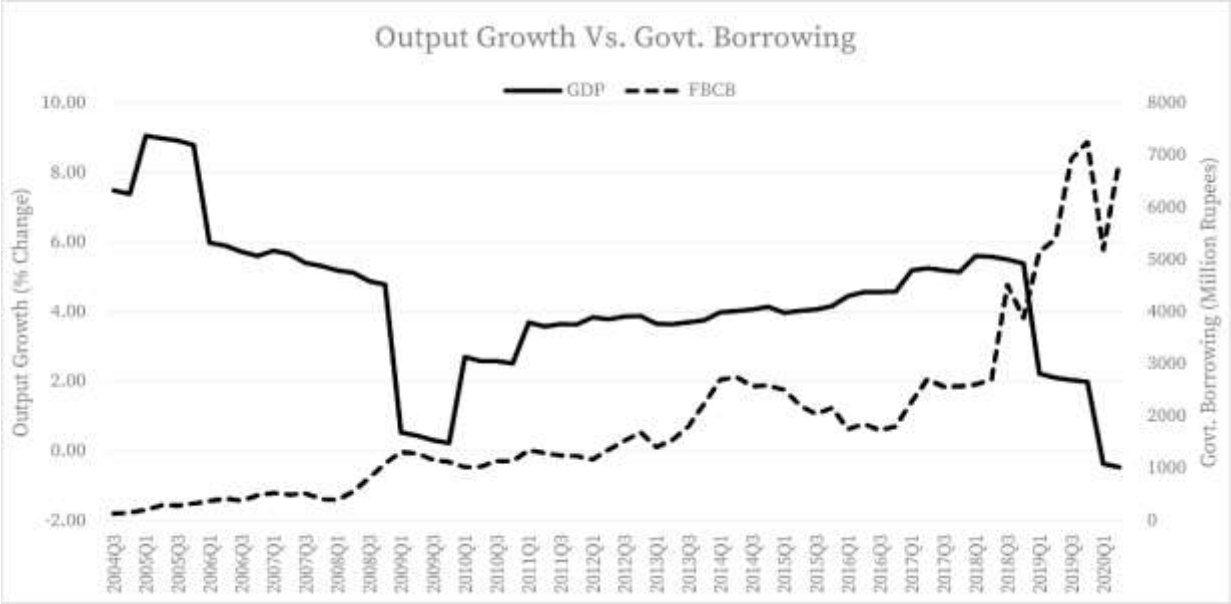
Pigou, A. (1941). Types of war inflation. *The Economic Journal*, *51*(204), 439-448.

Posen, A. (1998). Central bank independence and disinflationary credibility: a missing link? *Oxford Economic Papers*, *50*(3), 335-359.

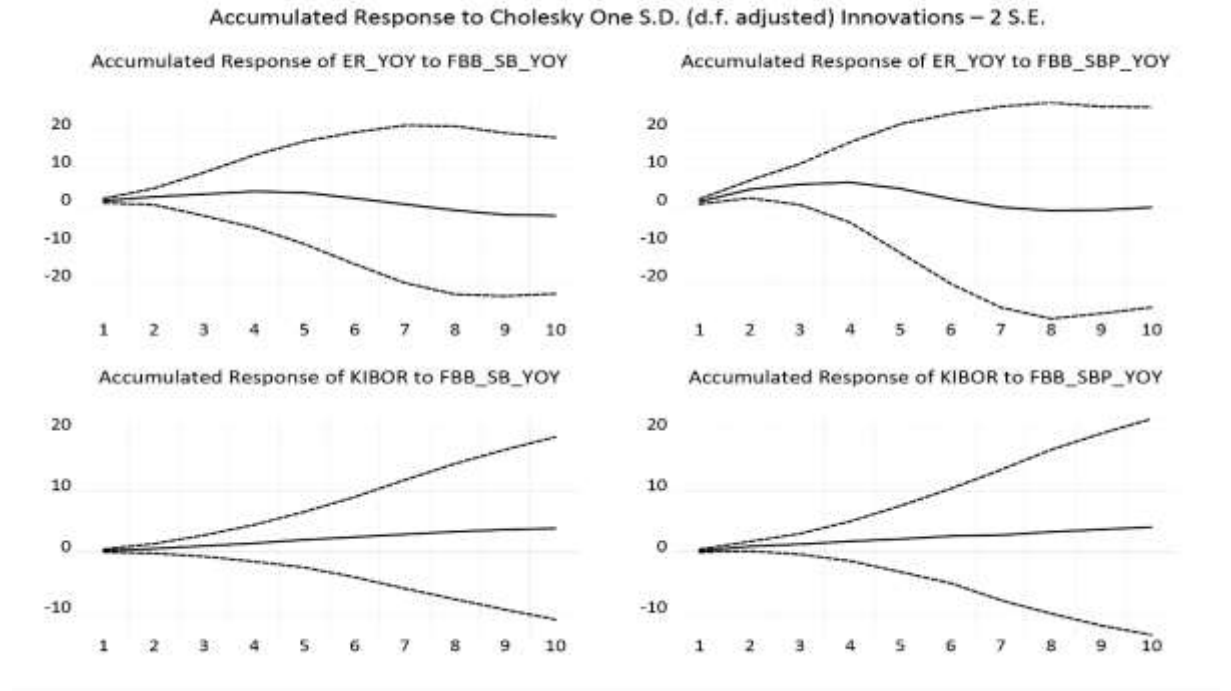
Qayyum, A. (2006). Money, inflation, and growth in Pakistan. *The Pakistan Development Review*, 203-212.

Sargent, T. J., & Wallace, N. (1975). "Rational" expectations, the optimal monetary instrument, and the optimal money supply rule. *Journal of Political Economy*, *83*(2), 241-254.
Sargent, T. J., & Wallace, N. (1981). Some unpleasant monetarist arithmetic. *Federal Reserve Bank of Minneapolis quarterly review*, *5*(3), 1-17.
Sargent, T. J. (1984). Autoregressive, expectations, and advice. *The American Economic Review*, *74*(2), 408-415.
Shabbir, T., Ahmed, A., & Ali, M. S. (1994). Are government budget deficits inflationary? evidence from Pakistan [with comments]. *The Pakistan Development Review*, 33(4), 955-967.
Sim, N., & Zhou, H. (2015). Oil prices, US stock return, and the dependence between their quantiles. *Journal of Banking and Finance*, *55*, 1-8.
Simons, H. C. (1941). For a free-market liberalism. *The University of Chicago Law Review*, *8*(2), 202-214.
Sims, C. A. (1980). Macroeconomics and reality. *Econometrica: journal of the Econometric Society*, 1-48.
Sims, C. A. (1986). Are forecasting models usable for policy analysis? *Quarterly Review*, *10*, 2-16.
Sims, C. A., Stock, J. H., & Watson, M. W. (1990). Inference in linear time series models with some unit roots. Econometrica: Journal of the Econometric Society, 113-144.
Svensson, L. E. (1999). Inflation targeting as a monetary policy rule. *Journal of Monetary Economics*, *43*(3), 607-654
Taylor, J. B. (1993). Discretion versus policy rules in practice. In *Carnegie-Rochester conference series on public policy*, *39*, 195-214.
Turner, A. (2014). Rethinking the monetization taboo. *Project Syndicate* [Online], March 18th 2014.
Thorbecke, W. (1997). On stock market returns and monetary policy. *The Journal of Finance*, *52*(2), 635-654.
Werner, R. A. (2003). *Princes of the Yen: Japan's central bankers and the transformation of the economy*. ME Sharpe.
Wray, L. R. (2012). Introduction to an alternative history of money. *Levy Economics Institute, working paper, (717).*

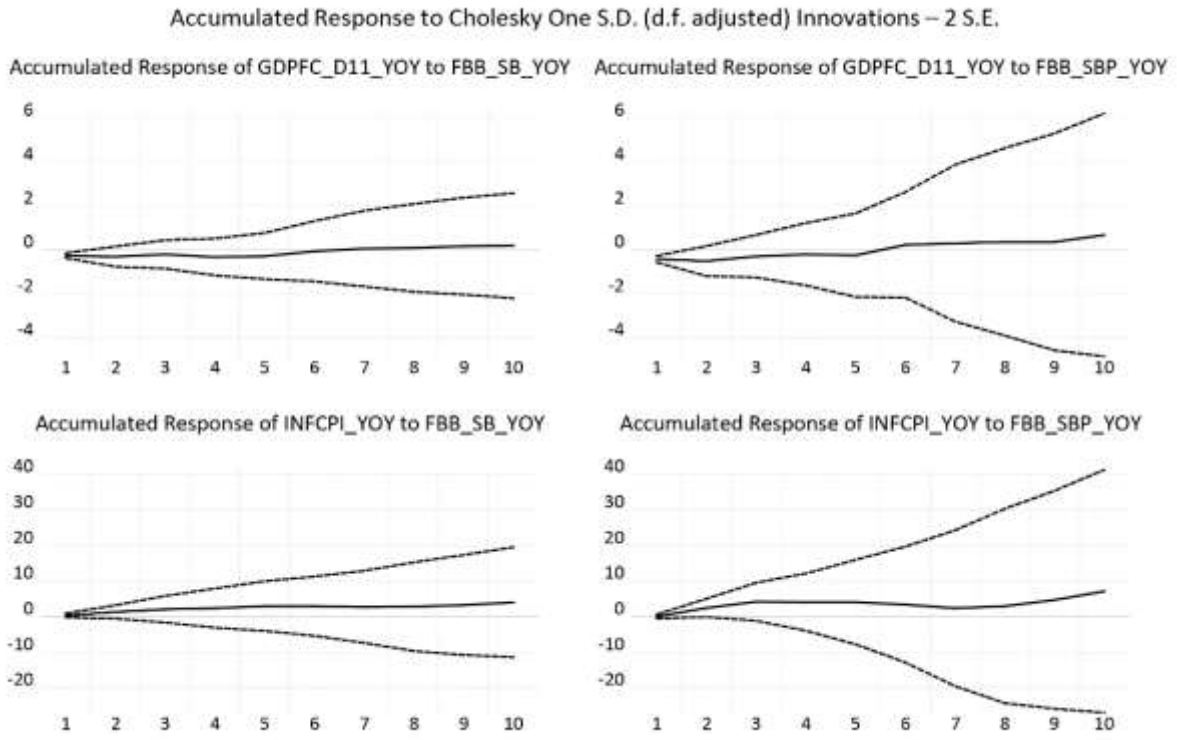
Appendix A1: *Quarterly Trend of Output Growth & Deficit Spending*



Appendix A2: *Impact of FBPB on the exchange rate (top-left) and interest rate (bottom-left) & Impact of FBCB on the exchange rate (top-right) and interest rate (bottom-right). Source: Author's Estimations - Base Cholesky Ordering (Output Growth, FBCB, FBPB, Interest Rate, Inflation Rate, Exchange Rate)*



Appendix A3: *Impact of FBPB on output growth (top-left) and inflation (bottom-left) & Impact of FBCB on output growth (top-right) and inflation (bottom-right).Source: Author's Estimations – Alternate Cholesky Ordering (FBCB, FBPB, Output Growth, Inflation Rate, Exchange Rate & Interest Rate)*



Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

Does Social Capital Surge between Religiosity and Subjective Well-being? A case study of Pakistan

ABSTRACT

This paper aims to examine the relationship between religiosity, social capital, and the subjective well-being of individuals in Pakistan. Subjective well-being can be observed in self-reported health, happiness, and life satisfaction. By using Partial Least Square Structural Equation Modeling (PLS-SEM) on the data for Pakistan, taken from the seventh wave of the World Value Survey (WVS-7), the results reveal that religion and social capital contribute to an individual's well-being. Subjective well-being increases for those who are more active in religious associations. Social capital has a significant positive impact on subjective well-being. Other factors such as health status, income, marital status, and education also influence the well-being of individuals in Pakistan.

AUTHORS

Maryam Tahir Banday *
PhD Scholar, School of Economics, Quaid-i-Azam University Islamabad, Pakistan.
Author's Contributions: 1,2,3,4,5,6
mtahirbanday@yahoo.com
https://orcid.org/0009-0001-3903-0616

Muhammad Tariq Majeed
Director & Professor of Economics, School of Economics, Quaid-i-Azam University Islamabad, Pakistan
Author's Contributions: 1,4,6,8
tariq@qau.edu.pk
https://orcid.org/0000-0001-9374-5025

Tania Luni
Research Scholar, School of Economics, Quaid-i-Azam University Islamabad, Pakistan.
Author's Contributions: 1,6,8
tania_luni@yahoo.com
https://orcid.org/0000-0002-7022-1920

Keywords
Happiness, life satisfaction, Partial Least Square Structural Equation Modeling (PLS-SEM), religiosity, social capital, well-being

JEL Classification
I31, I38, Z12, Z13

Please cite this article as:
Banday, M. T., Majeed, M. T., & Luni, T. (2023). Does social capital surge between religiosity and subjective well-being? A case study of Pakistan. *Kashmir Economic Review*, 32(1), 19-35.

*** Correspondence author**

Author's contribution in the article: 1- Conceived and designed the analysis, 2- Reviewed and compiled the literature, 3- Collected the data, 4- Contributed data or analysis tools, 5- Performed the analysis, 6- Wrote the paper, 7- Financial support for the conduct of the study, 8-Other

1. INTRODUCTION

Earlier studies on the economics of happiness and well-being focused on the relationship between income and well-being. It was supposed that high income is a determinant of improved well-being. The terms happiness and well-being are used interchangeably in literature. The Sachs et al. (2018) revealed that the happiest country in the world is Finland since 2016, followed by Denmark and Iceland. The top ten happiest nations were all figured to be among the highest-income nations having low unemployment and low-income inequalities. Income was considered the main source of happiness and the prime determinant of well-being. However, a person's well-being or happiness cannot be determined solely by his wealth or money. Stiglitz et al. (2009) described that besides money many other socio-economic factors have a strong impact on well-being and quality of life, these factors are the nature of jobs, leisure, health, quality of institutions, and social connections networks. All these factors are important. For instance, the United States, which is regarded as the world's richest nation, does not appear in the top 10 list of happy countries.

It is also propagated by Easterlin (1974, 1995), that the levels of well-being do not seem to increase with the increase in income, which is known as the "Easterlin Paradox". Stevenson and Wolfers (2008) analyzed data from various sources over the years and found that economic growth is surely related to well-being only in the short term. An individual with a higher level of income tends to report their higher well-being but this correlation weakens over a certain point and time this is also called diminishing marginal utility of income. Various factors contribute to the diminishing correlation between income and well-being such as health, satisfaction, social comparisons, and relationships.

Well-being can be categorized into objective and subjective dimensions. Objective well-being refers to the conditions of a person's life that contribute to his overall satisfaction related to income, employment, health, education, and access to basic services like housing, food, and water (Western & Tomaszewski, 2016). Thus, objective well-being can be measured through monetary variables (income and wealth). The other aspect of well-being is subjective well-being which refers to a person's own perception of their overall well-being, including their happiness, life satisfaction, and sense of purpose and meaning in life (Diener, 1984). Subjective well-being cannot be measured or compared directly across individuals and groups, but it is important because it reflects the individual experience of well-being and can provide insight into the factors that contribute to a person's overall sense of satisfaction and happiness (Diener et al., 1985). Many factors influence subjective well-being, such as money, a healthy diet, adequate sleep, and regular exercise. However, some other factors, such as lifestyle, the pattern of faith or beliefs and practices (religiosity), social connectedness, and support (social capital), have a more significant impact but have been acknowledged with limited attention in the literature on individual and societal well-being.

Religiosity is the level of religious devotion or commitment that an individual exhibits. It includes the intensity of one's beliefs, frequency of religious practice, and involvement in religious communities (Durkheim, 1972). Furthermore, religiosity can be analyzed through, belief in God, frequency of prayer or other religious practices, participation in religious ceremonies, and involvement in religious communities, such as attending religious events or volunteering for spiritual or religious organizations. Religiosity has a strong impact on individuals and society's well-being (Newman & Graham, 2018). It can lead to a variety of outcomes such as improving mental and physical well-being and providing opportunities to increase social connectedness (social capital).

Social capital is defined as the network of people who live and work in a society and enables that society to function effectively. Social capital refers to the networks, relationships, and social norms that facilitate cooperation and trust among individuals and groups (Coleman, 1988). Religion plays an important role in promoting social capital by forming bonds between individuals and creating shared values and beliefs. Some of the ways through which religion promotes social capital include religious institutions, shared moral

and ethical values, voluntary work, and support networks. Among religious institutions mosques, churches, and temples provide a space for individuals to come together and form relationships based on shared values and beliefs. These institutions often organize social events and activities, which can help individuals form new connections and build social capital. Religious teachings emphasize moral and ethical values such as honesty, kindness, and compassion. These shared values can help individuals build trust and cooperation, which are essential components of social capital. Religious institutions organize volunteer activities, such as free meal centers, hospitals, and charity events, which provide opportunities for individuals to serve their community and build social capital. Religious communities provide support networks for individuals and families experiencing difficulties. These networks can strengthen existing relationships and create new connections, which are both important for building social capital. Overall, religion can play a significant role in promoting social capital by creating opportunities for individuals to come together, form relationships, and build trust based on shared values and beliefs (Shapiro, 2022). People who have strong social connections tend to be happier and more satisfied with their lives. Furthermore, having close relationships with family and friends can increase positive emotions and reduce negative thoughts and feelings and thus contribute positively to individual subjective well-being.

There is a huge literature on religion and well-being and religion and social capital. None of the studies examined religiosity, social capital, and well-being altogether. The present study is unique in the sense that it is designed to analyze the impact of religiosity and social capital on the well-being of Pakistan. The direct and indirect effects of religiosity and social capital on well-being will be examined in the same model. It is the first attempt to capture these aspects together. Besides religiosity and social capital, other factors such as income, health status, marital status, and educational levels are also included in the analysis. The following hypotheses have been constructed:

$H_{11:}$ There is a positive relationship between religiosity and well-being
$H_{21:}$ There is a positive relationship between religiosity and social capital.
$H_{31:}$ There is a positive relationship between social capital and well-being and
$H_{41:}$ There is a positive impact of religiosity on well-being through social capital.

This paper is divided into four sections: in section 2 literature review is given; section 3 is based on data and methodology; section 4 offers a discussion of results and section 5 provides the conclusion.

2. LITERATURE REVIEW

Well-being is an important and well-researched topic. Well-being has two dimensions; one is subjective, and the other one is objective well-being. Subjective well-being incorporates ‘happiness’ and ‘life satisfaction’ where happiness is the current and unstable element, while life satisfaction is a stable and judging process that correlates with a long life (Diener, 1984; Krueger & Schkade, 2008). Life satisfaction is defined as the way people express their emotions and feelings and how they feel about their directions and options for the future (Anand, 2016). Money is not the only factor determining well-being, there are several factors including a person's natural temperament, his religious affiliations, social connections and relations, the communities they live in, and their capacity to solve their basic problems that influence subjective well-being.

2.1 Religion and well-being (SWB)

Literature suggests that religion may enhance various aspects of well-being in at least four ways through 1) social integration 2) the establishment of relations with others due to the practice of the same religion (for example; Divine interactions), 3) the provision of a system, 4) the promotion of more specific patterns of religious organization and personal lifestyle. Ellison (1991) claimed that religion has a dominant impact on the well-being of individuals. Religious practices and participation in religious activities have both direct

and indirect effects on well-being. While religious certainty has a positive, direct, and substantial effect on well-being. Individuals who have strong religious faith report higher satisfaction, happiness, and fewer psychological problems.

According to Kim-Prieto and Diener (2009), religion serves as a significant factor contributing to the diversity of emotional experiences among individuals across different countries. In their study, the authors surveyed students from 49 countries studying in the United States, representing five major religions: Christianity, Islam, Hinduism, Buddhism, and Judaism. The findings of the study revealed a significant association between religion and individuals' overall well-being. They concluded that religion has a strong positive and significant connection with well-being. Those who were highly religious were happier and more satisfied.

According to McCullough et al. (2002) and Ngamaba and Soni (2018), religious values and practices have been found to have positive effects on individual well-being. These studies suggest that religion fosters attitudes such as respect and love for interpersonal relationships, which contribute to individuals' experiences of pleasure and satisfaction. Religious values encourage the experience of certain positive and pleasant feelings or emotions. Gratitude and thankfulness are associated with the positive effects of following a particular faith. It also encourages prosocial behaviors, social capital, and spirituality. McCullough et al. (2002) and Metzl (2009) found that Protestant Christians have more positive effects of religion on their lives than Catholic Christians. The difference is due to their different worship style, community engagement, social and cultural interactions, and the influences of these interactions on their behaviors.

In another study, Metzl (2009) stated that in Hurricane Katrina it was found that the recovery of religious people was faster and acted more dignified than non-religious people. Geschwind *et al*. (2011) surveyed the population of the Buddhist religion and found a link between mediation and subjective well-being. Lutz et al. (2008) also analyzed that in the Buddhist religion, mediation shows a high religiosity level of individuals and has greater positive effect on neural activation in the brain and mental health. Sahraian et al. (2013) revealed that individuals with a more religious mindset experience more happiness in the Muslim community of Iran.

According to Rozer and Kraaykamp (2013), Buddhists and Christians had greater levels of well-being than non-religious people and followers of other religions. Ferriss (2002) conducted a comparative study of Protestants and Catholics and found that Protestants were happier than Catholics because of their religious practices. Faith or religion encourages good virtues like love, gratitude, caring behavior, and charitable actions. Ellison and Flannelly (2009) and Tovar-Murray (2011) claimed that religion discourages involvement in unhealthy behaviors. Religious people are happier, less depressed, and more willing to express gratitude than non-religious people.

Fisher et al. (2010) reported a deviation in the well-being of Muslims and Christians according to their religious teachings. Their findings suggest that Muslims seek more social support from family and Christians use more intrapersonal coping strategies. Tovar-Murray (2011) stated that religious behaviors promote spiritual beliefs, marital satisfaction, health, and happiness among Jewish, Protestant, and Roman Catholics. Religiosity promotes the ability to cope with hardships. Chatters et al. (1998) stated that religious beliefs help to decrease stress depression, and suicidal thoughts thus religion leads to better mental health.

Mochon et al. (2011) claimed that passionate believers benefit from their involvement, while those with weaker beliefs seem happy and less satisfied. Ellison and Flannelly (2009) conducted a study of African-American adults. The findings showed that religious involvement is negatively associated with depression

and stress. Inglehart et al. (1992) argued that faith acts as a medical institute, provides mental peace, and offers social connections through religious attendance.

Tewari et al. (2012) stated that Hindus' participation in a long-time gathering impacts their well-being. It increases their happiness and satisfaction levels. Levin (2013) found that religious activities are significantly associated with depression and stress. Religious people were found to be happier and more satisfied (Ellison, 1991; Frey & Stutzer, 2002).

Ngamaba and Soni (2018) explored that different religious groups have different levels of satisfaction. They used six waves of World Value Surveys (WVS) from 1981 to 2014. They reported that individual subjective well-being is the function of his/her religiosity level and country-level development. Their results revealed that Muslims are less happy and satisfied as compared to other divine religions. They suggested that an individual's health status, financial satisfaction, and freedom of choice are the important sources by which religious groups and governments across the globe can improve the subjective well-being (SWB) of individuals.

Feng et al. (2021) studied the relationship between well-being and religious participation within the Chinese cultural context. This study used Chinese General Social Survey data from 2015 for empirical analysis and reported that religious people are happier and more satisfied. The level of satisfaction and happiness varies from religion to religion. They found that Muslims are happier and more satisfied than non-Muslims.

Nezlek (2022) found that there is a significant difference between the happiness and satisfaction levels of believers and non-believers. Those who are believers have better health than others. Believers can trust the people in their surroundings like family, friends, neighbors, and other believers. He suggested that belief not only causes well-being but also generates social capital.

When examining the Quran, we found that happiness and well-being are very important and deep concepts while in conventional knowledge these concepts are frequently considered as being unimportant or simple emotions that are temporary sentiments at a given time. Quran tells us that by holding feelings of pleasure or contentment, happiness can help with handling your emotions, encouraging your faith, and becoming closer to Allah. There are some sources of happiness and increasing well-being that have been at various places in the Quran. From different verses of the Quran, we can understand that true happiness lies in faith, gratefulness, valuing time, and helping others. The first source is faith. The belief in God's existence is the fundamental source of real happiness and satisfaction.

> *"To God belongs the future of the heavens and the earth, and all matters are controlled by Him. You shall worship Him and trust in Him. Your Lord is never unaware of anything you do" (Quran, 11:123).*

Here, the Quran gives us a lesson that we should have a firm belief in the oneness of Allah almighty Allah and that having true faith and true submission to Allah means that we will be content, and therefore happy, about everything in life because we know it to be from Allah alone. If a person has faith in the oneness of Allah and His control over everything, then he/she will be satisfied with every event and happening. This verse also acts as a reminder that Allah is fully aware of every action of individuals so a person can never do wrong deeds due to accountability fear and will remain kind and fair with others.

> *"If you express gratitude, I shall certainly give you more, and if you are ungrateful, then My punishment is severe" (Quran, 14:7).*

Gratitude is the key to much of our achievement and well-being. God has promised in this verse that if we will be thankful to God for His blessings, He will surely bless us more which increases satisfaction and

happiness. By being grateful to Allah, we can learn to understand that everything we receive here on earth is a blessing and that Allah is the One behind everything we experience in life. The third important source of well-being is to be wary of time. The Quran says that if a person takes time as an asset, he must be successful and his well-being will be high.

> *"By the time, surely man is in loss, save those who believe and do good deeds, and enjoin on each other truth, and enjoin on each other patience" (Quran, 103:1-3).*

The Qur'an makes it clear that we must make the most of our time to properly live as the highest of all creatures to the fullest extent possible. Time is of the essence, the Qur'an says. We will succeed in this life and the one beyond it if we use our time wisely. The fourth important source of well-being that will bring Happiness is social interactions that generate social capital.

> *"Indeed, Allah enjoins justice, and the doing of good to others, and giving like kindred, and forbids indecency, and manifest evil, and wrongful transgression. He admonished you that you may take heed" (Quran, 16:91).*

The Qur'an warns us that we must strive hard to be pleasant to people if we want to feel good about ourselves. Being nice to people will only make you happier. We can perhaps become nice and trustworthy individuals by following what Allah has commanded in the Quran. By being courteous to others and doing good deeds, we can build social capital. The Quran emphasizes the need for successful relationships with other individuals. We must make sure that we are not surrounded by such people who have these attributes. We should be linked with those who are leading a life as true Muslims. We can get true happiness by leading a life that is genuinely committed to Allah and from those human beings who try to achieve nearness to God.

2.2 Social Capital and Well-being

Bourdieu (1986) defines social capital for the first time as an indicator of an individual's success. The author argued that social capital is a resource that is connected with group membership and social networks. The volume of social capital possessed by a given agent depends on the size of the network of connections that he can effectively mobilize. Coleman (1988) stated that on a micro-level social capital is the resources available to an individual embedded in social structures. These resources include including teamwork, protection, inspiration, and authority, are used by actors to achieve their interests (Portes, 1998), while the macro-perspective views social capital as the features of social organizations (i.e., networks, norms, social trust) that keep its members from pursuing individual rather than collective goals (Putnam, 2002). The advantages of social capital to society as a whole are emphasized from a macro perspective; all members of society should gain, not just a small group of people (Putnam, 2002; Scholz, 2003). Within macro and micro perspectives, social capital has further been conceptualized as informal (socializing with coworkers) versus formal (attending a club meeting), and bonding means having close social ties with others of similar demographic characteristics versus bridging means having close social ties with diverse others (Putnam & Goss, 2002).

In another study, social capital is also defined as the resources available to individuals living in a social structure for example information through networks and characteristics of social organization e.g., norms, and social trust through which members can take advantage (Scholz, 2003; Kritsotakis & Gamarnikow, 2004).

Social capital has a strong impact on individual and societal health, satisfaction, happiness, and well-being (Scholz, 2003). For example, on an individual level, social capital may promote positive health outcomes by providing health and well-being resources through social networks and social support (e.g., information

about the importance of preventative screenings, support to practice healthy behaviors, *etc*.) while at a societal level, social capital may enable collective action to foster safe communities with well-designed educational and health care systems, which would encourage health through lower crime rates, economic growth, and increased contact to health care services (Kawachi et al., 1999).

Social capital is distinct from social support in that social capital cannot be conceptualized as an individual-level variable but can also be conceptualized as a structural, contextual variable. In contrast, social support is solely an egocentric, individual-level variable. As an individual-level variable, social capital has been conceptualized as the resources available, including the frequency of socialization with work colleagues (Veenstra, 2000) and the extent an individual participates in community events (Almedom, 2005).

Social capital has been hypothesized as the features of social organizations that enable harmonization and cooperation for the benefit of all members of the organization, including the democratic distribution of income and wealth in a country (Islam et al., 2006) and membership of voluntary associations in a state (Kawachi et al., 1999). Social capital, in part, takes in the collective dimension of social ties that influences an individual's social networks and social support (Kawachi & Berkman, 2001). For example, a community is categorized by an integrated social structure that may facilitate high levels of social support among those individuals integrated into that community. Whether social capital was conceptualized as an individual or contextual level variable reviews of the social capital and well-being literature have confirmed social capital's positive relationship with individual mental and physical health, happiness, and well-being (Carlson & Chamberlain, 2003; Islam et al., 2006).

2.3 Religion and Social Capital

Religious organizations (mosques and churches *etc*.) are known in the social capital literature as creators and facilitators of social capital. Churches have a history of volunteerism (Wuthnow, 1991), advocate teachings of care and love for others (Park & Smith, 2000), and play a dominant role in many communities (Eng et al., 1985; Eng & Hatch, 1991). This may facilitate the production of social capital, not only within the religious organizations but also outside of the church into the larger community. Being a member of a religious organization may facilitate membership in other organizations, and participation in religious activities (e.g., church attendance) and also motivate participation in other social institutions, including political institutions. Religious belief may also produce social capital by providing a spiritual rationale for community involvement (Regnerus, 2003), encouraging the value of civic engagement, and upholding customs for being involved in broader society (Muller & Ellison, 2001). Thus, believing that religion is important and being committed to religious faith (e.g., through volunteering, or donating money) attachment to society may also increase, which may be evidenced through electoral and non-electoral participation, group involvement, and giving and volunteering (Regnerus, 2003).

Religious organizations can help believers develop social networks and social interactions beyond religious settings (Muller & Ellison, 2001). Religious institutions through religious sittings and religious occasions offer an atmosphere for social interaction. When combined with the support provided by religious institutions, religious values emphasizing the role of forgiveness, hope, and thankfulness in interpersonal relationships and social networks have the potential to encourage a sense of social trust and well-being among their followers (Krause, 2008).

According to a large body of research, religion has a positive effect on both church-related and secular volunteers (Becker & Dhingra, 2001; Ruiter & De Graaf, 2006). Among churchgoing Protestants, participation in church activities was significantly associated with community volunteerism through a church program, through a non-church organization, and with general community volunteerism, even after controlling for background characteristics (Park & Smith, 2000). Having a greater number of religious and spiritual social networks was also related to overall community volunteerism (Park & Smith, 2000). Dimensions of religious participation (e.g., attendance, membership, prayers), religious affiliation, and

religious beliefs were associated with voluntary association participation in a North American sample (Lam, 2002). Ruiter and De Graaf (2006) reported that those residing in more religious countries were nearly four times more likely to have volunteers than those residing in secular countries. Ecklund & Park (2007) argued that religious participation other than worship, religious giving, and religious volunteerism was positively associated with community volunteerism among Asian Americans.

Trusty and Watts (1999) explored that in national samples of youth, positive perceptions of religion, and higher levels of self-reported religiousness were associated with more volunteer work and participation in community service, respectively. Youniss et al. (1999) also stated that religion has a positive relationship with other aspects of social capital. In a national sample of youth, he found that religious involvement, participation in religious activities, and self-rated religiousness were positively associated with the provision of values and norms that encouraged positive behaviors like parental expectations, friend's hopes and values with intergenerational social networks (between youth and parents, between youth's parents with youth's friends' parents) (Muller & Ellison 2001). In another study, Trusty & Watts (1999) found that positive perceptions of religion were associated with higher levels of engagement in extracurricular activities.

Despite the body of literature linking religion and social capital religion and well-being studies have not adequately examined social capital as a potential mediator in the religion and well-being relationship. Active participation in a faith community may increase social capital, leading to improvement in well-being. Researchers have offered that something essential in being actively involved in a faith community may be accountable for the relationship between religion and well-being, particularly the association between religious attendance and individual well-being (Oman & Reed, 1998; Brown et al., 2003; Oman et al., 2005). Feng et al. (2021) highlighted that religious participation has a significant impact on happiness by providing a social network to people so they can get many direct and indirect benefits. These are sources of reducing stress and risk.

Given that social capital includes the resources available to individuals through their involvement in groups such as faith groups and the social features of those groups, social capital may be a powerful mediator in the religion–happiness and well-being connection. Assumed the previous literature on religion, social capital, and well-being, we supposed that greater religiosity is related to well-being, with social capital as a mediator in the religion and well-being relationship. From the review of existing literature, it seems that no study explores such type of relationship for Pakistan.

3. ECONOMETRIC METHODOLOGY

3.1 Theoretical background

According to Frankl (1967), individual good deeds and practices enhance individual happiness levels. Diener et al. (1984) introduced subjective well-being as a combination of happiness and life satisfaction. Donahue (1985) stated that religious practices create a social network by improving individual behavior and positively affecting subjective well-being. Similarly, according to Pargament (1992), religious practices act as a coping mechanism and affect individual mental health through spirituality. Batson et al. (1993) introduced faith as a social institution that causes individual satisfaction and happiness, religiosity improves psychological well-being by providing a sense of meaning and purpose in life. Ellison (1991) and Ellison & Levin (1998) elaborated on religion's impact on physical health such as mortality rates and psychological well-being. Chatters et al. (2008) stated religious services help to reduce mental disorders and improve mental health as well as physical health by improving individual social networks within religious institutions (for example churches), and Diener et al. (2011) suggest that religiosity has, direct and indirect, effect on the mental and physical well-being of the individual and improves the quality of life. Thus, it can be concluded that religious practices increase faith and improve social networks thereby

boosting individual satisfaction and happiness. This results in improved physical and mental health and reduced mental disorders thereby improving quality of life.

3.2 Data

We used the data from the seventh wave of the World Values Survey (WVS-7) for Pakistan to analyze the impact of religiosity on social capital and well-being. The number of observations is 1995. After filtration of missing observations, we get only 365 observations. The questionnaire consists of a complete module on religiosity, social capital, happiness, and well-being. The questionnaire has a section regarding the demographic variables including age, gender, marital status, education, population density (urban and rural), and income which is also used for the analysis.

This study used the Partial Least Square Structural Equation Modeling Technique (PLS-SEM) based on its ability to resolve measurement errors in variables (Chen, 2001). PLS SEM is a non-parametric technique and has extensive applications in administrative difficulties, specifically, where human association is found. PLS-SEM has been applied in social sciences, for example, in marketing and family business by Sarsted et al. (2014), in accounting by Lee et al. (2011), in tourism by Rasoolimanesh and Ali (2018), and in health economics by Yeary et al. (2012). PLS-SEM works well with the formative measures and answering the research questions. According to Babin et al. (2008), SEM's success is ascribed to its ability to measure latent variables and their relationships. It is a beneficial technique to investigate complete theories and understand concepts (Ridgon, 1998). Also, when the phenomenon under research is relatively new or changing, or when the theoretical model or measures are not well-formed, a PLS approach is often more suitable than the CB approach (Chin & Newsted, 1999).

The dependent variable in the current study is well-being. Three indicators are used to measure well-being including feelings of happiness, life satisfaction, and self-reported health.

3.2.1 Religiosity

Religion is a subjective, multidimensional, and complex concept, and there is no ‘‘gold standard’’ on how religion should be hypothesized. Considering the limitations of the data set, religion was conceptualized via dimensions based on religion and health literature (Ellison & Levin, 1998). Having faith in a divine self is one dimension of religion and it was assessed through beliefs (religious beliefs are assessed by four variables including belief in God, hell, heaven, and life after death) while other dimensions are religious attendance, and the importance of religion in life. According to Glock (1972), religious attendance was assessed by asking respondents about how often they pray, and how often they attend religious events. By using the approach of George et al. (2002) and Harding et al. (2005) importance of religion is assessed by three questions including i) Do you think you are a religious person? ii) Is the religion most important factor in your life? iii) Whenever science and religion conflict, religion is always, right.

3.2.2 Social capital

The conceptualization of social capital as it relates to well-being is still undergoing refinement (Carlson & Chamberlain, 2003). Thus, the theorized components of social capital (Putnam & Goss, 2002) and the previous literature using the Social Capital Community Benchmark Survey SCCBS (Kim & Kawachi, 2006) were used to hypothesize social capital for the present study through the variable Trust. The variable is measured through Trust your family, Trust your neighborhood, Trust people you know (friends), Trust people you meet for the first time and Trust people of another religion.

The initial model design has two exogenous latent variables (i.e. Religiosity and Social Capital). The path model shows the relationship between the three hypotheses with well-being. The inner model displays the relationship between the constructs, while the outer model displays the relationship between the construct and the indicator variables.

Table 1: List of Variables

Sr	Category	Abbreviations	Variables
1	Religiosity	R1	Believe in God
2		R2	Believe in Hell
3		R3	Believe in Heaven
4		R4	Religion is Important in life
5		R5	Importance of God
6		R6	Believe in life after death
7		R7	Whenever science and religion conflict, religion is always right
8		R8	How often do you attend religious services?
9		R9	How often do you pray
10		R10	The only acceptable religion is my religion
11		R11	The meaning of religion is to follow religious norms and ceremonies vs to do good to other people
12		R12	Meaning of religion: To make sense of life after death vs to make sense of life in this world
13		R13	Religious person
14	Social Capital	s1	Trust Your Family
15		s2	Trust Your Neighborhood
16		s3	Trust People you know personally
17		s4	Trust people you meet for the first time
18		s5	Trust People of another religion
19		s6	Trust people of another nationality
20	Well-being	W1	Happiness Level
21		W2	Life Satisfaction
22		W3	Self-reported health
23		w21	Frequency your family's last 12 months gone without enough food
24		w22	Frequency your family the last 12 months felt unsafe from criminals
25		w23	The frequency you & family have last 12 months gone without needed medical treatment
26		w24	The frequency you & family have last 12 months gone without cash
27		w25	Frequency of the last 12 months how often have you or your family remained shelterless?

3.3 Proposed Model

$$WB = f(SC, Rl, Gend, Edu, Inc, Age, MS) \quad (1)$$

$$SC = f(RL) \quad (2)$$

Where $Gend$ represents the gender of the respondent, Edu represents the education level of respondents, Inc represents the income level of the respondent, Age represents the age of the respondent, MS represents the marital Status of the respondent, SC represents the social capital, RL represents the religiosity Level of the respondent, and WB represents the subjective Well-being

i. Structural Model

$$\text{Wellbeing} = \alpha_0 + \alpha_1 \text{SC} + \alpha_2 \text{RL} + \alpha_3 \text{Gend} + \alpha_4 \text{Edu} + \alpha_5 \text{Inc} + \alpha_6 \text{Age} + \alpha_7 \text{Ms} + \varepsilon_1 \quad (1)'$$

$$\text{Social Capital} = \delta_0 + \delta_1 \text{RL} + \varepsilon_2 \quad (2)'$$

In Figure (1) H_1 is the relationship between religiosity and well-being, H_2 represents the relationship between religiosity and social capital, H_3 represents the relationship between social capital and well-being and H_4 represents the relationship between religiosity, social capital, and well-being.

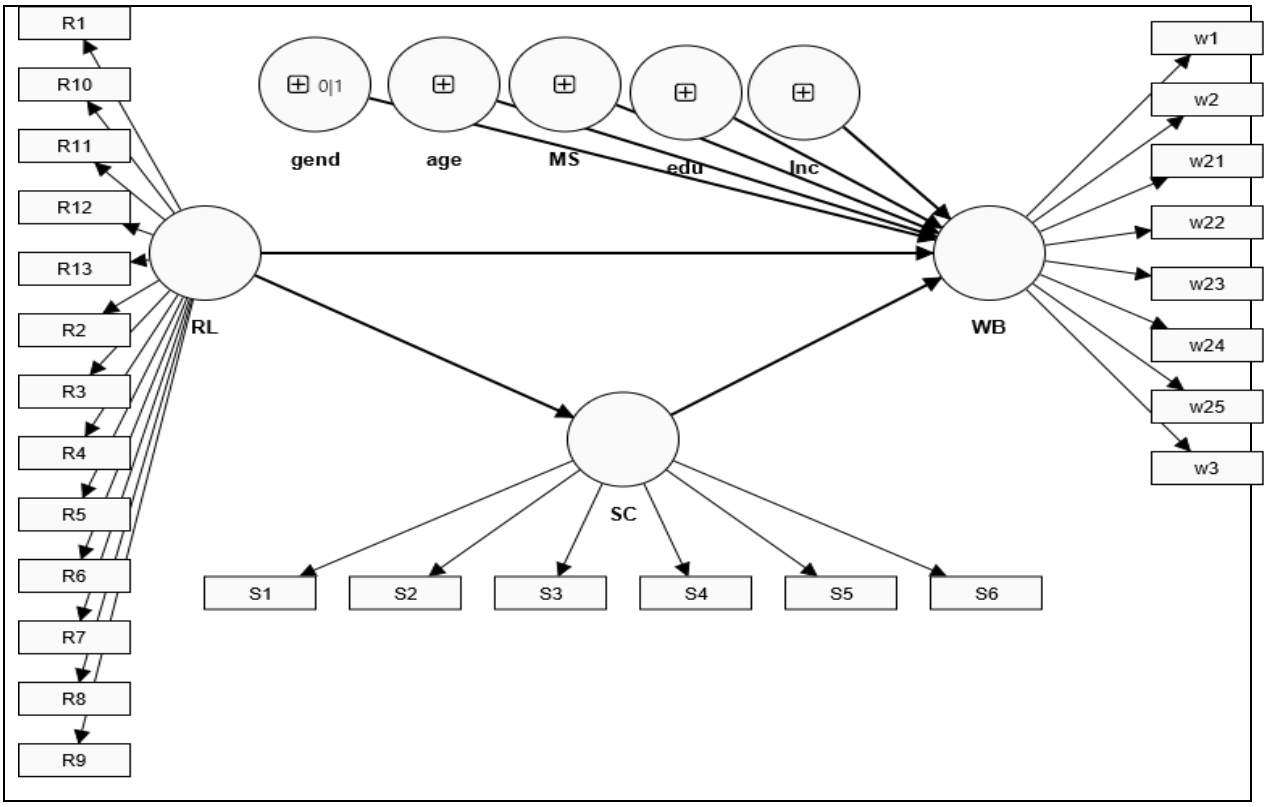


Figure 1: *Proposed model of religiosity, social capital, and well-being*

4. RESULTS AND DISCUSSION

The results depict that some of the religiosity constructs have loadings less than 0.7. Items having a loading less than 0.7 should be removed (Nunnaly, 1978). R_7, R_{10}, R_{11}, R_{12}, and R_{13} constructs of religiosity are less than 0.5 while all other items show loading greater than 0.7, positive, and statistically significant. Similarly, items of the construct social capital, s_1 to s_4 are significant, however, loadings of s_1, s_2, s_3, and s_6 appear with positive signs and loading greater than 0.7.

Well-being has three main items W_1 W_2, and W_3, where W_2 is life satisfaction and it is further subdivided into five more items w_{21}, w_{22}, w_{23}, w_{24}, and w_{25} (Diener, 1985). Factor loadings of W_2, w_{22}, w_{24}, and w_{25} are greater than 0.7 and show a strong relationship with well-being. The religiosity construct shows a strong path coefficient with well-being. Thus hypothesis 1 is accepted that religiosity has a positive and significant effect on well-being. The findings are in line with Ellison (1991), Aman et al. (2019) and Villani et al. (2019) results that religious beliefs and practices increase individual happiness and life satisfaction. It can

be inferred that the significance of religion helps to improve well-being. Therefore, having religious beliefs and focusing on the teachings of religion cope admirably during crises and hard times of life, thus positively ensuring well-being.

Social capital construct loadings s_2, s_3, and s_6 show a high relationship, s_1 has a moderate relationship while s_4 and s_5 show a weak relationship. Our results show that religiosity has a positive and significant impact on social capital. Results are in line with Kerri et al. (2013) and Muller & Ellison (2001) reported that religious involvement is consistently and positively associated with various forms of social capital and with each adolescent outcome. They determined that religious involvement remains modestly but significantly linked with desirable outcomes even controlling the effects of social capital.

Table 2: Outer Loadings, Cronbach's Alpha, and Composite Reliability Values

Variables	**Items**	**Loadings**	**(P-Values)**	**AVE**	**Cronbach's Alpha**	**Composite Reliability**
Religiosity	R1	0.89	0.000	0.530	0.620	0.783
	R2	0.75	0.050			
	R3	0.60	0.010			
	R4	0.76	0.000			
	R5	0.82	0.000			
	R6	0.83	0.000			
	R7	0.51	0.005			
	R8	0.75	0.000			
	R9	0.71	0.000			
	R10	0.21	0.078			
	R11	-0.03	0.065			
	R12	-0.05	0.091			
	R13	0.12	0.005			
Social Capital	s1	0.61	0.000	0.610	0.612	0.762
	s2	0.89	0.000			
	s3	0.95	0.000			
	s4	0.13	0.000			
	s5	0.29	0.020			
	s6	0.81	0.086			
Well-being	W1	0.63	0.056	0.560	0.702	0.719
	W2	0.72	0.009			
	W3	0.62	0.006			
	w21	-0.30	0.000			
	w22	0.82	0.021			
	w23	0.29	0.000			
	w24	0.74	0.000			
	w25	0.80	0.000			

Well-being construct items are W_1, W_2, W_3, w_{21}, w_{22}, w_{23}, w_{24} and w_{25}. Factor loadings of w_2, w_{22}, w_{24}, and w_{25} are significant and above 0.7 suggesting a high relationship with the construct. The social capital has a positive and significant effect on well-being. The findings align with Islam et al. (2006) and Yeary et al. (2012) who found that social capital has an indirect positive impact on the health and subjective well-being of individuals living in a society. This is because it enhances the ability of communities to collaborate and address health issues collectively. Social capital promotes collective efforts for the betterment of society, but it can also lead to social exclusion. Individuals with higher levels of social capital tend to experience greater happiness and have improved job prospects.

5. CONCLUSION AND POLICY IMPLICATIONS

The study investigated the relationship between religiosity, social capital, and well-being. The study applied PLS-SEM to 1996 observations for Pakistan from the seventh wave of the world value survey. Both the processes of identifying the ratios and the most significant parameters were completed by using the PLS-SEM methodology.

The most significant construct for well-being is religiosity. Religiosity has a direct and indirect, positive, and significant impact on well-being. Social capital also has a positive significant impact on well-being. As religiosity is a subjective construct and cannot be measured accurately, therefore, there is always room for further improvement in defining this variable. A lack of complete understanding of religious teachings does not contribute to well-being, as it can promote rigid thinking, overdependence on laws and rules, an emphasis on guilt and sin, and disregard for personal individuality and autonomy. To benefit from religion, a deep understanding of religion along with the application of religious teaching is required that can enhance well-being at both the individual and aggregate level. Religious organizations can play a key role in the promotion of social capital that enhances well-being.

Religiosity, social capital, and well-being are subjective concepts and it is hard to quantify them. The results obtained from different proxies vary according to the situation. Therefore, a detailed survey should be designed to capture all subjective and objective aspects of social capital, religiosity, and well-being. As this study is based on the seventh wave of the world value survey, it does not capture obligatory factors including prayers, and Zakat (obligatory and non-obligatory donations) which can be explored by future studies. The sample size should be increased to see the generalized effects of religiosity and social capital on well-being. Furthermore, as the present study only considered a Muslim country (Pakistan) this can be extended by comparing it with the well-being of individuals in other countries practicing divine religions. Though results cannot be generalized due to a limited sample still it can be inferred that by promotion of religious teachings and institutions well-being of individuals of society can be enhanced through religious social capital.

Acknowledgment
The authors acknowledge the comments made by the reviewers and members of the editorial board on the earlier version of this manuscript.

Funding Source:
The author(s) received no specific funding for this work.

Conflict of Interests:
The authors have declared that no competing interests exist.

REFERENCES

Almedom, A. M. (2005). Social capital and mental health: An interdisciplinary review of primary evidence. *Social Science & Medicine*, *61*(5), 943-964.

Aman, J., Abbas, J., Nurunnabi, M., & Bano, S. (2019). The relationship of religiosity and marital satisfaction: The role of religious commitment and practices on marital satisfaction among Pakistani respondents. *Behavioral Sciences*, *9*(3), 30-48.

Anand, P. (2016). Happiness explained: What human flourishing is and what we can do to promote it. Oxford University Press.

Babin, B.J., Hair, J.F., & Boles, J.S. (2008). Publishing research in marketing journals using structural equation modeling, *Journal of Marketing Theory and Practice*, *16*(4), 279-286.

Batson, C. D., Schoenrade, P., & Ventis, W. L. (1993). Religion and the individual: A social-psychological perspective. Oxford University Press.

Becker, P. E., & Dhingra, P. H. (2001). Religious involvement and volunteering: Implications for civil society. *Sociology of Religion*, *62(*3), 315-335.

Bourdieu, P. (1985). The social space and the genesis of groups. *Social Science Information*, *24*(2), 195-220.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*(4), 822-848.

Carlson, E. D., & Chamberlain, R. M. (2003). Social capital, health, and health disparities. *Journal of Nursing Scholarship*, *35*(4), 325-331.

Chatters, L. M., Levin, J. S., & Ellison, C. G. (1998). Public health and health education in Faith Communities. *Health Education & Behavior*, *25*(6), 689-699.

Chatters, L. M., Taylor, R. J., Jackson, J. S., & Lincoln, K. D. (2008). Religious coping among African Americans, Caribbean blacks, and non-Hispanic whites. *Journal of Community Psychology*, *36*(3), 371-386.

Chen, N.K. (2001). Bank net worth, asset prices, and economic activity. *Journal of Monetary Economics*, *48*(2), 415-436.

Chin, W. W., & Newsted, P. R. (1999). Structural equation modeling analysis with small samples using partial least squares. *Statistical Strategies for Small Sample Research*, *1*(1), 307-341.

Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology*, *94*, S95-S120.

Diener, E. (1984). Subjective well-being. *Psychological Bulletin*, *95(*3), 542-560.

Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, *49*(1), 71-75.

Diener, E., Tay, L., & Myers, D. G. (2011). The religion paradox: If religion makes people happy, why are so many dropping out? *Journal of Personality and Social Psychology*, *101*(6), 1278-1302.

Diener, Ed, Eunkook M. Suh, Richard E. Lucas, and Heidi L. Smith. (1999). Subjective well-being: Three decades of progress. *Psychological Bulletin*, *125*(2), 276-290.

Donahue, M. J. (1985). Intrinsic and extrinsic religiousness: The empirical research. *Journal for the Scientific Study of Religion*, *24*(4), 418-423.

Durkheim, E. (1972). Emile Durkheim: Selected writings. *Cambridge University Press*, *5*(6), 700-720.

Easterlin, R. A. (1974). Does economic growth improve the human lot? Some empirical evidence. In Nations and households in economic growth. Academic Press, 89-125.

Easterlin, R. A. (1995). Will raising the incomes of all increase the happiness of all*? Journal of Economic Behavior* & Organization, *27*(1), 35-47.

Ecklund, E. H., & Park, J. Z. (2007). Religious diversity and community volunteerism among Asian Americans. *Journal for the Scientific Study of Religion*, *46(*2), 233-244.

Ellison, C. G. (1991). Religious involvement and subjective well-being. *Journal of Health and Social Behavior*, *32*(1), 80-99.

Ellison, C. G., & Flannelly, K. J. (2009). Religious involvement and risk of major depression in a prospective nationwide study of African American adults. *The Journal of Nervous and Mental Disease*, *197*(8), 568-573.

Ellison, C. G., & Levin, J. S. (1998). The religion-health connection: Evidence, theory, and future directions. *Health Education & Behavior*, *25*(6), 700-720.

Eng, E., & Hatch, J. W. (1991). Networking between agencies and black churches: The lay health advisor model. *Prevention in Human Services*, *10*(1), 123-146.

Eng, E., Hatch, J., & Callan, A. (1985). Institutionalizing social support through the church and into the community. *Health Education Quarterly*, *12*(1), 81-92.

Feng, Y., Liu, X., Lin, T., Luo, B., Mou, Q., Ren, J., & Chen, J. (2021). Exploring the relationship between spiritual well-being and death anxiety in patients with gynecological cancer: a cross-section study. *BMC Palliative Care*, *20*(1), 1-10.

Fisher, J. (2010). Development and application of a spiritual well-being questionnaire called SHALOM. *Religions*, *1*(1), 105-121.

Ferriss, A. L. (2002). Religion and the quality of life. *Journal of Happiness Studies*, *3*(3), 199-215.

Frey, B. S., & Stutzer, A. (2002). What can economists learn from happiness research? *Journal of Economic Literature*, *40*(2), 402-435.

Geschwind, N., Peeters, F., Drukker, M., van Os, J., & Wichers, M. (2011). Mindfulness training increases momentary positive emotions and reward experience in adults vulnerable to depression: a randomized controlled trial. *Journal of Consulting and Clinical Psychology*, *79*(5), 618-628.

George, L. K., Ellison, C. G., & Larson, D. B. (2002). Explaining the relationships between religious involvement and health. *Psychological Inquiry*, *13*(3), 190-200.

Glock, C. Y. (1972). Images of God, images of man, and the organization of social life. *Journal for the Scientific Study of Religion*, *11*(1), 1-15.

Harding, S. R., Flannelly, K. J., Weaver, A. J., & Costa, K. G. (2005). The influence of religion on death anxiety and death acceptance. *Mental Health, Religion & Culture*, *8*(4), 253-261.

Inglehart, R., Foa, R., Peterson, C., & Welzel, C. (2008). Development, freedom, and rising happiness: A global perspective (1981–2007). *Perspectives on Psychological Science*, *3*(4), 264-285.

Islam, M. K., Merlo, J., Kawachi, I., Lindström, M., & Gerdtham, U. G. (2006). Social capital and health: Does Egalitarianism Matter? A Literature Review. *International Journal for Equity in Health*, *5*(3), 1-28.

Kawachi, I., & Berkman, L. F. (2001). Social ties and mental health. *Journal of Urban Health*, *78*(3), 458-467.

Kawachi, I., Kennedy, B. P., & Glass, R. (1999). Social capital and self-rated health: A contextual analysis. *American Journal of Public Health*, *89*(8), 1187-1193.

Kerri, M., Kerr, P. D. S., Cheater, F., & Morgan, A. (2013). The role and impact of social capital on the health and well-being of children and adolescents: A systematic review. Glasgow: *Glasgow Centre for Population Health*. Glasgow Caledonian University.

Kim, D., & Kawachi, I. (2006). A multilevel analysis of key forms of community-and individual-level social capital as predictors of self-rated health in the United States. *Journal of Urban Health*, *83*(5), 813-826.

Kim-Prieto, C., & Diener, E. (2009). Religion as a source of variation in the experience of positive and negative emotions. *The Journal of Positive Psychology*, *4*(6), 447-460.

Krause, N. (2008). The social foundation of religious meaning in life. *Research on Aging*, *30*(4), 395-427.

Kritsotakis, G., & Gamarnikow, E. (2004). What is social capital and how does it relate to health? *International Journal of Nursing Studies*, *41*(1), 43-50.

Krueger, A. B., & Schkade, D. A. (2008). The reliability of subjective well-being measures. *Journal of Public Economics*, *92*(8-9), 1833-1845.

Levin, J. (2013). Religious observance and well-being among Israeli Jewish adults: Findings from the Israel Social Survey. *Religions*, *4*(4), 469-484.

Lee, L., Petter, S., Fayard, D., & Robinson S. (2011). On the use of Partial Least Squares path modeling in accounting research. *International Journal of Accounting Information Systems*, *12*(4), 305-328.

Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends in cognitive sciences*, *12*(4), 163-169.

Lam, P. Y. (2002). As the flocks gather: How religion affects voluntary association participation. *Journal for the Scientific Study of Religion*, *41*(3), 405-422.

McCullough, M. E., Emmons, R. A., & Tsang, J. A. (2002). The grateful disposition: a conceptual and empirical topography. *Journal of Personality and Social Psychology*, *82*(1), 112-127.

Metzl, E. S. (2009). The role of creative thinking in Resilience after Hurricane Katrina. *Psychology of Aesthetics, Creativity, and the Arts*, *3*(2), 112-124.

Mochon, D., Norton, M. I., & Ariely, D. (2011). Who benefits from religion? *Social Indicators Research*, *101*, 1-15.

Muller, C., & Ellison, C. G. (2001). Religious involvement, social capital, and adolescents' academic progress: Evidence from the National Education Longitudinal Study of 1988. *Sociological Focus*, *34*(2), 155-183.

Newman, D. B., & Graham, J. (2018). Religion and well-being. Handbook of well-being.

Nezlek, J. B. (2022). Relationships among belief in God, well-being, and social capital in the 2020 European and world values survey: Distinguishing interpersonal and ideological prosociality. *Journal of Religion and Health*, *61*(3), 2569-2588.

Ngamaba, K. H., & Soni, D. (2018). Are happiness and life satisfaction different across religious groups? Exploring determinants of happiness and life satisfaction. *Journal of Religion and Health, 57(4)*, 2118-2139.

Nunnaly, J. (1978). *Psychometric Theory*. New York, NY: McGraw-Hill.

Oman, D., & Reed, D. (1998). Religion and mortality among the community-dwelling elderly. *American Journal of Public Health*, *88*(10), 1469-1475.

Oman, Doug, and Carl E. Thoresen. (2005). Do religion and spirituality influence health. *Handbook of the Psychology of Religion and Spirituality*, *24*, 435-459.

Park, J. Z., & Smith, C. (2000). 'To whom much has been given...': Religious capital and community voluntarism among churchgoing protestants. *Journal for the Scientific Study of Religion*, *39*(3), 272-286.

Putnam, R. D. (Ed.). (2002). Democracies in flux: The Evolution of Social Capital in Contemporary Society. *Oxford University Press*, USA.

Putnam, R. D., & Goss, K. A. (2002). Introduction. Robert D. Putnam, ed. Democracies in Flux. New York: Oxford University Press.

Portes, A. (1998). Social capital: Its origins and applications in modern sociology. *Annual Review of Sociology*, *24*(1), 1-24.

Pargament, K. I. (1992). Of means and ends: Religion and the search for significance. *The International Journal for the Psychology of Religion*, *2*(4), 201-229.

Rasoolimanesh, S. M., & Ali, F. (2018). Partial least squares-structural equation modeling in hospitality and tourism. *Journal of Hospitality and Tourism Technology*, *9*(3), 238-248.

Regnerus, M. D. (2003). Religion and positive adolescent outcomes: A review of research and theory. *Review of Religious Research*, 394-413.

Ridgon, E.E. (1998). Structural Equation Modelling. In G. A. Marcoulides (Ed.) *Modern Methods for Business Research*, 251-294.

Rozer, J., & Kraaykamp, G. (2013). Income inequality and subjective well-being: A cross-national study on the conditional effects of individual and national characteristics. *Social Indicators Research*, *113*(3), 1009-1023.

Ruiter, S., & De Graaf, N. D. (2006). National context, religiosity, and volunteering: Results from 53 countries. *American Sociological Review*, *71*(2), 191-210.

Sachs, J. D., Layard, R., & Helliwell, J. F. (2018). World Happiness Report 2018. *Sustainable Development Solutions Network (SDSN) (No. id: 12761).*

Sahraian, A., Gholami, A., Javadpour, A., & Omidvar, B. (2013). Association between religiosity and happiness among a group of Muslim undergraduate students. *Journal of Religion and Health, 52(1)*, 450-453.

Sarsted, M., Ringle, C.M., Smith, D., & Reams, R. (2014). Partial Least Squares Structural Equation Modeling (PLS-SEM): A useful tool for family business researchers. *Journal of Family Business Strategy, 5*(1), 105-115.

Scholz, C.W. (2003). Approaches to social capital: The emergence and transformation of a concept. *In American Sociological Association*, 1–34. Atlanta, GA: American Sociological Association.

Shapiro, E. (2022). A protective canopy: Religious and social capital as elements of a theory of religion and health. *Journal of Religion and Health*, *61*(6), 4466-4480.

Stevenson, B., & Wolfers, J. (2008). Economic growth and subjective well-being: Reassessing the Easterlin paradox. (Working Paper No. 14282). Retrieved from *National Bureau of Economic Research*. website: http://www.nber.org/papers/w*14282*.

Stiglitz, J., Sen, A., & Fitoussi, J. P. (2009). The measurement of economic performance and social progress revisited. Reflections and overview. *Commission On the Measurement of Economic Performance and Social Progress*, Paris.

Tewari, S., Khan, S., Hopkins, N., Srinivasan, N., & Reicher, S. (2012). Participation in mass gatherings can benefit well-being: Longitudinal and control data from a North Indian Hindu pilgrimage event. *PLOS ONE*, *7*(10), 7291-7296.

Tovar-Murray, D. (2011). The multiple determinants of religious behaviors and spiritual beliefs on well-being. *Journal of Spirituality in Mental Health*, *13*(3), 182-192.

Trusty, J., & Watts, R. E. (1999). Relationship of high school seniors' religious perceptions and behavior to educational, career, and leisure variables. *Counseling and Values*, *44*(1), 30-39.

Veenstra, G. (2000). Social capital, SES and health: an individual-level analysis. *Social Science & Medicine*, *50*(5), 619-629.

Villani, D., Sorgente, A., Iannello, P., & Antonietti, A. (2019). The role of spirituality and religiosity in the subjective well-being of individuals with different religious status. *Frontiers in Psychology*, *10(4)*, 1525-1540.

Western, M., & Tomaszewski, W. (2016). Subjective well-being, objective well-being and inequality in Australia. *PLOS One*, *11*(10), 1645-1665.

Wuthnow, R. (1991). Understanding religion and politics. *Daedalus*, *120*(3), 1-20.

Yeary, K. H. C. K., Ounpraseuth, S., Moore, P., Bursac, Z., & Greene, P. (2012). Religion, social capital, and health. *Review of Religious Research*, *54*(3), 331-347.

Youniss, J., McLellan, J. A., & Yates, M. (1999). Religion, community service, and identity in American youth. *Journal of Adolescence*, *22*(2), 243-253.

Kashmir Economic Review, Volume 32, Issue 1, June 2023

Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

Relationship between Housing Price Index and Consumer Price Index in Saudi Economy: A Vector Autoregression Approach

ABSTRACT

This is a pioneering attempt to examine the existence of the causal relationship between the housing price index (HPI) and the consumer price index (CPI), in Saudi Arabia. Vector Autoregression (VAR) approach has been used to analyze the data during the period 2013:1-2022:2. Granger Causality tests, variance decomposition analysis, and impulse response functions have also been employed to explore the nature of that relationship. The VAR estimates reveal that the CPI has an inverse relationship with the HPI in the first three lags out of five lags. The analysis of variance and response functions shows that CPI has a high explanatory power over changes in HPI (more than 48%), especially in the short run compared to the long run. The causal tests of Granger show that CPI does Granger cause housing prices index (HPI), and consequently, it suggests that inflation can serve as a precursor to future housing prices. The paper emphasizes the importance of future studies and research in this field.

AUTHORS

Dirar Elmahi Elobaid Ahmed
Associate Professor, College of Business and Economics, Qassim University, Qassim, Saudi Arabia.
Author's Contributions: 1,2,3,4,5,6
de.ahmed@qu.edu.sa
https://orcid.org/0000-0002-4342-3148

Muhammad Junaid Khawaja*
Associate Professor, College of Business and Economics, Qassim University, Qassim, Saudi Arabia.
Author's Contributions: 1,2,4,5,6
m.khawaja@qu.edu.sa
https://orcid.org/0000-0002-7669-4657

Keywords
Housing Price Index, CPI, VAR, Granger Causality, Saudi Arabia

JEL Classification
C4, E3, R3

Please cite this article as:
Dirar, E. E. A., & Khawaja, M. J. (2023). Relationship between housing price index and consumer price index in Saudi economy: A Vector Autoregression approach. *Kashmir Economic Review*, 32(1), 36-49.

*** Correspondence author**

Author's contribution in the article: 1- Conceived and designed the analysis, 2- Reviewed and compiled the literature, 3- Collected the data, 4- Contributed data or analysis tools, 5- Performed the analysis, 6- Wrote the paper, 7- Financial support for the conduct of the study, 8-Other

1. INTRODUCTION

The importance of housing for all is derived from the fact that shelter has always been one of the basic needs for an economic agent. House ownership and its value are among the main components of a high standard of living and they constitute the bulk of wealth per capita. As such, house ownership is among the largest per capita assets that can be used, along with meeting the need for shelter, in securing access to credit. According to Muellbauer and Murphy (1997), housing costs absorb almost a quarter of a person's disposable income. Housing prices and rents are positively correlated, so housing expenditure occupies a major portion of the household budget whether it is in the form of monthly rent or monthly house lease payments (Leamer, 2002). Therefore, economic activities can be affected by fluctuations in housing prices through variations in housing behavior patterns. There is a lack of research studies that investigate the determinants of housing prices in Saudi Arabia. This paper tries to fill this gap.

Besides, changes in housing prices have important implications for family decisions in terms of investment, consumption, and the overall economy. The global financial crisis in 2007 was triggered by the high-risk mortgage crisis of 2005, which led to negative repercussions not only for the housing markets but also for financial markets throughout the world. The recent financial crisis has also emphasized the significance of the correlation between global financial markets and housing prices. Several macroeconomic factors affect the demand and supply of housing. For example, market sensitivity is measured through housing prices. Many macroeconomic variables affect the housing price index, including the cost of the final goods and raw materials used, as well as inflation.

The objective of this study is to explore how the Housing Price Index (HPI) is affected by the Consumer Price Index (CPI) in an emerging economy like Saudi Arabia. This is a pioneering study about the relationship between CPI and HPI using Saudi data. Analysis of this relationship is important because so far, there has been no empirical research shedding light on this important relationship even though several studies have tried to predict HPI by the changes in CPI and other macroeconomic variables under the context of data from several countries.

The importance of this study emanates from the importance of housing markets in the economy. Housing demand is very sensitive to macroeconomic changes and is often used as an indicator of the business cycle. Consumption expenditure on housing is considered a long-term investment and is sensitive to interest changes. Hence it is very important to explore the relationship of HPI with CPI for the Saudi economy.

Saudi Credit Bureau has recently developed HPI using the Hedonic Regression technique. The primary focus of this paper is to provide an empirical analysis of the effect of CPI on the HPI. Data from the Saudi economy has been analyzed by using the Vector Autoregressive model (VAR) during the study period. This paper derives its importance from the analytical model used which will allow studying the impact of variables to empirically prove the causal associations between HPI and CPI. It is also expected that the results of the study will emphasize a better appreciation of the association between the variables by highlighting an empirical issue that has not got its depth in scientific research in the Saudi real estate sector. It is expected that future housing prices can be better forecasted using aggregate price levels in the KSA.

The research is divided into five parts, including the introduction and conclusion. Section 2 deals with the overview of the Saudi real estate sector, theoretical framework, and literature review, while section 3 discusses data and methodology. Section 4 presents both results and analysis. The last section reviews the findings and recommendations.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Overview of Saudi Real Estate

Saudi real estate sector has witnessed notable developments during the recent past, especially the housing sector, which continues to be affected by ongoing fiscal and monetary policies emphasizing the importance of house ownership as an important pillar of family stability and wealth creation in society. Consequently, the use of housing is no longer just for shelter or investment but rather has become an essential component of the infrastructure of the Saudi economy. Real estate prices, including housing, are related to the consumer price index. Housing prices constitute a significant proportion of the price index. However, as a result of several circumstances, such as variations in the money supply and income, price changes and the cost of living may cause an increase in home prices (Campbell & Cocco, 2004).

The residential real estate sector in the Kingdom of Saudi Arabia plays a significant and active part in the national economy. According to the Saudi General Statistics Authority, nearly 50% of citizens owned houses in Saudi Arabia in 2017. The sector has experienced high growth rates for the past four decades. According to SAMA statistics, the housing sector recorded high growth rates during the period (SAMA: 2003-2012). The annual growth rate in the sector was 11.4% during the said period. Given the social, economic, and developmental roles played by the housing sector, the government continued to pay great attention to the development of this sector. This interest has been reflected in the government's ongoing development policies and strategies to ensure that the housing sector plays a positive role in the national economy. For example, in the year 2008, the government established the so-called General Housing Authority, in addition to formulating a comprehensive housing strategy to encourage investment in housing.

Housing is also one of the largest areas of spending under the National Transformation Program, with a dedicated budget of 59 billion Saudi riyals over five years from the middle of the second decade of the current millennium, which represents a stimulating step for the sector. With a share of 65% of the total real estate market, a sustainable residential sector is formed to achieve ambitious reforms as expressed in the National Transformation Program and Vision 2030. As for the share of the building and construction sector in the GDP, this percentage varied between 6.71% in the year 2015 to 5.18% in the year 2018 (SAMA Annual Report, 2019).

Saudi Credit Bureau (SIMAH) has recently issued the housing price index for the KSA. Principal providers of mortgage service in KSA delivered more than 40,000 real estate records to develop the HPI. Quarterly variations in prices of residential properties were recorded with 2013 as a base year. The hedonic Regression technique was employed to calculate HPI. It is the same technique employed for estimating housing price indicators in major developed countries.

As for the concept of the consumer price index in the economy, it has been defined as a significant and continuous increase in the total volume of demand over the real supply, which leads to a series of sudden and continuous increases in the general price level. Or in a simple statement: there is excess demand for goods over the current supply potential, which results in the rise of commodity prices. As for real estate, it is defined as everything that is fixed in its place and cannot be moved without being damaged, such as lands. It includes buildings, trees, and other fixed objects, and everything that a person has added, such as buildings, improvements, and water and electricity lines. The property is divided into two parts: The first is land which includes residential land, commercial land, investment land, raw land, and agricultural land. As for the second section, the buildings include houses, apartments, palaces, villas, and buildings.

2.2 Systematic Literature Review Using Meta-Analysis

For steadily linking and producing findings from multiple quantitative studies in a research area relevant to this research paper, we used a meta-analysis approach. Meta-analysis is a group of statistical methods that combine the results of a considerable number of studies to postulate a comprehensive summary of knowledge in a research field (Littell et al., 2008). Thus, a meta-analysis combines the findings of single studies for specific relationships, it permits us to achieve accurate conclusions about the strength and direction of a relationship between variables. Therefore, this study follows systematic reviews that involve comprehensive search strategies that enable us to categorize all relevant studies to the research paper (DeLuca et al., 2008).

Thus, in this section of the study, the authors conducted a systematic review of the meta-analysis method to summarize the previous literature review relevant to the study. We first, define the search terms based on focal concepts in our conceptual model to search them in different databases later. For instance, to assess the relationship between housing prices and another explanatory variable such as the Consumer Prices Index (CPI), we consider search terms such as house prices, and Consumer Prices Index (CPI), to search all publications related to their meta-analysis framework.

Secondly, in terms of study inclusion criteria and sample composition, this research paper limited the sample of previous studies published in renowned academic journals to ensure the quality of findings. Finally, regarding the primary effect size measure for the meta-analysis in the field of economics and finance, we are more interested in the examination of correlation effects obtained from the regression model which is directly connected to the research question of the meta-analysis of the study. The basic research question was: is there a relationship between house prices and the Consumer Prices Index (CPI)? We decided to choose the period of (2000–2022) because the concept of housing prices and other macroeconomic determinants gained new momentum and researchers have extensively focused on this area of study since 1990th. Table 1 reflects a review of the Meta statistical approach which summarizes previous literature relevant to the present study.

The aggregate price level is one of the main macroeconomic factors that influences house prices. A set of earlier literature has found that inflation and other macroeconomic factors influence house prices. (Kenny, 1999; Case & Schiller, 1990). Numerous studies have been undertaken recently to understand how inflation affects the housing market. Feldstein (1992) pointed out that rising inflation decreases people's interest in real estate investment, which leads to a reduction in housing demand.

In their research paper, Afsheen and Diah (2022) employed an autoregressive distributed lag model (ARDL) to examine the relationship between GDP and housing prices in Malaysia. The study used quarterly data over the period (2011:1 -2020:4) for the six variables such as gross domestic product (GDP), housing prices (HP), lending rate (LR), exchange rate (EXCHR), and world governance indicators (VAA, PS, GE, RQ, ROL and COC). The results of ARDL cointegration tests running from housing price to GDP provide strong evidence to support the hypothesis that housing price and economic growth are cointegrated.

Rahman and Ridzuan (2020) examined the impact of GDP, CPI, base lending rate, and money supply on the house price index in Malaysia (1988-2017). The ARDL estimation postulated that, in the long run, GDP and base lending rate significantly affect the house price index in Malaysia whereas the money supply and consumer price index reflected a negative impact on the house price index.

Table 1: Literature on the Correlation between the Housing Price Index and the Consumer Price Index

Author (s) year of study	Geographical Location	Time Period	Control Variable	Method
Afsheen and Diah (2022)	Malaysia	2011-2020	Housing prices	ARDL
Rahman and Ridzuan (2020)	Malaysia	1988-2017	housing prices	ARDL
Marfatia et al. (2020)	OECD	1975-2017	Housing prices	ARDL
Korkmaz (2020)	Turkey	2010-2019	housing prices	Causality Test
Viktorija and Karpavičiūtė (2017)	Lithuania	2001-2014	Housing prices	Granger Causality test
Kuang and Liu (2015)	China	1996-2010	Housing prices	The general quadratic equilibrium model
Zandi et al. (2015)	Malaysian	2007-2014	Residential property prices	Analytical descriptive approach
Inglesi-Lotz & Gupta (2013)	South Africa	1970-2011	non-residential housing prices	ARDL model
Fengguang (2012)	China	2000-2010	Housing prices	The theory and method of system engineering
Meidani et al. (2011)	Iran	1990-2008	Housing Prices	Toda and Yamamoto's approach
Valadez (2011)	USA	2005-2009	Housing Prices	Number Crunching Statistical Service
Sari et al. (2007)	Turkey	1961-2000	Housing prices	The generalized variance decomposition approach
Apergis (2003)	Greece	1981-1999	Housing prices	An error correction vector autoregressive (ECVAR) model
Chen and Patel (1998)	Taipei	1971-1993	Housing prices	Granger causality tests, variance decomposition, and impulse response functions are based on the vector error correction model.

Marfatia et al. (2020) examined the time-frequency linkage of macroeconomic drivers and 15 OECD countries' housing markets during the period (1975q1- 2017q3). The results showed that the relationship between house prices and key macroeconomic indicators varies significantly across countries, time, frequencies, and the direction of causation. At the higher frequencies, house prices are more associated with interest rates in the short-run while at the lower frequencies, house prices are most linked to per capita income growth in the long-run. Moreover, at medium frequencies, the relationship between the stock market and the housing market is significant.

The study by Korkmaz (2020) aimed to explore whether the overall inflationary pressures prevailing in the Turkish economy affected housing prices in 26 residential areas, as shown by HPI. The study used CPI and PPI data from 2010:01 to 2019:01. The Konya Causality Test (2006) was employed to study the causal association between the variables. According to the main results inflationary pressures are caused by HPI for some housing areas of Turkey.

Viktorija and Karpavičiūtė (2017) examined the economic, financial, and demographic factors that affect housing prices. The paper discusses factors such as unemployment, inflation, interest rate, GDP, and immigration. Besides, the paper explores the overall impact of economic policies on housing prices in the state of Lithuania, during the period 2001:1 to 2014:4. The paper uses the Granger Causality test and the ADF to test stationary conditions. The paper reaches several conclusions, the most important of which are that housing prices are not caused by interest rates and inflation, rather they are highly dependent on GDP and unemployment in addition to other macroeconomic policies.

Kuang and Liu (2015) analyzed the phenomenon of escalation in house prices during the early part of the third millennium in China. The researchers use the general quadratic equilibrium model, which includes consumers, developers, enterprises, and the central bank to clarify the type of association between inflation and housing prices. Among several conclusions of the study, the most important is the existence of a reciprocal association between inflation and housing prices. Also, the effect of high housing prices on inflation is smaller than the positive influence of high inflation on housing prices.

Zandi et al. (2015) examined the extent of the impact of changes in some economic variables including GDP, inflation, GDP growth rate, and the prevailing interest rate on residential property prices in the Malaysian city of Penang during the period 2007-2014. The researchers used an analytical descriptive approach based on data available from secondary sources from the official authorities in Malaysia. The study discovered a positive association between the GDP and the prices of residential real estate, but no significant relationship between residential real estate prices and the rate of inflation. The authors also found that interest rate directly affects the prices of residential real estate.

Inglesi-Lotz and Gupta (2013) attempted to study the relationship between the prices of goods and services and non-residential housing prices in South Africa using quarterly data from 1970 to 2011. According to the experimental results of the ARDL model, it can be observed that long-term integration exists between the consumer price index and housing prices for all sectors. The results of Fischer coefficients also reveal that the estimates are not statistically different from the unit. The result conforms to the proposed theoretical framework for housing prices and consumer prices excluding housing costs. Overall, the paper concluded that in the long run, housing prices provide a stable, but quantitatively small, hedge against inflation in South Africa.

In their research paper, Fengguang (2012) used the theory and method of system engineering to study the relationship between house price volatility risk and price tolerance of the residents in China. The paper mainly explored the factors of housing price fluctuations, the hazard of price fluctuations, and control challenges. Finally, this paper provided some policy implications to control housing prices in the future.

Meidani et al. (2011) attempted to investigate the presence of a causal relationship between inflation, economic growth, and housing prices in Iran. The Toda and Yamamoto approach was employed by the study for quarterly data from 1990 to 2008. The results revealed that there is proof of a strong, multiple-way relationship between macroeconomic factors and housing prices. The tests for causation showed that CPI and GDP Granger cause housing prices, and that both housing prices and GDP have feedback effects. The study discovers no evidence of Granger causality of changes in real property prices on CPI.

Valadez (2011) investigated the relationship between house prices and GDP in the United States during the period (2005q1-2009q4). The authors employed Number Crunching Statistical Service (NCSS) software to conduct the regression analysis. In the results, it was found that housing price index changes can be used to find quarterly changes in Real GDP. Using the Toda and Yamamoto approach, Meidani et al. (2011) examined the existence of causality among house prices, inflation, and economic growth in Iran from 1990Q1 to 2008Q3. The results showed that consumer price index, gross domestic product, and exchange rates have significant and multidirectional links.

In their research paper, Sari et al. (2007) examined the link between housing prices and certain macroeconomic variables such as interest rates, output, money stock, and employment in Turkey for the period 1961-2000. The authors employed the generalized variance decomposition method. The study reached specific results that indicated that the monetary aggregate has a relatively more substantial impact on housing investment compared to other variables. Whereas, shocks to interest rates, output, and prices have slight effects on changes in housing prices in Turkey.

Apergis (2003) investigated the dynamic changes in prices of houses traded caused by employment, inflation, and housing loan rates in Greece. The study employed the Error Correction Vector Autoregressive model to explore how real house prices are affected by macroeconomic factors. The results of variance decompositions reveal that a major part of fluctuations in housing prices is mainly initiated by the loan rate for housing, followed by inflation and employment.

Chen and Patel (1998) investigated dynamic causal links between housing prices and other factors including short-term interest rates, gross household income, construction costs, stock price indices, and completions of housing, in Taiwan. The study used (VAR), variance decompositions, the Granger causality tests, and impulse response functions. According to the results, all factors have a Granger causal effect on the prices of houses. However, the stock price index and house prices have a bidirectional reaction effect. The results of variance decomposition results show greater fluctuations in future prices caused by turbulences in current house prices. The other five determinants explain 34% of the variance in housing prices.

2.3 Theoretical Framework: Macroeconomic Determinants Affecting Housing Prices

To know housing prices, understanding the primary factors of property pricing is essential. This is because housing is a unique kind of asset that is valuable both as an investment and as a consumer good. Some of the prevailing current literature, as it appears later in some paragraphs of this paper, indicates that movements in housing prices are closely related to several macroeconomic factors. The demand for housing is almost due to macroeconomic fundamentals such as GDP per capita, inflation, unemployment, interest rates, and other demographic factors. It is easy for these macroeconomic variables to be affected by economic changes. On the other hand, other variables on the supply side are almost rigid to respond to economic changes, at least in the short term. Because of these and other considerations, most current literature focuses on the demand side when estimating housing price determinants.

Friedman's (1957) permanent income hypothesis seems to provide the first theoretical insight regarding the wealth effect of house prices. The perception is simple. Since home equity is a vital factor of homeowners'

wealth, an unpredicted house price rise would increase the estimated lifetime wealth of homeowners. Based on the perception that individuals would wish to smooth consumption over their lifetime, the increase in lifetime wealth would surge their desired consumption. Lately, Morris (2006) provided a partial equilibrium model to question the wealth effect and expected that both age and expected mobility affect the wealth effect. Theoretical models, e.g., Skaarup and Bodker (2010), and the empirical literature on the housing market, suggest that over the long-run house prices depend positively on GDP Per Capita. This section illustrates developments in these factors for the Saudi economy. It also presents the data developed for policy, institutional, and structural factors that can affect house price dynamics through their influence on housing prices. GDP per capita plays a key role in shaping house price trends. The higher the GDP Per Capita (GDPP) of households, the more they can spend to purchase a house or service a mortgage, pushing up house prices.

3. DATA AND METHODOLOGY

As mentioned earlier, this study proposes to explore the association between inflation and HPI in Saudi Arabia. Quarterly data for the study variables (HPI & CPI) from 2013:Q1-2022:Q2, has been collected from the annual reports issued by the Saudi Central Bank. The VAR model has been applied by the study because this model can appropriately deal with possible endogeneity problems (Dreger & Wolters, 2009). All system variables are also allowed to be affected by each other internally in a VAR model. Granger Causality test, analysis of variance and impulse response functions were also employed to analyze the association between CPI and the housing price index. An empirical equation is formulated to determine the effect of the general level of prices on the housing price index in the form of a level as follows:

$$HPI_t = \alpha + \beta \, ln \, CPI_t + U_t \qquad (1)$$

where HPI_t presents Housing Price Index (dependent variable), CPI_t presents Consumer Price Index (independent variable), α and β are the parameters and U_t presents the random term.

Based on the several studies carried out in the context of different countries including Feldstein (1992) and Kuang and Liu (2015) among others, we develop the hypothesis of this study as follows:

H_A: CPI has a positive effect on HPI.

4. RESULTS AND DISCUSSION

4.1 Analysis of Unit Roots

To test the stationarity of system variables in the model, Augmented Dickey-Fuller test statistics have been engaged. According to the results, HPI from 2013:Q1-2022:Q2, doesn't have a unit root at the level, while CPI contains a unit root at the level and is non-stationary only at the 1st difference. Table 2 reflects the ADF test results of the mentioned variables. Therefore, these variables are stationary at different levels. The hypothesis that HPI and CPI contain the unit root has been rejected at a level and first difference consecutively at the 5% level of significance.

Table 2: ADF Tests Statistics for Unit Roots

Variables	Levels	1st Difference (intercept)
DHPI	-3.2143*	
DCPI	-2.1689	-6.9652*

Note: * represents significance at a 5% level, respectively.

4.2 Analysis using VAR

The VAR model is usually used to analyze the effect of system-related time-series correlations and random disturbances on system dynamics. Using the D(HPI) and D(CPI) variables to create a VAR model, Table 3 shows the results of the VAR model and estimates of the variables. The data reflects the relationship between the coefficients of CPI and HPI. Table 2 reveals that the CPI has an inverse significant relationship with the HPI in the short run. Findings are also in line with the results of papers reviewed earlier. While the same variable, CPI has an insignificant positive relationship with the HPI in the long run.

The adjusted R-squared test reveals that 99% of the explained variations in the dependent variable which is caused by variations in the independent variable. The value of R-square indicates that the model has an almost perfect fit.

Table 3: Results based on Vector Autoregression

Sample (adjusted): 2014Q3 2022Q2
Included observations: 32 after adjustments
DHPI = C(1)*DHPI(-1) + C(2)*DHPI(-2) + C(3)*DHPI(-3) + C(4)*DHPI(-4) + C(5)*DHPI(-5) + C(6)*DCPI(-1) + C(7)*DCPI(-2) + C(8)*DCPI(-3) + C(9) *DCPI(-4) + C(10)*DCPI(-5) + C(11)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.6173	0.1558	3.9633	0.0166
C(2)	-0.0243	0.2918	-0.0831	0.9377
C(3)	0.3172	0.6502	0.4878	0.6512
C(4)	-1.0190	0.7782	-1.3095	0.2605
C(5)	1.1104	0.4515	2.4591	0.0698
C(6)	-0.1546	0.1317	-1.1735	0.3057
C(7)	-0.4420	0.1555	-2.8421	0.0468
C(8)	-0.1207	0.1358	-0.8888	0.4243
C(9)	0.2139	0.0858	2.4932	0.0672
C(10)	0.1166	0.1056	1.1045	0.3313
C(11)	48.9793	23.4788	2.0861	0.1053
R-squared	0.997019	Durbin-Watson stat		1.642423
Adjusted R-squared	0.989567	S.D. dependent variable		5.738201
S.E. of regression	0.586121	Prob. (F-statistic)		0.000132
Sum squared resid	1.374152	F-statistic		133.7853

4.3 Granger Causality

The study has also conducted the Granger causality test to see whether the HPI and the system variable CPI were causally related. The interval length chosen based on the Akaike Information Criterion for the variables is five. The results of the Granger causality test are shown in Table 4. The test results indicate that the p-value for the CPI is 0.0157 which implies that CPI does Granger cause HPI. This shows that the Granger non-causality from CPI to HPI null hypothesis can be disproved. Therefore, the results confirm the existence of one-way causation from CPI to HPI. According to the findings, future house prices may be predicted by inflation. The findings are also in line with those earlier reviews by Chen and Patel (1998) and Meidani et al. (2011).

Table 4: VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: DHPI			
Excluded	Chi-sq	d.f.	Prob.
DCPI	13.9873	5	0.0157
All	13.9873	5	0.0157

4.4 Test of Source of Volatility

The variance decomposition and impulse response functions are applied to provide additional understanding of the relationships between home prices and their determinants. These two methods allow us to assess the relative significance of the variables outside the sample period and provide a signal of the system's dynamic characteristics.

4.4.1 Impulse Response Function

The paper follows the Cholesky-based VAR model to analyze the effect of CPI on HPI. The housing prices for a standard deviation of another variable for 38 quarters is an example of a variable response that can be described by a response function. The Schwarz Information Creation (SIC) and AIC data indicate that the interval size for our VAR model should be 5. The response of HPI to shocks to CPI based on the impulse response function has been shown in Figure 1. The blue line depicts the HPI movement and represents a yellow confidence dash line with two standard deviations. A positive CPI shock causes HPI to decrease, and this initial decrease is statistically significant as revealed by Figure 1. This result is in line with the findings of Feldstein (1992) and Kuang and Liu (2015).

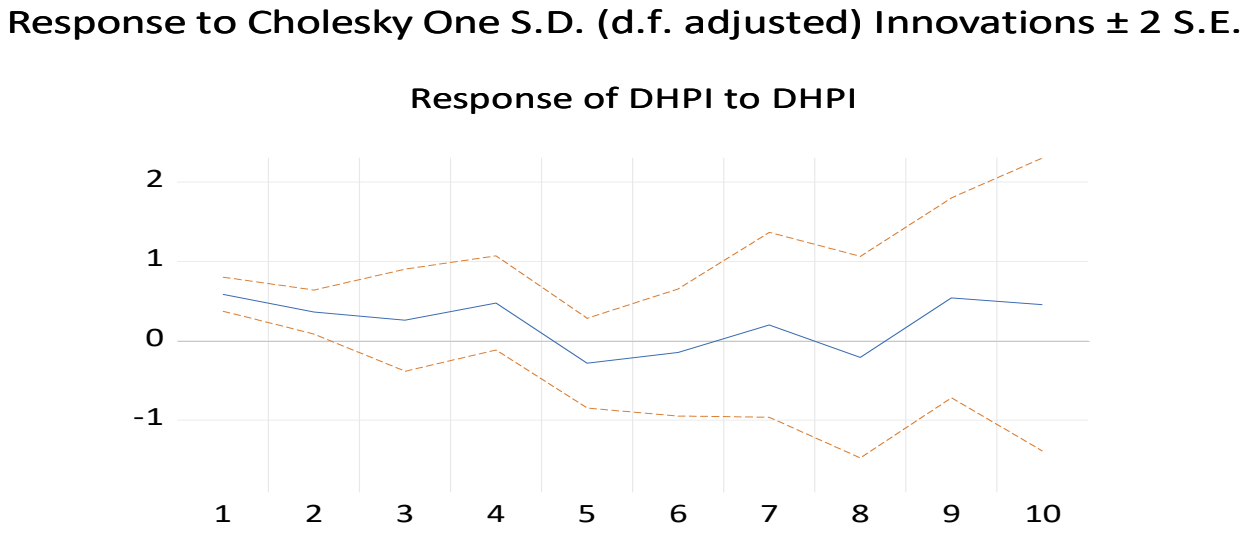


Figure 1: *Impulse Response Function*

4.4.2 Variance Decomposition

The percentage of variation in housing prices (HPI) induced by shocks originating from the CPI is measured by the variance decomposition. Table 5 shows variance decomposition estimates for a 38-quarter time horizon. Data reflects that the single system variable (CPI) can explain more than 63.94% of the variance of the expected error in the housing prices in the short term as modeled by VAR. Moreover, it should be noted that more than 48% of the housing price disparities in the long-term are explained by the shocks on the CPI which implies that the CPI is a good endogenous variable in the system mainly in the short-run. The finding proposes that people's expectations for future housing price changes are influenced by the current shift in overall prices. The average of 49.9% variability contributed by (CPI) changes, implies that the remaining 50.1% of the variability in (HPI) is explained by itself.

Table 5: Variance Decomposition of DHPI

Period	S.E.	DHPI	DCPI
1	0.5861	100.0000	0.0000
2	0.7569	82.7524	17.2476
3	1.2246	36.0539	63.9461
4	1.3500	42.0642	57.9358
5	1.4064	42.8387	57.1613
6	1.4153	43.4102	56.5898
7	1.4644	42.4115	57.5885
8	1.4801	43.5301	56.4699
9	1.6224	47.3124	52.6876
10	1.6860	51.1110	48.8890

4.5 Post-Estimation Tests

4.5.1 Serial LM Test

Autocorrelation in the errors in a regression model is tested by the Breusch-Godfrey Serial Correlation LM Test. According to Table 6, the probability of the observed Chi-squared is less than 0.05, which is unsatisfactory. According to the results, the null hypothesis of the absence of serial correlation of errors is rejected which means the presence of autocorrelation problem.

Table 6: Breusch-Godfrey Serial Correlation LM Test

Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	1.6064	Prob. F(2, 2)	0.3837
Obs Chi-squared	9.2450	Prob. Chi-Square(2)	0.0098

4.5.2 Heteroscedasticity Test: Breusch-Pagan-Godfrey

Since the probability of the observed Chi-squared is greater than 0.05, the results are acceptable. According to Table 7, we cannot reject the null hypothesis of no Homoscedasticity.

Table 7: Heteroscedasticity: Breusch-Pagan-Godfrey Test

Null hypothesis: Homoscedasticity			
F-statistic	0.1225	Prob. F(10,4)	0.9966
Obs* Chi-squared	3.5166	Prob. Chi-Square(10)	0.9665
Scaled explained SS	0.3422	Prob. Chi-Square(10)	1.0000

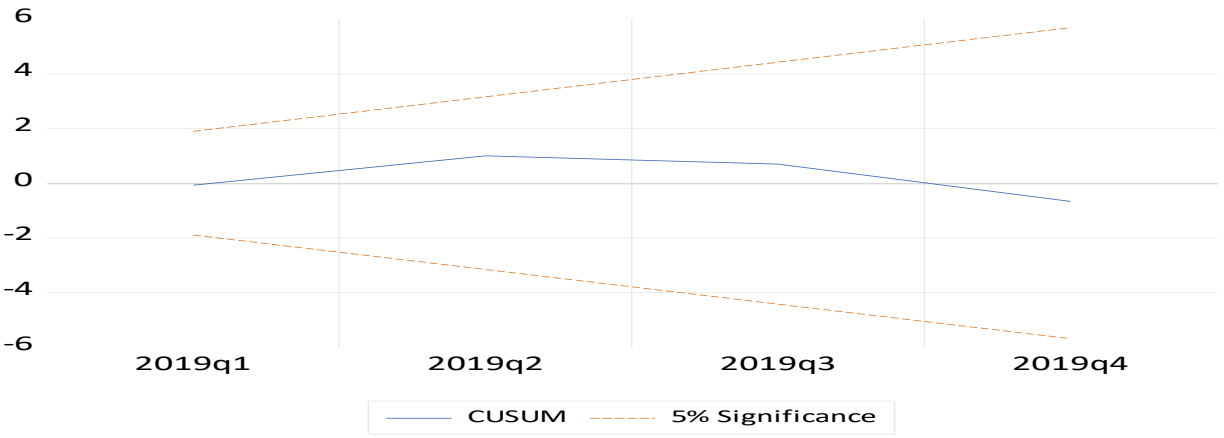


Figure 2: *Stability Test CUSUM*

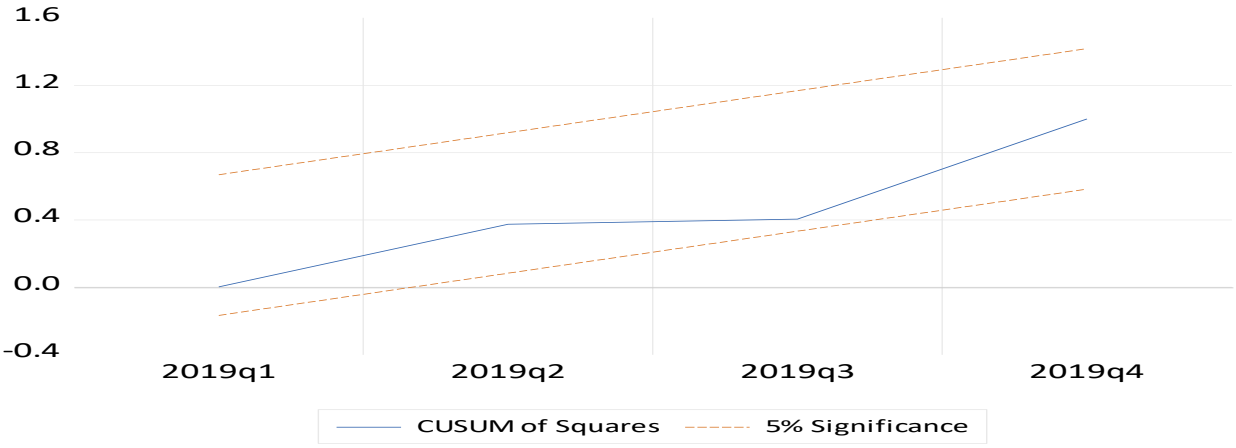


Figure 3: *Stability Test CUSUM of Squares*

5. CONCLUSION AND POLICY IMPLICATIONS

This paper is a pioneering attempt to examine the relationship between the consumer price index (CPI) and the housing prices index (HPI) in Saudi Arabia during the period from 2013-2022. The Granger causality test, variance decomposition analysis and impulse response functions methods are employed for impact analysis by using the VAR approach. The study has reached several conclusions. The analysis of the variance decomposition function shows that CPI has a high explanatory power over changes in HPI (more than 54%), especially in the short term compared to the long term. This means that CPI is an effective and reliable variable that can be used when dealing with housing prices. The impulse response functions show that a positive shock to the CPI has effects on housing prices, particularly during the third period after the initial shock. The result of the Granger causality test shows that the CPI Granger causes HPI. However, HPI does not Granger cause CPI. The limitation of the study includes the limited availability of data. Although other variables may have their effect on housing prices, this research paper limits the investigation to the relationship between the CPI and housing prices.

The study calls for more future studies and research considering other variables that might affect the housing price index in the Kingdom, such as exchange rates, GDP, money supply, and other demographic and institutional variables. There are important policy implications of this research study. According to the results, CPI Granger causes HPI which necessitates that the government should focus on controlling inflation which will keep housing prices under control.

Acknowledgment
The authors acknowledge the comments made by the reviewers and members of the editorial board on the earlier version of this manuscript.

Funding Source:
The author(s) received no specific funding for this work.

Conflict of Interests:
The authors have declared that no competing interests exist.

REFERENCES

Afsheen, S. & Diah, M.L. (2022). The Relationship between house prices and economic growth in Malaysia: An empirical analysis. Proceedings of the 7th North American International Conference on Industrial Engineering and Operations Management, Orlando, Florida, USA, June 12-14.

Apergis, N. (2003). Housing prices and macroeconomic factors: Prospects within the European monetary union. *International Real Estate Review*, 6(1), 63-74.

Campbell, J. & Cocco, J. (2004). How do housing prices affect consumption? Evidence from microdata. Harvard Institute of Economic Research, Discussion Paper Number 2045.

Case, K.E., & Shiller, R.J. (1990). Forecasting prices and excess returns in the housing Market. *American Real Estate and Urban Economics Association Journal*, 18(3), 253-273.

Chen, M., & Patel, K. (1998). House price dynamics and Granger causality: An analysis of Taipei new dwelling market. *Journal of the Asian Real Estate Society*, 1(1), 101-126.

DeLuca, G., Gibson, C.M., Bellandi, F., Murphy, S., Maioli, M., & Noc, M. (2008). Early glycoprotein IIb-IIIa inhibitors in primary angioplasty (EGYPT) cooperation: An individual patient data meta-analysis. *Heart*, 94, 1548-1558.

Dreger, C. & Wolters, J. (2009): M3 velocity and asset prices in the Euro area, *Empirica*, 36, 51-63.

Feldstein, M. S. (1992). Comment on James M. Poterba's paper, tax reform and the housing market in the late 1980s: Who knew what, and when did they know it? Real estate and credit crunch, Federal Reserve Bank of Boston Conference Series, 36, 252-257.

Fengguang, J. (2012). The study of the relationship between house price and price tolerance in China from the perspective of systems engineering. *Systems Engineering Procedia,* 5, 74-80.

Friedman, M. (1957). *A Theory of Consumption Function*. Princeton University Press.

Inglesi-Lotz R. & Gupta, R. (2013). Relationship between housing prices and inflation in South Africa: An ARDL approach. *International Journal of Strategic Property Management*, 17(2), 1-11.

Kenny, G. (1999). Modeling the demand and supply sides of the housing market: Evidence from Ireland. *Economic Modeling*, 16(3), 389-409.

Korkmaz, O. (2020). The relationship between housing prices and inflation rate in Turkey: Evidence from panel Konya causality test. *International Journal of Housing Markets and Analysis*, 13(3), 427-452.

Kuang, W. & Liu P. (2015). Inflation and housing prices: Theory and evidence from 35 cities in China. *International Real Estate Review*, 18(2), 217-240.

Leamer, E.E. (2002). Bubble Trouble? Your home has a P/E ratio too, UCLA Anderson Forecast, June 2002.

Littell, J.H., Jacqueline C., & Vijayan P. (2008). *Systematic reviews and meta-analysis, pocket guides to social work research methods*, Oxford, NY.

Marfatia, H., André, C. & Gupta, R. (2020). Predicting housing market sentiment: The role of financial, macroeconomic and real estate uncertainties, University of Pretoria Department of Economics Working Paper 2020-61.

Meidani, A., Zabihi, M., & Ashena, M. (2011). House prices, economic output, and inflation interactions in Iran. *Research in Applied Economics*, 3(1), 1-15.

Morris, E. D. (2006). Examining the wealth effect from home price appreciation. University of Michigan working paper.

Muellbauer, J. & Murphy, A. (1997). Booms and busts in the U.K. housing market. *The Economic Journal*, 107, 1701–27.

Rahman, M. & Ridzuan, A. (2020). Factors that Determine House Price Index in Malaysia. *International Journal of Academic Research in Accounting, Finance and Management Sciences*. 10. 351-359.

Sari, R., Ewing, B., & Aydin, B. (2007). Macroeconomic variables and the housing market in Turkey. *Emerging markets Finance and Trade*, 43. DOI - 10.2753/REE1540-496X430501.

Skaarup, M. & Bodker, S. (2010). House prices in Denmark: Are they far from equilibrium? Denmark Finanministeriet Working Paper 21/2010.

Saudi Arabia Central Bank (SAMA) (2003, 2019). Annual Reports, https://www.sama.gov.sa/en-us/economicreports/pages/report.aspx?ms=112

Valadez, R. M. (2011). The housing bubble and the GDP: A correlation perspective. *Journal of Case Research in Business and Economics*, 3, 1-18.

Viktorija, C., & Karpavičiūtė, L. (2017). The analysis of the determinants of housing prices. *The Independent Journal of Management Production*, 8(1), 49-63.

Zandi, G., Supramaniam, M., Aslam, A. & Theng, L. (2015). The economic factors affecting residential property price: The case of Penang Island. *International Journal of Economics and Finance*, 7(12), 200-210.

Kashmir Economic Review, Volume 32, Issue 1, June 2023

Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

Young or Experienced Female Workers: Who Faces More Gender Wage Discrimination in Pakistan?

ABSTRACT

The objective of the study was to investigate the gender earning gap at the different stages of a career in urban, rural, and overall Pakistan. By using Blinder (1973) and Oaxaca (1973) methodology, the study found that age, marital status, employment status, and education have a significant impact on earnings. Oaxaca Blinder decomposition results suggest that age has a greater impact on earnings for experienced earners in the urban labor market and young earners in the rural labor market. Marriage has a higher impact on earnings in the urban and rural labor market for young earners. Young female workers face more discrimination in wages in urban, rural, and overall Pakistan. Moreover, among young female earners, relatively higher discrimination is faced by those who work in urban areas than those who work in rural areas. Whereas experienced female earners face more discrimination in rural areas. Legislation has been enacted to discourage the wage gap between males and females. However, the government needs to conduct audits and assessments of workplaces to make the labor markets in the country more inclusive.

AUTHORS

Zopash Khan *
Lecturer of Economics, Kashmir Institute of Economics, The University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan.
Author's Contributions: 1,2,3,4,5,6
zopash.khan@ajku.edu.pk
https://orcid.org/0000-0001-7892-8325

Keywords
Wage Differential, Human Capital, Gender Discrimination
JEL Classification
J16, J24, J31, J71

Please cite this article as:
Khan, Z. (2023). Young or experienced female workers: Who faces more gender wage discrimination in Pakistan? *Kashmir Economic Review*, 32(1), 50-65.

*** Correspondence author**
Author's contribution in the article: 1- Conceived and designed the analysis, 2- Reviewed and compiled the literature, 3- Collected the data, 4- Contributed data or analysis tools, 5- Performed the analysis, 6- Wrote the paper, 7- Financial support for the conduct of the study, 8-Other

1. INTRODUCTION

Pakistan has been ranked 142 out of the 146 countries on the Global Gender Gap Index 2023[1] in a report published by the World Economic Forum. The index highlights the worrisome situation of gender inequality in Pakistan. In 2006, Pakistan's gender parity score was 0.553 and as per the 2023 report, the gender parity score is 0.575. In fifteen years, there has been no major improvement in the score. Women in Pakistan face various kinds of discrimination at different levels, especially in the workplace (International Labor Organization, 2020). According to the ILO report, one of the examples of structural gender discrimination in the labor force is the gender wage gap:

> *"…The gender pay gap needs to be considered in the context of overall gender inequality. It is one of the more visible examples of structural gender discrimination stemming from the horizontal and vertical segmentation of labour forces. The greater participation of women in the labour market and their higher levels of education alone have proven to be insufficient to dismantle this segmentation…"*

Wage discrimination is the foundation of the gender inequality. Grybaite (2006) described two sets of explanations for gender earning differential: (i) Human capital model, and (ii) Labor market discrimination model. The human capital model attributes the gender wage gap to inexperience of the female workers in the labor market. Moreover, due to family commitments, women experience a discontinuity in work, which reduces their incentive to invest in formal education and on-the-job training. The human capital model may not be able to explain the entire gender wage difference. The labor market discrimination model along with the human capital model presents the complete picture of the gap.

Economic and value discrimination needs to be understood as per the labor market discrimination model. The term "Economic discrimination" highlights when otherwise similar workers doing the same job receive different pay, employment chances, or promotions. Whereas "Value discrimination" is related to jobs that mostly employ women are paid less as compared to jobs that employ more men. In this regard, the International Labor Organization, in their report, discussed the discriminatory aspect of the gender wage gap, which results in different pay scales for male and female workers.

> *"…there are a number of objective elements that explain the gender pay gap, research has shown that those elements do not account for the whole gap. There may be factors that are unknown or unaccounted for, but also there can be an aspect of discrimination on the basis of sex, whereby a job done by a woman is perceived as worth less than a similar job done by a man. In the absence of objective job evaluation methods and practices, gender bias can easily occur in determining pay scales for women and men…"*

Becker (1985) analyzed that some individuals in the labor market have a "taste for discrimination", which is:

> *"...If an individual has a taste for discrimination, he must act as if he were willing to pay something, either directly or in the form of reduced income, to be associated with some persons rather than others…"*

Becker's analysis suggests that employers and coworkers often have a taste for discrimination, what he called employer discrimination and employee discrimination, respectively. In this study, the focus shall be

[1] Global Gender Gap Report 2023, World Economic Forum.

on economic discrimination and employer discrimination against women in the labor market, which leads to wage differences among the male and female labor force in the country.

One of the main reasons for discrimination against women in the labor market is their underrepresentation in leadership, which doesn't provide younger females an environment to grow in their careers. This factor has been highlighted by a report published by the International Labor Organization (2020):

> *"…Far fewer women than men are in management and leadership positions, especially at higher levels. When women are managers, they tend to be more concentrated in management support functions such as human resources and financial administration than in more strategic roles. This brings down the average salary of female managers compared to that of male managers…"*

In Pakistan, as discussed previously, women's share in managerial positions is only 4.9%. A lower share of women in managerial and leadership positions can be considered as one of the reasons for the gender wage gap. (International Labor Organization, 2020) The lack of a "women's voice" at the upper tier is a contributing factor in the economic discrimination against women.

It has been established in previous literature that the gender wage gap exists in the labor market of Pakistan. (Yasmin et al., 2021; Qazi et al., 2018; Siddiqui & Siddiqui, 1998). This study intends to further investigate gender wage gaps faced by young and experienced female workers by empirically estimating structural gender discrimination i.e. gender wage gap at different career levels in workplaces of urban, rural, and overall Pakistan. Young and experienced earners are separated to analyze the impact at different career stages. Young earners are usually at the beginning of their careers. Whereas experienced earners are usually more established as compared to young earners. Therefore, our study attempts to analyze the gender wage gap faced by young and experienced female workers.

This article is structured as follows: Section 2 presents a review of the literature. Section 3 discusses data and descriptive. The econometric methodology is presented in Section 4. Section 5 analyzes empirical results. Section 6 discusses Oaxaca decomposition results. Section 7 presents the conclusion.

2. LITERATURE REVIEW

Debate on earning differential was initiated by Becker (1972). However, empirical analysis began in the 1970s by Oaxaca (1973). Oaxaca's study examined earning differentials among men and women earners by estimating average discrimination in the US. Across the globe, many researchers have investigated gender wage differential in different countries and regions (Malkiel & Malkiel, 1973; Filer, 1983; Daymont & Andrisani, 1984; Newell & Reilly, 1996; Ashraf, 1996; Miller, 2008; Oostendorp, 2009; Piazzalunga & Tommaso, 2019; Castagnetti & Giorgetti, 2019; Chakraborty, 2020; Liu & Su, 2020; Aktas & Anil, 2021; Orkideh & Vidya, 2021; Orkoh et al., 2022). Gender wage gap exists in almost all sectors such as medicine hospitality, etc. (Warner & Lehman, 2019; Oliver & Sard, 2020). It affects not only women but society as a whole. (Picatoste et al., 2023). Empirical studies suggest evidence of the sticky floor in the private sector and the glass ceiling in the public sector. (Ghignoni & Pastore, 2023).

Women prefer low-wage jobs due to working hour flexibility and shorter commuting times, (Ciminelli et al., 2021). Therefore, setting a wage floor can help reduce gender inequality. (Caliendo & Wittbrodt, 2022). However, technological progress has narrowed gender earning gaps, particularly in developed countries (Ge & Zhou, 2021; Cortes et al., 2022). Information and communication technology has promoted innovation in other sectors such as finance in the form of fintech. Financial technology reduces the gender wage gap and enhances female entrepreneurship. (Guo et al., 2021).

The gender earning gap has also been estimated by Pakistani researchers. Several studies have determined gender earning differentials in different dimensions by using data from Pakistan. For the first time, Ashraf and Ashraf (1993) explored the gender earning gap in Rawalpindi by using the Socioeconomic Household Survey of Rawalpindi 1975, collected by the Pakistan Institute of Development Economics. Results indicated that 68.5% of the earning gaps were due to discrimination against the female labor force. However, this analysis was restricted to only one city i.e. Rawalpindi.

Ashraf et al. (1993) expanded their analysis to the whole country. Using the Household Integrated Economic Survey (HIES) of the years 1979 and 1985-86, they compared the gender wage gap for different years. The study found overwhelming evidence that the earning gap has sharply declined from 63.27% (HIES 1979) to 33.09% (HIES 1985-89). They used Oaxaca (1973), and Cotton (1988) for both analyses. By using the same methodology and variables, Ashraf and Ashraf (1998) reported 47.9% differentials among male and female earners. Ashraf et al. (2009) updated previous work after almost a decade by using HIES 2001-2002 for Punjab province. They found that 15.4% of the earning gaps were due to gender discrimination, which was less as compared to previous papers.

Recently, Yasmin et al. (2021) used data from two decades i.e. 1997-98, 2006-07, and 2017-18 from the labor force survey of Pakistan. They found, using Oaxaca- Blinder and Neumann Oaxaca decomposition technique that the wage gap due to unobservable factors, which is often called discrimination was 39% in 1997-98; 79% in 2006-07; and 87% in 2017-18.

Umair and Naz (2020) investigated the gender wage gap in urban migrant workers by using a labor force survey 2017-18. They used the OLS technique and estimated that urban-urban migrant women workers earn 45% less than men counterparts. They also pointed out that differences in working hours and endowment also contribute to increasing gender earning differences. The gender earning gap in the urban labor market of Pakistan was also investigated by Ali and Akhtar (2016) by using the Oaxaca Blinder decomposition technique. They estimated higher mean wages for men as compared to women workers. Their study indicated higher returns to human capital investment for women at all levels of education.

Qazi et al. (2018) have contributed to the literature by analyzing discrimination against women in the Telecommunication sector. They conducted semi-structured interviews and revealed that only a few women raised their voices against discrimination of any kind and others chose to stay silent or accepted the discrimination, which resulted in maintaining the practice. Moreover, Ali and Jiang (2016) found a relationship between the gender wage gap and economic growth in Pakistan. They confirmed the long-run relation between economic growth and wage differentials and found that the gender wage gap is detrimental to growth in the long run.

Ali and Akhtar (2014) used the Oaxaca Blinder decomposition technique to find the gender earning gap in Pakistan on the data compiled through the Household Integrated Economic Survey (HIES) 2010-11. They concluded that male married workers earn more than unmarried male workers and female married workers earn less than female unmarried workers, with the same characteristics.

Moreover, Abrar ul Haq et al. (2012) estimated gender disparity in returns to higher education in a collected sample of 430 individuals from the Bahawalpur district of Pakistan. The author concluded that the returns of higher education are more for men in the private sector than their female counterparts. Female workers in the rural areas were at a disadvantage in terms of wages than male workers.

Yasin et al. (2010) found gender discrimination in the labor market of the Punjab province of Pakistan by using the Labor Force Survey 2003-04. Their study used the OLS method to estimate the gender pay gap. They deduced that women in the labor market of the province are equally talented and have the same productivity as their male counterparts if they don't have to face discrimination in the labor market. Among

cities of the Punjab province, Women in Bahawalpur earn more as compared to women in the cities of the province.

Aslam (2009) used OLS and household fixed effects to estimate the gender earning gap in Pakistan. She used the Pakistan Integrated Household Survey 2002 for the analysis. The study found a convex education earning profile, which indicates an increase in earnings with receiving a high level of education. An unexplained part of the earning gap using OLS was estimated at 88% and 94% in the fixed effect sample.

Sabir and Aftab (2007) explored the gender wage over the period covering 1996-97 and 2004-25 to analyze the impact of economic development on the gender pay gap. Their study used Blinder (1973) and Oaxaca (1973) methodology. Due to increasing economic development, women are provided with more opportunities, which results in increasing the gender wage gap. The study found an increase in the absolute wage gap over the wage scale, but a decrease in the gender earning differential at the higher level of wage distribution.

Awan and Hussain (2007) studied returns to the education and gender earning gaps in Pakistan. This study used an extension to Becker and Mincer models on the Pakistan Integrated Household Survey 1998-99 and 2001-2002. They concluded that women workers earn less than male workers in Pakistan, which is due to discrimination against women in the labor force. The income gap between educated and uneducated work employees tends to increase with experience. Differences in the quality of education affect income distributions.

Siddiqui and Siddiqui (1998) explored the male-female earning gap in the country. They have particularly focused on how personal characteristics change over time and how discrimination results in earning differences in the labor market. They used Oaxaca (1973) and Cotton (1988) methodology. Data used is from the Household Income and Expenditure Survey 1993-94. They concluded that 55% of the earning differential was due to biases in the job market towards female workers. Human capital is an important factor in reducing discrimination. These estimates were sensitive to the specification of earning functions.

These studies have discussed gender earning differential in Pakistan, which indicates that in every dimension i.e. area-wise, employment sector-wise, etc., women face biases due to their gender at workplaces. However, there is hardly any study that has explored earning differentials at different career stages among men and women in urban, rural, and overall Pakistan. This study is an attempt to estimate and compare earning differentials faced by young and experienced women workers in comparison to their male counterparts. To fill the gap in the literature, this study is conducted and provides detailed insight into the matter.

3. DATA AND DESCRIPTIVE STATISTICS

Data has been taken from Pakistan Social and Living Standard Measurement 2014-15. PSLM 2014-15 provides data at the Provincial or District level. As per the World Economic Forum, the gender parity score has improved by 2% since 2006. Therefore, PSLM 2014-15 is also suitable for our analysis. It provides adequate information for the analysis. That's why it has been preferred over other surveys such as LFS. Moreover, the gender parity score has shown negligible improvement, therefore the use of the data set from 2014-15 survey is justified. The PSLM survey is conducted by the Pakistan Bureau of Statistics. 122,663 individuals were selected from the data set who had any kind of income for the study. 83.6% of the selected dataset were female and 16.4% of the earners in the data set were female. Data descriptive are presented in Table 1. As shown in Table, age has the highest mean whereas age squared has the highest standard deviation. Mean age of the selected sample is 38.02, whereas, the standard deviation is 14.49. The mean of

the marital status is 0.81. The mean of education dummy variables declines with an increase in education level.

Table 1: Summary Statistics of Variables

Variable	Mean	Standard Deviation	Skewness	Kurtosis
Age	38.02	14.49	0.505	-0.253
Marital status	0.81	0.392	-1.587	0.518
Employment status	0.46	0.498	0.166	-1.973
edu.1 (below Primary)	0.25	0.433	1.154	-0.668
edu.2 (below matric)	0.25	0.433	1.154	-0.668
edu.3 (below high secondary)	0.12	0.325	2.334	3.447
edu.4 (below graduation)	0.05	0.220	4.071	14.575
edu.5 (above graduation)	0.06	0.23	3.657	11.375

4. METHODOLOGY

To explore gender earning gaps, three regions of analysis have been chosen i.e. Overall- Pakistan, Urban Pakistan, and Rural Pakistan. The framework of the analysis has been further divided into three subdivisions i.e.

i. All earners in the sample,
ii. Young earners (individuals whose age is below 40)
iii. Experienced earners (individuals whose age is 40 or above) in the sample.

The idea behind selecting different age groups is that young earners are usually at the initial stages of their career, whereas, experienced earners are at the advanced stage of their career. Moreover, with increasing age, the earnings of an individual become more stable. Therefore, gender earning gaps at the initial and advanced stages of a career can be investigated.

Estimation of wage differential was initiated by Blinder (1973) and Oaxaca (1973). Literature on the gender earning differential mostly relies on the Oaxaca-Blinder decomposition method to analyze the gap. The same technique has been used by this study to explore the gender earning gap in the workplaces of Pakistan across different age groups. Moreover, for the gender wage gap analysis, wage function is separately estimated for female and male earners in Equation 1 and Equation 2 respectively, in which the variable of interest in the study is explained by a vector of determinants.

$$W_f = \alpha_f + \beta_f x_f + \varepsilon_f \quad (1)$$

$$W_m = \alpha_m + \beta_m x_m + \varepsilon_m \quad (2)$$

Where, W_f is a log of the wages of females and W_m is the log of wages for males. x_m and x_f are vectors of mean values of independent variables of male earners and female earners. Moreover, $\alpha_m$and α_f indicates the coefficient of variable for male earners and female earners, respectively. A counterfactual equation is constructed in which the coefficient of females is replaced with that of males so that earning differences among men and women can be estimated in Equation 3.

$$W_f^* = \alpha_m + \beta_m x_f + \varepsilon_f \quad (3)$$

Now,

$$\bar{W}_m - \bar{W}_f = \left(\bar{W}_m - \bar{W}_f^*\right) + \left(\bar{W}_f^* - \bar{W}_f\right)$$

$$\bar{W}_m - \bar{W}_f^* = \beta_m(\bar{x}_m - \bar{x}_f)$$
$$\bar{W}_f^* - \bar{W}_f = (\alpha_m - \alpha_f) + (\beta_m - \beta_f)\bar{x}_f$$

To get a simple log mean wage difference between men and women, we subtract Equation 1 from Equation 2 to get Equation 4:

$$W_m - W_f = \beta_m(\bar{x}_m - \bar{x}_f) + (\alpha_m - \alpha_f) + (\beta_m - \beta_f)\bar{x}_f \quad (4)$$

Thus the difference in the log of wages is segmented into two parts i.e. endowment and coefficient. "$\beta_m(\bar{x}_m - \bar{x}_f)$" in the equation is explained term that is due to endowments and $(\beta_m - \beta_f)\bar{x}_f$ the term indicates differences that occur due to discrimination (Brown, 2011). Equation 5 presents an econometric model for the study of all earners in Pakistan.

$$Wi = \alpha_0 + \alpha_1(Age_i) + \alpha_2(Sq.Age_i) + \alpha_3(MS_i) + \alpha_4(ES_i) + \alpha_5(edu.2_i) + \alpha_6(edu.3_i) + \alpha_7(edu.4_i) + \alpha_8(edu.5_i) + \varepsilon_i \quad (5)$$

We have taken the log of wages (W) as the dependent variable, whereas Age, age squared ($Sq.Age$), marital status (MS), employment status (ES) and five dummy variables of education ($edu.1, edu.2, edu.3, edu.4$& $edu.5$) have been taken as independent variables. Age, age squared, and marital status are personal characteristics, whereas employment status is the employment characteristics of the earners. A description of explanatory variables is presented in Table 2. Age is taken as a proxy of experience. Mincer (1974) estimated experience by using the formula (age – years of education – 5). Age squared is taken to check the non-linearity of age. Various studies have analyzed gender earning differentials using the above variables (Ashraf et al., 1993; Aslam, 2009).

Equation 6 presents an econometric model for young-age earners:

$$Wy = \alpha_0 + \alpha_1(Age_y) + \alpha_2(Sq.Age_y) + \alpha_3(MS_y) + \alpha_4(ES_y) + \alpha_5(edu.2_y) + \alpha_6(edu.3_y) + \alpha_7(edu.4_y) + \alpha_8(edu.5_y) + \varepsilon_y \quad (6)$$

An econometric model for experienced earners is presented in Equation 7:

$$We = \alpha_0 + \alpha_1(Age_e) + \alpha_2(Sq.Age_e) + \alpha_3(MS_e) + \alpha_4(ES_e) + \alpha_5(edu.2_e) + \alpha_6(edu.3_e) + \alpha_7(edu.4_i) + \alpha_8(edu.5_i) + \varepsilon_e \quad (7)$$

Table 2: Description of Explanatory Variable

Variable	Description
PERSONAL CHARACTERISTICS	
Age	Age in years
Sq. Age	Squared of age
Marital status	Married= 1, otherwise 0
EMPLOYMENT CHARACTERISTICS	
Employment status	Paid employee=1, otherwise 0
EDUCATION CHARACTERISTICS	
edu.1 (below Primary) Base category	Education attained less than 5 years of schooling = 1 otherwise 0
edu.2 (below matric)	Education attained from grade 5- 9 years of schooling = 1 otherwise 0
edu.3 (below high secondary)	Education attained from grade 10- 11 years of schooling = 1 otherwise 0
edu.4 (below graduation)	Education attained from grade 12- 13 years of schooling = 1 otherwise 0
edu.5(above graduation)	Education attained more than graduation = 1 otherwise 0

5. EMPIRICAL RESULTS

Using the Oaxaca (1973) and Blinder (1973) decomposition technique, the gender wage gap has been analyzed in Overall Pakistan, Urban Pakistan, and Rural Pakistan in this Section. \\ Subsection 5a presents econometric results for all age earners. Subsection 5b presents econometric results for young earners and Subsection 5c presents results for experienced earners.

5.1 All Age Earners

Coefficient estimates of all earners are presented in Table 3. Variables (Age, $Sq.age$, MS, ES, and $edu.2$, $edu.3, edu.4$ &$edu.5$) are statistically significant for all earners for all region of analysis. As per estimates, the impact of age on wages is strongest for female workers in rural areas and is comparatively weakest for males in rural areas. Furthermore, in all regions of analysis (Urban, Rural, and Overall Pakistan) age has a positive relation with wages. We have already discussed that to check the non-linearity of Age, Age squared is added to the analysis. Results show that age squared is negative for all age groups in overall Pakistan, urban, and rural Pakistan analysis for both male and female earners which indicates that wages increase with age but at a decreasing rate.

Estimates of marital status also suggest that marital status has a positive impact on earning but the extent of impact differs among male and female workers across the region of analysis. In all three regions of our analysis (Overall Pakistan, Urban, Rural), the effect of marital status is higher for women as compared to their male counterparts. These results are aligned with Ashraf and Ashraf (1993). Moreover, Ahituv & Lerman (2005) have also suggested in their study that marriage brings job stability as it brings stability in other life aspects.

Furthermore, ES is significant for both female and male earners of Pakistan, urban and rural areas of Pakistan. Estimates show a negative relation between the earnings and employment status of the workers, which means that paid employees earn less as compared to other categories of employment. For overall Pakistan and rural areas, the influence of employment status on earnings is stronger for the female workers but for the earners in urban areas of the country, the impact of ES is stronger for male earners than female counterparts.

Education has an important effect on earnings which is in alignment with previous literature (Ashraf et al., 1993b; Awan & Hussain, 2007; Aslam 2009). Our results suggest a positive and significant impact of all levels of education on wages in urban, rural, and overall Pakistan. $edu.1$ has been taken as the base category. If we look at the coefficient estimates of education dummies ($edu.2$, $edu.3$, $edu.4$ &$edu.5$), they suggest that increase in education of workers results in more wages. An increase in the level of education has a greater impact on the earnings of female workers. If we compare results for the urban labor market for male and female workers, we observe that the impact of education is higher for female earners. Comparing rural labor market estimates suggests that education ($edu.2$, $edu.3$, $edu.4$ & $edu.5$) has a significantly higher impact on earnings of female wage earner than male wage earners. Estimates for overall Pakistan suggest the same results.

5.2 Young Earners

Another framework of the analysis is of young earners (age less than 40). Coefficient estimates of the young earners are presented in Table 4.

Variables ($Sq.Age, MS, ES, edu.2, edu.3, edu.4,$ & $edu.5$) have a statistically significant influence on earnings for all region of analysis for young earners. Age is statistically significant for men and women in overall Pakistan and rural Pakistan. The impact of age on earnings is stronger for male earners than female earners when they are young in rural, urban, and overall Pakistan. Concavity of age holds as in the previous analysis.

Table 3: Coefficient of All Age Group

Coefficient	Male Earners						Female earners					
	Pakistan – Urban		Pakistan - Rural		Pakistan – Overall		Pakistan - Urban		Pakistan - Rural		Pakistan - Overall	
	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value
Constant	9.9199	238.29	10.0639	495.52	10.0306	549.75	8.5162	56.70	8.3523	130.38	8.3854	143.48
Age	0.0779	33.74	0.0663	58.28	0.0685	67.12	0.0714	8.50	0.0869	22.12	0.0834	23.64
Sq.Age	-0.0007	-31.44	-0.0006	-52.47	-0.0006	-60.78	-0.0005	-6.00	-0.0008	-17.99	-0.0007	-18.74
Marital Status	0.1622	8.84	0.1362	13.69	0.1390	15.90	0.2368	3.45	0.2653	7.54	0.2623	8.40
Employment status	-0.1715	-14.86	-0.1338	-22.77	-0.1382	-26.43	-0.1409	-3.17	-0.4216	-20.43	-0.3726	-19.94
Edu.2	0.2142	15.13	0.2350	35.64	0.2356	39.65	0.4265	7.36	0.5089	17.61	0.5026	19.58
Edu.3	0.4683	28.80	0.4512	51.63	0.4639	60.91	1.0485	15.12	1.1352	23.67	1.1284	28.89
Edu.4	0.6061	29.03	0.6049	45.73	0.6170	55.71	1.3259	16.93	1.3653	21.11	1.3945	28.19
Edu.5	1.0420	58.01	0.9548	69.06	1.0100	94.90	1.7837	30.51	1.8316	35.10	1.8841	50.80
R- squared	0.3047		0.1905		0.2174		0.3071		0.1995		0.2305	
Adjusted R Sq.	0.3044		0.1904		0.2173		0.3054		0.1992		0.2302	

Table 4: Comparison of Coefficient of Young Earners

Coefficient	Male Earners						Female Earners					
	Pakistan - Urban		Pakistan - Rural		Pakistan - Overall		Pakistan - Urban		Pakistan - Rural		Pakistan - Overall	
	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value
Constant	9.2065	92.47	9.3900	176.05	9.3487	198.60	9.1156	21.09	8.1281	51.33	8.1964	55.74
Age	0.1455	19.17	0.1239	30.10	0.1278	35.28	0.0261	0.79	0.0959	7.49	0.0910	7.74
Sq. Age	-0.0020	-14.65	-0.0017	-22.64	-0.0017	-26.57	0.0003	0.67	-0.0007	-3.33	-0.0006	-3.22
Marital Status	0.1089	6.39	0.0807	8.33	0.0818	9.72	0.1649	2.24	0.1570	4.19	0.1494	4.50
Employment status	-0.2439	-18.18	-0.1376	-20.25	-0.1545	-25.48	-0.1035	-1.84	-0.2609	-10.96	-0.2336	-10.70
Educ.2	0.1102	6.79	0.1605	20.88	0.1568	22.65	0.3711	5.01	0.0315	12.42	0.3947	13.72
Educ.3	0.3032	15.80	0.3213	31.85	0.3276	36.92	0.9200	10.71	0.0518	19.26	0.9847	22.67
Educ.4	0.4341	18.28	0.4613	31.59	0.4698	38.00	1.1274	11.63	0.0671	17.10	1.1619	21.50
Educ.5	0.8068	36.39	0.7426	45.28	0.7939	61.55	1.6073	21.23	0.0545	29.48	1.6380	39.63
R. Squared	0.3357		0.2164		0.2424		0.2992		0.2380		0.2608	
Adj R. Sqd	0.3352		0.2163		0.2423		0.2962		0.2374		0.2603	

Econometric results for MS are the same as in the analysis of all age earners. Furthermore, ES shows a negative relation with earnings as in the all-age earner analysis. However other findings are different from the previous analysis. Employment status is stronger for male workers than the female earners when they are young.

Education ($edu.2, edu.3, edu.4$ &$edu.5$) has a positive and important impact on earnings. Results are similar to the previous analysis, but for female workers in rural areas, it can be noted from estimates in the Table that at the highest level of education($edu.5$) effect of education not only declines as compared to the previous level of education ($edu.4$) but coefficient is also weaker than a male counterpart in the rural labor market.

5.3 Experienced Earners

This subsection presents estimates of experienced earners (age 40 or greater) which are presented in Table 5. Regression estimates suggest that with the increasing age of experienced female earners, their income tends to decrease in rural and overall Pakistan. Estimates of Age are insignificant for the urban workers of the country. $Sq.Age$ approves the nonlinearity of the age as in the previous two analyses for both men and women in rural and overall Pakistan. Marital status(MS)significantly influences the earnings of experienced earners. Contrary to the previous two analyses, the impact of marriage is stronger for male earners than female earners in the urban, rural, and overall labor markets of Pakistan. Employment status (ES) has an insignificant impact on the income of old earners.

Furthermore, Education ($edu.2, edu.3, edu.4$ & $edu.5$) has a similar impact on the earnings of experienced earners as in the all earner analysis. Education significantly affects earnings and the impact is higher for female workers than their male counterparts.

By comparing Table 4 and Table 5, our results further suggest that the impact of marriage on earnings is greater on women at a young age while impact of the marriage on earnings is greater for experienced male workers. Moreover, returns to higher education are greater for experienced female earners as compared to young female workers.

5.4 Oaxaca Decomposition

The Oaxaca decomposition technique decomposes the earning differentials into three parts i.e. endowments, coefficient, and interaction. The 'Endowment' segment of the earning differentials suggests that differences in earnings are due to characteristics such as education attained, experience, skills, etc. The 'Coefficient' segment suggests that the differences in the earnings of the individuals are due to discrimination. "Interaction" term shows the interaction between both endowment and coefficient. Decomposition results are presented in Table 6.

Results suggest that in the case of all earners in Pakistan, the earning differential between male and female earners is 1.1549. Endowments account for 7.27% of the total earning differential whereas, discrimination accounts for 84.2% of the total wage differential. Furthermore, earning differentials between young men and women earners is 0.1579, out of which 2.15% of the difference is due to endowments and 91.6% of the difference is due to wage discrimination between male and female earners. In the case of the experienced earners, the earning difference between male and female earners is 1.0932. 11.52% of the wage differential is due to endowments and 75% of the difference is due to discrimination against women. This shows that the earning differential decreases with the increase in age young earner females face more discrimination than experienced females, which is also suggested in the case of Thai labor market (Khorpetch and Kulkokarn, 2011).

Table 5: Comparison of Coefficient of Experienced Earners

Coefficient	Male Earners						Female Earners					
	Pakistan - Urban		Pakistan - Rural		Pakistan - Overall		Pakistan - Urban		Pakistan - Rural		Pakistan - Overall	
	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value	Coefficient	t. value
Constant	10.1805	38.97	9.9667	75.89	10.0081	85.51	9.8171	12.28	11.8407	25.15	11.4856	28.31
Age	0.0508	5.79	0.0548	13.11	0.0541	14.34	0.0272	0.99	-0.0390	-2.46	-0.0280	-2.04
Sq. Age	-0.0005	-7.05	-0.0005	-14.73	-0.0005	-16.32	-0.0001	-0.73	0.0003	2.19	0.0002	1.89
Marital Status	0.4864	4.69	0.4901	7.70	0.4842	8.91	0.1318	0.44	0.1431	0.73	0.1541	0.93
Employment status	-0.8046	-4.06	-0.1487	-14.52	-0.1336	-14.74	-0.2240	-3.11	-0.7289	-19.09	-0.6254	-18.49
Edu.2	0.30788	12.31	0.3058	26.65	0.3068	29.65	0.4254	4.53	0.7851	12.77	0.6940	13.53
Edu. 3	0.6345	22.90	0.6058	39.10	0.6148	46.19	1.2371	10.34	1.4457	13.61	1.4193	17.67
Edu.4	0.7886	21.05	0.8014	31.87	0.7997	38.75	1.6543	12.14	2.0176	11.88	1.9199	17.71
Edu.5	1.2530	42.93	1.1869	50.56	1.2232	69.40	2.1069	20.59	2.5146	17.46	2.4319	29.68
R Squared	0.2166		0.1189		0.1455		0.2945		0.1352		0.1731	
Adj. R Sqd.	0.2159		0.1187		0.1454		0.2903		0.1341		0.1723	

Table 2: Oaxaca Decomposition of All, Young and Experienced Earners in Urban, Rural, and Overall Pakistan

Decomposition	Pakistan - Overall			Pakistan- Urban			Pakistan- Rural		
	All earners	Young Earners	Experienced earner	All earners	Young Earners	Experienced earners	All earners	Young Earners	Experienced earners
Overall Difference	1.1549	1.1579	1.0932	0.8598	0.8500	0.8650	1.2045	1.2047	1.1384
Endowment	0.0840	0.0250	0.1259	-0.01585	-0.0939	0.1278	0.096	0.0425	0.1235
Coefficient	0.9723	1.0609	0.8199	0.845	0.9760	0.6392	1.010	1.0822	0.8602
Interaction	0.0985	0.0719	0.1473	0.0300	-0.0321	0.09798	0.0977	0.0800	0.1548

A comparison of the urban labor market of Pakistan suggests that the estimate of the overall difference for all earners is 0.8598 between men and women earners. 1.8% of the differences in wages are due to the endowment, which is explained by variation in income. However, around 98% of the difference in wages is due to the unexplained term which can be attributed to discrimination against female workers in the labor market. Moving to the next column, we see a more dismal situation for female young earners in the urban labor market of Pakistan, where, 73% of the variation in earnings of experienced male and female workers is due to unexplained factors. Estimates of discrimination are very high. Comparing columns for young and experienced earners in the urban labor market suggests that females are more discriminated against when they are young or at the initial stage of their careers.

Furthermore, in the rural labor market of the country, analyzing statistics in the Table indicates that the overall difference estimate is 1.2045 for all earners. 8.02% of the differences are due to differences in characteristics of individuals (i.e. Personal, Employment, and Education), whereas, 83.07% of the differences are due to discriminatory factors against women. Estimates, further, suggest that the overall difference between young male and female earners is 1.2047. Out of these overall differences, 89.8% of the differences are due to unexplained factors.

For experienced earners, the overall difference between incomes of both genders is 1.1384. Endowment contributes 10.8% of the differences and 75.6 % of the wage differences among experienced earners of rural areas is due to biases towards women. Comparing the last two columns of the rural labor market, we can observe that young women face more discrimination in the labor market as compared to experienced female workers in rural areas as well. These results reflect a dismal state of the gender wage gap in the country as well as in urban and rural areas separately. These results show that in both urban and rural areas of Pakistan, women workers at the initial stage of their careers encounter more discrimination as compared to those women who are at an advanced stage of their careers.

6. CONCLUSION AND POLICY IMPLICATIONS

This study has explored gender earning gap varies across different age groups or career levels in Pakistan and its urban and rural labor market as well. Blinder (1973) and Oaxaca (1973) methodology has been used to decompose earning gaps among male and female earners. Data has been selected from the Pakistan Social and Living Standard Measurement published by the Pakistan Bureau of Statistics. We analyzed the gender wage gap in three frameworks: i. All Earners ii. Young Earners and iii. Experienced Earners. Young and experienced workers are taken for the analysis to dissect wage differences faced by them and the level of difference among them.

When coefficient estimates from Table 4 and Table 5 are compared, we analyze that the effect of age on earnings is greater for experienced earners than young earners in the urban labor market. Moreover, in the urban labor market, the impact of marriage is more for young earners than experienced earners. The introduction of flexible workspaces and facilities such as daycare, etc. can make the environment more inclusive for young women.

Returns to a different level of education are more likely for experienced earners than young earners in the urban labor market. In the rural market, the impact of age and marital status is more for young earners, whereas, the influence of education is more for experienced earners. Furthermore, comparing young female earners from urban and rural markets, the impact of marriage and education is high for young female earners in the urban labor market. Whereas the impact of age is higher for experienced female earners.

Decomposition results suggest that in rural and urban areas of Pakistan, young earners face more biases as compared to female earners with experience. Estimates also suggest that young female earners in the urban

labor market face more discrimination as compared to young female earners in the rural labor market. On the contrary, experienced female earners face more discrimination in rural areas than in urban areas. These results were analyzed by keeping in view that women have the same productivity characteristics as male workers.

The Constitution of Pakistan guarantees equal opportunities and eliminates discrimination among men and women in the country. Few other legislations have been enacted to eliminate discrimination in the labor market of Pakistan. There is a dire need to ensure the enforcement of these legislations, which requires effective and efficient institutions. Such a mechanism shall ensure penalties in case of violence of rules and regulations.

The gender parity index 2021 suggests that Pakistan requires 136 years to achieve gender parity in the country. Initiatives to empower women have been taken through cash transfer programs, provision of loans, allocating quota in jobs, and parliament. However, the country needs targeted measures to provide social, economic, political, and educational empowerment to women in the country to eliminate discrimination.

Experienced women should provide mentorship and networking opportunities to younger women to support women in their career development. The government should also keep an eye on regular audits and assessments of the workplaces to identify instances of gender discrimination. These measures are required to make the labor market in the country more inclusive.

Acknowledgment
The authors acknowledge the comments made by the reviewers and members of the editorial board on the earlier version of this manuscript.

Funding Source:
The author(s) received no specific funding for this work.

Conflict of Interests:
The authors have declared that no competing interests exist.

REFERENCES

Abrar ul Haq, M., Mehtab, N., & Khan, T. (2012). Gender Disparity in Economic Returns to Higher Education: Evidence from Private Formal Sector of Bahawalpur (Pakistan). *Interdisciplinary Review of Economics and Management*, 2(1). 34-40.

Ahituv, A., & Lerman, R. (2005). Job turnover, wage rates, and marital stability: How are they related? *Review of Economics of the Household*, 9(2), 221-249.

Aktas, K.Z., & Anil, M.M. (2019). Assessing the gender wage gap: Turkey in the years 2002-2019. *Economics and Business Review*, 70(1), 90-112.

Ali, A., & Jiang, L. J. (2016). Examining the relationship between inequalities in gender wage and economic growth in Pakistan. *Pakistan Journal of Gender Studies*, 12(1), 39–52.

Ali, L., & Akhtar, N. (2014). An analysis of the gender earning differentials in Pakistan. *Research Journal of Applied Sciences, Engineering and Technology*, 7(13), 2772-2784.

Ali, L., & Akhtar, N. (2016). Gender earnings gap in urban Pakistan: Evidence from ordinary least squares and quantile regressions. *Journal of Business Economics and Finance*, 5(3), 274-293.

Ashraf, J. (1996). Is Gender pay discrimination on the wane? Evidence from panel data, 1968-1989, *Industrial and Labor Relations Review*, 49 (3), 537-46.

Ashraf, J., & Ashraf, B. (1993). Estimating the gender wage gap in Rawalpindi City. *The Journal of Development Studies*, 29(2), 365-376.

Ashraf, J., & Ashraf, B. (1998). Gender earnings and discrimination in Pakistan. *The Indian Journal of Labor Economics*, 41(2), 317-26.

Ashraf, J., Ashraf, B., & Ahmed, A. M. (1993). An analysis of the male-female earnings differential in Pakistan [with Comments]. *The Pakistan Development Review*, 32(4), 895-904.

Ashraf, J., Williams, M. & Aydin, R. (2009). The determinants of gender wage discrimination in Pakistan: Econometric evidence from Punjab province. *Conference of Global Business and Management Forum 2009 (GBMF)*, GBMF. University of Dhaka, Bangladesh.

Aslam, M. (2009). Education gender gaps in Pakistan: Is the labor market to blame? *Economic Development and Cultural Change*, 57(4), 747-784.

Awan, M. S., & Hussain, Z. (2007). Returns to education and gender differentials in wages in Pakistan. *Lahore Journal of Economics*, 12(2), 49-68.

Becker, G. S. (1972). Investment in human capital: A theoretical analysis. *Journal of Political Economy*, *70*(5), 9-49.

Becker, G. S. (1985). Human capital, effort and the sexual division. *Journal of Labour Economics*, 3(5), 33-58.

Blinder, A.S. (1973). Wage discrimination: Reduced form and structural estimates. *The Journal of Human Resources*, 8(4), 436-455.

Brown, S., Roberts, J. & Taylor, K. (2011). The gender reservation wage gap: Evidence from British panel data. *Economics Letters*, 113(1), 88–91.

Caliendo, M., & Wittbrodth, L. (2022). Did the minimum wage reduce the gender wage gap in Germany? *IZA Institute of Labour Economics Discussion Paper Series No. 14926.*

Castagnetti, C., & Giorgetti, M.L. (2019). Understanding the gender wage differential between the public and private sectors in Italy: A quantile approach. *Economic Modelling,* 78, 240-261.

Chakraborty, S. (2020). Gender wage differential in public and private sectors in India. *The Indian Journal of Labour Economics*, 63(3), 765-780.

Ciminelli, G., Schwellnus, C., & Stadler, B. (2021). Sticky floor or the glass ceiling? The role of human capital, working time flexibility and discrimination in the gender wage gap, *OECD Economics Department Working Paper No. 1668.*

Cortes, G.M., Oliveria, A. & Salomons, A. (2021). Do technological advances reduce the gender wage gap, *Oxford Review of Economic Policy,* 36(4), 903-924.

Cotton, J. (1988). On the decomposition of wage differential. *The Review of Economics and Statistics*, 70(2), 236-243.

Daymont, T. N., & Andrisani, P. J. (1984). Job preferences, college major, and the gender gap in earnings. *Journal of Human Resources*, 19(3), 408-428.

Filer, R. K. (1983). Sexual differences in earnings: The role of individual personalities and tastes. *Journal of Human Resources*, 18(1), 82-99.

Ge, S., & Zhou, Y. (2020). Robots, Computers and the gender wage gap. *Journal of Economic Behavior and Organization*, 178, 194-222.

Ghignoni, E. & Pastore, F. (2023). The gender wage gap in Egypt: public versus private sector. *International Journal of Manpower*.

Grybaite, V. (2006). Analysis to theoretical approaches to gender pay gap. *Journal of Business Economics and Management*, 7(2), 85-91.

Guo, Q., Chen, S. & Zeng, X. (2021). Does FinTech narrow the gender wage gap? Evidence from China. *China and World Economy,* 29(4), 142-166.

International Labor Organization (2020). Understanding the gender wage gap, *Women in Business and Management*, 1-4.

Khorpetch, C., & Kulkokarn, K. (2011). Gender wage discrimination in the Thai Labor Market. *Applied Economics Research*, 18(2), 17-31.

Liu, S., & Su, Y. (2020). The geography of jobs and the gender wage gap. *FRB of Dallas Working Paper No. 2028.*

Malkiel, B. G., & Malkiel, J. A. (1973). Male-female pay differentials in professional employment. *The American Economic Review*, 63(4), 693-705.
Miller, P. W. (2009). The gender pay gap in the US: Does sector make a difference? *Journal of Labor Research*, 30(1), 52-74.
Newell, A., & Reilly, B. (1996). The gender wage gap in Russia: Some empirical evidence. *Labour Economics*, 3(3), 337-356.
Oaxaca, R. (1973). Male-female wage differentials in urban labor markets. *International Economic Review*, 693-709.
Oliver, X., & Sard, M. (2020). Gender wage gap in hospitality. *Journal of Hospitality and Tourism Research*, 45(2).
Oostendorp, R. H. (2009). Globalization and the gender wage gap. *The World Bank Economic Review*, 23(1), 141-161.
Orkideh, G., & Vidya, A. (2021). Gender wage gap: within and across borders. *Studies in Business and Economics*, 16(2), 74-83.
Orkoh, E., Blaauw, D., &Claassen, C. (2022). The trade openness – gender wage differential nexus: Household-level evidence from Ghana. *Review of Development Economics*, 26(1), 156-179.
Piazzalunga, D., & Tommaso, M.D. (2019). The increase of the gender wage gap in Italy during 2008-2012 economic crisis. *The Journal of Economic Inequality*, 17(2), 171-193.
Picatoste, X., Mesquita, A., & González-Laxe, F. (2023). Gender wage gap, quality of earnings and gender digital divide in the European context. *Empirica*, 50, 301–321.
Qazi, Q., Ansari, N. G., & Moazzam, A. (2018). Women's reaction to the gender pay gap: A study of the Pakistan telecommunication sector. *Pakistan Journal of Women's Studies: Alam-E-Niswan*, 25(2), 133-149.
Sabir, M., & Aftab, Z. (2007). Dynamism in the gender wage gap: evidence from Pakistan. *The Pakistan Development Review*, 865-882.
Siddiqui, R., & Siddiqui, R. (1998). A decomposition of male-female earning differentials. *The Pakistan Development Review*, 37(4), 885-898.
Umair, M., & Naz, L. (2020). Gender pay gap among urban-urban migrant workers: Pakistan's two-tier urban labor market. *Pakistan Journal of Gender Studies*, 20, 2663-8886.
Warner, A.S., & Lehmann, L.S. (2019). Gender Wage Disparities in Medicine: Time to Close the Gap. *Journal of General Internal Medicine*, 34, 1334–1336.
Yasin, G., Chaudhry, I. S., & Afzal, S. (2010). The determinants of gender wage discrimination in Pakistan: econometric evidence from Punjab Province. *Asian Social Science*, 6(11), 239.
Yasmin, S., Jamil, M., & Iqbal, M. (2021). The gender wage gap in Pakistan: extent, trends and explanations. *Formal Journal of Economic Studies*, 17(2), 1-30.

Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

The Impact of Division-Level Production Outcomes upon Punjab Aggregate Wheat Production: An Application of Correlated Component Regression Approach

ABSTRACT

This study analyzes the relative importance of division-level production outcomes in predicting the Punjab outcome for wheat crops using the annual time-series data from 1982 to 2020. A newly developed regression analytic approach, called correlated component regression (CCR), was applied to overcome suppression effects and multicollinearity data problems. Standardized regression coefficients have been used to determine the relative importance of each division. Herfindahl-Hirschman Index (HHI) was applied to measure the geographic concentration of the division-level impacts. The empirical analysis was used at two time periods in which the first period includes the crop years from 1987 to 2003 and the second period covers 2004 to 2020 crop years. The regression results provide an HHI value of 1175 during 1987-2003 and 1351 during 2004-2020. A smaller value of HHI during the period 1987-2003 indicates that the technological change along with high-yield varieties, use of fertilizers, and pesticides have led to a greater concentration for wheat in this period, and the opposite was true for 2004-2020.

AUTHORS

Muhammad Naveed
Lecturer, Department of Economics, Government Allama Iqbal Graduate College Sialkot, Pakistan.
Author's Contributions: 1,2,3,4,5,6
m_naveed_skt@yahoo.com
https://orcid.org/0000-0003-3348-3830

Hafsa Hina *
Assistant Professor, Pakistan Institute of Development Economics, Islamabad, Pakistan.
Author's Contributions: 1,2,3,4,5,6
hafsahina@pide.org.pk
https://orcid.org/0000-0001-9931-1957

Keywords
Correlated Component Regression, Production Performance Index, Relative Significance in Prediction, Punjab, Geographical Concentration, Technological Change

JEL Classification
C19; Q10

Please cite this article as:
Naveed, M., & Hina, H. (2023). The impact of division-level production outcomes upon Punjab aggregate wheat production: An application of correlated component regression approach. *Kashmir Economic Review*, 32(1), 66-79.

*** Correspondence author**

Author's contribution in the article: 1- Conceived and designed the analysis, 2- Reviewed and compiled the literature, 3- Collected the data, 4- Contributed data or analysis tools, 5- Performed the analysis, 6- Wrote the paper, 7- Financial support for the conduct of the study, 8-Other

1. INTRODUCTION

Agriculture is considered the mainstay of Pakistan's Economy. Development in this sector reduces poverty and ensures sustainable food security in the country. According to the Economic Survey of Pakistan 2018-19, the agriculture sector has contributed 18.5 percent to Pakistan's gross domestic product (GDP) and provided 38.5 percent of the domestic labor force. Although the share of the agriculture sector has decreased in recent years, it is still considered a vital sector of the national economy as its good performance has a significant role in economic growth and poverty reduction. Important crops, namely cotton, rice, wheat, maize, and sugarcane, contribute predominantly to the agriculture sector of the national economy. Wheat is considered the leading staple food in Pakistan. In 2019-20 total wheat production of 24946 thousand tonnes, and a yield of 2827 Kgs per hectare was recorded in the country. Moreover, the share of wheat to value-added in agriculture and GDP of Pakistan was 8.7 percent and 1.7 percent respectively in 2019-20.

The largest production share in the total wheat production of Pakistan comes from Punjab. The economy of Punjab has a significant impact on the economy of Pakistan because the total percentage of the economy of Punjab in the GDP of Pakistan was 54.2 percent in 2017-18. Moreover, the contribution of agriculture in the economy of Punjab was 23 percent, 20.8 percent, and 20.20 percent in 2012-13, 2015-16, and 2017-18 respectively. During 2018-19, 38.94 percent of the total cropped area was cultivated wheat in Punjab. Punjab itself produced 19401.86 thousand tonnes of wheat in 2019-20, almost 78 percent of the total wheat produced in Pakistan. Punjab has nine divisions, and each division contributes differently to the whole wheat production of Punjab.

During the 1987 to 2003-time period, the highest average production share was held by the Multan division at 14.89 percent, followed by Bahawalpur (13.57 percent), Gujranwala (13.50 percent), Faisalabad (13.47 percent), D.G. Khan (11.46 percent), and Sahiwal (11.30 percent). While at the same period, the Rawalpindi division has contributed the lowest average production share at 4.66 percent. From 2004 to 2020, Bahawalpur had the most significant average production share at 15.29 percent, followed by Gujranwala (14.35 percent), Multan (13.87 percent), Faisalabad (13.65 percent), and D. G. Khan (12.76 percent). In contrast, the Rawalpindi division contributed the lowest average production share at 3.82 percent (Crop Reporting Service, Punjab Lahore).

As Punjab is a major producer of wheat crop in Pakistan, thus a significant change in wheat production in Punjab may affect the national wheat production. Therefore, it is crucial to know Punjab divisions' behavior and relative importance for Provincial wheat production. A careful review of the academic literature to date has turned up no evidence of any studies that have examined the relative implications of division level wheat contribution to Punjab provincial supply. To address this research gap, this study has the following objectives:

- The main objective of this study is to apply a recently developed regression analytic technique, called a correlated component regression (CCR), to measure the relative importance of division-level production outcomes in predicting the provincial production outcome for the wheat crop.
- A second important objective of this study is to analyze whether the technological change along with high-yield varieties, use of fertilizers, pesticides and policy factors would lead to a greater or lower geographic variation of the relative importance of each division upon the provincial aggregate.

To determine the relative importance of each division on Punjab wheat production, regression analyses were conducted using the Punjab production performance index as the dependent variable and each division's production performance index as independent variables. Standardized regression coefficients were calculated from these regressions, and these coefficients were used to rank the divisions based on their significance in influencing Punjab provincial wheat production. Due to issues with datasets such as its multicollinearity as well as sparsity, simple ordinary least squares (OLS) regression methods were not

suitable as they resulted in large standard errors and unreliable insignificant coefficient estimates. Therefore, a regression technique called correlated component regression (CCR), developed in 2011, and was applied in this study.

CCR is specifically designed to handle sparse and multicollinear datasets, providing more reliable and stable coefficient estimates. By applying this methodology, the study aimed to provide a comprehensive understanding of the relative importance of each division's production outcomes in influencing Punjab wheat production. The use of CCR allowed for more robust and accurate estimations, overcoming the challenges posed by sparse and multicollinear data.

The second significant goal of this study is to find out the influence of technology and policy factors on the ranking of the 9 divisions and the geographical concentration of their relative importance. To achieve this, the time-series dataset was divided into two distinct periods: the years 1987 to 2003, and the years 2004 to 2020. The Herfindahl-Hirschman Index (HHI) was used in the study to determine the geographic concentration of importance. The HHI was computed by considering the percentage shares of the absolute values of the standardized regression coefficients. This index provides a measure of the concentration of importance across different divisions. By computing the HHI for both time periods in relation to wheat production, it became possible to assess the impact of technology and policy factors on the concentration of wheat production. The results from these calculations shed light on the degree to which technology and policy influences have contributed to the geographic concentration or dispersion of importance in the context of wheat production.

2. LITERATURE REVIEW

In literature, most of the studies have focused on the impact of climate change, input requirements such as plowing, seed rate, irrigation, fertilizer, farm size, and change in the conventional agriculture practices to the use of effective microorganisms upon wheat yields.

The studies that focused on the impact of climate-related variables, namely CO_2, rainfall, temperature, environmental degradation, on wheat production in Pakistan includes Janjua et al., 2013), Qureshi and Iglesias (1994), Arooj et al. (2018). Interestingly the finding of these studies does not align with each other such as Janjua et al. (2013) haven't found the impact of climate change on wheat production in Pakistan whereas fertilizers would be the only remedy to counter any deficiency of wheat production. Empirical results of Arooj et al. (2018) showed that environmental degradation has a significant impact on wheat production in Pakistan and a 7.2 percent increase in wheat production was caused by a one percent increase in wheat area. Likewise, Chandio et al. (2019) found fertilizer consumption, cultivated area, and support price have a positive and significant effect on wheat production. But on the other hand, Rauf et al. (2017) found that the use of fertilizer for the production of wheat and the yield of wheat does not maintain a significant results association.

Siddiqui et al. (2012) have studied the effect of climate change on wheat, cotton, rice, and sugarcane in Punjab, taking the annual time series data from 1980 to 2008. Estimated results of the fixed effect model show that climate change positively impacts wheat productivity. In contrast, the impact of climate change was negative for sugarcane, rice, and cotton.

Improvement in crop yields not only achieves food sustainability but also enhances its contribution to gross domestic product. The agriculture sector contributes 23% to GDP. Raza et al. (2012), Rehman et al. (2016), and Ali et al. (2020) studied the nexus of agriculture gross domestic product (AGDP) with wheat production, maize, and rice and confirmed the significant influence of these crops in AGDP. Rauf et al. (2017) also showed that there exists a powerful and highly significant relationship between area under

cultivation for wheat and agriculture GDP. It is not necessary that all crops significantly affect the agricultural GDP as due to the higher cost of production of any crop may adversely affect the agricultural GDP such as Rehman and Jingdong (2017) analyzed the relationship between agricultural gross domestic product (GDP) and major food crops, including rice, wheat, cotton, sugarcane, corn, and tubers in China using annual time series data from 1980 to 2015. The study's empirical analysis shows that the production of wheat, cotton, corn, tubers, and sugarcane has a positive and significant impact on China's agricultural gross domestic product. However, rice production has a negative and insignificant impact on the agricultural GDP of China.

Pakistan cannot become a food-sufficient country until or unless it shifts from conventional agriculture practices to advanced ones. Hussain et al. (1999) intensively studied the use of effective microorganisms on rice and wheat. The results of their three-year study in Pakistan showed that effective microorganisms can improve soil quality; increase the growth, increase the yields and nutrient uptake of rice and wheat; provide plant protection against diseases and allow the farmers to increase their net profits.

From the review of literature, it is clear that most of the studies in the case of Pakistan have focused on the factors that affect the yield of production but a careful review of the academic literature to date has turned up no evidence of any studies that have examined the relative implications of division level wheat contribution to Punjab provincial supply. However, Bullock (2021) has analyzed the impact of state-level production outcomes upon U.S. aggregate soybean and corn production. In the study, the relative importance of each state was determined by the absolute value of the standardized regression coefficients. The degree of concentration was measured by applying the Herfindahl-Hirschman Index. The empirical results were found for two time periods: a pre-Genetic Modification cover 1975 to 1995 crop years and a post-Genetic Modification include 1996 to 2017 crop years. The study results show that U.S. corn production was geographically less concentrated in state-level importance, and the opposite was true for soybean production.

3. DATA AND METHODOLOGY

In the present research, the time series data at an annual frequency from 1982 to 2020 on wheat production is used for nine divisions, namely, Rawalpindi, Gujranwala, Lahore, Faisalabad, Sargodha, Sahiwal, Multan, Bahawalpur, and Bahawalnagar. The Punjab level aggregate data of wheat production is also used in this study. The data on wheat production is taken from the Directorate of Agriculture Crop Reporting Service, Punjab Lahore (crs.agripunjab.gov.pk) and Crops, Area an d Production (by districts) volume I issued by the Federal Bureau of Statistics. The wheat production is measured in tonnes. This study analyzes the data by applying the Correlated Component Regression (CCR) technique. The Production Performance Index (PPI) was constructed for two time periods in which the first period includes the crop years from 1987 to 2003 and the second period covers 2004 to 2020 crop years. Herfindahl-Hirschman Index (HHI) has also been applied for geographic concentration. A comprehensive introduction of all these measures is given below.

3.1 Production Performance Index (PPI)

In measuring the relative under-or over-performance of wheat production per year, a metric called production performance index (PPI), first developed by Bullock (2021), was constructed as a proxy for the divisionally and provincially production level relative to recent previous years. This study also follows the index constructed by Bullock (2021). This index is defined as follows:

$$PPI_t = P_t - OA(P_{t-1}, P_{t-2}, P_{t-3}, P_{t-4}, P_{t-5}) \quad (1)$$

Where P_t shows the current year production of wheat in Punjab and each of 9 divisions of the Punjab, and $OA(\cdot)$ indicates the Olympic Average function (calculated by ignoring the minimum and maximum values from the previous five-year values and taking the average of remaining three-year values). Hence, the PPI

measures the degree by which the current year's production either decreased (under-performed) or exceeded (over-performed) the average production level from the previous five years. The PPI series is generally stationary and reduces the effects of autocorrelation because it was calculated by taking the lagged differencing. The Olympic average was used to reduce the influence of extremely bad or good production years when fixing the past benchmark of what could be taken as a "normal" level of production for a specific division of Punjab province at the time of comparison.

3.2 Correlated Component Regression (CCR)

The Correlated Component Regression technique (CCR) was developed by Magidson (2011) to address a significant issue encountered in traditional regression approaches, namely multicollinearity and suppression effects. Multicollinearity and suppression effects arise when explanatory variables exhibit moderate to high correlation with each other and have no direct impact on the dependent variable. These problems can lead to large variances and standard errors of estimated regression coefficients, rendering them unstable and statistically insignificant (Pandey & Elliot, 2010). In datasets like the one considered in this study, where the explanatory variables are highly correlated, a model's seemingly good predictive performance may be attributed to overfitting. Magidson (2013) demonstrated that the CCR approach is particularly effective for sparse and multicollinear datasets, as it provides more reliable and stable estimates of regression coefficients. A major advantage of CCR is its ability to mitigate confounding effects caused by high correlations among predictors and yield more robust parameter estimates. Bullock (2021) employed the CCR technique, which we have also adopted in this study. The CCR algorithm employs the ordinary least square (OLS) method to estimate a set of P single-variable regression equations. In the first step, we estimate the loadings for each explanatory variable by running Y on each explanatory variable through the Ordinary Least Square (OLS) technique as follows:

$$\hat{Y} = \hat{\gamma}_g^{(1)} + \hat{\lambda}_g^{(1)} X_g \tag{2}$$

Y indicates the dependent variable and X_g shows independent variables with $g = 1,2,3, \dots, P$; $\hat{\gamma}_g^{(1)}$ and $\hat{\lambda}_g^{(1)}$ are the constant and slope coefficients respectively for the specific independent variable g. The first correlated component variable, S_1, is then defined as the weighted sum of all 1-predictor effects using the slope coefficients obtained from (2) like weights, that is:

$$S_1 = \frac{1}{P}\sum_{g=1}^{P} \hat{\lambda}_g^{(1)} X_g \tag{3}$$

The predictions for Y in the 1-component CCR model are obtained by applying OLS regression of Y on S_1, that is:

$$\hat{Y} = \hat{\alpha}^{(1)} + \hat{\beta}_1^{(1)} S_1 \tag{4}$$

With the relevant CV metric, CV-R^2 or CV-MSE has been saved from the above regression for later determination of the optimal number of correlated components retained in the final model. The component variable S_1 is called the direct effects component because it shows the direct effect of each explanatory variable upon the outcome variable without capturing the suppressor effects.

Similarly, the 2-component variable S_2 is constructed by first estimating the following model for each predictor through the application of simple OLS, that is:

$$\hat{Y} = \hat{\gamma}_g^{(2)} + \hat{\lambda}_{1,g}^{(2)} S_1 + \hat{\lambda}_g^{(2)} X_g \tag{5}$$

The second correlated component variable S_2 is defined as the weighted sum of all 2-predictor effects using the slope coefficients of the explanatory variables estimated from (5) like weights, that is:

$$S_2 = \frac{1}{P}\sum_{g=1}^{P} \hat{\lambda}_g^{(2)} X_g \tag{6}$$

The predictions for Y in the 2-component CCR model are obtained by applying OLS regression of Y on S_1 and S_2, that is:

$$\hat{Y} = \hat{\alpha}^{(2)} + \hat{\beta}_1^{(2)} S_1 + \hat{\beta}_2^{(2)} S_2 \quad (7)$$

As the component variable S_2 and all the later derived component variables show the correlation with component variable S_1, component variable S_2 and all the later derived component variables capture the suppressor variables effects. It improves the prediction in the component variable model by removing the irrelevant variation from at least one of the explanatory variables with direct effects. This process for the derivations of component variables can continue until the optimal number of components is achieved.

In general, for any K (K is less than P)-component variables, S_k is defined by first estimating the following model through OLS for each of the independent variables, that is:

$$\hat{Y} = \hat{\gamma}_g^{(K)} + \hat{\lambda}_{1,g}^{(K)} S_1 + \hat{\lambda}_{2,g}^{(K)} S_2 + \cdots + \hat{\lambda}_{K-1,g}^{(K)} S_{K-1} + \hat{\lambda}_g^{(K)} X_g \quad (8)$$

After predicting regression equation (8), final correlated component variable S_k is constructed as follows:

$$S_k = \frac{1}{P} \sum_{g=1}^{P} \hat{\lambda}_g^{(k)} X_g \quad (9)$$

The predictions for Y in the k-component CCR model are obtained by applying OLS regression of Y on $S_1, S_2, \ldots, S_k$ that is:

$$\hat{Y} = \hat{\alpha}^{(K)} + \hat{\beta}_1^{(K)} S_1 + \hat{\beta}_2^{(K)} S_2 + \cdots + \hat{\beta}_k^{(K)} S_k \quad (10)$$

Putting (3), (6), and (9) in (10), we obtain the following:

$$\hat{Y} = \hat{\alpha}^{(K)} + \hat{\beta}_1^{(K)} \left(\frac{1}{P} \sum_{g=1}^{P} \hat{\lambda}_g^{(1)} X_g \right) + \hat{\beta}_2^{(K)} \left(\frac{1}{P} \sum_{g=1}^{P} \hat{\lambda}_g^{(2)} X_g \right) + \cdots + \hat{\beta}_k^{(K)} \left(\frac{1}{P} \sum_{g=1}^{P} \hat{\lambda}_g^{(k)} X_g \right) \quad (11)$$

From (11) we can get:

$$\hat{Y} = \hat{\alpha}^{(K)} + \hat{\beta}_k^{(K)} \left(\frac{1}{P} \sum_{g=1}^{P} \hat{\lambda}_g^{(k)} X_g \right) \quad (12)$$

$$\hat{Y} = \hat{\alpha}^{(K)} + \sum_{g=1}^{P} \hat{\beta}_g X_g \quad (13)$$

Where

$$\hat{\beta}_g = \frac{1}{P} \sum_{k=1}^{P} \hat{\beta}_k^K \hat{\lambda}_g^{(k)} \quad (14)$$

Equation (14) shows that the regression coefficient $\hat{\beta}_g$ for an explanatory variable X_g is simply the weighted sum of the loadings where the estimated coefficients obtained from the final component model (10) are used as weights. Estimated coefficients obtained from (14) are called non-standardized regression coefficients. The standard errors of the non-standardized regression coefficients are obtained by using the formula given below:

$$SE(\hat{\beta}_g) = \frac{1}{P}\sqrt{\sum_{k=1}^{K}\left(SE(\hat{\beta}_k^K)\right)^2(\hat{\lambda}_g^k)^2} \quad (15)$$

Where $\hat{\lambda}_g^k$ indicate the loadings and $SE(\hat{\beta}_k^K)$ represent the standard errors of the estimated coefficients of the final correlated component regression model. The divisions are ranked based on the absolute values of standardized regression coefficients. These are calculated as follows:

$$\hat{\beta}_g^* = \left(\frac{\hat{\sigma}_g}{\hat{\sigma}_y}\right) \times \hat{\beta}_g \quad (16)$$

Where $\hat{\sigma}_g$ represents the standard deviation of each independent variable and $\hat{\sigma}_y$the explained variable's standard deviation. Standardized regression coefficients are used to check which explanatory variables have a larger impact upon the explained variable. The standardized regression coefficient indicates the marginal effect (in standard deviations) upon the explained variable of a one standard deviation change in the explanatory variable. The absolute values of the standardized regression coefficients of each division and the percentage share of the total sum of absolute coefficients are used to determine the rank of each division. Divisions with a greater ranking represent that a one standard deviation change in their PPI measure has a greater effect (in standard deviations) upon the provincial PPI measure.

3.3 Herfindahl-Hirschman Index (HHI)

The Herfindahl-Hirschman Index (HHI) was initially developed by Herfindahl and Hirschman. Bullock (2021) applied the HHI as a measure of geographic concentration. This was determined by computing HHI using the absolute values of the percentage-shared standardized regression coefficients. Following the methodology proposed by Bullock (2021), this study also utilizes the HHI to assess the importance of geographic concentration for the division-level impacts during both time periods. The following equation provides a mathematical definition of the HHI:

$$HHI = \sum_{i=1}^{n}(s_i.100)^2 \quad (17)$$

Where n indicates, the number of divisions included in the regression and s_i is the percentage share of the total sum of absolute standardized coefficients for the i^{th} division (in decimal format). Changes in the value of HHI can be used to determine the degree of change in geographic concentration between the two time periods using the percentage share of standardized regression coefficients. The main hypothesis developed was whether the technological change along with high-yield varieties, use of fertilizers, and pesticides would lead to a greater or lower geographic variation of the relative importance of each division upon the provincial aggregate. A smaller value of HHI in any period would imply that the technological change along with high-yield varieties, use of fertilizers, and pesticides have led to greater concentration in that period.
In our analysis, we utilized the COR Express software developed by Statistical Innovations for estimation purposes. To determine the optimal values for two important parameters, namely the number of components (K) and the number of explanatory variables (P) in the CCR model, we employed relevant cross-validation techniques.

4. RESULTS AND DISCUSSION

Two critical parameters, namely the optimal number of correlated component variables K and the number of predictors P, have been determined using relevant cross-validation. To find the optimal value of component variables K, the eight maximum number of correlated components has been set, and cross-validation of 4-fold was used for both periods. Furthermore, we have taken all the nine divisions of Punjab in the estimation model, and the step-down procedure for variable selection has not been applied. During

the period 1987-2003 CCR model with 4 component variables maximized the value of CV-R^2, whereas the 7 component variables maximized the value of CV-R^2 during the 2004-2020 period. Therefore, we have taken 4 and 7 component variables in our analysis from 1987 to 2003 and 2004 to 2020, respectively. The cross-validation R^2 for both the study periods are reported in Table 1.

Table 1: Cross-Validation R^2 for Both the Time Periods

Predictors	Component Variables	CV-R^2	
		1987-2003	2004-2020
9	1	0.967	0.977
9	2	0.993	0.990
9	3	0.995	0.993
9	4	0.996	0.995
9	5	0.996	0.995
9	6	0.995	0.996
9	**7**	0.995	0.997
9	8	0.994	0.997

(Source: Authors' calculation).

Table 2: Correlated components regression coefficients and standardized regression coefficients of wheat production for both the periods

Correlated Component	Coefficient	Std. Error	T-Stat	Standardized Coefficient	Share of Standardized Total
			1987 to 2003		
S1	0.23	0.01	42.75***	1.11	78.01
S2	0.29	0.03	8.39***	0.20	14.29
S3	0.83	0.25	3.27***	0.07	5.03
S4	0.51	0.27	1.87*	0.04	2.68
2004 to 2020					
S1	0.25	0.02	14.77***	0.86	38.17
S2	0.13	0.23	0.55	0.03	1.13
S3	1.73	0.31	5.57***	0.24	10.66
S4	3.07	0.80	3.84***	0.40	17.51
S5	3.08	0.90	3.42***	0.45	20.06
S6	0.61	0.20	3.02***	0.10	4.59
S7	0.43	0.22	1.93*	0.18	7.88

*, ** and *** indicate significantly different from zero at 10%, 5%, and 1% level of significance, respectively. (Source: Authors' calculation).

Table 2 shows the correlated components, non-standardized regression coefficients, and standardized regression coefficients for both periods. These results are obtained from (10). From 1987 to 2003, the first three components are statistically significant at a 1% significance level, whereas the last component is significant at a 10% significance level. However, the coefficient of the first, third, fourth, fifth, and sixth component variables is significantly different from zero at a 1% significance level from 2004 to 2020. At the same time, the coefficient of the last component variable is significant at a 10% level of significance. The correlated component variable S1 has a very high direct effect of 78.01 percent shares of standardized regression coefficients from 1987 to 2003. In contrast, at the same time, the remaining three components S2, S3, and S4, have only 21.99 percent indirect effect. Similarly, during the period 2004 to 2020, the correlated component variable S1 has a very low direct effect 38.17 percent shares of standardized regression coefficients while at the same time, the remaining six components, S2, S3, S4, S5, S6, and S7, have 68.13 percent indirect effect.

Table 3: Individual Division's non-standardized coefficients, standardized regression coefficients, and percentage shares of absolute standardized coefficients during the period of 1987 to 2003

Rank	Division	Coefficients	Std. Error	t-Statistic	Standardized Coefficient	Share
1	Gujranwala	1.1065	0.06	18.62***	0.22	15.54
2	Bahawalpur	1.31	0.07	19.02***	0.21	14.71
3	Multan	0.85	0.04	19.03***	0.19	13.57
4	Lahore	1.05	0.12	8.99***	0.16	11.20
5	Sargodha	2.42	0.28	8.49***	0.14	9.79
6	D.G. Khan	0.99	0.12	8.50***	0.14	9.57
7	Rawalpindi	0.62	0.10	6.25***	0.13	9.22
8	Faisalabad	0.71	0.07	10.51***	0.12	8.52
9	Sahiwal	0.86	0.12	7.20***	0.11	7.87
	Constant	-73763.48	33814.10	-2.18*		
Herfindahl-Hirschman Index					1175	

*, ** and *** indicate significantly different from zero at 10%, 5%, and 1% level of significance, respectively. (Source: Authors' calculation).

The individual division's non-standardized regression coefficients, standardized regression coefficients along with their statistical significance, and percentage shares ranked by the absolute values of standardized coefficients during the period 1987 to 2003 are shown in Table 3. The estimated results show that the coefficients of all divisions have a positive and statically significant effect on wheat production of Punjab at a 1% level of significance from 1987 to 2003. In addition, the estimated results also specify that during this period, production outcomes in Division Gujranwala, Bahawalpur, and Multan had a major share of 43.82 percent upon the Punjab wheat production outcome. Lahore, Sargodha, D.G. Khan, Rawalpindi, and Faisalabad have 11.20 percent, 9.79 percent, 9.57 percent, 9.22 percent, and 8.52 percent shares respectively in Punjab wheat production. Sahiwal has the lowest share of 7.87 percent in Punjab wheat production. The Herfindahl-Hirschman Index (HHI), based on the standardized regression coefficients shares, has a value of 1175, which is below the 1500 threshold that the U. S. Department of Justice and the Federal Trade Commission consider a low level of concentration.

Table 4: Individual Division's non-standardized coefficients, standardized regression coefficients, and percentage shares of absolute standardized coefficients during the period of 2004 to 2020

Rank	Division	Coefficients	Std. Error	t-Statistic	Standardized Coefficient	Share
1	Gujranwala	1.15	0.11	10.44***	0.32	18.57
2	Multan	1.19	0.17	7.12***	0.28	16.13
3	Faisalabad	1.22	0.85	1.42	0.27	15.50
4	D.G. Khan	1.23	0.26	4.64***	0.23	13.47
5	Rawalpindi	1.02	0.30	3.43***	0.21	12.00
6	Bahawalpur	0.97	0.17	5.62***	0.19	10.97
7	Sahiwal	0.59	0.33	1.81	0.09	5.15
8	Lahore	0.74	0.27	2.72**	0.07	4.29
9	Sargodha	0.48	0.19	2.59**	0.07	3.92
	Constant	1635.37	42545.44	0.04		
Herfindahl-Hirschman Index					1351	

*, ** and *** indicate significantly different from zero at 10%, 5%, and 1% level of significance, respectively (Source: Authors' calculation).

Table 4 provides the information regarding individual division's non-standardized regression coefficients, standardized regression coefficients, and their statistical significance and percentage shares ranked by the absolute values of standardized coefficients from 2004 to 2020. The estimated results show that the coefficients of all divisions have a positive and statistically significant effect on wheat production of Punjab at 1% and 5% level of significance during the period of 2004-2020 except Faisalabad and Sahiwal divisions which have a positive but statistically insignificant effect on wheat production of Punjab. In addition, the estimated results also specify that during this period, production outcomes in Division Gujranwala and Multan had a major share of 34.70 percent upon the Punjab wheat production outcome. Moreover, Division Faisalabad, D.G. Khan, Rawalpindi, Bahawalpur, Sahiwal, and Lahore have 15.50 percent, 13.47 percent, 12.00 percent, 10.97 percent, 5.15 percent, and 4.29 percent shares respectively in Punjab wheat production. Sargodha has the lowest share of 3.92 percent in Punjab wheat production during this period. The Herfindahl-Hirschman Index (HHI), based on the standardized regression coefficients shares, has a value of 1351, which is below the 1500 threshold that the U.S. Department of Justice and the Federal Trade Commission consider a low level of concentration.

The estimated results of Division-level change in rankings and shares during two time periods (1987-2003) and (2004-2020) for nine divisions of Punjab are reported in Table 5. The level of geographic concentration, based on the absolute shares of standardized regression coefficients, has improved moderately, as shown by the 176-point increase in the HHI value. From 1987 to 2003, the top three divisions (Gujranwala, Bahawalpur, and Multan) hold 43.82 percent share, with Gujranwala holding 15.54 percent Bahawalpur holding 14.71 percent, and Multan holding 13.57 percent share. During the period 2004 to 2020, a total of 45.67 percent share has been held by these three divisions with 18.57 percent share was held by Gujranwala, Bahawalpur held 10.97 percent share, and Multan held 16.13 percent share. Faisalabad Division has improved its ranking by +5, whereas D. G. Khan, Rawalpindi, and Sahiwal have improved their rankings by +2 places between the two study periods under analysis. However, the Bahawalpur, Lahore, and Sargodha divisions have decreased their ranking by -4 places during the two study periods. The Faisalabad division enjoyed the largest improvement in share +6.98 percent, followed by D. G. Khan +3.89 percent and Gujranwala +3.03 percent. Lahore and Sargodha have the largest decrease in the share of -6.91 percent and -5.87 percent, respectively, during two time periods.

Table 5: Division-Level Change in Rankings and Shares between Two Time Periods

Division	Rank			Shares		
	1987-2003	2004-2020	Change	1987-2003	2004-2020	Change
Gujranwala	1	1	0	15.54	18.57	+3.03
Bahawalpur	2	6	-4	14.71	10.97	-3.74
Multan	3	2	+1	13.57	16.13	+2.56
Lahore	4	8	-4	11.20	4.29	-6.91
Sargodha	5	9	-4	9.79	3.92	-5.87
D.G. Khan	6	4	+2	9.57	13.47	+3.89
Rawalpindi	7	5	+2	9.22	12.00	+2.78
Faisalabad	8	3	+5	8.52	15.50	+6.98
Sahiwal	9	7	+2	7.87	5.15	-2.72
HHI	**1175**	**1351**	**176**			

(Source: Authors' calculation).

To check the validity of the model in both periods, certain diagnostic and stability tests are applied, and the estimated results of these tests are shown in Table 6. The empirical analysis of the diagnostic tests indicates that the model has not shown any problem of non-normality, autocorrelation, heteroscedasticity, and instability of the estimated parameters during both periods. Moreover, Figure 1 and Figure 2 represent that the cumulative sum of square residuals (CUSUMSQ) during both periods does not cross the straight line at

a 5% level of significance. It indicates the non-presence of structural instability in the estimated parameters of the model during both periods.

Table 6: Diagnostic Tests for both the Time Periods

Test	Value of Test Statistic	Probability Value	Critical Value
Diagnostic tests of the model during 1987-2003			
Normality Test (Jarque Bera)	0.13	0.94	$\chi^2_{0.05(2)} = 5.99$
Serial Correlation LM Test	0.72	0.39	$\chi^2_{0.05(1)} = 3.84$
ARCH Test	0.08	0.77	$\chi^2_{0.05(1)} = 3.84$
Ramsey Reset Test	0.04	0.84	$\chi^2_{0.05(1)} = 3.84$
Diagnostic tests of the model during 2004-2020			
Normality Test (Jarque Bera)	0.09	0.96	$\chi^2_{0.05(2)} = 5.99$
Serial Correlation LM Test	2.65	0.10	$\chi^2_{0.05(1)} = 3.84$
ARCH Test	0.10	0.76	$\chi^2_{0.05(1)} = 3.84$
Ramsey Reset Test	0.05	0.82	$\chi^2_{0.05(1)} = 3.84$

(Source: Authors' calculation).

Figure 1: Cumulative Sum of Square Residuals of the Model during 1987-2003

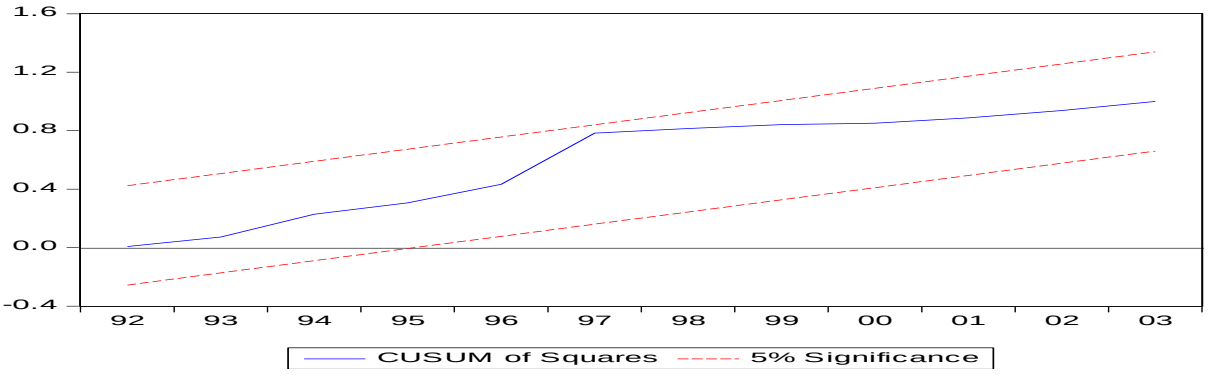
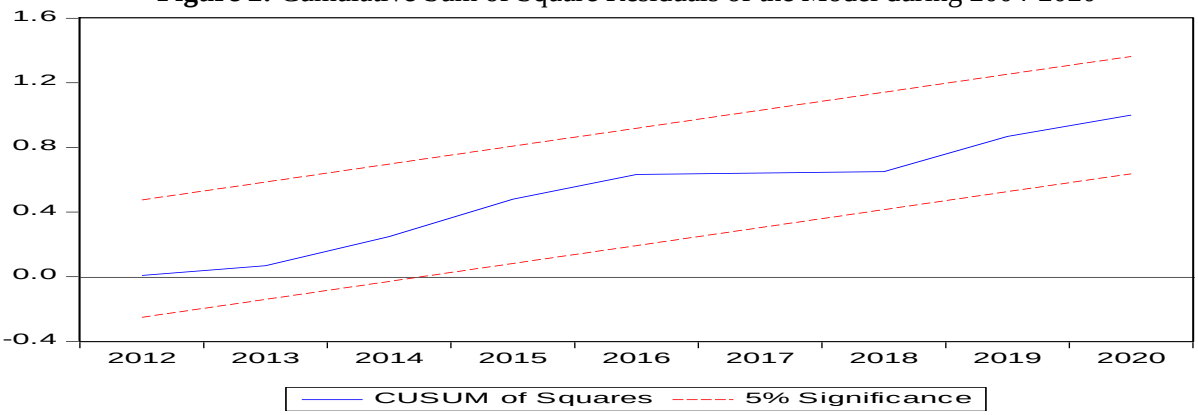


Figure 2: Cumulative Sum of Square Residuals of the Model during 2004-2020



5. CONCLUSION AND POLICY IMPLICATIONS

This study analyzes the division level geographic importance for Punjab wheat production using a regression methodology called correlated component regression. The important feature of this technique is that it can be best applicable for the data sets such as those used in the present study in which there exists a problem of sparse and/or multicollinearity. A PPI metric called a production performance index had been constructed to measure the production performance of each of 9 divisions as well as Punjab aggregate by excluding the Olympic average (calculated by ignoring the minimum and maximum values from the previous five values and taking the average of remaining three values) from the value of the current year. This index was calculated for wheat production during two time periods in which the first period includes the crop years from 1987 to 2003 and the second period covers 2004 to 2020 crop years.

A correlated component regression model was estimated for each period with Punjab aggregate PPI as the explained variable and nine divisions PPI as the predictor variables. The percent shares of the absolute value of the standardized regression coefficients from the estimated regression models were used to determine each division of Punjab's rank and relative importance. To determine the concentration in each period, an HHI was found using the percent shares of the standardized regression coefficients for each period under analysis and compared across the periods. This study's major hypothesis was whether the technological change along with high-yield varieties, use of fertilizers, and pesticides had shown a greater level of geographic concentration of production importance in the first period (1987-2003) or the second period (2004-2020). The estimated value of HHI checked this.

Our results indicate that the level of geographic concentration, based on the absolute shares of standardized regression coefficients, has improved moderately, as shown by the 176-point increase in the HHI from 2004 to 2020. From 1987 to 2003, the top three divisions (Gujranwala, Bahawalpur, and Multan) held 43.82 percent share, with Gujranwala holding 15.54 percent, Bahawalpur holding 14.71 percent, and Multan holding 13.57 percent share. During the 2004 to 2020 period, the top three divisions (Gujranwala, Multan, and Faisalabad) held 50.20 percent share, with Gujranwala holding 18.57 percent, Multan holding 16.13 percent, and Faisalabad holding 15.50 percent share. Faisalabad Division has improved its ranking by +5 places, whereas D. G. Khan, Rawalpindi, and Sahiwal have improved their ranking by +2 places between the two study periods under analysis.

However, the Bahawalpur, Lahore, and Sargodha divisions have decreased their ranking by -4 places during the two study periods. The Faisalabad division enjoyed the largest share improvement +6.98 percent, followed by D. G. Khan +3.89 percent and Gujranwala +3.03 percent during two time periods. Lahore and Sargodha have the largest decrease in the share of -6.91 percent and -5.87 percent, respectively, during two time periods. Gujranwala division has the highest share in the Punjab aggregate during both the study periods. Diagnostic tests indicate that the model has not shown any problem of non-normality, autocorrelation, heteroscedasticity, and instability of the parameters. The cumulative sum of square residuals (CUSUMSQ) during both periods indicates no structural instability in the estimated parameters of the model.

From the above results, the following conclusions can be drawn.

- **i.** It is very interesting to note that the rankings determined by the estimated correlated component regressions do not imitate each division's simple average production shares. The rankings determined by the correlated components regressions and simple average production share may differ because the correlated components regressions measure both the direct (prime variable) and indirect (suppressor variable) effects of each division's PPP metric.
- **ii.** Correlated component regression results from 1987 to 2003 provide a smaller value of the standardized coefficient HHI. This demonstrates that the technological change along with high-

yield varieties, use of fertilizers, and pesticides have shown a greater geographic dispersion of the relative importance of each division upon the Punjab aggregate during the time span of 1987 to 2003. The opposite was true for the timeframe of 2004 to 2020.

iii. A third notable change in the regression results during the time period of 2004 to 2020 was that the number of indirect effects components had increased from four to seven. The share of standardized coefficient (S1) called direct effect has decreased from 78.01 percent in the first period (1987-2003) to 38.17 percent in the second period (2004-2020).

Acknowledgment
The authors acknowledge the comments made by the reviewers and members of the editorial board on the earlier version of this manuscript.

Funding Source:
The author(s) received no specific funding for this work.

Conflict of Interests:
The authors have declared that no competing interests exist.

REFERENCES

Ali, I., Khan, I., Ali, H., Baz, K., Zhang, Q., Khan, A., & Huo, X. (2020). Does Cereal crops asymmetrically affect Agriculture gross domestic product in Pakistan? Using NARDL model approach. *Ciência Rural*, *50*.

Bullock, D. W. (2021). The Influence of State-Level Production Outcomes upon US National Corn and Soybean Production: A Novel Application of Correlated Component Regression. *Journal of Agricultural and Applied Economics*, 53(1), 55-74.

Chandio, A. A., Jiang, Y., & Rehman, A. (2019). Using the ARDL-ECM approach to investigate the nexus between support price and wheat production: An empirical evidence from Pakistan. *Journal of Asian Business and Economic Studies*, 26, 139-152.

Hussain, T., Javaid, T., Parr, J., Jilani, G., & Haq, M. (1999). Rice and wheat production in Pakistan with Effective Microorganisms. *American Journal of Alternative Agriculture*, 14(1), 30-36.

Janjua, P. Z., Samad, G., & Khan, N. (2014). Climate Change and Wheat Production in Pakistan: An Autoregressive Distributed Lag Approach, NJAS-Wageningen Journal of Life Sciences, 68, 13-19.

Magidson, J. (2013). Correlated component regression: Rethinking regression in the presence of near collinearity. In New perspectives in partial least squares and related methods Springer, New York, 65-78.

Pandey, S., & Elliott, W. (2010). Suppressor variables in social work research: Ways to identify in multiple regression models. *Journal of the Society for Social Work and Research*, *1*(1), 28-40.

Qureshi, A. & Iglesias, A. (1994). Implication of Global Climate Change for Agriculture in Pakistan: Impacts on Simulated Wheat Production, Climate Institute Washington DC, 1-14.

Rauf, A., Liu, X., Sarfraz, M., Shahzad, K., & Amin, W. (2017). Economic stance of wheat crop yield in Pakistan: application of ARDL bound testing model. *J. Glob. Innov. Agric. Soc. Sci*, *5*, 175-180.

Raza, S. A., Ali, Y., & Mehboob, F. (2012). Role of agriculture in the economic growth of Pakistan. *International Research Journal of Finance and Economic*, 83, 181-185.

Rehman, A., & Jingdong, L. (2017). An econometric analysis of major Chinese food crops: An empirical study. *Cogent Economics & Finance*, *5*(1), 1323-1372.

Rehman, A., Jingdong, L., Shahzad, B., Chandio, A. A., Hussain, I., Nabi, G., & Iqbal, M. S. (2015). Economic perspectives of major field crops of Pakistan: An empirical study. *Pacific Science Review B: Humanities and Social Sciences*, *1*(3), 145-158.

Siddiqui, R., Samad, G., Nasir, M., & Jalil, H. H. (2012). The impact of climate change on major agricultural crops: evidence from Punjab, Pakistan. *The Pakistan Development Review*, 261-274.

Kashmir Economic Review
ISSN(P): 1011-081X, ISSN(E): 2706-9516
http://www.ker.org.pk

Assessing the Technical Efficiency of Small Farmers Cultivating Wheat in Punjab, Pakistan: A Stochastic Frontier Analysis (SFA)

ABSTRACT

Agriculture is essential in developing countries since it employs most people and contributes significantly to GDP. Wheat is an important crop for both money and food. Land utilization, productivity, and efficiency increase agricultural output. This study aims to asses the technical efficiency of small farmers cultivating wheat in Punjab, Pakistan.The dataset used in this study encompasses 419 small-scale wheat farmers from 2018-19. It offers a comprehensive information regarding production costs and input utilization for the wheat crop. The Stochastic Frontier Analysis yields an average technical efficiency estimate of 84%. The findings suggest that technical efficiency increases by 16 percent without altering the level of inputs utilized.

AUTHORS

Baber Amin*
Lecturer in Economics, School of Economics, IIIE, International Islamic University Islamabad, Pakistan.
Author's Contributions: 2,4,5,6
baber.amin@iiu.edu.pk
https://orcid.org/0000-0001-3194-9332

Muhammad Avais Tahir
Senior Research Economist, Punjab Economic Research Institute, Lahore, Pakistan
Author's Contributions: 1,3,4,5,6
avais.tahir@peri.punjab.gov.pk
https://orcid.org/0000-0001-9490-9332

Sajid Amin
Research Assistant, Department of Economics, Government College University Lahore, Pakistan.
Author's Contributions: 1,2,3,5,6
sajidamin26262@gmail.com
https://orcid.org/0000-0002-0149-4810

Shahzad Hussain
Professor of Economics, Department of Economics, Government College University Lahore, Pakistan.
Author's Contributions: 1,2,4,6
shahzad.hussain@gcu.edu.pk
https://orcid.org/0000-0002-3830-4793

Keywords
Technical efficiency, Stochastic Frontier Analysis, PERI

JEL Classification
Q12, O13, Q17

Please cite this article as:
Amin, B., Tahir, M.A., Amin, S., & Hussain, S. (2023). Assessing the technical efficiency of small farmers cultivating wheat in Punjab, Pakistan: A Stochastic Frontier Analysis (SFA). *Kashmir Economic Review*, 32(1), 80-89.

*** Correspondence author**

Author's contribution in the article: 1- Conceived and designed the analysis, 2- Reviewed and compiled the literature, 3- Collected the data, 4- Contributed data or analysis tools, 5- Performed the analysis, 6- Wrote the paper, 7- Financial support for the conduct of the study, 8-Other

1. INTRODUCTION

Agriculture is essential in developing countries since it employs most people and contributes significantly to GDP. Wheat is considered a vital cash crop contributing to food security. Land utilization, productivity, and efficiency all play a role in increasing agricultural output. Productivity can be improved by developing technology or increasing the performance of the resources available. Improving the quality of the tools at the farmer's disposal is a significant concern. The analysis of technical efficiency (T.E. hereafter) is critical. Because through T.E. production of wheat can be improved. In this paper, we calculate the T.E. of small wheat farmers. The small farmer is more concerned about food security rather than profitability. Most of the world's rural population relies on smallholder farming for food production and income, particularly in developing nations. There may be 500 million smallholdings worldwide and 2.1–2.5 billion individuals engaged in small-scale farming (FAO). Efficiency growth and the utilization of extra production variables are two significant elements that could increase agricultural production Ahmad & Bravo-Ureta, (1995). Moreover, Salam and Hameed (2022) , Diaz Balteriro et .al (2006) analyzed the technical efficiency of producing major food grains in Punjab. Results of the study show a large variation in the farmers' technical efficiency at the farm level. Most of the wheat farmers are working under increasing return to scale. Results of the study also show that if the inputs decrease from 10 percent to 29 percent without reducing the outputs.

Prices of inputs also matter in agriculture because high input prices increase the cost of production. For example, prices of diesel, fertilizers, and pesticides increase the cost of production, and the efficiency of the farmers will be affected (Chandio et al.,(2017), Bachewe et al., (2019) . According to Good et al. (1993), productivity is made up of two components: technological change and T.E. According to Kalirajan (1997), research and development are the primary drivers of technological advancement, while education, experience, and a more extensive infrastructure are crucial for boosting the effectiveness of the system. Wheat yields may also vary on farms with similar topographic features and availability of varied input resources. The "technical efficiency gap" is primarily caused by the variations in management strategies used at these farms, which in turn cause yield variation. Citing several research, including those by Fresco et al. (2021), Wadud and White (2000), Pingali (2002), Ahmad et al. (2002), Heisey (2001), Kalirajan et al. (1997), Thirtle et al. (1995), and Lin (1992). Moreover, credit is essential for the improvement of the technical efficiency of the farmers. Masuku et al. (2015) , Ahmed et al. (2014), analyzed how credit affects technical efficiency. Results of the study showed that credit positively influences the efficiency of the farmers.

Therefore, determining the main factors limiting wheat yield and the poor levels of technological diffusion are the main areas of concern. It will be easier to prioritize technical interventions, recognize the need for agroecology-specific enhanced varieties, and plan future policies with the support of documentation of restrictions. The main objective of this study has designed to evaluate Punjab's wheat farms' productivity and compile the factors affecting it. The survey's top priorities included analyzing the efficiency levels of wheat farmers in various production systems, the factors that affect efficiency levels, and then ranking the technological interventions and best agricultural practices required to close yield gaps in multiple zones in order of importance.

2. SPECIFICATION OF THE EMPIRICAL MODEL

The idea of efficiency illustrates how a production process' inputs and outputs are connected (Diaz et al., 2004). Several efficiency metrics can be utilized to assess the capabilities of farmers, including T.E., allocation efficiency, and economic efficiency. The research uses metrics, Farrell (1957) first suggested to evaluate T.E. (1957). T.E. is the capacity of a piece of land to yield as much as possible with a given level of input or to do so while using the fewest number of information possible. These two ideas are input-oriented $(I-O)$ and output-oriented $(O-O)$. T.E. has been analyzed by numerous scholars, including

Coelli et al. (2002), Dhungana et al. (2004), Rodríguez Díaz (2005), We use $(I-O)\ TE$ in this paper to increase production by using various inputs more effectively. Technical effectiveness can be further broken down into scale effectiveness (SE) and pure technical effectiveness (TE), as suggested by Rodriguez Diaz et al. (2005).

3. DEA AS A MEASURE OF EFFICIENCY

Parametric and nonparametric approaches to measuring performance through stochastic frontier production function method and the DEA methodology. The DEA methodology offers several distinct advantages compared to the econometric approach for evaluating productivity. It is a nonparametric technique that does not require assumptions about the distribution of inefficiency terms. Additionally, DEA allows for comparing performance indexes between different production methods. This enables the calculation of the "efficiency gap" that isolates each farmer's behaviour from the best production practices, which can be evaluated based on observed inputs and outputs of efficient firms. (Haji, 2006; Malano et al., 2004; Wadud & White, 2000). Several other researchers have made substantial contributions in measuring technical efficiency like Aparicio et al. (2020), Ebrahimi et al. (2021).

Moreover, by applying data envelopment analysis, a small sample size cannot significantly affect the measure of efficiency (Chambers, 1998; Toma, 2017) and the selection of data envelopment analysis because of its flexibility and ability to calculate sub-vector efficiencies. The research model presented in this study incorporates information on K inputs and M outputs collected from n individual farms. The input and output data for the i^{th} farm are represented by column vectors x_i and y_i, respectively. The $K \times N$ input matrix X, and $M \times N$ output matrix Y, represent data for all small wheat farms in the sample. Equation 1 is used in the DEA methodology to calculate T.E.

$$\boldsymbol{Min}_{\ \theta\lambda}\theta \qquad (1)$$

Subject to

$$-y_i + Y\lambda \geq 0 \qquad (2)$$

$$\theta x_i - X\lambda \geq 0 \qquad (3)$$

$$N_1\lambda = 1 \qquad (4)$$

$$\lambda \geq 0 \qquad (5)$$

By resolving equation 1, where is a scalar, N_1 is a $N \times 1$ vector of ones and is a $N \times 1$ vector of constants, one can determine the T.E. score for the i^{th} farm. Each farm goes through this process once, and the final value—which ranges from 0 to 1—represents the T.E. score. The farm is effective and located on the frontier, according to a score of one. It is worth noting that the variable returns to scale (VRS) specification of Equation 1 includes a convexity constraint $N_1 = 1$. This constraint is implemented to ensure that the farms are not operating above their ideal scale. Equation 1 would adopt a CRS without this limitation if the farms operated optimally (Fraser & Cordina, 1999).

In agriculture, increasing the number of inputs does not necessarily result in a proportional output increase. For example, increasing the amount of water supplied to crops may not result in a linearly proportional increase in crop volume. This highlights the need for a variable return-to-scale option, which may be more appropriate for addressing the productivity assessment problem in agriculture Rodríguez -Deaz et al., 2005). Furthermore, comparing both scores holds great significance, providing valuable insights regarding scale efficiency (S.E.). Coelli et al. (2002) showed that the relationship is as follows:

$$SE = TE_{crs}/TE_{vrs} \qquad (6)$$

If scale efficiency (S.E.=1), it shows CRS and efficiency if the value of the scale efficiency is less than one, it shows that scale inefficiency exists.

Applying the concept of sub-vector efficiency introduced by Farrell et al. (1957), the technical sub-vector efficiency for the variable input k is computed for each farm i by solving the following programming problem, as proposed in this study.

$$\boldsymbol{Min}_{\theta\lambda}\theta^{\boldsymbol{k}} \quad (7)$$

Subject to:

$$-y_i + Y\lambda \geq 0 \quad (8)$$

$$\theta^k \mathrm{x}_i^k - X^k\lambda \geq 0 \quad (9)$$

$$\mathrm{x}_i^{n-k} - X^{n-k}\lambda \geq 0 \quad (10)$$

$$N_1\lambda = 1 \quad (11)$$

$$\lambda \geq 0 \quad (12)$$

Within this equation, the variable θ^k signifies the T.E. score assigned to the sub-vector of input k for the i^{th} farm. The third constraint in the given equation takes into account the presence of xi and X, where the k^{th} input (column) is omitted and represented as x_i^{n-k} and X^{n-k}, respectively. Conversely, the second constraint only considers the k^{th} input and is represented by x_i^k and X^k. All other variables are defined similarly as in Equation 1.

4. DATA

The (PERI) provided the data for this study, which divided the Punjab province into three zones based on the irrigation sources. The zones are barrani (rain-fed), partially barren, and irrigated. To ensure representation of all farm types. Ecological zones were used to partition the irrigated area into Cotton-Wheat, Rice-Wheat, and Mixed-Wheat Zones. Respondents were chosen based on the size of their farms in the particular village that was included in the sample.

The selection criteria ensured that the study concentrated on a diverse range of farm sizes to capture an in-depth portrait of the village's agricultural landscape because the sample village was chosen to represent the larger farming community population. The study included small-sized farmers from Rawalpindi, Chakwal, Bhakkar, Sheikhupura, Gujranwala, Hafizabad, Narowal, Nankana, Faisalabad, Okara, Sargodha, Bahawalnagar, Rahim Yar Khan, Khanewal, Dera Ghazi Khan, Vehari, and Muzaffargarh. The study included 419 wheat growers, and the data collected included the cost of production and inputs used in wheat production, with wheat yield per acre serving as the dependent variable. Table 1 displays the range of values for the input variables that were employed in the study.

These variables include the total area of land allocated for wheat cultivation, the amount of farmyard manure applied per acre, the seed rate per acre, the number of pesticides and weedicides used per acre, the number of irrigations per acre, the number of labour utilized for wheat production per acre, the cost of land preparation per acre, and the number of fertilizer bags applied per acre. The minimum and maximum values of these variables are presented in Table 1 to provide a comprehensive overview of the input variables used in the study.

The study employed input variables measured per-acre basis, except for the area sown for wheat, which was used to assess the returns to scale of farming. Additionally, the study included efficiency variables such as the farmers' age and education, wheat cultivation area, credit access, awareness of the agriculture department, and traditional knowledge, with their respective minimum and maximum values also presented in Table 1.

Table 1: Summary of Statistics of Variables

Variable	Unit	Obs.	Mean	Std.Dev.	Min	Max
Land Rent	Rs	419	13691.050	6669.973	2000	32500
Seed quantity	Kgs	419	40.532	2.686	35	47.000
Irrigation Number	Number of irrigation water	419	3.937	1.819	0.000	8.000
Total fertilizer Bag	Number of Bags	419	2.744	.968	0.000	6.500
Fyam Yard manure	Number of cartloads	419	2.194	1.300	0.000	6.000
Weedicide Numbers	Number of sprays	419	.994	.289	0.000	2.000
Yield	40 kg	419	34.624	8.606	6.000	63.000
Man days	Man Days	419	9.072	27.584	.219	154.750

Table 2: Socioeconomic characteristics

Age	**Frequency**	**Percentage (%)**
>=30	68	16.23
31-40	85	20.29
41-50	97	23.15
51-60	89	21.24
>60	80	19.09
Household Size	**Frequency**	**Percentage (%)**
1-4	94	22.43
5-9	276	65.87
10-14	45	10.74
>14	4	0.95
Mean	6.38	
Education Level	**Frequency**	**Percentage (%)**
No Formal Education	118	28.16
Primary Education	67	15.99
Matriculation	183	43.68
Intermediate	31	7.4
Bachelours	20	4.77
Mean	6.23	
Farming Experience	**Frequency**	**Percentage (%)**
1-20	88	21
21-40	201	47.97
>40	130	31.03
Farm Size (Acres)	**Frequency**	**Percentage (%)**
0-1	18	4.3
1-2	95	22.67
2-3	125	29.83
3-4	90	21.48
4-5	81	19.33
5	10	2.39
Mean	2.54	
Zone	**Frequency**	**Percentage (%)**
Baraani	55	13.13
Partial Baraani	42	10.02
Irrigated Rice	94	22.43
Irrigated Mix	67	15.99
Irrigated Cotton	161	38.42

The socioeconomic characteristics of the farmers are presented in Table 1. The age distribution of the farmers shows more than 15 percent (16.23 %) of the farmers are not more than 30 years of age. Similarly, more than 20 percent (20.29 %) of farmers aged between 31 to 40 years and less than 25 percent (23.15) of farmers aged between 41 to 50 years. At the same time, less than 20 percent of the farmers were above 60. Their mean age was 46.38 years. The mean age of the respondents shows that most of the farmers are young and physically active. Most respondents (65.87 %) had household sizes of 5 to 9 people, and more than 10 percent (10.74) farmers had household sizes between 10 to 14 per person.

The respondents' educational attainment has been classified into five groups: no formal education, primary education, matriculation, intermediate education, and bachelor's education level. The results indicate that most respondents possess a matriculation education level (43.68%), whereas more than one-quarter of farmers (28.16%) have not received any formal education. Thus, the literacy level of the farmers is high in farmers. More than 50 % of the farmers had more than 50 years experienced. The distribution of the farm sizes respondents shows that most farmers cultivated up to 2 to 3 acres.

The mean farm size of the respondents is about 2.45 acres. The distribution of the zones is barani, partial barani, irrigated rice, irrigated mix, and irrigated cotton. More than 20 percent of the wheat grower in irrigated rice zones, and more than 10 percent (10.02) of farmers were in partial barani areas.

Table 3: Average Estimates of Technical Efficiency Estimates from DEA Models

Variable	Observation	Mean	Std.Dev.	Min	Max
CRS	419	.833	.155	.235	1
VRS	419	.987	.04	.75	1
SE	419	.844	.153	.235	1

Table 4: Technical Efficiency Estimates using DEA Models

	CRS		VRS		SE	
Technical Efficiency	Number of farmers	Percentage of farmers	Number of farmers	Percentage farmers	Number of farmers	Percentage farmers
0 -0.5	12	2.86	-	-	11	2.63
0.5-0.6	23	5.49	-	-	20	4.77
0.6- 0.7	45	10.74	-	-	42	10.02
0.7- 0.8	85	20.29	3	0.72	75	17.90
0.8- 0.9	89	21.24	24	5.73	91	21.72
0.9-1.00	165	39.38	392	93.56	180	42.96

Variable return to scale and constant return to scale input-oriented T.E. are calculated using data envelopment analysis DEA. The DEA model-derived T.E. estimates are displayed as average values. Compared to the other farms in the sample, these estimates show how effectively the sample farms convert their input resources into output. The average T.E. estimates provide a helpful summary of the sample farms' overall efficiency and can be used to pinpoint areas where productivity increases may be possible. According to Table 3, the mean T.E. scores for constant return to scale (CRS-DEA) and variable return to scale ($CRS-DEA$) are 0.833% and 0.987%, respectively. In addition, scale efficiency is calculated by using the relationship between CRS and variable return to scale. The average scale efficiency is .84 percent. Most farmers are technically efficient between 0 .9 -1 range (Table 5). Thirty-nine percent of farmers are technically efficient in CRS and 93.56 percent in VRS, which lies in this range. Moreover, agriculture department awareness and traditional awareness have positively and significantly affected the efficiency of the farmers when the farmers have more understanding about crop activity.

Table 5: Comparison of Factors Affecting Technical Efficiency

Variables	(1)	(2)	(3)
	CRS	VRS	SE
Age	0.154***	1.206***	0.160***
	(0.0112)	(0.0365)	(0.0111)
Household size	0.0560***	0.323***	0.0524***
	(0.0183)	(0.0595)	(0.0182)
Education	0.0129*	0.0545**	0.0139*
	(0.00747)	(0.0243)	(0.00743)
Area sown	0.0217	0.0161	0.0309**
	(0.0141)	(0.0460)	(0.0141)
Credit	0.0881***	0.109	0.0817**
	(0.0340)	(0.110)	(0.0338)
Agriculture department awareness	0.118***	0.721***	0.101***
	(0.0331)	(0.108)	(0.0329)
Traditional awareness	0.113***	0.704***	0.0990***
	(0.0292)	(0.0949)	(0.0290)
Observations	419	419	419
R-squared	0.964	0.992	0.965

S.R in parentheses; *** p<0.01, ** p<0.05, * p<0.1

The *OLS* regression results are presented in Table 5. Table 5 shows the determinants of the T.E. of small farmers. The dependent variable of the OLS regression model is the T.E. score of the wheat crop's small farmers for 2017-2018. The respondent's age in CRS and variable return to scale have a positive and significant impact on the efficiency of the farmers. It means older farmers have more efficient compared to young farmers. The reason is that farmers have become more skillful as they grow older due to cumulative farming experience. This result was consistent with the argument (Alemu, 2018; Liu et al., 2000). Farmers' ability to acquire and use knowledge of improved technologies is aided by education. In this study, education is measured in years of formal schooling. The sign of education is positive and significant. It means educated farmers are more efficient as compared to uneducated farmers. This may be because trained and educated farmers can better combine information from different sources and apply new knowledge and technology to their farms, resulting in higher wheat yields. More educated farmers use inputs in wheat growing better way.

Similarly, the coefficient of the estimated household size of the farmers and the education of the farmers positively and significantly affects the efficiency of the farmers in CRS and VRS. The wheat crop area is statistically significant and positively affects the efficiency of the farmers. The coefficient value of the area sown of wheat shows that the area of crop increases; farmers are more efficient.

Credit is a crucial component of agricultural production systems. It helps producers to fulfill their cash needs because of the output cycle. Since it temporarily fixes a liquidity/working capital shortage, the amount of Credit increases farmers' performance. In this analysis, the amount of Credit is hypothesized in such a way that farmers who received Credit from formal or informal sources during a given production season were expected to be more productive than those who received no credit. The empirical studies by Biam et al. (2016), Ali et al. (2014), found a positive and significant relationship between Credit and farmers' T.E., which was in line with this study. The study results indicate that Credit is an essential determinant of efficiency. The availability of Credit increases the efficiency level of the farmers. The estimated coefficient value of the Credit shows that efficiency and Credit positively correlate.

5. CONCLUSION AND POLICY IMPLICATIONS

The primary objective of this study was to apply SFA analysis methods to assess the T.E. of smallholder wheat farmers. The data utilized in this study was acquired from the Punjab Economic Research Institute (PERI) based in Lahore. This study analyzes a dataset of 419 small wheat farmers and includes information on production costs and input utilization for the crop. The SFA estimate for T.E. was 84 percent on average. The results of the SFA study indicate that T.E. can be enhanced by 16% without any alteration in the input levels. The analysis further suggests that factors such as education level, transportation costs, farm size, and geographical area positively impact T.E.

The study lends credence to the claim that Punjabi wheat farmers may be more technically effective, which would improve wheat production. We suggest the following policy alternatives to increase the productivity and effectiveness of small-scale wheat growers in Punjab based on the findings of this study. First, the SFA model's parameters demonstrate that labour, seed, and farmyard manure impact productivity. In light of these findings, policymakers should prioritize educating farmers on the appropriate and balanced use of inputs. Based on the second recommendation's analysis, irrigation water availability significantly impacts crop yield, emphasizing the need for accessible canal water at the appropriate time. Water shortages can be resolved by implementing plans to make rainwater collection more widely used and limiting water loss through canal or watercourse lining. Thirdly, it is recommended that the agricultural extension service plan be scheduled at the beginning of each year, with extension agents organizing training sessions to educate farmers on effective crop production methods. Moreover, there is a need to restructure the wheat extension efforts.

Acknowledgment
The authors express their gratitude for the valuable input provided by the reviewers and members of the editorial board during the review process of the previous version of this manuscript.

Funding Source:
The author(s) did not receive any dedicated funding for this research paper.

Conflict of Interests:
The authors have stated that they do not have any conflicts of interest to disclose.

REFERENCES

Ahmad, M., & Bravo-Ureta, B. E. (1995). An econometric decomposition of dairy output growth. *American Journal of Agricultural Economics*, *77*(4), 914-921.

Ahmad, M., Chaudhry, G. M., Iqbal, M., & Khan, D. A. (2002). Wheat productivity, efficiency, and sustainability: A stochastic production frontier analysis. *The Pakistan development review*, 643-663.

Ahmed, M. H., Lemma, Z., & Endrias, G. (2014). Technical efficiency of maize producing farmers in Arsi Negelle, Central Rift valley of Ethiopia: Stochastic frontier approach. *Poljoprivreda i Sumarstvo*, *60*(1), 157.

Alemu, M. D., Tegegne, B., & Beshir, H. (2018). Technical efficiency in Teff (Eragrostisteff) production: the case of smallholder farmers in Jamma district, South Wollo Zone, Ethiopia. *Journal of Agricultural Economics and Rural Development*, *4*(2), 513-519.

Ali, S., & Khan, M. (2014). Technical efficiency of wheat production in district Peshawar, Khyber Pakhtunkhwa, Pakistan. *Sarhad Journal of Agriculture*, *30*(4), 433-441.

Aparicio, J., & Esteve, M. (2022). How to peel a data envelopment analysis frontier: A cross-validation-based approach. *Journal of the Operational Research Society*, 1-15.

Bachewe, F. N., Koru, B., & Taffesse, A. S. (2019). Cereal productivity and its drivers: The case of Ethiopia. *Gates Open Res*, *3*(1332), 1332.

Biam, C. K., Okorie, A., & Nwibo, S. U. (2016). Economic efficiency of small scale soybean farmers in Central Agricultural Zone, Nigeria: A Cobb-Douglas stochastic frontier cost function approach. *Journal of Development and Agricultural Economics*, *8*(3), 52-58.

Chambers, R. G., Chung, Y., & Färe, R. (1998). Profit, directional distance functions, and Nerlovian efficiency. *Journal of Optimization Theory and Applications*, *98*, 351-364.

Chandio, A. A., Magsi, H., Rehman, A., & Sahito, J. G. M. (2017). Types, sources and importance of agricultural credits in Pakistan. *Journal of Applied Environmental and Biological Sciences*, *7*(3), 144-149.

Coelli, T., Rahman, S., Thirtle, C., (2002). Technical, Allocative, Cost and Scale Efficiencies in Bangladesh Rice Cultivation: A non-parametric Approach. Journal of Agricultural Economics 53 (3) 607-627.

Dhungana, B.R., Nuthall, P.L., Nartea, G.V., 2004. Measuring the economic inefficiency of Nepalese rice farms using data envelopment analysis. *The Australian Journal of Agricultural and Resource Economics*, *48 (2)*, 347-369.

Díaz, J. R., Poyato, E. C., & Luque, R. L. (2004). Applying benchmarking and data envelopment analysis (DEA) techniques to irrigation districts in Spain. *Irrigation and Drainage: The Journal of the International Commission on Irrigation and Drainage*, *53*(2), 135-143.

Diaz-Balteiro, L., Herruzo, A. C., Martinez, M., & González-Pachón, J. (2006). An analysis of productive efficiency and innovation activity using DEA: An application to Spain's wood-based industry. *Forest Policy and Economics*, *8*(7), 762-773.

Ebrahimi, B., Tavana, M., & Charles, V. (2021). A note and new extensions on "interval efficiency measures in data envelopment analysis with imprecise data". *Operational Research*, *21*(4), 2719-2737.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society Series A: Statistics in Society*, *120*(3), 253-281.

Fraser, I., & Cordina, D. (1999). An application of data envelopment analysis to irrigated dairy

Fresco, L. O., Geerling-Eiff, F., Hoes, A. C., van Wassenaer, L., Poppe, K. J., & van der Vorst, J. G. (2021). Sustainable food systems: Do agricultural economists have a role? *European Review of Agricultural Economics*, *48*(4), 694-718.

Good, D. H., Nadiri, M. I., Röller, L. H., & Sickles, R. C. (1993). Efficiency and productivity growth comparisons of European and US air carriers: a first look at the data. *Journal of Productivity Analysis*, *4*(1-2), 115-125.

Haji, J. 2006. Production Efficiency of Smallholders' Vegetable-dominated Mixed Farming System in Eastern Ethiopia: A non-parametric Approach. *Journal of African Economies*, 16(1), 1–27.

Heisey, P. W. (2001). *Agricultural Research and Development, Agricultural Productivity, and Food Security* (No. 1474-2016-120824).

Kalirajan, K. P., & Shand, R. T. (1997). Sources of output growth in Indian agriculture. *Indian Journal of Agricultural Economics*, *52*(4), 693-706.

Kebede, T., Berhane, G., Gebru, M. (2014). Technical efficiency in *teff* production by small scale farmers in Tigray. *International Journal of Research*. 4(10), 85–97.

Lin, J. Y. (1992). Rural reforms and agricultural growth in China. *The American Economic Review*, 34–51.

Liu, J., Ding, F. Y., & Lall, V. (2000). Using data envelopment analysis to compare suppliers for supplier selection and performance improvement. *Supply Chain Management: An International Journal*, *5*(3), 143–150.

Liu, Z., & Zhuang, J. (2000). Determinants of technical efficiency in post-collective Chinese agriculture: Evidence from farm-level data. *Journal of Comparative Economics*, *28*(3), 545–564.

Malano, H., Burton, M., & Makin, I. (2004). Benchmarking performance in the irrigation and drainage sector: a tool for change. *Irrigation and Drainage: The Journal of the International Commission on Irrigation and Drainage*, *53*(2), 119–133.

Masuku, M. B., Raufu, M. O., & Malinga, N. G. (2014). The impact of credit on technical efficiency among vegetable farmers in Swaziland. *Sustainable Agriculture Research*.

Pingali, P. L., & Traxler, G. (2002). Changing locus of agricultural research: Will the poor benefit from biotechnology and privatization trends? *Food policy*, *27*(3), 223-238.

Rodríguez Díaz, J. A., Pérez Urrestarazu, L., Camacho Poyato, E., & López Luque, R. (2005). IGRA. A tool for applying the benchmarking initiative to irrigated areas. *Irrigation and Drainage: The journal of the International Commission on Irrigation and Drainage*, *54*(3), 307–319.

Salam, A., & Hameed, A. (2022). Technical Efficiency in Production of Major Food Grains in Punjab, Pakistan. *Asian Development Review*, *39*(02), 201-222.

Thirtle, C., Hadley, D., & Townsend, R. (1995). Policy-induced Innovation in Sub-Saharan African Agriculture: A Multilateral Malmquist Productivity Index Approach. Development Policy Review, 13(4), 323–348.

Toma, P., Miglietta, P. P., Zurlini, G., Valente, D., & Petrosillo, I. (2017). A non-parametric bootstrap-data envelopment analysis approach for environmental policy planning and management of agricultural efficiency in EU countries. *Ecological indicators*, *83*, 132-143.

Wadud, A., & White, B. (2000). Farm household efficiency in Bangladesh: a comparison of stochastic frontier and DEA methods. *Applied Economics*, *32*(13), 1665–1673.