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Journal of Economic Sciences is a biannual research journal related to the field of different fields of economic sciences. The team of the Journal is following the rules defined by HEC (Higher Education Commission). The mission of this Journal is to promote research in the field of Economics and it provides a dynamic platform for researchers and professionals to share their efforts and circulate their achievements and practical experience through providing opportunities for print and online access to quality material for all those who have their interests in research in the field of economics.

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Table of Contents

Journal of Economic Sciences
Volume 2, Issue 2
https://www.jesciences.com

Domestic Violence and Women Health in Pakistan: During the Period of COVID-19

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Abstract
Domestic violence increased sharply in Pakistan during COVID-19 due to the lockdown, severely affecting families, individuals, and communities. The purpose of this study is to estimate the prevalence and factors of domestic violence at household levels during COVID-19 and how women's health is affected due to this domestic violence. Primary data is collected through the questionnaire from the women of 500 households by using the random sampling technique. Ordinary least square method and 3D graphs are used to estimate the prevalence and factors of domestic violence. Moreover, binary logistic regression is employed to find the relationship between women's health and domestic violence. The results show a strong relationship between COVID-19 Consequences, domestic violence, and women's health. Empowerment, financial contribution, and economic decision-making have an effective role in reducing domestic violence and improving women's health. Empowerment and economic decision-making are the key factors to reduce domestic violence at the household level and improve women's health. It is suggested to reduce domestic violence at the household level by monitoring the factors of domestic violence for the improvement of women's physical and mental health.

Keywords: *Domestic violence, Women health, Women empowerment, Financial contribution, Economic decision making, COVID-19*

JEL Classification: *I12, J11, J12*

1. Introduction
The pandemic COVID-19, currently the largest global health issue, is threatening the entire world. People of all genders, ages, and ethnicities are affected by the pandemic and its social, psychological, and economic impact is getting worst with the passage of time. Women's hidden vulnerabilities have come to light as a result of the pandemic-induced lockdown, which has forced them to stay at home and work from home. This situation lessens women's autonomy, especially in patriarchal households, which is demonstrated by the rise in domestic violence cases worldwide (Peterman et al., 2020). According to a United Nations study, 90% of married women have experienced psychological abuse, and 50% of married women have experienced sexual violence (Niaz, 2004). Domestic violence is defined as "any physical or psychological abuse performed by a respondent against children, women or other vulnerable individuals that is gender-based. According to the World Health Organization, domestic violence involves sexual coercion of women by a current or former male intimate partner as well as psychological and physical harm (Harvey, Garcia-Moreno, & Butchart, 2007). Domestic violence, also known as intimate partner violence or domestic abuse, is defined by the United Nations as a pattern of behavior in any relationship to acquire or maintain control over an intimate partner. Abuse is defined as coercive or threatening physical, financial, sexual, emotional, or physiological behavior toward another person (Woodlock, 2017).

In Pakistan, domestic violence is a pervasive social and health problem. An estimated 5000 women are killed by domestic violence each year, and thousands more suffer injuries or disabilities. Women have accused intimate partners of attacking them in a number of different ways, including through emotional, physical and sexual aggression. Every year, domestic abuse results in 5000 deaths of women and thousands more injuries or disabilities (Hansar, 2007). Women health is closely related with the child health. Domestic violence is one of the reason that can damage women physical and mental health. It is worth exploring how domestic violence has impacted domestic violence and women health during Covid-19.

Pakistan has been impacted by COVID-19, just like the rest of the globe. On February 26, 2020, the first case of COVID-19 was confirmed when a student in Sindh province tested positive after returning from Iran (Mazhar & Tanwir, 2022). Due to medicine's limited understanding of the virus, it was determined that the only treatment at this time was "lockdown". Financial difficulties also emerged as a result of the operations' suspension, and Pakistan's unemployment rate was sharply raised. Around 18.5 million individuals lost their jobs between 2020 and 2021 in Pakistan and according to estimates by the Government of Pakistan, gender-based violence cases sharply increased during the years of COVID-19. According to research by the Aurat Foundation, 25 districts in the four provinces and Gilgit-Baltistan together reported 2297 cases of violence against women (Murder, Rape/ Gang Rape, Abduction/Kidnapping, Suicide, "Honour" Killing) from January 2020 to December 2020. In Punjab, 57% of cases were reported with 27% of the total cases, Sindh had the second-highest incidence of gender-based violence, followed by KP with 8%, GB with 6%, and Baluchistan with 2% of the cases (Perveen, 2020).

COVID-19, however, also caused stress along with other factors. Women are more likely to experience violence, exploitation, abuse, and neglect during the social isolation practices of social distance. Evidence from the past showed that men and women were influenced by illness outbreaks in their daily activities in distinct ways (Malik & Naeem, 2020). Violence in all its forms—physical, psychological, and sexual—is frequently discussed in the literature. On the other hand, various forms of violence are not precisely categorized. Pedicel claims that in addition to being slapped, beaten, and kicked, etc., women may also encounter violence that is indescribable (Woodlock, 2017). Additionally, a different study found that the majority of women with secondary infertility also had some psychological issues and had reported having been verbally and physically assaulted (Sami & Ali, 2006). However, conceding that "even low-severity violence" always causes issues with women's physical and mental health. Compared to emotional abuse, physical violence leaves deeper wounds and has longer-lasting impacts (Reyes, 2007).

Previous literature has focused on the effects of COVID-19 on livelihood, women's health and domestic violence and how the pandemic in Pakistan affected women differently as individuals and communities, as well as how the pandemic affected women's livelihoods owing to financial issues. Due to public emergencies, all the domestic workers who work in home-based small and medium-sized businesses were laid off as a result of companies being unable to pay wages during the lockdown (Malik & Naeem, 2020). Due to COVID-19, which has been deemed a global public health emergency, nearly 40,000 people have died in the United Kingdom. Increased occurrences and reports have thrust what is typically thought of as private violence into the public eye, making the lockdown measures in the public sphere a window into the actual violence that is present in the domestic sphere. The separation between the public and private spheres has been weakened as a result of the COVID-19 lockdown in the United Kingdom.

As employment and childcare have moved inside the home, the hidden inequalities of austerity have come to light, illuminating the growing racial, class, and gender divides in society (Krishnadas & Taha, 2020).

Evans, Lindauer, and Farrell (2020) noted a surge in Intimate Partner Violence (IPV) during the Covid-19 pandemic in the United States. Their study found that the closure of schools, workplaces, and other social activities confined individuals to their homes, leaving many victims, particularly female partners, trapped with their abusers. Shockingly, one in four women encountered physical, emotional, psychological, and sexual abuse from their partners. Additionally, the closure of schools and the shift to virtual learning increased the stress levels of mothers, further exacerbating the adverse effects on women's health.

In a separate investigation by Boxall, Morgan, and Brown (2020), the onset and escalation of domestic violence among women in Australia was linked to the outbreak of Covid-19. The first Covid-19 case in Australia was reported in January 2020, and the study conducted an online survey of 15,000 women in May 2020. The survey results revealed that 4.6% of respondents experienced physical or sexual abuse from their current or former cohabiting partners, while nearly 12% reported instances of emotional abuse, controlling behavior, and harassment by their partners.

For women and their children, abuse, particularly violence from an intimate partner or in the home, has serious negative health effects. Violence against women can result in harm, and sexual, serious physical, emotional, and reproductive health issues, including HIV, STIs and unintended pregnancies. According to this study, COVID-19 increases violence against women by making families spend more time together, deal with more stress, and possibly lose their jobs or their income. School closures worsen this load and add to their stress. Physical separation, staying at home, and other measures may have negative consequences for women who are victims of violence and their children, according to all stakeholders participating in the COVID-19 response. In many places, health workers, the majority of whom are women, may be vulnerable to abuse at home or at work (Ali, Rogers, & Heward-Belle, 2021).

According to Munir, Munir and Rubaca (2021) the lockdown has a negative impact on the jobs ratio, particularly in Pakistan's rural areas. The findings of this study are based on data from interviews. Based on eleven in-depth interviews and one focus group discussion held in rural areas of the twin cities of Islamabad and Rawalpindi, the poll found that the COVID-19 lockdown's destruction of income levels has worsened partner violence in the nation (Munir, Munir, & Rubaca, 2021). In Pakistan, violence refers to the study of mental, physical, and sexual attack on living beings at home. Domestic violence, according to this study, can include torture, punishment, injury, robbery, forced sexual attempts, and any other violent act that undermines a person's honor, respect, or self-esteem. Women's violence has become a big concern around the world. This is a grave violation of human rights (Mirani, Mirani, Memon, Chohan, & Qabulio, 2021). The globe has become a global village, with a rapid flow of information. The prevalence of anxiety and depressive disorders among students also revealed anxiety, disease, or depression issues. Additionally, the study's findings showed that during the COVID-19 outbreak lockdown, students' perceptions of disease were linked to lower mental health, whereas they were linked to higher levels of melancholy and anxiety disorders. According to this study, young people who were exposed to the COVID-19 outbreak are more likely to be predisposed to mental health problems (Aqeel et al., 2022).

The existing literature highlights the significant impact of Covid-19 on women's health, with studies conducted in various countries such as the UK, USA, and Australia. However, there is a noticeable research gap in the context of Pakistan. Given the potential influence of location, economics, and culture on the extent of violence during the Covid-19 pandemic in Pakistan, it is imperative to investigate the effects of lockdown measures on the prevalence and exacerbation of domestic violence. Furthermore, this research should explore how these factors impact women's health in the Pakistani context.

Due to the increasing rate of domestic violence during COVID-19, it was required to find out the key factors of domestic violence which may increase or decrease the prevalence of domestic violence at households. Because during the pandemic overall health of women and children were adversely affected and for improving the health of women it was necessary to find out the factors behind the domestic violence which was repeatedly received by the women due to lockdown.

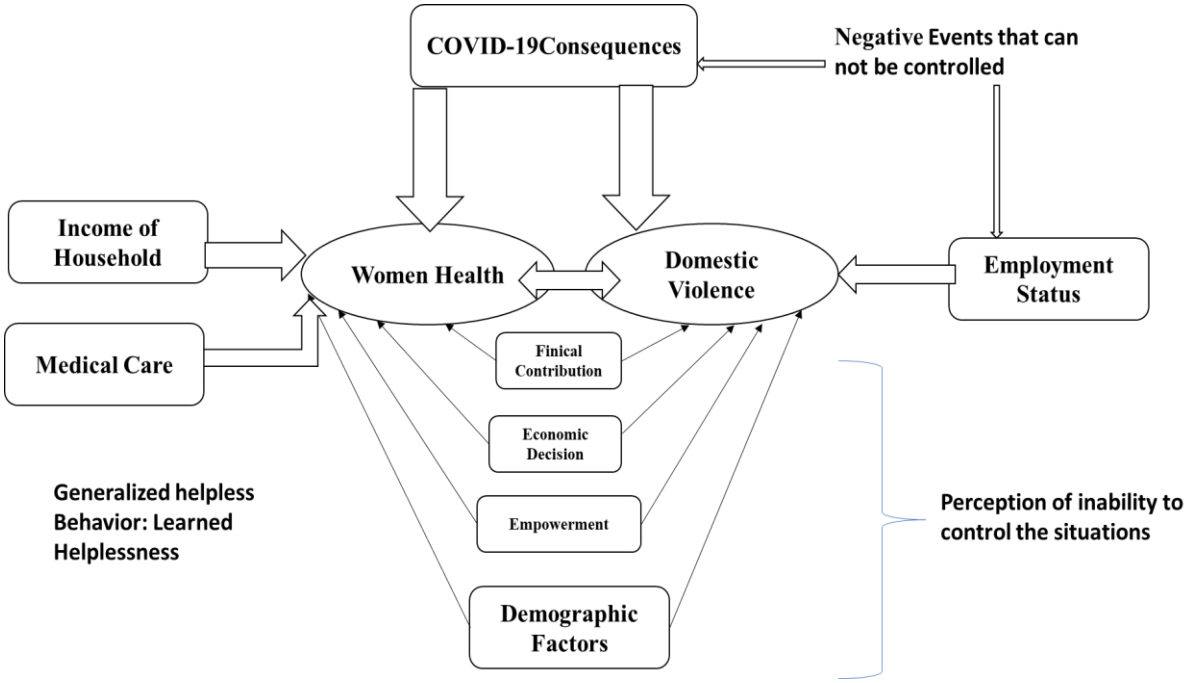
2. Data and Methods

2.1 Theoretical Framework

Communities can respond to domestic violence more effectively by having a shared understanding of its origins. This understanding also helps communities to avoid having divergent responses that might expose attempts to protect victims and hold batterers accountable. When the American movement for maltreated women started in the early 1970s, psychopathology was the most widely accepted explanation for why men beat their partners. According to this theory, husbands who abuse their wives suffer from mental illnesses that can be managed with medication or psychiatric treatment. However, researchers found that the behavior of domestic violence offenders' did not resemble that of those who suffer from mental diseases. Only their intimate partners are the targets of maltreated women. Violence is not limited to romantic partners for those with schizophrenia. The "learned helplessness" notion was another hypothesis put forth by American psychologist Lenore Walker investigated the behavior of women who remain in abusive marriages. According to Walker's theory, women stay in violent relationships because ongoing abuse saps their motivation to quit. However, the learned helplessness theory failed to consider the numerous social, economic, and cultural determinants that might make a woman decide to stay in an abusive relationship. Women frequently have very sound justifications for remaining, such as fear of self- or child-inflicted harm or an inability to provide for themselves financially. If they leave, they can face rejection from their family and community.

The learned helplessness argument also runs afoul of the fact that women who are subjected to abusive relationships frequently make attempts to leave and take proactive measures to try to mitigate the harm done to them and protect their children. Abused women do not live their lives in a position of "learned helplessness." A process of "staying, leaving, and returning" is instead something they frequently do. A Largely Unrecognized Phenomenon Sometimes Encouraged by Court Practices (Zorza, 2004). American psychologist Lenore Walker investigated the behavior of women who remain in abusive marriages. According to Walker's theory, women stay in violent relationships because ongoing abuse saps their motivation to quit. However, the learned helplessness theory failed to consider the numerous social, economic, and cultural determinants that can make a woman decide to stay in an abusive relationship. The current study adapted the learned hopelessness theory, because during the lockdown and unpredictable situations of COVID-19. Women in households was facing the domestic violence on the risk of their mental and physical health. This study is an attempt to find the concerns of COVID 19 and its effects on women health and domestic violence.

Figure 01: Conceptual Framework



Source: Author's Contribution

2.2 Sample Size and Data Collection

Primary data has been collected from the 500 women of different households during the lockdown due to COVID-19. A convenient sampling technique has been adopted for the selection of women and the target population was a total of 500 women in the region of Bahawalpur District. The variables and measurable scales adopted for the research are given below in Table no 1.

Table 01: Description of Variables and Measurement of Scale

Variables	Descriptions	Reported Questions	Code in Survey/ Measurement	Measurement Scale
Domestic Violence Index	An Index has been created for domestic violence.	What do you think which type of violence is justified?	Physical=1 Verbal=2 Psychological=3 Sexual=4 All above=5	Additive Index Range from 1-20.
		How many times did you experience physical violence?	In numbers	
		How many times did you experience verbal violence?	In numbers	
COVID-19 Consequences	An Index has been created to capture the consequences	Social Isolation due to lockdown	Don't Know=0 Strongly Disagree=1 Disagree=2 Agree=3	Additive Index Range between 1 to 28
		School closures during lockdown		
		Economic Instability		
		Loss of Job during Lockdown		
		Doing work from home during the lockdown		

		Long Stay at home increases the Family Conflicts during lockdown	Strongly Agree=4	
		Family conflicts increase stress at home		
Women's Health	Women's health is measured with any health problem	Are you facing any health issues for the last three months?	Yes =1 No=0	Yes =1 No=0
Education	Completed Years of Education	Education of Women	In Years	Discrete
Age	Age of respondent	Age of Women	In Years	Discrete
Marital Status	Marital Status of respondent	Marital Status of Women	Married=1 Single/Divorce/Widow=0	Married=1 Single/Divorce/Widow=0
Treatment for COVID-19 During Lockdown	Access for treatment	Was there any difficulty in treatment due to the lockdown?	Yes =1 No=0	Yes =1 No=0
Family Member Have COVID-19	Presence of COVID-19	Any member from your family has/had Coronavirus?	Yes =1 No=0	Yes =1 No=0
Employment Status	Employment status of respondent	Are you doing a job?	Employed=1 Otherwise =0	Employed=1 Otherwise =0
Financial Contribution	Role of respondent in household budget	If you have any financial responsibility then how much do you contribute to the family budget?	Yes =1 No=0	Yes =1 No=0
Economic Decision Making	Economic Decision Making	To what extent you are involved in the economic decision making of the house during COVID-19 related lockdown?	More=1 Less=0	More=1 Less=0
Empowerment During Lockdown	Empowerment During Lockdown	Do you think that you will feel free to take decision regarding consult a doctor?	More=1 Less=0	More=1 Less=0
Medical Care	Access	Did you take any proper medical care from the hospital during COVID-19?	Yes =1 No=0	Yes =1 No=0
Income of Household	Income of Household during lockdown	What's your monthly income during lockdown?	In Rupees	In Rupees

Source: Survey

2.3 Model Specification

Two models have been formulated for testing the hypothesis. Ordinary Least Square Regression was used to test hypothesis 1: There is an association between domestic violence and COVID-19. Ordinary least squares technique (OLS) was used for calculating the coefficients of linear regression equations that depict the connection between one or more independent quantitative variables and a dependent variable is called by using the SPSS 22.

Regression Equation

$$DV= \beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4+ \beta_5X_5 +\beta_6X_6+ \beta_7X_7+ \beta_8X_8+\beta_9X_9+ \beta_{10}X_{10}+ \beta_1X_{11} +e_i \quad \textbf{(01)}$$

DV= Domestic Violence
X1= COVID-19 Consequences
X2= Women's Health
X3= Education of Respondent
X4= Age of Respondent
X5= Marital Status of Respondent
X6=Treatment During Lockdown
X7= Family Member Have COVID-19
X8= Employment Status
X9=Financial Contribution
X10=Economic Decision Making
X11=Empowerment During Lockdown

For predicting the impact of domestic violence and COVID-19, Binary logistic regression was used to test the hypothesis 2: There is association between women health and domestic violacein. 0 or 1 are the only two possible values for the binary target variable in a regression model called binary logistic regression (LR). Given that the output is either women with any health issue (1) or women have not any health issue (0).

Regression Equation

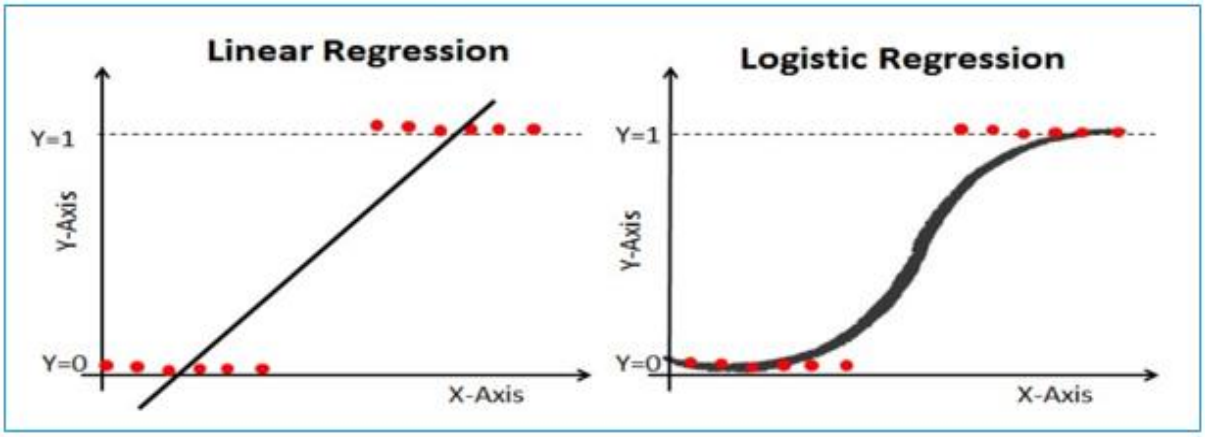
$$WH= b_0+b_1X_1+ b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+b_9X_9+b_{10}X_{10}+b_{11}X_{11}+b_{12}X_{12}+e_i \quad \textbf{(02)}$$

WH=Women Health
X1= COVID-19 Consequences
X2=Domestic Violence
X3=Education of Respondent
X4=Age of Respondent
X5=Marital Status of Respondent
X6=Treatment During Lockdown
X7=Family Member Have COVID-19
X8=Financial Contribution
X9 =Economic Decision Making
X10= Empowerment During Lockdown
X11=Medical Care
X12= Income of Household

This diagram illustrates how the general logistic regression model for a single predictor can be expanded to a model with k predictors. The likelihood that Y equals one given X is given by p in this equation, where the independent variable X's are, and the dependent variable Y is. The maximum likelihood method, which we'll discuss in a moment, is used to estimate the model parameters, B0 to b K. The variables on the left side of the equation lie between minus and plus infinity.

$$log\frac{p}{1-p} = b0 + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + b7X7 + b8X8 + b9X9 + b10X10 + b11X11 + b12X12 + e_i \quad \textbf{(03)}$$

Figure 02: Linear Regression vs Logistic Regression



3. Results and Discussions

Table 2 presents the results of the ordinary least square method and finds a significant relationship between domestic violence and COVID-19 consequences. In many houses, domestic violence seems to be increasing due to COVID-19 and especially in the case of a lockdown. Frustration, economic instability, closure of schools, and working from home became the reason for domestic violence among the families and women who suffered mentally, and physically during the lockdown.

Table 02: Ordinary Least Square Method for the Analysis of Domestic Violence

Explanatory Variables	***DV=Domestic Violence***			
	Coefficient	***Standard Error***	***T-statistics***	***P-Value***
COVID-19 Consequences	.022	.021	1.063	.061
Women's Health	REF: Without health problem/Issue			
	.139	.277	2.502	.032
Education of Respondent	.022	.022	1.662	.094
Age of Respondent	-.004	.015	-.2.275	.017
Marital Status of Respondent	REF: Single/Divorce/Widows			
	-.095	.244	-2.389	.026
Treatment During Lockdown	REF: Having no difficulty in treatment during lockdown			
	.221	.289	1.651	.095
Family Member Have COVID-19	.308	.294	1.748	.061
Employment Status of Respondent	REF: No Employment			
	-.185	.111	-1.672	.092
Financial Contribution from Respondent	REF: Not contributing			
	-.021	.109	-2.190	.011
Economic Decision Making	REF: Don't have Economic Decision Making			
	-.104	.132	-2.792	.045
Empowerment During Lockdown	REF: Don't have Empowerment			
	-.054	.104	-2.514	.029
Constant	-.074	.107	.000	.514

Source: Survey

Other control variables of the model show a significant relationship with domestic violence, i.e. women with some health issues face domestic violence and women with more education years also tolerate

domestic violence at home. Because during the lockdown, the women with more education during work from home and also have to look after household chores which creates a critical, quarrel, and frustrating environment that ultimately results in domestic violence (Sediri et al.,2020). Elder and married women have the probability to reduce the chances of domestic violence showing a negative and significant relationship with domestic violence. Women with employment, having the financial contribution in the family budget, economic decision making and empowerment seems to less chances to tolerate the domestic violence followed by the negative and significant relationship with the domestic violence (Iqbal, Farooq & Padda, 2021; Sharma, & Khokhar, 2022). The households where the greater number of family members were suffering with the COVID-19, seems to be increased the chances of happening the domestic violence among the women (Nduna, & Tshona, 2021).

Table 3, showed the results of Binary Logistic Regression analysis to predict the effects the domestic violence on the women health. According to these results, domestic violence has the probability to be increase the health issues among the women followed by the odd ratio greater than one which showed the positive and significant relationship with domestic violence and women's health issues. This positive relationship indicated that domestic violence adversely effects health of women.

Table 03: Binary Logistic Model for the Analysis of Women Health

Explanatory Variables	***DV=Women's Health***			
	Coefficient	***Standard Error***	***P-Value***	***Odd Ratio***
COVID-19 Consequences Index	.043	.028	.124	1.043
Domestic Violence received by Respondent	REF: Not Receive Domestic Violence			
	.034	.070	.626	1.035
Education of Respondent	-.022	.024	.024	.995
Age of Respondent	-.005	.018	.069	.995
Marital Status of Respondent	REF: single/Divorce/Widow			
	.302	.299	.013	1.353
Treatment During Lockdown	REF: Having no difficulty in treatment during lockdown			
	2.153	.306	.000	8.606
Family Member Have COVID-19	.957	.334	.004	2.604
Financial Contribution				
	-.248	.126	.049	.780
Economic Decision Making				
	-.309	.161	.055	.734
Empowerment During Lockdown				
	-.020	.128	.075	.920
Medical Care	REF: Have not Medical Care			
	.417	.295	.057	1.517
Income of Household	-.022	.006	.075	.820
Constant	-3.129	1.351	.021	1.044

Source: Survey

COVID-19 consequences index and a greater number of family members having the COVID-19, access to hospitals during lockdown and difficulty for treatment increased the chances of health issues among the women during the lockdown. On the same time more years of education and age of respondent reduces the chances of health issues among the women during the lockdown due COVID-19 disease (Malathesh, Das, & Chatterjee, 2020). Women financial contribution in the family budget, having economic decision making and empowerment during the lockdown saved the women form the health issues. Women who are financially strong and have the power of economic decision making, these

women are empowered. Empowerment always improved the wellbeing and health of women (Usta, Murr & El-Jarrah, 2021). The same results and relationship among the domestic violence, women's health and COVID-19 presented in the Figure 3 and 4.

Figure 03: Domestic Violence and COVID-19

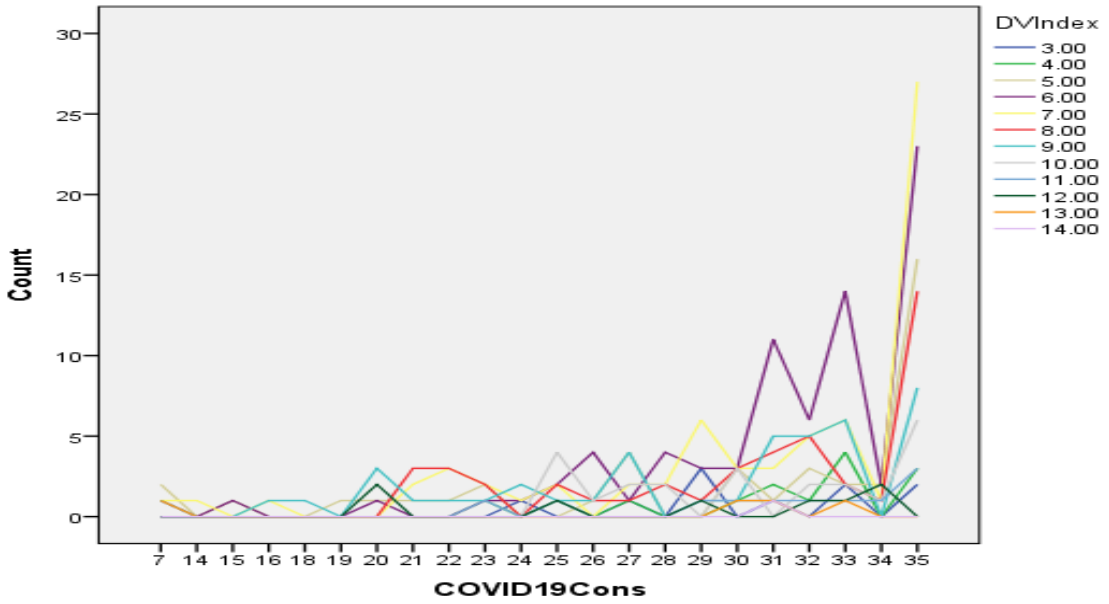
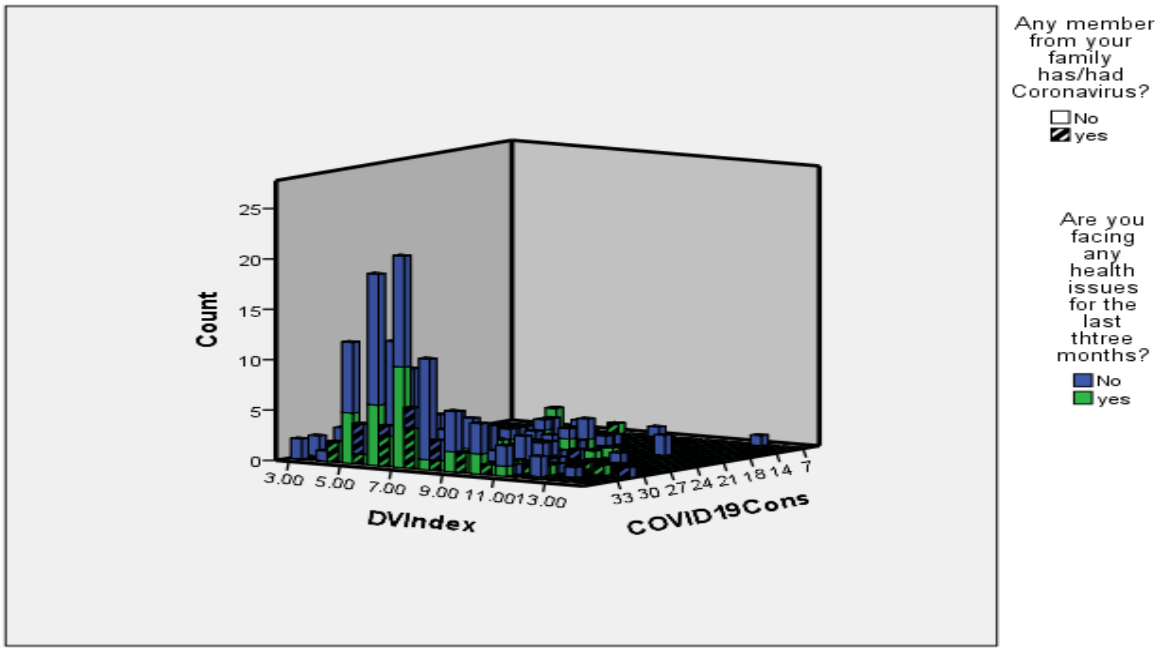


Figure 04: Domestic Violence, Women Health and COVID-19



The COVID-19 pandemic and the subsequent lockdowns implemented in many countries like in Pakistan, had a significant impact on various aspects of society, including domestic violence. There were reports from around the world suggesting an increase in domestic violence cases during lockdowns (Shumba et al., 2020)

The main cause which is associated with the pandemic, such as financial difficulties, job loss, and social isolation, exacerbated tensions within households, leading to a rise in domestic violence incidents. Lockdown measures often confined women and perpetrators together at home, making it difficult for women to seek help or report abuse (Kourti et al., 2023). Fear of retaliation and reduced access to support services further hindered reporting. Many domestic violence shelters and support services faced challenges in providing assistance during lockdowns due to limited resources and concerns about virus transmission (Lyons & Brewer, 2021).

4. Conclusion

The present research revealed that lockdown consequences in Pakistan due to the pandemic increased the chances of domestic violence and health issues among women. In response to domestic violence, women faced health issues during the lockdown (Peterman et al., 2020). During the lockdown period, all the economic and social activities were performed on the premises of houses which resulted in social distancing and financial crises. Economics and social behaviors were adversely affected during the lockdown due to a cut-off from social gatherings, official routines, and the closure of schools (Aqeel et al, 2022). All these changes in behavioral responses affected the physical and mental health of people. And unfortunately, women and children are the highly affected part of the population.

This study is an effort to combat domestic violence during and after lockdowns have highlighted the importance of a comprehensive approach involving governments, law enforcement, healthcare providers, and community organizations (Krishnadas and Taha, 2020). Ensuring access to support services, promoting awareness, and addressing the root causes of domestic violence are essential steps in protecting the rights and safety of women and COVID-19 pandemic and lockdown measures had complex and multifaceted effects on women's health, particularly concerning domestic violence.

Women who facing domestic violence often experience physical injuries and health problems as a result of the abuse. The pandemic further complicated access to healthcare services, as many individuals were hesitant to seek medical attention due to fears of contracting COVID-19 in healthcare settings (Malik & Naeem, 2020). Some women may have delayed or missed necessary medical care and screenings during the pandemic due to restrictions, leading to a potential decline in overall health and the detection of medical conditions.

Lockdowns sometimes made it difficult for women to access essential support services, including shelters, counseling, and legal aid. Overwhelmed support systems and reduced funding posed additional challenges. The isolation imposed by lockdowns exacerbated feelings of loneliness and powerlessness among women of domestic violence, which can have significant negative implications for health and emotional well-being (Mirani et al., 2021).

4.1 Policy Implications and Future Direction

In developing countries occurrence of natural disasters and the spread of communicable diseases is common which gets worst due to a lack of resources, awareness, medical care, and unfitting policy implications. Policies should be formulated according to the demographic structure (age, and gender) of the population. There is also a need to find out the health issues of children and domestic violence in case of child labor. Efforts to mitigate the impact of domestic violence on women's health during lockdowns require a holistic approach that combines public health measures, support services, and policies aimed at preventing and addressing domestic violence. This includes ensuring access to healthcare, mental health services, legal assistance, and safe housing for survivors. It is essential to recognize that the effects of domestic violence on women's health are not limited to the pandemic period and require ongoing attention and support. Addressing domestic violence during and after the COVID-

19 pandemic requires a coordinated, multi-sectoral approach that prioritizes the safety, health, and well-being of women and their families. It's important to recognize that the effects of domestic violence are far-reaching, and addressing them is not only a matter of crisis response but also a long-term commitment to creating a safer and more equitable society.

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Analyzing the Impact of Foreign Capital Inflows on Domestic Savings in Pakistan: A Comprehensive Time Series Investigation

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Abstract

This research delves into the ramifications of foreign capital inflows on domestic savings within the context of Pakistan. Utilizing annual time series data spanning from 1972 to 2022, this study employs the Auto Regressive Distributed Lag (ARDL) methodology alongside causality analysis. The findings underscore that factors such as labor force participation rate, gross fixed capital formation, deposit interest rate, foreign direct investment, trade, GDP growth, and foreign remittances exert a favorable influence on gross domestic savings over the long term. Conversely, variables encompassing age dependency, external debt stock, and net official development assistance exhibit a detrimental impact on gross domestic savings. Furthermore, the outcomes derived from the Granger causality test reveal the absence of causal relationships between foreign direct investment, remittances, trade, external debt, and gross domestic savings. Notably, unilateral causality is identified solely between net official development assistance and gross domestic savings.

Keywords: *Foreign Aid, FDI, Foreign Debt, Foreign Remittances, Savings, ARDL, Causality Analysis*

JEL Classification: *E21, F35, F24*

1. Introduction

Nature has endowed Pakistan with a lot of human and natural resources including mountains, deserts, irrigated lands, and four seasons so Pakistan can be a suitable country for domestic and foreign investors. The government of Pakistan knows the requirements of foreign investors therefore comprehensive and investment-friendly policies are being devised. Savings are vital for capital formation, productivity, and sustainable development. Foreign capital inflows have a significant role in the growth process of the capital-deficient productive capacity of the economy. Foreign capital inflows are the main resources that enhance domestic savings as well as the economic growth of a nation from the developing world. These have also been considered the key elements in the process of economic globalization and integration. Foreign capital inflows boost the economic development of a country and increase the production and job opportunities in an economy (Ahmad et al., 2002).

Foreign capital inflows play a very important role in low-income countries because there is a lack of modern technology, capital, and skilled labor (Ahmad, 1986). The major components of foreign capital inflows are foreign direct investment, foreign aid, foreign remittances, and foreign debt. Domestic savings play an essential role in the economic growth progress of an economy. It can help the economy to become financially strong (Chaudhry et al., 2009). Domestic savings are important in emergency cases. It can also be used in many ways, for example to build a factory, to start a new business, to invest

in an existing business, to enhance a business, etc. There are a lot of studies that have been done to explain the link between foreign capital inflows (FCI) and domestic savings. This study shows the link between foreign capital inflows and domestic savings in Pakistan.

The plan of the paper is as follows: Section 2 presents the review of the literature. Model specification is given in section 3. Section 4 describes data and ARDL model specification. Section 5 explains the results and discussions. Section 6 consists of the conclusion and policy recommendations.

2. Foreign Capital Inflows and Savings: An Empirical Review

In this section, we are reviewing the studies that are based on foreign capital inflows and savings.

As a flow of foreign capital, remittances can play a vital role in household savings. Privara and Trnovsky (2021) identified how remittances have contributed to raising household savings along with other macroeconomic factors in Baltic countries after piercing financial stress in 2009. OLS and fixed effect methods were adopted to estimate the results. Results indicated that in the long run remittances are the fundamental drivers of household savings. Additionally, savings were not affected by economic fluctuations in the short run but were reliant on demographic determinants as well as foreign capital, which may convey instability in financial flows and economic development of Baltic countries.

Idrees et al. (2020) investigated the influence of foreign capital flows on domestic savings in Pakistan over the period 1981 to 2010. To analyze the effect of foreign aid, remittances as well as foreign direct investment on household savings authors used the multiple regression analysis. Findings revealed that remittances and FDI have a significant and positive influence while foreign aid exhibited negative effect on savings. So it has been suggested that if Pakistan wants to raise the level of household savings, it should emphasize the significance of FDI along with remittances.

Hamdar and Nouayhid (2017) examined the role of foreign capital inflows on savings and investment in a less developed country. The authors used the time series data from the period 1989 to 2010 by applying OLS. The researchers used savings as a dependent variable while the variables of investment and foreign capital inflows were used as independent variables. The study found a negative association between capital inflows, domestic savings, and investment because the amount of profit that is earned through foreign capital inflows is used to build and maintain infrastructure like schools, roads, etc. in less developed countries like Lebanon.

Hossain (2014) analyzed the impact of foreign capital inflows on domestic savings in developing countries. The researcher used the panel data from the period 1971 to 2010 and applied the common correlated effects mean group (CCEMG) technique. The study found a negative relationship between foreign capital inflows and domestic savings because FCI was used to enhance foreign reserves and to decrease the deficits that exist in the balance of payment in developing nations.

In their study, Ali and Nishat (2009) examined the repercussions of foreign capital inflows on domestic savings within developing nations. The scholars employed time series data spanning the interval from 1975 to 2008. The study used the OLS and ARDL methodology. The researchers used foreign capital inflows as explanatory variables while domestic savings as a dependent variable. The authors found a negative relationship between foreign capital inflows and domestic savings in developing countries because the link between the employment rate and foreign capital inflows is positive which is why foreign capital inflows become the cause of to rise in the employment rate. As we know Pakistan is a

consumption-oriented country so the main part of the income of the people is used for consumption purposes which becomes the cause of the low savings rate.

Verma and Wilson (2005) highlighted the association between FCI, economic growth, investment, and domestic savings in a developing country. The study used time-series data from the period 1950 to 2001 and utilized the full information maximum likelihood method and cointegration technique. The authors used foreign capital inflows and economic growth as independent variables and domestic savings and investment as dependent variables. The researchers found a negative relationship between foreign capital inflows and domestic savings.

Ahmad et al. (2002) examined the impact of foreign capital inflows on domestic savings in Pakistan from the period 1972 to 2000. The results were estimated by applying the error correction model and cointegration techniques. The authors found a negative relationship between foreign capital inflows and domestic savings because the foreign capital inflows are used to make the resources that are not so beneficial for the people in developing countries and the revenues which were generated by using these resources increased the consumption and became an obstacle to enhance domestic savings in Pakistan.

Khan et al. (1992) conducted an estimation concerning the influence of foreign capital inflows on domestic savings within a low-income nation. The research employed time series data spanning from 1959 to 1988 and adopted the Ordinary Least Squares (OLS) methodology. The authors found the negative linkage of foreign capital inflows with domestic savings because the maximum amount of foreign capital inflows were used for consumption purposes which were considered as the main hurdle to accelerate domestic savings in Pakistan.

Mapalad (1998) investigated the link between foreign capital inflows and domestic savings in the Philippines. The study was based on time-series data from the period 1952 to 1993. The researcher found no direct link between foreign capital inflows and domestic savings by applying two-stage least squares technique and inferred that the national savings rate was mainly determined by these variables: its lagged value, augmentation of per capita real income, and balance of payment crises as inducted by a model in the less developed country.

Aslam (1987) pointed out the connection between foreign capital inflows and domestic savings and investment in Pakistan from the period 1963 to 1985. The results of the study were estimated through the multiple regression analysis technique. The study found a negative association of inflows of capital with domestic savings because dependency on foreign capital inflows forced the country to have low growth which decreased the real wage rate and became the cause of low savings in Pakistan.

Ahmad (1986) highlighted the impact of foreign capital inflows on domestic savings in Bangladesh from the period 1960 to 1980. The estimation technique which was used in this study was the two stages least square method. The author found a non-negative association between domestic savings and foreign capital inflows because foreign capital inflows did not replace domestic savings in Bangladesh.

Chen (1977) asserted the effect of foreign capital inflows on domestic savings in developing countries from the period 1956 to 1971. The methods that were used for the estimation were the OLS method and two-stage least squares technique. The study found a negative relationship between foreign capital inflows and domestic savings due to official inflows. The relationship between these variables (foreign capital inflows and domestic savings) varied from nation to nation. In certain nations, it was positive and in others it was negative.

Grinols and Bhagwati (1976) probed the link between foreign capital inflows and domestic savings in less developed countries from the period 1960 to 1970. The study found a negative association between foreign capital inflows and domestic savings because developing countries depended on foreign loans and the number of foreign capital inflows was used for the repayment of the loan and its interest. Due to this, the number of foreign capital inflows might not be used for the investment which indicated low domestic saving in developing nations.

From the above-mentioned studies, we have concluded that all the studies have the same view about the negative relationship between foreign capital inflows and savings. The studies were mostly on developing countries and the authors have used two stages least squares (2SLS) method, ordinary least square (OLS) method, generalized method of moment (GMM) technique, autoregressive distributed lag (ARDL) model, error correction model (ECM) and cointegration techniques. The studies give various reasons for the negative link between foreign capital inflows and saving: foreign capital inflows do not replace domestic savings.

3. Model Specification

To examine the linkage between foreign capital inflows and gross domestic savings in Pakistan, the following model is displayed in equation (1).

$$GDS = f(LFPR, GFCF, GDPG, DR, DEPR, FDI, REM, TRADE, ED, ODA) \quad \textbf{(1)}$$

The econometric form is shown in equation (2):

$$GDS = \beta_0 + \beta_1 LFPR + \beta_2 GFCF + \beta_3 GDPG + \beta_4 DR + \beta_5 DEPR + \beta_6 FDI + \beta_7 REM + \beta_8 TRADE + \beta_9 ED + \beta_{10} ODA + \mu \quad \textbf{(2)}$$

Where:
GDS = Gross Domestic Savings (% of GDP)
LFPR = Labor force participation rate (% of total population ages 15+)
GFCF = Gross fixed capital formation (% of GDP)
GDPG = GDP growth (annual %)
DR = Deposit interest rate (%)
DEPR = Age dependency ratio (% of working-age population)
FDI = Foreign direct investment, net inflows (% of GDP)
REM = Personal remittances received (% of GDP)
TRADE = Trade (% of GDP)
ED = External debt stocks (% of GDP)
ODA = Official development assistance (% of GNI)

4. Data and Methods

The data used is annual time series data of Pakistan ranging from 1972 to 2022. Data used in the analysis are taken from World Development Indicators. We have applied the ARDL technique to estimate the results. The general form of ECM (error correction model) is given in equation (3) which explains the impact of foreign capital inflows (foreign aid, foreign direct investment, foreign debt, foreign remittances, trade, gross domestic product growth, gross fixed capital formation, age dependency ratio, deposit interest rate, and labor force participation rate) on gross domestic savings.

$$\Delta(GDS)_t = \alpha + \beta_1(GDS)_{t-1} + \beta_2(LFPR)_{t-1} + \beta_3(GFCF)_{t-1} + \beta_4(GDPG)_{t-1} + \beta_5(DR)_{t-1} + \beta_6(DEPR)_{t-1} + \beta_7(FDI)_{t-1} + \beta_8(REM)_{t-1} + \beta_9(TRADE)_{t-1} + \beta_{10}(ED)_{t-1} + \beta_{11}(ODA)_{t-1} + \sum_{i=1}^{a_1}\delta_1\Delta(GDS)_{t-i} + \sum_{i=0}^{a_2}\delta_2\Delta(LFPR)_{t-i} + \sum_{i=0}^{a_3}\delta_3\Delta(GFCF)_{t-i} + \sum_{i=0}^{a_4}\delta_4\Delta(GDPG)_{t-i} + \sum_{i=0}^{a_5}\delta_5\Delta(DR)_{t-i} + \sum_{i=0}^{a_6}\delta_6\Delta(DEPR)_{t-i} + \sum_{i=0}^{a_7}\delta_7\Delta(FDI)_{t-i} + \sum_{i=0}^{a_8}\delta_8\Delta(REM)_{t-i} + \sum_{i=0}^{a_9}\delta_9\Delta(TRADE)_{t-i} + \sum_{i=0}^{a_{10}}\delta_{10}\Delta(ED)_{t-i} + \sum_{i=0}^{a_{11}}\delta_{11}\Delta(ODA)_{t-i} + \varepsilon_t \quad \textbf{(3)}$$

The coefficients of long-run parameters are βi and in the autoregressive distributed lag model (ARDL) the short-run dynamic coefficients are δi. The error term is ε_t while Δ is the operator of the first difference. If a long-run relationship exists, long-run coefficients are estimated through the following equation (4).

$$\Delta(GDS)_t = \alpha + \sum_{i=1}^{a_1}\eta_1(GDS)_{t-i} + \sum_{i=0}^{a_2}\eta_2(LFPR)_{t-i} + \sum_{i=0}^{a_3}\eta_3(GFCF)_{t-i} + \sum_{i=0}^{a_4}\eta_4(GDPG)_{t-i} + \sum_{i=0}^{a_5}\eta_5(DR)_{t-i} + \sum_{i=0}^{a_6}\eta_6(DEPR)_{t-i} + \sum_{i=0}^{a_7}\eta_7(FDI)_{t-i} + \sum_{i=0}^{a_8}\eta_8(REM)_{t-i} + \sum_{i=0}^{a_9}\eta_9(TRADE)_{t-i} + \sum_{i=0}^{a_{10}}\eta_{10}(ED)_{t-i} + \sum_{i=0}^{a_{11}}\eta_{11}(ODA)_{t-i} + \varepsilon_t \quad \textbf{(4)}$$

The short-run domestic savings equation in the ARDL model can be estimated with equation (5).

$$\Delta(GDS)_t = \alpha + \sum_{i=1}^{a_1}\lambda_1\Delta(GDS)_{t-i} + \sum_{i=0}^{a_2}\lambda_2\Delta(LFPR)_{t-i} + \sum_{i=0}^{a_3}\lambda_3\Delta(GFCF)_{t-i} + \sum_{i=0}^{a_4}\lambda_4\Delta(GDPG)_{t-i} + \sum_{i=0}^{a_5}\lambda_5\Delta(DR)_{t-i} + \sum_{i=0}^{a_6}\lambda_6\Delta(DEPR)_{t-i} + \sum_{i=0}^{a_7}\lambda_7\Delta(FDI)_{t-i} + \sum_{i=0}^{a_8}\lambda_8\Delta(REM)_{t-i} + \sum_{i=0}^{a_9}\lambda_9\Delta(TRADE)_{t-i} + \sum_{i=0}^{a_{10}}\lambda_{10}\Delta(ED)_{t-i} + \sum_{i=0}^{a_{11}}\lambda_{11}\Delta(ODA)_{t-i} + \omega ECM_{t-1} + \varepsilon_t \quad \textbf{(5)}$$

The parameters with summation signs denote the short-run coefficients and parameters of the error correction model (ECM). ω represents the speed of adjustment.

5. Results and Discussions

5.1 Descriptive Statistics and Correlation Analysis

Table 1 shows the results of descriptive statistics of the main variables.

Table 1: Descriptive Statistics of Key Variables

	Mean	Median	Max	Min	SD	Skewness	Kurtosis	JB	Prob.	Obs.
GDS	10.67	10.06	17.61	1.45	4.35	0.04	2.03	1.81	0.40	46
LFPR	30.19	29.82	32.98	27.46	1.68	0.32	1.96	2.83	0.24	46
GFCF	15.81	16.49	19.24	11.44	2.10	-0.67	2.32	4.33	0.11	46
GDPG	4.82	4.84	10.22	0.81	2.10	0.20	2.67	0.52	0.77	46
DR	6.39	7.19	10.17	-1.63	2.23	-1.60	5.90	35.89	0.00	46

DEPR	81.44	86.98	88.91	65.08	8.53	-0.77	1.87	6.94	0.03	46
FDI	0.68	0.50	3.67	-1.18	0.91	1.44	6.03	33.42	0.00	46
REM	5.13	4.96	10.25	1.45	2.17	0.23	2.22	1.55	0.46	46
TRADE	33.53	33.35	38.91	27.72	2.75	-0.18	2.69	0.43	0.81	46
ED	0.26	0.26	0.35	0.19	0.04	0.24	1.97	2.48	0.29	46
ODA	2.43	2.11	7.48	0.71	1.46	1.51	5.49	29.29	0.00	46

DEPR has the highest mean value which is 81.44 % of the working-age population and ED has the lowest mean value which is 0.26 % of GDP in the set of data. DEPR has the highest median value in the arranged set of data which is 86.98 % of the working-age population and ED has the lowest mid-value which is 0.26 % of GDP. Max represents the maximum values in the series. Min shows the minimum values in the whole set of data. DEPR has the maximum value in the whole set of data which is 88.91 % of the working-age population. DR has the minimum value in the series which is -1.63 %. DEPR has the highest value of standard deviation in the whole set of data and that is 8.53 % of the working-age population which shows the greater spread in the series and ED has the lowest value of standard deviation in the whole series which shows the distance of individual value from the average or mean value that is round about 0.04 % of GDP. The variables GDS, LFPR, GDPG, FDI, REM, ED, and ODA are positively skewed. While the other variables GFCF, DR, DEPR, and TRADE are negatively skewed. The variables DR, FDI, and ODA are leptokurtic. All the other variables GDS, GFCF, GDPG, LFPR, DEPR, ED, REM, and TRADE are platykurtic. The probability value of JB stats of GDS, LFPR, GFCF, GDPG, REM, TRADE, and ED of these variables are in a symmetrical distribution. The other variables DR, DEPR, FDI, and ODA are in non-symmetrical distribution.
Table 2 shows the results of the correlation matrix of the main variables.

Table 2: Correlation Matrix of Key Variables

Correlation	GDS	LFPR	GFCF	GDPG	DR	DEPR	FDI	REM	TRADE	ED	ODA
GDS	1.00										
LFPR	-0.55	1.00									
GFCF	0.40	-0.45	1.00								
GDPG	-0.13	-0.09	0.23	1.00							
DR	-0.33	-0.03	0.26	-0.05	1.00						
DEPR	0.20	-0.82	0.50	0.23	0.23	1.00					
FDI	0.46	0.11	0.42	-0.15	-0.16	-0.23	1.00				
REM	-0.74	0.37	-0.14	0.44	0.18	-0.05	-0.44	1.00			
TRADE	0.14	-0.31	0.40	0.08	0.37	0.16	0.26	-0.07	1.00		
ED	0.04	0.43	-0.30	-0.13	-0.20	-0.78	0.13	-0.08	0.12	1.00	
ODA	-0.21	-0.27	0.12	0.18	0.10	0.60	-0.31	0.10	-0.16	-0.75	1.00

There is a negative moderate correlation between GDS and LFPR because its value is -0.55. GDS has a positive moderate correlation with GFCF and FDI. GDS has a negative weak correlation with GDPG and ODA. There is a positive weak correlation between the variables GDS and TRADE, GDS and ED, and GDS and DEPR. GDS has a negative strong correlation with REM. LFPR has a negative moderate correlation with GFCF and TRADE. LFPR has a negative weak correlation with GDPG, DR, and ODA. LFPR has a negative strong correlation with DEPR because its value is -0.82. LFPR has a positive moderate correlation with ED and REM. LFPR has a positive weak correlation with FDI. GFCF has a positive weak correlation with GDPG, DR, and ODA. GFCF has a positive moderate correlation with DEPR, FDI, and TRADE. GFCF has a negative weak correlation with REM. GFCF has a negative moderate correlation with ED. There is a negative weak correlation between GDPG and DR, GDPG and FDI, and GDPG and ED. GDPG has a positive weak correlation with DEPR, TRADE, and ODA. DR

has a positive weak correlation with DEPR, REM, and ODA. DR has a positive moderate correlation with TRADE because the coefficient value of TRADE is 0.37. DEPR has a negative weak correlation with FDI and REM. DEPR has a positive weak correlation with TRADE. DEPR has a negative strong correlation with ED. DEPR has a positive moderate correlation with ODA. FDI has a negative moderate correlation with REM and ODA. FDI has a positive weak correlation with TRADE and ED because the coefficient values of these variables are 0.26 and 0.13 which represent the weak correlation and the signs of the coefficient are positive that's why it shows a positive weak correlation between these variables. There is a negative weak correlation between REM and TRADE and REM and ED because the coefficient values of these variables are -0.07 and -0.08. There is a positive weak correlation between REM and ODA. There is a positive weak correlation between TRADE and ED. TRADE and ODA have a negative weak correlation because the sign of the coefficient is negative which is why there is a negative weak correlation between TRADE and ODA. ED and ODA have a negative strong correlation.

5.2 Results of ADF Unit Root

Table 3 shows the results of the ADF unit root analysis. The results of the ADF test show that there is a mixed order of integration among the variables. So, the optimum methodology suggested by the econometricians is ARDL so, we would apply ARDL for the estimation of the model.

Table 3: ADF Unit Root Test Results

Unit Root Test on Level							
Variables	**Intercept**	**Lags**	**Intercept and Trend**	**Lags**	**None**	**Lags**	**Conclusion**
GDS	-2.06 (0.25)	0	-2.04 (0.56)	0	-0.60 (0.44)	0	NS
LFPR	-0.84 (0.79)	0	-1.31 (0.87)	0	0.50 (0.82)	0	NS
GFCF	-2.23 (0.19)	0	-2.71 (0.23)	0	-0.01 (0.67)	0	NS
GDPG	-5.13 (0.00)	0	-5.78 (0.00)	0	-1.49 (0.12)	0	S
DR	-2.01 (0.27)	0	-2.19 (0.48)	0	-0.63 (0.43)	0	NS
DEPR	-2.60 (0.09)	3	-2.69 (0.24)	3	-2.52 (0.01)	0	S
FDI	-2.80 (0.06)	1	-2.87 (0.17)	1	-1.52 (0.11)	0	S
REM	-1.93 (0.31)	0	-2.57 (0.54)	0	-0.64 (0.42)	0	NS
TRADE	-3.56 (0.01)	0	-3.49 (0.05)	0	-0.09 (0.70)	0	S
ED	-1.74 (0.40)	0	-4.62 (0.00)	0	-0.51 (0.82)	0	NS
ODA	-2.09 (0.24)	0	-4.04 (0.01)	0	-1.70 (0.08)	0	S

5.3 Results of Bounds Test

Table 4 shows the results of the bounds test analysis. It shows that the value of the F-statistic is greater than the upper bound I (1) at a 5% and 10% level of significance. That is why the long-run relationship exists and when a long-run relationship exists it means cointegration also exists.

Table 4: Bounds Test based on F-Test

		5% Critical Value Bounds		10% Critical value Bounds	
Model	**F-Statistic**	I(0)	I(1)	I(0)	I(1)
GDS/ LFPR GFCF GDPG DR DEPR FDI REM TRADE ED ODA	3.898275	2.06	3.24	1.83	2.94

5.4 Long Run Results

We now elucidate the long-term findings, as presented in Table 5.

Table 5: Long Run Estimates of Foreign Capital Inflows and Domestic Savings

Dependent Variable: GDS				
Selected Model: ARDL(1, 1, 2, 2, 0, 0, 1, 0, 1, 2, 0)				
Variable	**Coefficient**	**Std. Error**	**t-Stat**	**Prob.**
LFPR	1.331079	0.601742	2.212043	0.0372
GFCF	1.577382	0.396808	3.975176	0.0006
GDPG	0.696735	0.419356	1.661441	0.1102
DR	0.717473	0.219922	3.262401	0.0034
DEPR	-0.471273	0.170875	-2.757992	0.0112
FDI	1.593886	0.758833	2.100445	0.0469
REM	0.886175	0.304680	2.908544	0.0079
TRADE	0.346237	0.209057	1.656187	0.1113
ED	-0.798129	0.251496	-3.173530	0.0042
ODA	-1.036126	0.424761	-2.439315	0.0228
C	89.394122	35.363465	2.527867	0.0188

In the extended timeframe, a notable and statistically significant correlation is observed between Gross Domestic Savings (GDS) and Labor Force Participation Rate (LFPR). As labor force participation increases, it will enhance the production of industrial units. It will enable the industry to do efficient production. Efficient and more production in industrial units will attract people for more investment in different industries. For more investment, people will borrow from the banking sector. More demand for loans can be fulfilled by urging people to enhance their savings. Secondly, more investment will lead to more production. More productivity means more GDP growth which will cause an increase in gross domestic savings (Graham, 1987; Oropesa, Yamada et al., 1990 Joubert and Todd, 2011).

In an economy for efficiency and more production, there is a need to replace the old capital goods with new capital assets. This is also essential to increase the capital goods like machinery, labor, tools, and transportation assets to increase the productivity of different sectors in the economy. This process is called capital formulation. It would be beneficial only when there is the best and efficient utilization of these resources. The capital goods can be attained domestically as well as through foreign investments. If there is more capital formulation in different sectors, there will be more production units that will have efficient production of goods and services. This will positively influence the gross domestic product and become the cause of high GDP growth. More growth in the gross domestic product will uplift the domestic savings of the country. So, the coefficient value of GFCF is 1.57. The coefficient is positive which represents the positive and significant relationship between GDS and GFCF in the long run. Our results are compatible with the studies (Kanu et al., 2014; Jagadeesh, 2015; Shuaib et al, 2015; Gibescu, 2010; and Armstrong et al, 1996).

It is obvious that if there is high GDP growth in the economy, it will lead to more gross domestic savings. Different methods can help to increase the GDP growth i.e. if the banks charge a low policy rate, people will get more loans that will prove beneficial to increase the economic activity as well as GDP growth. In this modern era, the best way to uplift GDP growth is to do innovation in all sectors. This will decrease the cost of doing business as well as enhance productivity which ultimately increases the GDP growth and domestic savings. The sign of the coefficient of GDPG is positive which shows the long-run positive and insignificant relationship between GDPG and GDS. The studies by Waithima, 2008; Odhiambo, 2009; Oladipo, 2010 and Misztal, 2011 have found the positive impact of GDS on GDP growth.

If the central bank of the country increases the deposit rate, it will attract the people for more savings in banks. Through more savings, the supply of loanable funds will increase in banks. When the supply of loanable funds increases, it will push down the policy rate at which banks advance the loans to the people. The investor will demand more loans from banks to put these in economic activities at a low-interest rate. The investors borrow the loan from banks and invest it into economic activity and that will enhance the production of different sectors. It will also increase the profitability ratio of investors which attracts the other investors from their home country or abroad to put their investment in these sectors. Through more profit, the investors can reallocate their savings to different economic units. These steps positively influence the gross domestic product as well as gross domestic savings. The coefficient value of DR is 0.71, which shows the positive and significant relationship between DR and GDS in the long run. So, our results are in line with the studies (Mushtaq and Siddiqui 2017; Oshikoya, 1992 and Molho, 1986).

In an economy, when the burden of older people increases, domestic savings will go down. The reason behind this negative relation is that people who are retired from their jobs use their saved part of the money. They are not participating in economic activity but they are using their saved resources to meet their basic needs. These people are considered a burden on the economy because they are using the saved part of their money without earnings. When in an economy people of this category increase, there will be less domestic savings. Hence, the negative coefficient of DEPR signifies a substantial and adverse long-term association between DEPR and GDS. Our results are consistent with the studies (Apergis and Christou, 2012; Keho, 2012 and Gupta, 1975).

The economic reason for the positive relationship between foreign direct investment and domestic savings is that more foreign direct investment will generate more economic activity. Gross domestic product will increase due to foreign direct investment and it will enhance domestic savings. FDI is also used in productive ways that will lead to high economic growth and an increase in domestic savings. FDI enhances the investment in a country creating more economic growth and domestic savings. The estimated parameter of FDI is positive and statistically significant. So, our results are supported by different studies which are Bano and Tabbada, 2015; Hassen and Anis, 2012; Chani et al, 2010 and Dhar and Roy, 1996.

If the residents of the country send more remittances back to their country, this money may be used for consumption and savings purposes. More consumption leads to an increase in aggregate demand of an economy and that will increase the economic activity as well as GDP and domestic savings. Another use of remittances is to save money. The majority of people save their money in banks and this amount can be used as loanable funds. This activity generates the investment in economy which will improve economic growth and increase domestic savings because foreign remittances contribute to encouraging financial development and help to eliminate poverty conditions. In this way, remittance inflows play a vital role in promoting

economic activity and lead to a decrease in poverty alleviation in developing countries. The coefficient represents the long-run positive and significant relationship between REM and GDS. Our results are compatible with the studies (Inoue, 2018; Azam et al, 2016; Imai et al, 2014; Lartey, 2013; Javid et al, 2012; Baldé, 2011and Morton et al, 2010).

A good relationship between countries has a positive impact on trade. If more trade-in economy, it means that there is a high GDP growth rate that will lead to more domestic savings. The coefficient of TRADE is 0.34 which shows the positive and insignificant relationship between TRADE and GDS in the long run. So, our results are consistent with the studies (Inoue, 2018; Lartey, 2013; Gruben and Mcleod, 1998; Sheikh et al. 2018; Sheikh et al. 2019).

If a country is facing an external debt burden, then the major part of the gross domestic product of the economy is used for debt services that will negatively impact gross domestic savings. Debt burdens hangover economies and scares off investors due to high anticipated future tax-reducing public savings. The inverse linkage between debt burden and domestic savings is that foreign funds appear to substitute domestic savings and the resources generated through foreign debt have been used partially for spending purposes. Hence, the computed ED value further confirms the presence of an adverse and statistically noteworthy association between ED and GDS. This observation aligns with the outcomes reported in prior research conducted by Sheikh et al. (2015), Oageng and Boitumelo (2017), Jappelli et al. (2014), Aliyu and Usman (2013), Chaudhry et al. (2009), as well as Okafor and Tyrowicz (2009), all of which substantiate the detrimental influence of ED on GDS. Net official development assistance has a negative impact on economic growth because the countries are dependent and the miscellaneous course of actions and self-governing expansion for the reason that democracies are the major problems to imperfections. Foreign aid is used for development projects in low-income countries because the poor countries magnetize the largest part of aid infraction to their earnings and the poor countries hoard least not the actual in the less developed countries and developing countries are dependent on developed countries. Corruption and political instability are also the main reasons for this correlation. So, the coefficient shows the negative and insignificant relationship between ODA and GDS in the long run. Our results are compatible with the studies (Afawubo and Mathey, 2017; Mohey-ud-din, 2005; Bowles, 1987 and Mosley, 1980).

5.6 Error Correction Results

The results of error correction estimates are discussed in Table 6.

Table 6: Error Correction Estimates of Foreign Capital Inflows and Domestic Savings

Dependent Variable: GDS
Selected Model: ARDL(1, 1, 2, 2, 0, 0, 1, 0, 1, 2, 0)

Variable	Coefficient	Std. Error	t-Stat	Prob.
D(LFPR)	0.112061	0.718251	0.156019	0.8774
D(GFCF)	1.017616	0.389417	2.613176	0.0155
D(GFCF(-1))	-0.765257	0.358479	-2.134730	0.0437
D(GDPG)	0.050045	0.167854	0.298146	0.7683
D(GDPG(-1))	0.269141	0.205715	1.308323	0.2037
D(DR)	-0.692286	0.204963	-3.377611	0.0026
D(DEPR)	-0.454729	0.185964	-2.445250	0.0225
D(FDI)	0.231846	0.714896	0.324308	0.7486
D(REM)	-0.855065	0.362697	-2.357522	0.0273
D(TRADE)	0.040320	0.166487	0.242178	0.8108
D(ED)	-0.568675	0.179807	-3.162696	0.0043
D(ED(-1))	0.440809	0.170434	2.586386	0.0165

D(ODA)	-0.999752	0.471164	-2.121879	0.0448
CointEq(-1)	-0.964894	0.176519	-5.466246	0.0000

5.7 Granger Causality Analysis

Granger causality test is used to check the causality between two variables mostly in time series analysis. The first step in the analysis of Granger causality is to choose the optimum lag. Table 7 shows the lag selection criteria. According to the results, the optimum lag is 2 because at lag 2 the value of AIC and SC has the minimum values.

Table 7: VAR Lag Order Selection Criteria

Endogenous variables: GDS LFPR GFCF GDPG DR DEPR FDI REM TRADE ED ODA

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-717.6621	NA	6.715680	33.12101	33.56705	33.28642
1	-396.1230	467.6934	0.000863	24.00559	29.35816*	25.99058
2	-216.4936	171.4644*	0.000182*	21.34062*	31.59971	25.14518*

Table 8 shows the result of the Granger causality test.

Table 8: Pairwise Granger Causality Test

Null Hypothesis:	Lags	F-Statistic	Lags	F-Statistic	Lags	F-Statistic
LFPR ⇏ GDS	2	2.86139 (0.0690)	3	2.44343 (0.0794)	4	2.3445 (0.0743)
GDS ⇏ LFPR		2.33951 (0.1094)		1.13061 (0.3493)		1.35930 (0.2685)
GFCF ⇏ GDS	2	0.47612 (0.6247)	3	0.23903 (0.8686)	4	0.67942 (0.6110)
GDS ⇏ GFCF		0.31080 (0.7346)		0.51663 (0.6734)		0.43110 (0.7851)
GDPG ⇏ GDS	2	1.41558 (0.2547)	3	1.00672 (0.4007)	4	0.68084 (0.6100)
GDS ⇏ GDPG		0.50200 (0.6091)		0.57827 (0.6330)		0.45211 (0.7701)
DR ⇏ GDS	2	0.02257 (0.9777)	3	0.43683 (0.7280)	4	0.50738 (0.7306)
GDS ⇏ DR		0.59302 (0.5574)		0.38636 (0.7635)		1.51265 (0.2204)
DEPR ⇏ GDS	2	5.82903 (0.0060)	3	5.70166 (0.0026)	4	5.55007 (0.0015)
GDS ⇏ DEPR		7.77538 (0.0014)		4.02412 (0.0142)		1.55213 (0.2094)
FDI ⇏ GDS	2	0.31063 (0.7347)	3	0.74549 (0.5319)	4	0.93550 (0.4551)
GDS ⇏ FDI		1.69843 (0.1959)		1.70201 (0.1834)		1.31759 (0.2832)
REM ⇏ GDS	2	1.15472 (0.3254)	3	0.78485 (0.5266)	4	0.67452 (0.6143)
GDS ⇏ REM		0.76167 (0.4735)		0.44943 (0.7192)		0.79776 (0.5550)
TRADE ⇏ GDS	2	1.75898 (0.1853)	3	0.72982 (0.5408)	4	0.73101 (0.5771)
GDS ⇏ TRADE		0.87822 (0.4234)		0.44568 (0.7218)		2.00670 (0.1157)
ED ⇏ GDS	2	1.31877	3	0.95249	4	0.70407

		(0.2788)		(0.4253)	(0.5947)
GDS ⇏ ED		0.20015 (0.8194)		0.21691 (0.8840)	0.46365 (0.7619)
ODA ⇏ GDS	2	0.03050 (0.9700)	3	0.28296 (0.8373)	0.85992 (0.4981)
GDS ⇏ ODA		3.68220 (0.0343)		0.68599 (0.0610)	1.45625 (0.2378)
GFCF ⇏ LFPR	2	1.62660 (0.2093)	3	1.40096 (0.2579)	1.06361 (0.3895)
LFPR ⇏ GFCF		2.49004 (0.0957)		1.74673 (0.1743)	1.96100 (0.4228)
GDPG ⇏ LFPR	2	0.18018 (0.8358)	3	0.47326 (0.7028)	1.47645 (0.2310)
LFPR ⇏ GDPG		0.22081 (0.8028)		0.30578 (0.8210)	0.24350 (0.9116)
DR ⇏ LFPR	2	3.92003 (0.0279)	3	2.56459 (0.0693)	4.53410 (0.0048)
LFPR ⇏ DR		0.65401 (0.5254)		0.45585 (0.7148)	0.20618 (0.9332)
DEPR ⇏ LFPR	2	4.80575 (0.0135)	3	2.67285 (0.0615)	2.83529 (0.0394)
LFPR ⇏ DEPR		1.54432 (0.2259)		0.96635 (0.4189)	0.26347 (0.8993)
FDI ⇏ LFPR	2	3.09538 (0.0562)	3	1.22837 (0.3131)	1.47315 (0.2320)
LFPR ⇏ FDI		0.50008 (0.6102)		0.75535 (0.5263)	0.51287 (0.7267)
REM ⇏ LFPR	2	2.69528 (0.0798)	3	1.23061 (0.3123)	2.30907 (0.0779)
LFPR ⇏ REM		1.76214 (0.1847)		1.48748 (0.2338)	0.78865 (0.5407)
TRADE ⇏ LFPR	2	1.19630 (0.3129)	3	1.25068 (0.3054)	1.03822 (0.4019)
LFPR ⇏ TRADE		1.34358 (0.2724)		0.79487 (0.5046)	0.64268 (0.6358)
ED ⇏ LFPR	2	2.60354 (0.0865)	3	1.10280 (0.3603)	0.94561 (0.4497)
LFPR ⇏ ED		1.62811 (0.2090)		2.01367 (0.1288)	1.78725 (0.1542)
ODA ⇏ LFPR	2	0.17206 (0.8426)	3	0.48050 (0.6979)	0.26902 (0.8958)
LFPR ⇏ ODA		1.40241 (0.2581)		0.76898 (0.5190)	0.47451 (0.7541)
GDPG ⇏ GFCF	2	2.84997 (0.0296)	3	2.55682 (0.0699)	1.84434 (0.1431)
GFCF ⇏ GDPG		0.04595 (0.9551)		0.06817 (0.9765)	0.24869 (0.9085)
DR ⇏ GFCF	2	0.46774 (0.6298)	3	0.43299 (0.7306)	0.47595 (0.7531)
GFCF ⇏ DR		0.45932 (0.6350)		1.43387 (0.2485)	1.91131 (0.1311)
DEPR ⇏ GFCF	2	7.64113 (0.0015)	3	6.68984 (0.0010)	5.82501 (0.001)
GFCF ⇏ DEPR		0.34937 (0.7073)		0.25167 (0.8596)	0.05604 (0.9939)
FDI ⇏ GFCF	2	1.72511 (0.1911)	3	2.83308 (0.0514)	1.83896 (0.1441)

		0.06938		0.44280		0.37457
GFCF ⇏ FDI		(0.9331)		(0.7238)		(0.8251)
		1.26073		1.00052		2.71854
REM ⇏ GFCF	2	(0.2945)	3	(0.4034)	4	(0.0458)
		0.27925		0.76663		1.03597
GFCF ⇏ REM		(0.7578)		(0.5201)		(0.4030)
		0.03967		0.21725		0.44285
TRADE ⇏ GFCF	2	(0.9611)	3	(0.8838)	4	(0.7768)
		1.31305		3.45537		3.83103
GFCF ⇏ TRADE		(0.2803)		(0.0260)		(0.0113)
		2.40021		2.02049		1.50207
ED ⇏ GFCF	2	(0.1036)	3	(0.1279)	4	(0.2235)
		1.00103		1.46574		1.53631
GFCF ⇏ ED		(0.3765)		(0.2397)		(0.2138)
		2.37221		2.29087		1.25572
ODA ⇏ GFCF	2	(0.1066)	3	(0.0947)	4	(0.3070)
		0.80373		0.91196		1.12242
GFCF ⇏ ODA		(0.4549)		(0.4449)		(0.3627)
		0.72388		0.49020		1.08209
DR ⇏ GDPG	2	(0.4911)	3	(0.6912)	4	(0.3808)
		1.5939		1.17707		1.14436
GDPG ⇏ DR		(0.2149)		(0.3816)		(0.3524)
		0.40433		0.32525		0.35346
DEPR ⇏ GDPG	2	(0.6701)	3	(0.8071)	4	(0.8398)
		0.82068		0.63830		1.88476
GDPG ⇏ DEPR		(0.4474)		(0.6952)		(0.1357)
		2.52264		1.81462		1.47537
FDI ⇏ GDPG	2	(0.0929)	3	(0.1614)	4	(0.2313)
		1.24990		0.64441		0.57520
GDPG ⇏ FDI		(0.2975)		(0.5914)		(0.6825)
		3.42571		2.33370		2.43611
REM ⇏ GDPG	2	(0.0423)	3	(0.0898)	4	(0.0660)
		0.47990		0.84393		2.00286
GDPG ⇏ REM		(0.6224)		(0.4786)		(0.1163)
		0.80528		2.10542		2.17750
TRADE ⇏ GDPG	2	(0.4541)		(0.1161)	4	(0.0925)
		3.09895		1.94980		1.70928
GDPG ⇏ TRADE		(0.0561)		(0.1385)		(0.1707)
		1.41232		1.26550		1.80273
ED ⇏ GDPG	2	(0.2555)	3	(0.3003)	4	(0.1411)
		2.05718		2.27245		1.78641
GDPG ⇏ ED		(0.1411)		(0.0962)		(0.1543)
		1.67177		1.09711		1.51174
ODA ⇏ GDPG	2	(0.2011)	3	(0.3629)	4	(0.2214)
		1.57423		3.20152		1.82670
GDPG ⇏ ODA		(0.2200)		(0.0347)		(0.1472)
		0.77923		0.78078		1.11159
DEPR ⇏ DR	2	(0.4656)	3	(0.5123)	4	(0.3671)
		2.79955		1.55511		0.34892
DR ⇏ DEPR		(0.0728)		(0.2166)		(0.8429)
		1.11786		1.06906		0.63174
FDI ⇏ DR	2	(0.3370)	3	(0.3740)	4	(0.6433)
		4.50715		3.47391		2.69413
DR ⇏ FDI		(0.0712)		(0.0255)		(0.0472)
		0.99599		0.88443		0.73288
REM ⇏ DR	2	(0.3783)	3	(0.4581)	4	(0.5759)
DR ⇏ REM		0.24994		0.43493		0.37309

		(0.7801)		(0.7293)	(0.8262)
TRADE ⇏ DR	2	1.13435 (0.3318)	3	1.27334 (0.2977)	1.26892 (0.3013)
DR ⇏ TRADE		0.58612 (0.5612)		1.38594 (0.2623)	1.76747 (0.1582)
ED ⇏ DR	2	3.90817 (0.0282)	3	3.96160 (0.0152)	2.43260 (0.0663)
DR ⇏ ED		2.51058 (0.0939)		1.13108 (0.3491)	0.88204 (0.4850)
ODA ⇏ DR	2	1.39760 (0.2593)	3	1.00316 (0.4026)	0.72558 (0.5808)
DR ⇏ ODA		1.99527 (0.1496)		1.57465 (0.2124)	1.40567 (0.2537)
FDI ⇏ DEPR	2	2.51353 (0.0937)	3	1.93165 (0.1414)	0.90467 (0.4722)
DEPR ⇏ FDI		3.54943 (0.0381)		7.49106 (0.0005)	7.82965 (0.0001)
REM ⇏ DEPR	2	3.63222 (0.0355)	3	2.33428 (0.0897)	2.05288 (0.1089)
DEPR ⇏ REM		2.68797 (0.0803)		2.88295 (0.0487)	2.33545 (0.0752)
TRADE ⇏ DEPR	2	0.17940 (0.8364)	3	0.11923 (0.9842)	0.30100 (0.8752)
DEPR ⇏ TRADE		0.63604 (0.5347)		0.25963 (0.8540)	0.31164 (0.8682)
ED ⇏ DEPR	2	0.25211 (0.7784)	3	0.34894 (0.7901)	0.29619 (0.8784)
DEPR ⇏ ED		3.21783 (0.0506)		1.64615 (0.1954)	1.42932 (0.2454)
ODA ⇏ DEPR	2	1.02004 (0.3700)	3	0.03869 (0.9897)	0.04086 (0.9967)
DEPR ⇏ ODA		0.97952 (0.3845)		0.93193 (0.4353)	0.54516 (0.7037)
REM ⇏ FDI	2	0.29841 (0.7436)	3	0.27884 (0.8403)	0.22036 (0.9252)
FDI ⇏ REM		0.07956 (0.9237)		0.21486 (0.8855)	0.06862 (0.9910)
TRADE ⇏ FDI	2	0.01724 (0.9829)	3	0.08462 (0.9680)	0.06456 (0.9920)
FDI ⇏ TRADE		0.49480 (0.6134)		0.40299 (0.7517)	0.32203 (0.8612)
ED ⇏ FDI	2	1.19063 (0.3146)	3	1.98931 (0.1324)	1.43430 (0.2439)
FDI ⇏ ED		0.07798 (0.9251)		1.94940 (0.1386)	1.81619 (0.1485)
ODA ⇏ FDI	2	1.03509 (0.3647)	3	0.86159 (0.4698)	0.73158 (0.5769)
FDI ⇏ ODA		0.18003 (0.8359)		0.06958 (0.9758)	0.04342 (0.9963)
TRADE ⇏ REM	2	4.09354 (0.0241)	3	3.05816 (0.0401)	1.80437 (0.1508)
REM ⇏ TRADE		0.58181 (0.5635)		0.59846 (0.6201)	0.73319 (0.5757)
ED ⇏ REM	2	0.71839 (0.4937)	3	0.35966 (0.7825)	0.71107 (0.5901)
REM ⇏ ED		0.18642 (0.8306)		0.20690 (0.8910)	2.13153 (0.0982)

ODA ⇏ REM	2	0.49876 (0.6111)	3	1.15250 (0.3412)	4	0.91535 (0.4666)
REM ⇏ ODA		0.43288 (0.6517)		1.78647 (0.1672)		1.96830 (0.1224)
ED ⇏ TRADE	2	1.27340 (0.2910)	3	0.82485 (0.4886)	4	1.45517 (0.2374)
TRADE ⇏ ED		0.51670 (0.6004)		0.61308 (0.6108)		1.25184 (0.3079)
ODA ⇏ TRADE	2	0.84091 (0.4390)	3	1.99623 (0.1319)	4	2.69754 (0.0476)
TRADE ⇏ ODA		2.62799 (0.0850)		1.76266 (0.1717)		0.48055 (0.7498)
ODA ⇏ ED	2	1.09406 (0.3449)	3	1.25348 (0.3049)	4	0.98601 (0.4287)
ED ⇏ ODA		3.87397 (0.0292)		1.90165 (0.1468)		1.00663 (0.4181)

At first, we take GDS (gross domestic savings) dependent. variable and independent variables are LFPR, GFCF, GDPG (GDP growth), DR (deposit interest rate), DEPR (age dependency ratio), FDI (foreign direct investment), REM (personal remittances), ED (external debt stock) and ODA (net ODA received). There is unilateral causality between the variables LFPR and GDS because LFPR Granger causes GDS but GDS does not Granger causes LFPR. There is no causality between GFCF and GDS because both variables do not Granger cause. There is also no causality exists between GDPG and GDS because GDPG does not Granger cause GDS at lag 2, 3, and 4 and GDS does not Granger cause GDPG at lag 2, 3, and 4. At lag 2, 3 and 4 DR does not Granger cause GDS and GDS does not Granger cause DR so, there is no causality exist between DR and GDS. Bilateral causality exists between DEPR and GDS because DEPR Granger causes GDS at lag 2, 3, and 4, and GDS Granger causes DEPR at lag 2 and 3 but does not cause at lag 4. So, we consider that GDS Granger causes DEPR because it causes two lags but does not cause one lag.

FDI does not Granger cause GDS and GDS do not Granger cause FDI at lag 2, 3, and 4 so, there exists no causality between FDI and GDS. REM and GDS do not Granger cause at any of the given lags which is why there exists no causality between these variables. There is no causality between the variables TRADE and GDS because these variables do not Granger cause anymore at the given lags 2, 3, and 4. There exists no causality between ED and GDS because ED and GDS do not Granger cause at lag 2, 3, and 4. There is unilateral causality between ODA and GDS because ODA does not Granger cause GDS at lag 2, 3, and 4 but GDS Granger cause ODA at lag 2 and 3 so, there is one-way causality. LFPR has no causality with GFCF and GDPG. LFPR has unilateral causality with DR and DEPR there exists a one-way causality between the variables. There exists no causality between FDI and LFPR because both variables do not Granger cause. REM and LFPR have unilateral causality because REM Granger causes LFPR at 2 and 4 lags but LFPR does not Granger cause REM in all the three lags. LFPR has no causality with TRADE, ED, and ODA.

GDPG has unilateral causality with GFCF because GDPG Granger cause but GFCF does not. No causality exists between DR and GFCF the reason behind this is that both variables DR and GDPG do not Granger cause each other. There is a one-way causality between DEPR and GFCF. GFCF has no causality with the variables FDI, REM, ODA, and ED but unilateral causality with TRADE. GDPG has no causality with DR, DEPR, FDI, TRADE, ED, and ODA

because these variables do not Granger cause but GDPG has unilateral causality with REM the reason behind unilateral causality between GDPG and REM is that REM Granger cause GDPG at 2,3 and 4 lag and GDPG does not Granger cause REM at 2, 3 and 4 lags. DR has no causality with DEPR, REM, TRADE, and ODA but unidirectional causality with FDI. There is unilateral causality between FDI and DEPR and bilateral or two-way causality between DEPR and REM. DEPR has no causality with TRADE, ED, and ODA. FDI has no causality with REM, TRADE, ED, and ODA. REM has one-way causality with TRADE and no causality with ED and ODA. TRADE has no causality with ED and ODA. And ED has no causality with ODA the reason behind this is that ODA does not Granger cause ED at any of the given lags and ED $\nRightarrow$ ODA at 2, 3, and 4 lags. The sign $\nRightarrow$ represents that does not Granger Cause.

6. Conclusion

This study delves into the implications of foreign capital inflows on domestic savings in Pakistan within the temporal scope of 1972 to 2022. The empirical outcomes obtained through the Auto Regressive Distributed Lag (ARDL) analysis unveil noteworthy patterns. Specifically, gross domestic savings demonstrate a substantial and positive correlation with factors such as labor force participation rate, gross fixed capital formation, deposit interest rate, foreign direct investment, and foreign remittances. However, the relationships with trade and GDP growth manifest as positive yet statistically insignificant. Conversely, the age dependency ratio and external debt stock exhibit significant and negative impacts on gross domestic savings. Meanwhile, net official development assistance displays a negative influence that lacks statistical significance. The coefficient derived from the error correction term underscores the model's robust significance and its tendency to gravitate toward equilibrium. Consequently, the findings affirm a positive nexus between foreign capital inflows and domestic savings in Pakistan.

The results of the Granger causality test, in contrast, reveal the absence of causal connections between foreign direct investment, remittances, trade, external debt, and gross domestic savings. Notably, unilateral causality is observed solely between net official development assistance and gross domestic savings.

Drawing from the study's outcomes, several policy implications can be formulated:

- The government may focus on technical education. To enhance the industrial units this will enhance the LFPR.
- There is a need to focus on the government to provide opportunities for capital formation by creating ease of doing business.
- The central bank may increase the deposit interest rate so that more deposits would be possible in the savings account and gross domestic savings would increase.
- Policymakers may design policies that attract foreign direct investment from other countries which will have a positive impact on gross domestic product as well as gross domestic savings.

The overseas may transfer their remittances to the country through a proper channel which can participate in the growth of GDP and have a positive impact on domestic savings.

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Identifying Threshold Level of Urbanization for Economic Growth in Developing and Developed Asian Economies

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Abstract

This study scrutinized the relationship between urbanization and economic growth in 11 developed and 23 underdeveloped Asian countries from 1998 to 2021. The study formulated dynamic and static models and employed the Fixed Effect Model and Dynamic GMM for estimation. The results of both static and dynamic models illustrated that urbanization augments growth in developed and developing countries, however, the nature of this relationship is non-linear. The study calculated the threshold level of urbanization and established that after this threshold level, the impact of urbanization on growth reverses. In the static model, developed and developing countries have thresholds of 68.08% and 53.8%, respectively. In the dynamic model, developed and developing countries maintained thresholds of 77.6% and 61.5%, respectively. The study concluded that urbanization and growth share a non-linear association in both developed and developing countries, and this relationship is not contingent upon the type of model or technique being used.

Keywords: *Urbanization, Threshold, Economic Growth, Dynamic GMM, Fixed Effects*

JEL Classification: O1, O18, O47

1. Introduction

Urbanization serves as a key conduit for economic growth, the terms urbanization and economic growth are frequently used together in economic literature (Liang et al., 2023). Hence, numerous studies have consistently demonstrated that for economies to increase their income levels, a significant proportion of the population has to migrate to urban areas. This is due to the fact that cities serve as central hubs for both regional and international networks, thereby facilitating effective channels for economic growth (Ahimah-Agyakwah et al., 2022). Urbanization is the movement of a sizable population from rural to urban regions, or the growth in the number and size of existing cities. While, in economics, it refers to labor migration from agriculture to industry. Redirecting resources from less productive areas (like agriculture) to more productive ones (like industrial) can prove to be a vital factor in boosting growth (Henderson & Becker, 2000). The basic idea is that the negative marginal productivity of labor due to an abundance of agricultural workers drives excess labor elsewhere, primarily in the industrial sector. This results in positive marginal productivity, and consequently contributes to economic growth. Hence, urbanization is regarded not only as a factor influencing economic growth but also as a condition that is adequate to guarantee economic advancement (Gallup et al., 1999).

Urban areas are commonly recognized as the catalysts for fostering growth, as enhanced employment prospects and access to basic facilities encourage workers to move towards the industrial sector and take part in production processes. On the other hand, in rural areas workers do not have access to the basic facilities and work for lower wages, hence their productivity remains low resultantly the output per unit decreases. Therefore, relocation of labor from one towards another sector acts as a driving force for

enhanced productivity (Zhao, 2023). Likewise, Arif (2005) maintained that people migrate to acquire health facilities and improve their standard of living, hence urbanization is one of the vital elements to enjoy the privileges. Rural areas lack basic employment facilities making it hard for individuals to have better living conditions. Likewise, Drinkwater et al. (2004) in their study argued that one significant consequence of migration relates to the economic growth of the region. However, depending on the particulars of the migration process, such as whether it is vertical or horizontal, the effects of migration can have different impacts, either positive or negative. Vertical migration, specifically from rural to urban areas, has been found to have a substantial and positive influence on economic growth. Similarly, the literature approved that urbanization and economic growth are related but the nature of their relationship can be either positive or negative. In this respect, Kuddus et al. (2020) argued that the correlation between urbanization and growth is contingent upon the economic state of a nation. Furthermore, Arouri et al. (2014) found an inverse U-shaped connection between urbanization and growth.

Numerous studies have been conducted on the topic of urbanization and its impact on growth. Nonetheless, there is a lack of agreement regarding whether the correlation between urbanization and growth is favorable or unfavorable. Hence, the discussion remains inconclusive regarding the relationship between the two variables. Thereby, leaving a curvature for future study to examine the nexus and finally put an end to the longstanding argument. In this respect, the current study will be a step forward in this direction by exploring the relationship between urbanization and economic growth for both developing and developed economies. Likewise, insufficient attention has been given to the non-linear correlation between urbanization and economic growth. No study other than one conducted by Nguyen & Nguyen (2017) has attempted to calculate the threshold level of urbanization, however, the scope of the given study remained limited to only seven Asian countries. In this regard, this study will contribute to the literature by not only estimating the threshold level of urbanization but also including developed and developing nations and comparing their findings. The determination of the threshold level of urbanization is crucial for governments, as it signifies the point at which accommodating additional populations within cities becomes challenging. Consequently, having a precise understanding of this threshold level empowers policymakers in developed and developing nations to formulate migration policies that address the transition from rural to urban areas appropriately. Furthermore, this study will demonstrate its significance by providing recommendations for effectively managing urbanization to ensure it remains within a certain limit.

2. Literature Review

2.1 Evidence of Linear Relationship

Ahimah-Agyakwah et al. (2022) investigated the link between growth and urbanization in 30 African countries over the period 1970 to 2019. The results obtained after the application of GMM proved that urbanization surges growth, study argued that more population density in cities enhances productivity and indirectly improves growth. Similarly, Shaban et al. (2022) conducted a state-level study for India covering the years 1971 to 2020, the estimates obtained after bootstrap modeling verified the positive outcome of urbanization on growth. The study maintained that an unbalanced migration trend is followed in the country due to more allocation of resources in the cities. Moreover, Zhao (2023) attempted to explore the economic impact of urbanization in China, the author found urbanization to be beneficial for the economic uplift of a country. The study concluded that urbanization not only increases the per capita income but also reduces the regional disparities. Moreover, due to the availability of skilled workers as a consequence of urbanization, the country became able to increase output. A study by Shabu (2010) identified the existence of a direct relationship between urbanization and growth in developing countries. The author discussed that urbanization contributes to the augmentation of growth, as cities are widely regarded as catalysts for such progress. Likewise, Ou *et al.* (2008) argued that larger Chinese cities experience a growth at a faster pace in comparison to smaller ones, the author further added that urbanization is crucial for its growth-enhancing effect.

Afzal (2009) gathered data for Pakistan's economy over the period 1950 to 2001 to address the consequences of rapid population growth and rural-urban migration on growth. The author claimed that the population growth rate shrinks the net savings and consequently deteriorates the growth. However, urbanization is found to have growth-augmenting results. Moreover, the study concluded that the population growth rate is the driving force behind urbanization. Likewise, comparable results were obtained by Naing (1989) that extension in city sizes and population growth encourages urbanization. The study maintained that more employment and production activities in urban areas promote productivity and indirectly influence growth. Furthermore, Loughran & Schultz (2005) added that a firm's and industrial performance is contingent upon the geographical location. As it is witnessed that firms located in rural areas have to bear additional costs to approach the markets whereas urban firms experience less costs and more profits. The study maintained that high profits earned by urban industry are channeled toward the development of an economy. Haider et al. (2006) agreed that although urbanization poses various challenges related to the accumulation of population, hygiene, and the provision of educational and health facilities, however, it also presents new opportunities for fostering growth in a country. The study suggested that urbanization is essential for fostering innovations and growth. Drinkwater et al. (2004) in a survey of Europe in the year 2000 put forward the notion that labour migration is essential to induce productive activities for nurturing growth.

On the other hand, some studies have found an inverse relation between urbanization and growth, for instance, when examining the link between urbanization and growth in Nigeria from 1971 to 2014, Ali et al. (2022) discovered a detrimental connection. The empirical findings were evaluated using the FMOLS methodology, which revealed that urbanization has an adverse effect on growth. The authors' conclusion suggests that individuals residing in urban areas in Nigeria possess limited financial resources and do not make substantial contributions to economic activities. Likewise, Lewis (2010) by gathering data for Indonesia from 1960 to 2007 analyzed how urbanization and demographic changes influence growth. The study established that changes in work force yield fruitful outcomes for growth whereas urbanization is found to have adverse effects on growth. The author recommended that the government ought to increase spending on urban infrastructure to augment the growth of the country.

Literature also illustrated the existence of a bi-directional relationship between these two factors, for instance, Liang et al. (2023) verified the presence of a two-way relationship between urbanization and growth. The study used data from the Chinese economy for the period 1978 to 2019, the causality test revealed that urbanization is essential to augment the growth. Moreover, it was also revealed that the progress of both components is interdependent. The study conducted by Jacobs et al. (2023) focused on a South African province and examined data from the period 1997 to 2020. The authors employed causality and co-integration tests in their analysis. The empirical evidence has substantiated the presence of a causal link between growth and urbanization. The study concluded that economic growth is associated with an increase in employment opportunities and a corresponding migration of individuals towards urban areas. Likewise, Bakirtas & Akpolat (2018) examined the causality between growth and urbanization by garnering data from 6 emerging countries covering the period from 1971 to 2014. The Granger test indicated that urbanization and growth share a bi-directional relationship.

2.2 Evidence of Non-Linear Relationship

Kamble & Gulabrao (2013) while conducting a study on the Indian economy verified the presence of a non-linear association between urbanization and growth. Results indicated a direct and two-way association between two variables, however, the nature of this link is not straight. The authors discussed that after reaching a certain limit, the effect of urbanization becomes reversed and at that level, it begins to reduce the growth. It was argued that at a higher rate of urbanization, the economy is prone to several challenges related to population density, employment, and health facilities, hence, due to this fact after threshold urbanization tends to decline the growth. Moreover, a study by Ahimah-Agyakwah et al. (2022) for African economies indicated the occurrence of a positive but non-linear association concerning urbanization and growth. Likewise, Quigley (2007) claimed that urbanization at the initial stages proved to help fulfill the labor demand, however, at the later stages it contributed to several

economic and social challenges. The study established that excessive urbanization could be destructive for growth but an appropriate level of urbanization is crucial for growth. Aligning with subsequent studies, Nguyen & Nguyen (2017) in a study of 7 Asian economies over the period 1986 to 2016 found a two-way association between urbanization and growth. The study witnessed a U-shape relationship between both variables, it was discussed that at the initial stage, urbanization has growth growth-improving effect, however after achieving a certain level its effect becomes reversed.

Di Clemente et al. (2021) demonstrated the presence of a non-linear association between two phenomena. The authors posited that during the initial phases of urbanization, a country experiences a substantial acceleration in both its exports and production, leading to a correspondingly rapid growth trajectory. At advanced stages, the export sector has undergone significant development, such that any subsequent increase in urbanization at the moment does not exhibit any further economic transformations. Similarly, Sato & Yamamato (2005) in their study of European and developing countries for the period 1790 to 1990 confirmed the presence of a U-shape relationship. The study also underlined that the association between these two factors is bi-directional as growth also facilitates the process of urbanization. Literature is evident in the existence of both natures of linkages such as positive and negative between urbanization and growth. As Arouri *et al.* (2014) in a study of African countries discussed the growth augmenting effect of urbanization is not always consistent. Hence, the authors maintained that the link between growth and urbanization is complex and is entirely dependent upon the stages of urbanization. For instance, at early stages, an increase in urbanization is perceived to enrich the growth whereas at later stages urbanization extends at an optimal level, any development in urbanization beyond this point would have unfavorable consequences for growth. The past studies confirmed the complexity of association between two variables, hence in order to gain a comprehensive understanding of the urbanization and growth relation, it is imperative to identify the threshold level of urbanization and to analyze how the influence of urbanization on growth changes beyond this threshold. Similarly, Li & Hu (2015) employed regression analysis to examine the link between urbanization and growth during the period from 1978 to 2012 in China. Their findings confirmed a non-linear association between these two variables.

Therefore, there is no consensus among previous scholars as to whether the relationship between urbanization and growth is positive or negative, or whether it is linear or non-linear. As a result, this study makes an effort to resolve this controversy by including both linear and non-linear urbanization-related variables in the econometric model.

3. Data and Methodology

3.1 Theoretical Framework

The theoretical foundations of this study are derived from two models presented by Lewis (1954) and Todaro (1976). Lewis (1954) put forward the model of migration for developing countries, the theory claimed that developing countries consist of surplus labor in the agriculture sector due to which the marginal productivity remains less than zero. Hence, the model suggested that shifting surplus labor from agriculture towards the industrial sector would result in increased productivity in the traditional sector. Moreover, the shortage of labor in the industrial sector would be eliminated, consequently, more employment and production activities would take place. According to the model, urbanization increases industrial growth by eradicating a shortage of workers and results in rapid output production, hence, the model concluded that urbanization indirectly fosters growth. As argued by Henderson & Becker (1998) in developing countries urbanization and growth go hand-in-hand due to the fact that growth arises from the transformation of the agriculture sector into the industrial sector.

The second model serving as the foundational framework is derived from the urbanization model pioneered by Todarro (1976), this model claimed that sectoral movements of labor are regarded as a fundamental economic phenomenon. Moreover, the theory states that workers migrate due to wage differential and in search of improved quality of life, workers anticipate that by moving into the cities

their earnings would be more compared to their current ones. Hence, the difference between anticipated and current earnings encourages people to migrate. Theory illustrated that urbanization and industrialization are like two faces of the same coin that co-exist. In urbanization, factors of production are reallocated from less less-performing or agriculture sector towards the high-performing or industrial sector, in this way, urbanization directly rates the process of industrialization by offering improved productivity and supplying additional production factors.

Todaro's (1976) model of migration primarily focused on modern or developed nations that possess higher levels of industrialization, and operated under the assumption of full employment within the economy. Accordingly, the migration of labor from rural to urban areas, driven by anticipated wage rates, would cause a reduction in wage rate disparities as a consequence of market forces of supply and demand. It is commonly posited that individuals possessing advanced skills and education are likely to encounter a diverse range of employment opportunities. Conversely, individuals lacking specialized skills often face a limited set of options, typically consisting of either engaging in agricultural work or relocating to urban areas in search of alternative employment prospects. In the context of developed countries, there exist numerous opportunities, resulting in a relatively small proportion of the labor force experiencing unemployment. Conversely, in developing nations with limited opportunities, a larger percentage of the population could face unemployment. In particular, the prevalence of this phenomenon in developing nations would cause a significant portion of migrants to experience unemployment.

Before shifting from one to another sector, laborers need to assess the potential risks of unemployment and underemployment that are linked to migration, as well as the disparities in wage rates (Todaro, 1976). Therefore, it is evident from the preceding discussion that unplanned urbanization, particularly in developing nations, would give rise to issues such as shortages of fundamental necessities and unemployment. Furthermore, due to the severe consequences of excessive urbanization on macroeconomic determinants, the growth rate would also decline. In addition to theoretical models, empirical studies have also provided evidence that excessive urbanization is not conducive to economic growth. For instance, Arouri et al. (2014) carried out a study on African economies and witnessed an inverse U-shaped connection between urbanization and growth. Likewise, Nguyen & Nguyen (2017) also found that the relationship between these factors is non-linear, suggesting that after attaining a threshold level the growth-enriching role of urbanization becomes reversed.

3.2 Empirical Model

The empirical model formulated in this study is given by the underneath equation,

$$GDPC_{it} = \gamma_0 + \gamma_1 UR_{it} + \gamma_2 UR^2{}_{it} + \gamma_3 INV_{it} + \gamma_4 POP_{it} + \gamma_5 TRADE_{it} + \mu_{it} \quad (1)$$

Where γs are. parameters, UR shows urbanization measured as urban population as % of total population, INV illustrates Investment measured by Gross Fixed Capital, GDPC presents Gross Domestic Product Per Capita, POP depicts % of the population not in the labor force, UR^2 is Square of Urbanization, while TRADE variable is measured as trade as % of GDP. The data for all these variables is gathered from World Development Indicators.

i = 11 for developed countries model and 23 for developing countries

t = the year 1998 to the year 2021

Panel data is considered to be more informative compared to cross-sectional and time series data due to its ability to capture dynamic relationships as well as causalities across different units over time. However, it is challenging to employ pooled ordinary least squares (OLS) in this study, as the heterogeneity might exist across cross sections making pooled OLS an unsuitable technique. Moreover, Hsiao (2007) highlighted that OLS estimators become biased in the presence of heteroscedasticity, hence, this study cannot rely on OLS for estimation. Therefore, in this study both static and dynamic model is developed, the static model is estimated with the Fixed Effect (FE) Model while the dynamic

model is estimated with a two-step Generalized Method of Moment (GMM). The static model that is designed in this study is written as:

$$GDPC_{it} = \alpha_0 + \alpha_1 UR_{it} + \alpha_2 UR^2{}_{it} + \alpha_3 INV_{it} + \alpha_4 POP_{it} + \alpha_5 TRADE_{it} + \mu_{it} \quad (2)$$

The estimation of equation (2) will be conducted using a panel regression model. The decision to apply either a Fixed Effect (FE) or Random Effect (RE) model is contingent upon the results of the Hausman test. In the FE model, individual-specific effects are correlated with independent variables while in the RE model, individual-specific effects are uncorrelated with regressors. When the assumptions of FE are met, the fixed effect model produces more efficient outcomes in comparison to the random effects model, and vice versa. The Hausman test is employed as a means of selecting between two estimation techniques, the null hypothesis of the test posits that random effect is the most appropriate model. While the alternative hypothesis recommends the utilization of fixed fixed-effect model. In this study the null hypothesis. The findings derived from the implementation of the Hausman test in this study suggest that the fixed effect model is more suitable than the random effects model. Consequently, the aforementioned equation will be estimated using the fixed effect model.

According to a study conducted by Ahimah-Agyakwah et al. (2022), it was suggested that the growth rate of the current year is influenced by the growth rate of the previous year. Therefore, utilizing a static model and disregarding the past values of the growth rate in the model could end up in the issue of the model under specification and yield biased outcomes. Moreover, previous researchers [Ahimah-Agyakwah et al. (2022), Di Clemente et al. (2021), Nguyen & Nguyen (2017), and Arouri et al. (2014)] have demonstrated the presence of a bi-directional relationship between growth and urbanization, thereby necessitating the concern of endogeneity. Therefore, as a means of ensuring the reliability of the findings, this study incorporates a dynamic model that includes a lagged dependent variable. Furthermore, to address the problem of endogeneity arising from the lagged variable and the potential for two-way causality, the model will be estimated using dynamic GMM. The dynamic model is expressed in the following form:

$$GDPC_{it} = \beta_0 + \beta_1 GDPC_{it-1} + \beta_2 UR_{it} + \beta_3 UR^2{}_{it} + \beta_4 INV_{it} + \beta_5 POP_{it} + \beta_6 TRADE_{it} + \mu_{it} \quad (3)$$

In the above equation, the lag of the dependent variable is added as an independent variable, likewise, the lag of independent variables and dummy variables of years are used as instruments. Roodman (2006) argued that GMM is a flexible estimation technique as it permits the inclusion of not only internal but also external instruments as well. According to Roodman (2006), the GMM is considered a flexible estimation technique due to its ability to incorporate both internal and external instruments. In the dynamic model, the potential for endogeneity arises due to the inclusion of a lagged dependent variable as an independent variable. The GMM estimation procedure developed by Arellano & Bond (1991) and extended by Arellano & Bover (1995) is employed to address these concerns. The GMM possesses the advantage of effectively addressing the issue of unobserved heterogeneity and mitigating the problem of endogeneity arising from explanatory variables in the estimation of panel data. Moreover, the application of GMM offers a strategy to overcome the substantial difficulties linked to sample selection, measurement, and simultaneity (Arellano & Bond, 1991). According to Roodman (2009), the two-stage GMM approach exhibits lower standard error and bias compared to the one-stage GMM method, therefore, considering the numerous benefits of the two-step GMM, this study employs the same methodology to estimate a dynamic model.

4. Finding and Results

4.1 Descriptive Statistics

Table 1. Descriptive Statics

	Developed Countries' Sample				Developing Countries' Sample			
Variable	Mean	Standard Deviation	Max	Min	Mean	Standard Deviation	Max	Min
UR^2_{it}	6858.4	2692.25	10000	1018.63	3391.95	2358.10	8277.17	128.8
UR_{it}	80.82	18.08	100	31.91	53.93	21.99	90.97	11.35
POP_{it}	9.96	5.18	27.47	2.07	5.47	2.25	14.42	2.13
$TRADE_{it}$	136.35	109.26	442.62	18.34	76.12	37.13	220.40	21.92
$LnGDPPC_{it}$	9.75	1.103	11.44	6.51	7.82	1.157	10.35	5.32
$LnINV_{it}$	24.03	2.47	29.28	20.16	23.47	1.97	27.39	18.71

Source: Author's Calculation

Mean urbanization in developed countries is 80.8 units, and its minimum and maximum values are 32 and 100 units respectively. Whereas in developing countries, urbanization has a mean value of 53.9 units and maintains the minimum and maximum value of 11 and 90 units respectively. Likewise, the deviations of 21.9 units from the mean are greater in the developing country sample compared to 18 units of deviations in a developed sample. The data illustrated that there is a huge gap between urbanization levels in both sample countries. Moreover, the mean value of GDP remained at 9.75 and 10.35 units in developed and developing countries respectively. Similarly, a huge difference between the mean value of TRADE is witnessed in both samples, as it maintained values of 136.35 and 76.12 units respectively in developed and developing countries.

4.2 Panel Data Regression Results

In order to examine the correlation between urbanization and growth, this study estimated two models, denoted Model 1 and Model 2 as described in the methodology section. The utilization of the Hausman test is necessary to identify the most appropriate techniques for estimating static models. The Hausman test is employed to evaluate the null hypothesis that the random effect model is an appropriate fit against the alternative that the fixed effect model is suitable. The outcomes of static model (1) for developed countries and developing countries are presented in columns 2 and 3 of underneath table respectively. The results demonstrate that the p-value for both models is statistically significant, indicating that the null hypothesis, which suggests the use of random effects, is rejected. Hence, the estimation of equation (1) is conducted through the utilization of fixed effects.

Table 2. Results of Impact of Urbanization on Economic Growth

Panel A: Estimation Results of FE Model: Dependent Variable LnGDP

Variables	Model 1	Model 2
UR_{it}	0.099***	0.017***
	(0.000)	(0.000)
UR^2_{it}	-0.0007***	-0.0002***
	(0.000)	(0.0000)

POP_{it}	-0.061***	-0.041***
	(0.000)	(0.000)
$TRADE_{it}$	0.001	0.002***
	(1.53)	(0.000)
$LnINV_{it}$	0.055***	0.732***
	(0.000)	(0.000)
Constant	7.220***	9.784***
	(0.000)	(0.000)
Panel B: Diagnostic Tests		
Hausman Test		
Chi Square	32.93	Chi Square 32.93
P-value	0.000	P-value 0.000

*Note: ***, **, and * shows 1%, 5%, and 10% level of significance.*

Source: *Author's Calculation*

The findings of both Model I and Model II align with the anticipated results. Additionally, in Model II, all of the independent variables demonstrate statistical significance. In contrast, the coefficient of trade in Model I was found to be statistically insignificant. The findings from both Model I and Model II demonstrate a high degree of similarity, indicating that the association between urbanization and economic growth is not contingent upon the economic status of a nation. In both of the models, urbanization turned out to be positive demonstrating a growth fostering effect, moreover, the co-efficient remained significant in both models. Results are in line with previous related studies on the urbanization and growth literature [Jacobs et al. (2023), Zhao (2023), Liang et al. (2023), Shaban et al. (2022), Di Clemente et al. (2021), and Arouri et al. (2014)]. Results confirmed that urbanization is crucial to enriching the growth in both developed and developing countries.

Conversely, the square of urbanization exhibited a negative coefficient in both models, suggesting the presence of a nonlinear relationship. Furthermore, it has been demonstrated that this nonlinearity also confirms the existence of an inverted U-shaped relationship between urbanization and growth. The empirical findings align with previous literature that posited that excessive urbanization beyond a certain threshold has detrimental effects on economic growth. For instance, a study by Rakodi (2004) found that a persistent upturn in urbanization deteriorates growth. Likewise, Nguyen & Nguyen (2017) conducted a study that established the existence of a nonlinear connection and determined a threshold level of urbanization for seven countries, beyond which the effects of urbanization exhibit a reversed pattern. In both models, the sign urbanization square's coefficient is negative and significant at a 1% level of significance, demonstrating that the impact of urbanization reverts from positive to negative after a certain level as cities have a finite capacity to accommodate people and provide essential amenities. So threshold level of urbanization after which its impact reversed is being calculated below. Therefore, the empirical results of this study align with previous scholarly works [Ahimah-Agyakwah et al. (2022), Di Clemente et al. (2021) and Kamble & Gulabrao (2013)] which indicate that the link between urbanization and growth is intricate and exhibits non-linear patterns. This implies that the influence of urbanization on growth strengthens initially, then urbanization attains a threshold level and subsequently diminishes once a specific degree of urbanization is reached. Hence, it is essential to compute the threshold level of urbanization that redefines the growth relation, in the subsequent section the threshold level for both developed and developing countries is calculated.

Only a contrasting result is obtained for the trade variable, as in Model I trade variable illustrates growth enhancing effect for developed countries, whereas in Model II the given variable remained insignificant. The research conducted by Doğan et al. (2023) provides empirical evidence that aligns with the conclusions of Model I, which posits that trade stimulates growth in developed nations. While the findings for developing countries contradict the conclusions reached by [Nurjannah et al. (2023) and Elhakim & Ali (2023)] that trade promotes growth in these countries.

The findings indicate that investment exerts a significant positive influence on economic growth in both Models. Studies carried out by [Kanu & Ozurumba (2014) and Jhingan (2006)] approve the outcomes of the current study. The co-efficient of population not in the labor force variable appears with a negative sign. In this regard, Nguyen & Nguyen (2017) observed a detrimental effect of population on growth, specifically concerning individuals who are not part of the labor force.

4.3 Computation of Threshold Level of Urbanization

In order to compute the threshold level of urbanization for economic growth following procedure is being used.

$$GDPC_{it} = \beta_0 + \beta_1 UR_{it} + \beta_2 UR^2{}_{it} + \pi_1 INV_{it} + \pi_2 POP_{it} + \pi_3 TRADE_{it} + \mu_{it} \quad (4)$$

By applying the Ceteris paribus condition on equation (4) and taking derivative w.r.t Urbanization we get.

$$\frac{d(GDPC_{it})}{d(UR_{it})} = \beta_1 + 2\beta_2 UR_{it} \quad (5)$$

Now apply the first-order condition for maximization on the above equation by putting equals to zero.

$$0 = \beta_1 + 2(-\beta_2) UR_{it} \quad (6)$$

$$2\beta_2 UR_{it} = \beta_1 \quad (7)$$

$$UR_{it} = \frac{\beta_1}{2\beta_2} \quad (8)$$

The formula presented in equation (8) will be used to compute urbanization in developed as well as developing countries.

4.4 Threshold Level of Urbanization in Developed Countries

In order to compute the threshold level of urbanization for economic growth following procedure is being used.

$$LnGDPC_{it} = -7.220375 + 0.0999061 * UR_{it} - 0.0007337 * UR^2{}_{it} + 0.5509075 * LNINV_{it} - 0.0610565 * POP_{it} + 0.0005887 * TRADE_{it} + \mu_{it} \quad (9)$$

Now putting the values of Betas in equation (6) we get,

$$0 = 0.0999061 - 2(0.0007337) UR_{it} \quad (10)$$

$$2(0.0007337) UR_{it} = 0.0999061 \quad (11)$$

$$UR_{it} = \frac{0.0999061}{2(0.0007337)} \quad (12)$$

$$UR_{it} = \frac{0.0999061}{0.0014674} = 68.08375\ \% \quad (13)$$

Hence threshold level of urbanization for developed countries is 68.08% a sign that the urbanization coefficient is positive and a sign that the urbanization square coefficient is negative which shows that initially, urbanization has a positive impact on economic growth after a certain limit its impact reverts to negative.

4.5 Threshold Level of Urbanization in Developing Countries

Model for developing countries after attaining estimated parameters can be written as,

$$LnGDPC_{it} = -9.784804 + 0.0166311 * UR_{it} - 0.0001544 * UR^2{}_{it} + 0.7321524 * LNINV_{it} - 0.0408015 * POP_{it} + 0.0022928 * TRADE_{it} + \mu_{it} \quad (14)$$

Putting the value of parameters in equation (6) to compute the threshold level of urbanization for developing countries.

$$0 = 0.0166311 - 2(0.0001544)UR_{it} \quad (15)$$

$$2(0.0001544)UR_{it} = 0.0166311 \quad (16)$$

$$UR_{it} = \frac{0.0166311}{2(0.0001544)} \quad (17)$$

$$UR_{it} = \frac{0.0166311}{0.0003088} = 53.85\% \quad (18)$$

Hence threshold level of urbanization for developing countries is 53.8%

4.6 Robustness Check with Dynamic Model

Results of the dynamic model are reported in the table underneath, the panel B of the table illustrates the diagnostic test results of dynamic GMM. The results confirmed the non-existence of autocorrelation of second order for both samples. Moreover, the Hansen test established that the instruments used in the study were valid for both samples.

Table 3. Results of Impact of Urbanization on Economic Growth

Panel A: Results of Dynamic GMM: Dependent Variable LnGDP

Variables	Model 1	Model 2
UR_{it}	0.043***	0.324**
	(0.008)	(0.017)
UR^2_{it}	-0.0003**	-0.002***
	(0.015)	(0.014)
POP_{it}	-0.136***	-0.073
	(0.000)	(0.322)
$TRADE_{it}$	0.007***	0.0091**
	(0.000)	(0.041)
$LnINV_{it}$	0.096***	0.527
	(0.000)	(0.171)
$LnGDP_{it-1}$	0.068***	0.536**
	(0.000)	(0.030)
Constant	-2.211***	-20.592**
	(0.000)	(0.030)

Panel B: Diagnostic Tests		
AR (2)	-1.46 (0.144)	-0.65 (0.514)
J stat	18.46 (0.767)	19.89 (0.786)

*Note: ***, **, and * shows 1%, 5%, and 10% level of significance.*

Source: *Author's Calculation*

The growth rate of the current year is determined by that of previous years, the results also indicated that lagged growth augments the current rate of growth in both samples of countries, this result is significant in both samples of countries.

The dynamic model also confirmed that urbanization positively influences the growth in both sets of countries, while, urbanization square is negatively associated with the growth. Moreover, the formula illustrated in equation (8) is utilized to determine the threshold urbanization level. The threshold level for developing countries appeared as 61.55%, while for developed countries it turned out to be 77.66%. The threshold urbanization is observed to be more pronounced in developed countries due to their capacity to accommodate larger urban populations and offer sufficient amenities and infrastructure. In contrast, developing nations typically demonstrate a higher reliance on agriculture and other activities centered in rural areas. Furthermore, these nations possess a constrained urban capacity to accommodate a growing population and resources for a larger population. Therefore, regardless of whether a static or dynamic model is employed, the relationship between urbanization and growth consistently exhibits a non-linear pattern, as indicated by the negative value of UR^2 in both types of models. The size of the coefficient in the dynamic and static models is the only observed difference, resulting in a higher threshold level of urbanization in the dynamic model.

In both the static and dynamic models, the coefficients of all variables exhibit consistent signs. Specifically, the findings indicate that investment and trade openness have a positive impact on economic growth in both samples. Furthermore, the coefficient representing the proportion of the population not engaged in the labor force is found to have unfavorable consequences for economic growth.

5. Conclusion and Policy Implications

The study aimed to explore the relationship between urbanization and economic growth in both developed and developing Asian countries from year 1996 to 2018. The threshold level of urbanization is calculated for both developing countries and developed countries. The Hausman test is employed to choose between Fixed and Random effects for estimating the static model, the test predicted the utilization of the Fixed Effect Model. To ensure the reliability of the findings, a dynamic model is constructed, and the two-step GMM is used for estimating the parameters of the dynamic model. The findings derived from both the static and dynamic models demonstrate a clear and consistent pattern, indicating that urbanization has a growth-enriching effect in both developed and developing nations. Furthermore, the coefficient of UR^2 exhibited a negative value in both the dynamic and static models for both developed and developing countries suggesting that the relation between urbanization and growth is non-linear in both sets of countries and that this non-linearity is not dependent on the specific estimation technique employed.

Using a static model, the study found that the threshold urbanization in developed countries is 68.08% while in developing countries it is 53.08 percent. In contrast, after applying the dynamic model, the threshold appeared to be 77.66% and 61.55% for developed and developing countries respectively. The study concludes that developed countries have higher levels of threshold urbanization compared to developing countries, regardless of the specific technique applied. This phenomenon can be attributed to the greater availability of resources in developed countries, which enables them to accommodate the

influx of urban population and offer essential amenities. In addition, developed nations offer a broader spectrum of employment prospects, consequently leading to a rapid expansion in economic growth. On the other hand, developing nations encounter difficulties in accommodating the significant rise in urban population and providing access to vital services due to their limited capacity. Moreover, investment and trade variables illustrated growth-enhancing effects for both sets of countries, while population growth is found to have a detrimental effect on growth in developed as well as developing countries.

Based on empirical findings, the present study makes fewer recommendations, firstly, it is suggested that developing countries implement measures to facilitate a more seamless transition from rural to urban areas, as they have not yet reached the required level of urbanization. The significance of this matter lies in the potential of urbanization to enhance the trajectory of economic growth, as evidenced by the findings of the current investigation. Therefore, the public sector must offer infrastructure and essential amenities in urban regions as a means to encourage the migration of labor from the agricultural towards the industrial sector. Secondly, developed economies need to address the issue of wage rate differentials as a significant proportion of the population of such countries resides in urban areas, where the level of urbanization exceeds the established threshold. In this context, the public sector must assume a proactive role in ensuring equitable access to amenities and opportunities for workers in rural areas, similar to those provided to urban residents. This step will prove to be essential in maintaining a harmonious equilibrium between these two sectors. Lastly, countries characterized by a higher degree of urbanization have to formulate policies aimed at directing the labor force's capabilities towards more productive endeavors, such as contributing to economic growth, promoting employment opportunities, and fostering environmental sustainability, rather than encouraging the rapid pace of urbanization.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Exploring Macroeconomic Determinants of Inflation in Pakistan; Fresh Insights from Vector Autoregressive Analysis

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Abstract

It is a widespread argument that mild inflation is in favor of the economic growth of an economy. However, high inflation can be destructive to consumers as well as to businesses and the overall economy. Hence, identifying essential sources of inflation is crucial for both the central bank and economic units. The purpose of this study, therefore, is to examine the key determinants of inflation in Pakistan by using time series data over the period extending from July 1993 to May 2021 and employing the Vector Autoregressive (VAR) method. The variables are seasonally adjusted while growth rates of all the variables are used except for the interest rate in the study. The model results revealed that global crude oil prices, imports, money supply, and government borrowing are the most important determinants of inflation in Pakistan. Furthermore, the findings also showed that the exchange rate and interest rate have a positive effect on inflation and are statistically significant. Based on the findings, the study recommended that inflation may be kept under control by taking the following measures such as controlling government borrowings, money supply, and particularly, imports. Additionally, regulating exports and interest rates can also help in combating the problem of inflation.

Keywords: *Inflation, Money Supply, Government Borrowing, Imports, Purchasing Power*

JEL Classification: *E21, E31, H50*

1. Introduction

Inflation seems to be a universal phenomenon in any economy. However, among other economic challenges in Pakistan, inflation in recent times is considered one of the most important in the country. In the words of Shapiro (1972), inflation is a steady rise in the general price level that results from the increase in the costs of goods and services in an economy over a period of time. However, high inflation is not in benefit of the economy as it has a negative impact on the economic activities of the country (see, Junejo et al., 2021; Runganga, 2020). When the prices of goods and services are continuously rising, then each unit of money in hands of consumers buys less and can leads economy to in unstable position, as people discourages to save larger and investment more. Hence, it is going to be difficult for the local currency to serve as a medium of exchange and a store of value in an inflationary economy without having a negative impact on income distribution, output, and employment along with a decline in the value of the country's currency and a rise in her exchange rate when compared to other currencies (Jhingan, 1997).

Inflation also creates panic in the people, and they begin hoarding essential items, to keep themselves save from paying more tomorrow. This negatively effects the daily supply chain and goods becomes

scare in the market, that slowdown the economic activities of the country (Runganga, 2020). However, the trend of inflation in Pakistan over the time was influenced by both demand and supply side factors. For instance, Bashir et al. (2016) reported both demand and supply side factors. In his words, the rise in inflation from the demand side is generally caused by roads and government expenditures. However, supply side factors that usually caused inflation includes high imports, huge external debts and government revenues (see also, (Iqbal et al., 2022; Ahmed et al., 2014a; Arif & Ali, 2012; Abdus & Zafar, 2005). The crude oil prices and the faster devaluation of the local currency also determine inflation and there is a negative correlation found between them (GENÇ et al., 2023; Hussain et al., 2022; Saleem et al., 2022). Moreover, the recent flood in the country that washed away a larger portion of crops, faster depreciation of local currency and rising of imports compared to the exports are also considered some of the important factor in creating inflation in Pakistan. Similarly, Aurangzeb and Haq (2012) suggested that interest rates, exchange rates, fiscal deficits, and unemployment rates are the important determinants that determines inflation in Pakistan

Hence, the identification of essential sources of inflation is very important for the policy makers to accurately forecast, and to efficiently and effectively design monetary policy for the purpose of prices stability in the economy (see, Ratnasiri, 2011). The objective of this study, therefore, is to have a fresh examination of the determinants of inflation in Pakistan. The rest of the study is organized as follows; Section 2 provides a brief literature review while section 3 covers the proposed estimation methodology which is followed by section 4, dedicated to results and discussions of the study. The last section provides concluding remarks of the study with some policy recommendations.

2. Literature Review

Determinants of inflation are presented in various ways in the previous studies. For instance, Khan and Schimmelpfennig (2006) examined the monetary determinants that contributed to forecast inflation in Pakistan. Using a monthly data set from 1998 to 2005, the Johansen co-integration technique was employed in this study to establish the results. Based on the findings, role of monetary determinants was dominant in affecting the rate of inflation with a one-year lag. Furthermore, the growth of broad money and the growth of private sector credit were significant determinants of inflation that could be used to forecast future inflation. Similarly, in the study of Ellahi (2017), both the money supply and national expenditure have a significant impact on inflation, while national expenditure having a positive impact and the money supply having a negative impact. Moreover, imports of goods and services have a positive impact on inflation whereas GDP growth has a negative effect. The results for the short run effect suggested that none of the variables appear to be a significant determinant of inflation in the short run.

A recent study conducted by GENÇ et al. (2023) for Pakistan and Turkey, showed that currency deprecation causes inflation in both nations. Other factors contribute to inflation in both nations, includes interest and oil prices. Using time series data from 1970 to 2020 and employing ARDL model for Pakistan, Shoukat et al. (2023) concluded that economic globalization, government expenditures have a positive and significant impact on inflation in Pakistan while GDP and exchange rate (insignificant) show a negative impact on inflation in their study. Furthermore, Saleem et al. (2013) empirically examined the impact of macroeconomic variables such as the fiscal deficit, interest rate, gross domestic product, exchange rate, and unemployment rate on the inflation rate in Pakistan's economy. The study used time series data from the period of 1990 to 2011. According to the findings, there is a negative correlation between the unemployment rate, the fiscal deficit, and inflation, whereas there is a positive correlation between the exchange rate, GDP, interest rates, and inflation (see also, GENÇ et al., 2023; Ghumro & Memon, 2015).

Table 1. Summary of recent empirical literature

Studies	Country/ Time period	Approach(es)	Findings
GENÇ et al. (2023)	Pakistan and Turkey 2010 to 2021	Wavelet Coherence Model	Currency depreciation, interest and oil prices causes inflation in both nations.
Shoukat et al. (2023)	Pakistan 1970 to 2020	ARDL	Economic globalization and government expenditures positively related with inflation while GDP negatively related with inflation, however, the negative impact.
Hussain et al. (2022)	Pakistan 1980 to 2020	ARDL	Exports, gross fixed capital formation, the money supply, and oil prices are all positively correlated with inflation.
Iqbal et al. (2022)	Pakistan 1989 to 2019	ARDL	In the long run, the exchange rate was negatively but M2 positively related to inflation. However, in the short run, GDP and Exchange rate was positive but M2 was negatively related.
Saleem et al. (2022)	Pakistan 2001 to 2018	VECM model	There is a negative correlation between inflation and devaluation of the currency.
Iqbal et al. (2021)	Pakistan 1991 to 2019	ARDL Co-integration Analysis	Increase in energy demand leads to energy inflation.
Junejo et al. (2021)	Pakistan 1990-2020	Quantitative Research Approach	Inflation has negative impact on Economic growth.
Zakaria et al. (2021)	South Asia 1980M1–2018M12	Co-integration and VAR	The positive oil price shock significant and rises inflation but the negative is insignificant.
Runganga (2020)	Zimbabwe 1981 to 2018	Dynamic Ordinary Least Squares	Inflation negatively affect Economic growth.
Ahmed et al. (2018)	Pakistan July 2001 - June 2017	Vector Autoregressive	Imports and exports positively cause inflation.
Khan and Khan (2018)	Five Asian Countries 1973 t0 2016	Panel Estimation	Inflation is harmful for the rate of economic growth.
Qayyum and Sultana (2018)	Pakistan 1970 to 2017	Regression Analysis	All the variables positively and influencing food inflation except money supply.
Ellahi (2017)	Pakistan 1975 to 2015	ARDL	Expenditure and imports positive, but money supply and GDP growth implies negative impact on inflation.

Kartikasari (2017)	Indonesia 2009 to 2016	Panel Data Regression Analysis	Imports negatively affecting the economic growth.
Bashir et al. (2016)	Pakistan 972 to 2014	ARDL	All explanatory variables were significant in influencing inflation.
Ghumro and Memon (2015)	Pakistan 1980 to 2012	ARDL	Gross national expenditure, total reserve, exchange rate, money supply are positively influencing inflation.
Lim and Sek (2015)	28 Countries 1970 to 2011	ARDL	All variables in the analysis have significant in influencing inflation.
Saleem et al. (2013)	Pakistan 1990 to 2011	Regression Analysis	Exchange rate, GDP, interest rate positively correlated and inflation while unemployment rate, fiscal deficit, and inflation are negatively.
Arif and Ali (2012)	Bangladesh 1978 to 2010	Co-integration Error Correction	Broad money, import, GDP, and government expenditure have positively but export and Government Revenue negatively influence inflation.
Sahadudheen (2012)	India 1996Q1 to 2009Q2	Co-integration and Error Correction	The exchange rate had a negative correlation with inflation whereas the GDP and broad money had a positive.
Tafti (2012)	Iran 1971 to 2005	Vector Autoregressive	Liquidity and import prices have positive impact on inflation.
Altowaijri (2011)	Saudi Arabia 1996 to 2010	Formal Theoretical Model	Money supply has no impact on inflation.
Khan and Schimmelpfennig (2006)	Pakistan 1998 to 2005	Johansen co-Integration	Monetary factors have positive impact on rate of inflation

Junejo et al. (2021) reported that inflation have a significantly negative impact on the economic growth in Pakistan (see also, Haider et al., 2024; Runganga, 2020; Khan & Khan, 2018; Kartikasari, 2017). On the same line, Tafti (2012) examined the determinants of inflation in the Islamic Republic of Iran. For the years 1971 to 2005, the quarterly time series data was used. The vector autoregressive approach was employed in the present study. The dependent variable was inflation while the independent variables were gross domestic product and import price index. According to the findings, the consumer price index had a weak response to a shock in GDP, but had a strong response to a shock in import price index and liquidity. Altowaijri (2011) investigated the external and internal factors that causes inflation in Saudi Arabia over the years 1996 to 2010. The analysis suggested external factors as the primary source of inflation in Saudi Arabian kingdom, whereas the money supply had no impact on inflation. Likewise, Arif and Ali (2012) conducted study on inflation for Bangladesh by employing co-integration error correction techniques and using data from 1978 to 2010. According to the findings, government revenue and exports have a negative long-term impact on inflation, while broad money, GDP, imports, and government expenditure all have positive effects. The main short-run contributing factor, however, is money supply, which is caused by inflation.

Lim and Sek (2015) studied the factors that influence inflation in two groups, (low inflation and high inflation countries). The study utilized ARDL to a data set spanning the years 1970 to 2011 and

concluded that none of the determinants significantly affect inflation in high income counties, while all of the variables in low-income countries experience significant effects in short run. Similarly, Tolasa et al. (2022) explored macroeconomic determinants of inflation in Ethiopia by using annual data from 1981 to 2020 and employing ARDL model. They found that in the short run, money supply, real GDP, population growth, gross national saving and previous year imports are the key drivers of inflation while in the long run: real GDP, real effective exchange rate, lending interest rate are positive and significant determinants of inflation. However, Sahadudheen (2012) investigated the relationship between inflation and exchange rate in India, concluding that the GDP and broad money had a positive influence on inflation while the exchange rate had a negative impact. Moreover, using data for Pakistan from 1972 to 2014 and the ARDL model, Bashir et al. (2016) came to the conclusion that the supply side factors of inflation are imports, government revenue, electricity generation, and external debt, while the demand side factors of inflation are population, roads, and government expenditure. Long-term factors that contribute to inflation include external debt, government revenue, imports, and government expenditure. Over time, population growth, electricity production, and foreign direct investment all result in a decline in price level.

3. Methodology and Data

On the bases of economic theories and literature, we have selected the following economic variables to explore the possible relationship between them and inflation rate for Pakistan economy. We have selected, exchange rate (EXR), import (M), global crude oil (OilPB), monetary aggregate (M2), government borrowings (GB), large scale manufacturing index (LSM) as a proxy of GDP growth, interest rate along (DISR) with consumer price index inflation of Pakistan (CPI), details are given in table 2. This study utilized monthly data series starting from July 1993 to May 2021. The data is collected from Pakistan Bureau of Statistics (PBS) and State Bank of Pakistan (SBP). For this study we take growth rate (YoY) of seasonally adjusted data series except for the interest rate variable. In the study, consumer price index (CPI) is used as a proxy of inflation. This proxy is also recently used by Tolasa et al. (2022), Iqbal et al. (2022), Ahmed et al. (2018), and Ahmed et al. (2014a).The examination of unit root problem is considered as the foremost step in the time series data analysis. For this purpose, the Unit Root Test is employed to determine whether or not the data is stationary. However, the majority of the economic variables show a non-stationary trend. R-square and the t-score will increase if the variables are non-stationary, and this will cause spurious regression, which makes the results invalid. The first difference of such a time series will be stationary if the time series has a unit root (non-stationary). To check for stationarity in the data set, the Augmented Dickey-Fuller (ADF) unit root test under Schwartz information criteria is used. The ADF test includes the estimation of the following regression (Gujarati, 2004);

$$\Delta Y_t = \alpha + \beta_t + \delta_i Y_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta Y_{t-i} + \mathcal{E}_t \qquad (1)$$

Where Y_t is the variable under consideration, Δ is the first difference operator, t captures the temporal trend, $\mathcal{E}_t$ is the random error term and n is the maximum lag length. The optimal lag length is determined to ensure that the error term is white noise error term, while α, β, δ and γ are the parameters to be estimated. It is evident that the series under consideration has a unit root and is, thus, nonstationary if the null hypothesis of the test $\delta = 0$ is not rejected. In addition, we used Granger causality approach to find the structures of the causal relationships between Consumer Price Index and other variables. For the purpose of establishing whether one-time series may cause another, the Granger causality test is used.

The hypothesis would be considered rejected at that level if the probability value is less than 5%, and causality would be assumed to exist.

In this way we can find lags of the variables with appropriate lag length which causes inflation. If we find either a mix causality relationship or bivariate causality relationship, then we will be unable to find that which variable is endogenous and exogenous. In that case we switch to Autoregressive model. The test involves the estimation of the following pair of regressions (Gujarati, 2004);

$$Y_t = \sum_{i=1}^{n} \alpha_i X_t + \sum_{j=1}^{n} \beta_i Y_t + U_{1t} \quad (2)$$

$$X_t = \sum_{i=1}^{n} \lambda_i X_t + \sum_{j=1}^{n} \delta_i Y_t + U_{2t} \quad (3)$$

Where it is assumed that the disturbances U_{1t} and U_{2t} are uncorrelated. In passing, note that we will deal with bilateral causality in case we have two variables. However, in multivariable case in time series econometrics, this is extended to multivariable causality through the technique of vector auto regression (VAR).

3.1 Model Specification

One of the most effective, simple, and adaptive approaches for the analysis of multivariate time series is the vector auto-regression (VAR) model. Moreover, dynamic multivariate time series are a natural extension of the univariate autoregressive model. The VAR model has been shown to be particularly effective for forecasting and characterizing the dynamic behavior of economic and financial time series. In addition, the VAR model is utilized not only for data description and forecasting but also for structural inference and policy research. For a set of n time series variables $Y_t = (Y_{1t}, Y_{2t,} Y_{3t,} \ldots, Y_{nt})$ a VAR model of order p [VAR (p)] can be written as:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_P Y_{t-p} + U_t \quad (4)$$

where C is a $n \times 1$ vector of constants (intercepts), the A_P's $(n \times n)$ matrices of coefficient and $U_t = (U_{1t}, U_{2t,} U_{3t,} \ldots, U_{nt})$ is an $n \times 1$ vector of error terms satisfying; $E(U_t) = 0$ means that every error term has zero mean and $E(U_t U_{t-n}) = 0$ means that there is no serial correlation in individual error terms. The selection of the VAR lag order is an important first step in the model-building process. In this work we use the commonly used lag-order selection criteria Akaike Information Criteria (AIC) to choose the lag order.

4. Results and Discussions

The results of the descriptive statistics of the present study are given in Table 2. The descriptive statistics show that all the variables CPI, LSM, EXR, M, OilPB, M2, GB, and DISR have 335 total observations. The median and standard deviation value of each employed variable is also given in the present study. However, the mean value of each variable in Table 2 shows the average value of each variable and all variable values demonstrate positive signs of average values and high variability from their mean values. Having provided the descriptive statistics of all the variables used in the present study, next in time series analysis, the concept of correlation is very important. The aim of correlation analysis is to establish a relationship between two variables and to spot patterns or trends between them based on how they change in relation to other aspects. If there is a correlation between any two variables, it signifies that whenever one variable is changed methodically, the other variable also changed systematically.

Table 2. Descriptive Statistics of Variables Used in the Study

Variable	Mean	Median	Std. Dev	Min	Max	Obs.
CPI	8.18	7.94	4.07	1.34	22.17	335

LSM	4.51	4.01	9.13	-40.34	70.09	335
EXR	7.06	4.09	8.27	-7.40	32.52	335
M	7.96	7.07	21.15	-38.54	98.86	335
OilPB	9.66	4.29	37.40	-69.05	200.84	335
M2	14.03	14.14	3.48	2.77	20.85	335
GB	15.58	14.55	13.91	-11.57	71.35	335
DISR	11.29	10	3.59	6.25	20	335

Data Source: State Bank of Pakistan & Pakistan Bureau of Statistics

Over a particular amount of time, the variables change together. Usually, the variables are evaluated in terms of a base variable and are measured as positive or negative. If both variables rise at the same time, there is a positive correlation. If not, there is a negative correlation between the variables. Since our series are time series, we utilize Pearson correlation to examine the correlation between them over different lags. In table 3, the correlation of CPI with LSM is negative on level as well as on lags too. As the lag's length increases, the correlation between CPI and LSM decreases.

Table 3: Correlations between Inflation Rate and Economic Variables

Correlation of CPI with	**LSM**	**EXR**	**M**	**OilPB**	**M2**	**GB**	**DISR**
Level	-0.234	0.344	0.132	0.107	0.175	0.642	0.517
lag-1	-0.225	0.324	0.169	0.149	0.203	0.634	0.489
lag-2	-0.258	0.306	0.201	0.172	0.230	0.618	0.458
lag-3	-0.244	0.285	0.219	0.196	0.261	0.598	0.425
lag-4	-0.220	0.259	0.231	0.218	0.281	0.569	0.388
lag-5	-0.199	0.230	0.244	0.234	0.306	0.538	0.353
lag-6	-0.173	0.203	0.222	0.245	0.334	0.501	0.322
lag-7	-0.140	0.180	0.206	0.241	0.353	0.454	0.288
lag-8	-0.134	0.156	0.185	0.227	0.369	0.415	0.257
lag-9	-0.115	0.137	0.163	0.213	0.383	0.376	0.227
lag-10	-0.108	0.123	0.127	0.188	0.386	0.343	0.198

Source: Authors' calculations

The correlation of CPI with EXR and GB (Government Borrowing) is highly positive in terms of level as well as on lag months too. In lag months, the correlation of CPI and EXR and GB decreases as the lag months' increases. Similarly, the correlation of CPI with M (Import), OilPB (Global Crude Oil), M2, government borrowing and DISR is also positive. The impact of export, import and oil prices is small initially at level but then it eventually increases as the lag month also increases and then onwards decreases as the lag months' increases. The correlation of CPI with M2 is positive but small at level while when the lag months' increase, the correlation of CPI with M2 increases. The correlation of CPI with DISR is positive. This positivity of correlation between the CPI and DISR is due to the price puzzle (Hayat & Hanif, 2016).

Table 4: Augmented Dicky Fuller Test for Unit Root

Variables	**Level**		**1st Difference**	
	Intercept	Trend & intercept	Intercept	Trend & intercept
CPI	-1.649693	-1.568019	-9.886246*	-9.897228*
LSM	-3.460650*	-3.345745	-4.670365*	-4.682645*
EXR	-2.756405	-3.145375	-8.444504*	-8.418983*
M	-3.405927*	-3.376871	-6.804350*	-6.749748*

OilPB	-3.754473*	-3.786997*	-8.426489*	-8.396363*
M2	-2.452900	-2.429659	-7.338598*	-7.329391*
GB	-2.117563	-2.211186	-8.534605*	-8.518999*
DISR	-1.664963	-2.532136	-11.30310*	-11.31017*

Source: Authors' calculations, * shows significance at 5% level of significance

Referring to table 4, this study used standard Augmented Dickey-Fuller (ADF) unit test under Schwartz information criteria in order to check the stationarity of the series. The results show that OilPB are stationary at level. However, LSM and M are stationary at intercept only. The rest of variables are non-stationary at level. In order to avoid over estimation in the results, all variables are become stationary after taking the first difference.

Table 5: Granger Causality Test

Causality	**Probability**			
	Lags 2	Lags 4	Lags 6	Lags 13
CPI Cause LSM	0.01*	0.08	0.09	0.15
CPI Cause EXR	0.10	0.03*	0.03*	0.02*
M Cause CPI	0.00*	0.05*	0.00*	0.11
OILPB Cause CPI	0.00*	0.00*	0.00*	0.08
M2 Cause CPI	0.05*	0.10	0.07	0.05*
CPI Cause GB	0.02*	0.01*	0.00*	0.18
DISR Cause CPI	0.08	0.07	0.08	0.00*
CPI Cause DISR	0.00*	0.00*	0.00*	0.00*

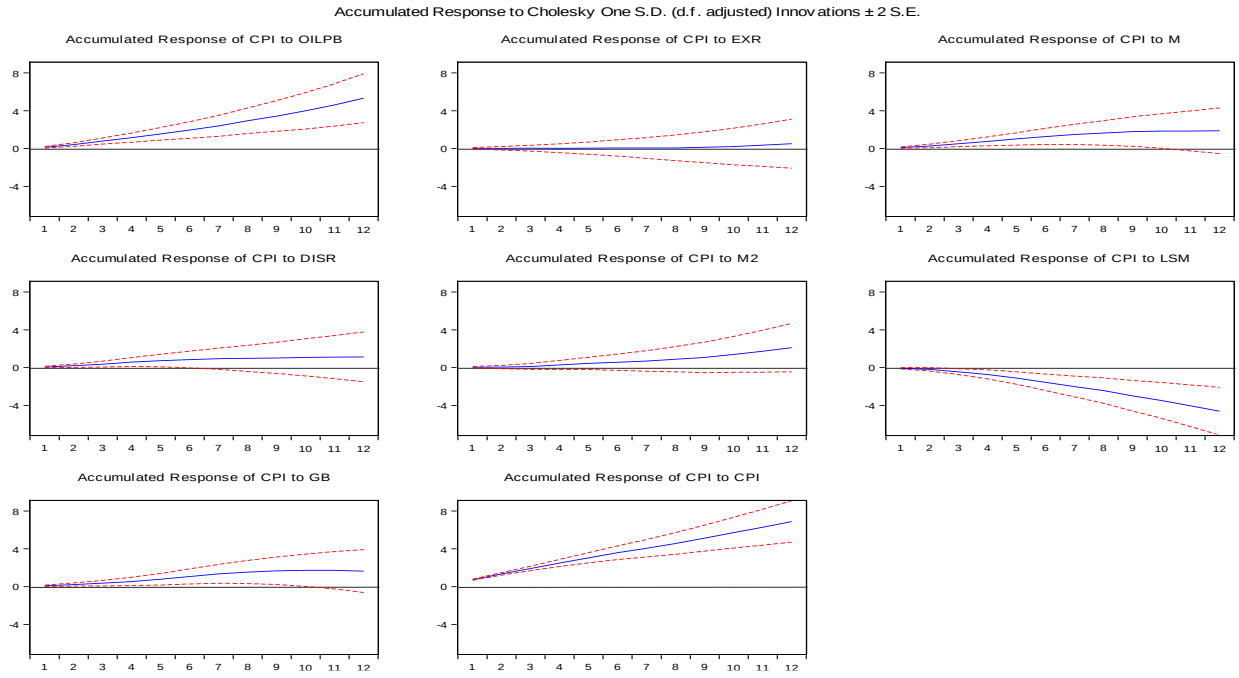
Source: Authors' calculations, * shows significance at 5% level of significance

The results in Table 5 show that in two months lag between CPI and LSM, the hypothesis that CPI does not Granger cause LSM can be rejected at the 5% level of significance. Thus, we found unidirectional causality running from CPI to LSM. In four, six- and thirteen-months lag between CPI and EXR, we found unidirectional causality running from CPI to EXR. In the result in two, four, and six-months lag between CPI and M, it is found that unidirectional causality exists, running from M to CPI. In two, four- and six-months lag between CPI and OilPB, it is found that unidirectional causality exists, running from OilPB to CPI. In two and thirteen lag months between CPI and M2, we found unidirectional causality is running from M2 to CPI. In two, four- and six-months lag between CPI and GB, it is found that unidirectional causality exists, running from GB to CPI. While in two, four, six-, and thirteen-months lag between CPI and interest rate, it is found that unidirectional causality is exist at two-, four- and six-month lag running from CPI to Interest rate and at thirteen-month lag bidirectional causality exist while in the rest of lags, causality does not exist. For all the variable Granger causality testing is applied at 5% level of significance respectively.

The VAR modeling is one of most successful, flexible, and easy way for multivariate time series analysis, standard VAR models can employ more than 6 to 8 variables. Since we have a large number of variables and due to large set of variables, there may be a chance of degree of freedom problem in VAR modeling. As a means of reducing this dimensionality problem, we have dropped Government Borrowing (GB) variable in VAR Modeling approach.

4.1 Impulse Response

In this section, impulse response functions are used to analyze the model's dynamic properties. The following figure shows the response of the CPI (inflation rate) to a standard deviation shock to the Global Crude oil (OILPB), Exchange Rate (EXR), Import (M), Interest Rate (DISR), Monetary aggregate (M2), Large-Scale Manufacturing Index (LSM), Government Borrowing (GB) and CPI, respectively. The time horizon, or the length of the shock, is represented by the x-axis, while the direction and magnitude of the impulse, or the dependent variable's percent variation, are shown by the y-axis. The impulse responses were generated using analytical (asymptotic) simulations that were 100 repetitions from the VAR.



The results suggest that global crude oil has a significant effect on Consumer Price Index (CPI). A positive shock to global crude oil has initially positive and low effects on CPI but later on, particularly when the time periods increase, the effects of global crude oil on CPI sharply increases. This is consistent with the theory that an increase in global crude oil will increase the domestic price level. Moreover, this confirmed the findings of GENÇ et al. (2023), Sek (2023), and Zakaria et al. (2021). Similarly, a positive shock in the exchange rate leads to a positive response from the CPI. This positive impact persists for about one year six periods and then gradually dies. This finding is in line with the Hussain et al. (2022)'s study. Their study further added that crude oil prices and real effective exchange are most significant determinants inflation in Pakistan (GENÇ et al., 2023). Moreover, in the case of import, the effect of one standard deviation shock to import on the CPI increases after 2 periods, reaches to peaks and then after 8 periods gradually declines. This result is an accordance with the findings of Ahmed et al. (2018), Ellahi (2017), and Ahmed et al. (2014a). The impact of the interest rate has a positive effect on CPI and as the period increases, the impact effects are also increasing. This finding is in line with the recent study of GENÇ et al. (2023) and Tolasa et al. (2022). However, Hayat and Hanif (2016) concluded in their study that the positive correlation between the interest rate and CPI is due to the price puzzle. Moreover, interest rate and inflation are the two most important macroeconomic variables as their behavior have significant influence over economic growth (Mensah & Okyere, 2015). The positive monetary shock exerts inflationary pressure on CPI. Initially its impact is very little but after 6 periods, it tends to be increasing. This finding is also an accordance with the findings of Tolasa et al. (2022), Hussain et al. (2022), Ellahi (2017), and Nisar and Tufail (2013). As claimed by Lim and Papi (1997), the excessive money supply is the primary source of inflation (also see, Ujkani & Gara, 2023). The response of CPI to large scale manufacturing index (as a proxy of GDP growth) shows that the effect of one standard deviation shock to large scale manufacturing index on the CPI is negative impact. This finding is in line with studies i.e. Junejo et al. (2021), Khan and Khan (2018), and Ellahi (2017). Moreover, with one standard deviation shock, initially, the effect of government borrowing is weak, however, after 5 periods it exerts an inflationary pressure on CPI. This positive influence of government borrowing on CPI is already concluded by previous studies i.e. Tolasa et al. (2022), Ahmed et al. (2014b), and Khan et al. (2007). CPI shock seems to have a highly significant impact on itself. One standard deviation CPI shock is characterized by one standard deviation increase in CPI in the next period. Positive effect remains increasing as the period increases.

5. Conclusion and Policy Remarks

For the economic units, it is important to identify the key sources that influence inflation and to anticipate it properly to keep safe themselves from paying more tomorrow. However, it also helps the central bank to design its monetary policy in an efficient and effective way. Therefore, using a VAR-based approach, this study attempted to examine the factors that influenced inflation in Pakistan from July 1993 to May 2021. The data is collected from Pakistan Bureau of Statistics (PBS) and State Bank of Pakistan (SBP) and then the data (variables) is seasonally adjusted while growth rates of all the variables is used except for the interest rate variable. Moreover, Consumer Price Index is taken is an indicator of Inflation while the rest of the variables are considered as determinants of Inflation.

This study concludes that global crude oil growth, imports growth, money supply growth and large-scale manufacturing index growth are the most important determinants of inflation in Pakistan. The increase in global crude oil prices, rise in demand for imports, and more money supply rises inflation, however, the expansion in large scale manufacturing reduces inflation in Pakistan. The effect of the other variables includes exchange rate, interest rate and government borrowing on inflation is positive and statistically significant. However, initially the effect of exchange rate growth on inflation is not statistically significant but later onwards the exchange rate effect on inflation is rises while the impact of the interest rate has a positive effect on CPI and as the periods increases, the impact effects is also increasing. and after some periods then it remains the same. The effect of government borrowing in initial periods is not important, however, after a few periods it exerts a strong inflationary pressure on CPI.

Based on the findings of the study, it is recommended that inflation can be kept under check by controlling government borrowings, money supply, and particularly, regulating imports and interest rate as the government has the control over these variables. In addition, large scale manufacturing should be enhanced as involved in leading to lower inflation. Besides this, Pakistan needs to encourage exports and regulate fluctuations in the exchange rate. Also, foreign direct investment needs to be attracted while the outflow of funds should be discouraged, which will help in currency stabilization. Furthermore, the public sector should encourage development expenditures and needs to reduce the current government expenditures, to control and achieve the desired level of inflation as recommended by Shoukat et al. (2023).

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Data Availability Statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Climate Change Impacts on Household Income in Pakistan: An Empirical Analysis

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Abstract

As climate change continues to pose a significant challenge globally, this study examines its impact on household income, delineating the differential impacts across agricultural and non-agricultural sectors in Pakistan. Utilizing household data from 2020 for 156,440 households across 126 districts of Pakistan, along with climate variable data spanning from 1961 to 2020, the research employs multiple regression analysis with robust standard errors to explore these impacts. The findings reveal that changes in the mean values of temperature and precipitation, as well as the variability of these climate variables, have a statistically significant impact on household income. Specifically, a one-degree Celsius rise in average temperature leads to a 3.3% decrease in income for households in the agricultural sector and a 0.4% decrease for those in non-agricultural sectors. The variability in temperature, indicated by a one-degree increase in its standard deviation, similarly results in a 4% income reduction for households across both sectors. Conversely, a one-decimeter increase in average precipitation is associated with a modest income increase of 0.33% and 0.19% for the agricultural and non-agricultural sectors, respectively. However, greater variability in precipitation adversely affects income in both sectors. The research highlights the vulnerability of households, especially those in agriculture, to climate change and shows non-agricultural sectors are also affected. It offers insights into climate change's economic impacts and suggests developing targeted policies to improve adaptation and resilience.

Keywords: *climate change, climate variability, household income, agricultural sector, Pakistan*

JEL Classification: I38, P36, Q54

1. Introduction

Climate change is a global challenge with profound implications for both natural and human systems. The repercussions of climate change are particularly acute for developing countries, where a significant portion of the population relies on climate-sensitive sectors such as agriculture for their livelihoods (Noack, 2015). Agriculture is highly vulnerable to climatic changes, as weather variables, including temperature and precipitation, are direct inputs into agricultural production (Deschenes & Greenstone, 2007). Many industries, such as textiles and food processing, are agro-based and either directly or indirectly linked to agriculture. Furthermore, many other sectors may also be affected because household consumer demand is dependent on agro-based income. Notably, climate change adversely affects both agricultural and industrial sectors, as its repercussions extend beyond the agricultural sector, influencing assets and workers' productivity through a variety of channels (Skoufias et al., 2011; IPCC, 2014). While the agricultural sector's vulnerability to climate change is well-documented, the impacts on non-agricultural sectors are less understood. Studies such as those by Dercon (2004) argue that climate

change has a broad economic impact, affecting not only agriculture but also manufacturing, services, and other sectors through complex channels.

Recent studies have increasingly focused on the economic vulnerabilities induced by climate change, highlighting the direct and indirect impacts on livelihoods. For instance, Hallegatte et al. (2016) discuss the pathways through which climate change exacerbates poverty, stressing the importance of analyzing the impact on household income. Among classes of welfare measures, income is considered the most important. As a result, examining the welfare implications of climate change across household and sectoral levels is critical. We need to understand more about the relationship between climatic and economic repercussions at the household level to quantify the effects of climate change. Furthermore, it is recognized that not only the mean values of temperature and precipitation but also the variability of these climate variables can have impacts on economic sectors (van der Wiel and Bintanja, 2021; Panda and Sahu, 2019).

Pakistan is one of the most vulnerable countries in the world to climate change (UNDP, 2015). According to the Global Climate Risk Index 2021 report, Pakistan has been ranked as the eighth most affected country in the world (Eckstein et al., 2021). As a predominantly agrarian economy, Pakistan is highly vulnerable to the adverse effects of climate variability. This vulnerability underscores the need for an in-depth examination of how climate change impacts household income across different economic sectors. Climate variability, particularly in terms of temperature and precipitation, has garnered significant global attention due to its continuous increase and detrimental effects on agriculture (van der Wiel and Bintanja, 2021; Panda and Sahu, 2019).

Previous studies have explored the relationship between climate conditions and household income, generally revealing adverse effects from heightened temperatures (Palanisami et al., 2008; Mendelsohn et al., 1994, 1996; de Medeiros Silva et al., 2019). Some investigations have delved into the influence of average climate variables on income, indicating that certain weather factors pose an increased risk (Isik and Devadoss, 2006; Ranganathan, 2009; McCarl et al., 2008). Despite the growing body of literature on the economic impacts of climate change and climate variability, there remains a gap in sector-specific analyses, especially in the context of Pakistan. This study aims to fill this gap by examining the differential impacts of climate change and climate variability on household income across agricultural and non-agricultural sectors in Pakistan. By utilizing household-level data from 2020 for 156,440 households across 126 districts and climate variable data from 1961 to 2020, this research employs a multiple regression analysis to explore the nuanced impacts of climate change.

The rest of the paper is organized as follows: Section 2 presents the literature review, while Section 3 describes the data and specifies the empirical model. Section 4 presents and discusses the results. Finally, Section 5 concludes with policy implications.

2. Literature Review

The Intergovernmental Panel on Climate Change defines climate change as "a statistically significant variation in either the mean state of the climate or in its variability, persisting over a wide range of time scales" (IPCC, 2001). Consequently, climate change refers to a shift in the average, standard deviation, and occurrence of extremes in climate parameters like precipitation and temperature that has been documented for at least 30 years. These are termed "long-term phenomena", while anomalies (deviations from long-run averages) are termed "short-term phenomena".

Climate change affects agricultural and industrial production negatively. Its effects are not limited to agriculture but also have adverse impacts on assets and workers' productivity (Skoufias et al., 2011; IPCC, 2014). Climate change poses major threats to household incomes, especially in developing

countries. As developing countries have fewer resources, it is therefore challenging for them to cope with the adverse effects of climate change (Noack, 2015). The effects of climate change, such as drought and flooding, as well as increases in temperature and precipitation, could harm the livelihoods of these households (McSweeney, 2005; Robinson, 2016). This harm can occur directly by reducing agricultural output and revenue or indirectly by influencing resource utilization and environmental conditions. According to Dasgupta et al. (2022), the extensive consequences of climate change are expected to result in more areas in poor countries becoming unsuitable for agricultural development. This could impact the number of individuals residing in rural areas. Another study (Ayindea et al., 2011) discovered that temperature changes have a detrimental influence on agricultural productivity in Nigeria, while precipitation changes have either a positive or negative effect, depending on the region. According to Skoufias (2011), the consequences of climate change on household welfare and deprivation can be felt through a variety of channels.

Extensive research has been conducted globally to investigate the effects of weather and climate change on agriculture, with a predominant focus on mean values of temperature and precipitation (Kumar et al. 2011; Cline 2007; Mendelsohn 2008; Kavi Kumar 2011; Mendelsohn et al. 1994). However, this approach may not fully capture the impacts on agricultural production, as weather variability has a more significant impact on crops (Thornton et al. 2014). Weather variability throughout crop growing seasons is likely to increase in the future, according to the IPCC Fifth Assessment Report (Kirtman et al. 2013), with more severe deleterious effects than changes in baseline weather variables. There is a wealth of literature on the influence of climate change on agriculture, different crops, and cropping patterns, both globally and in Pakistan. Climate change affects different industries in various ways (World Bank, 2015). It has an immediate impact on agriculture, but it also indirectly affects other sectors. Despite the growing body of literature on the economic impacts of climate change and climate variability, there remains a gap in sector-specific analyses, especially in the context of Pakistan.

3. Data and Methodology

In this section, we discuss the data sources and variable construction, followed by a discussion of the empirical model.

3.1 Data

For our analysis, we use household-level data and climate data. We utilize household-level data from the Pakistan Social and Living Standards Measurement (Government of Pakistan, 2020). This dataset comprises a sample of 156,440 households with positive income from 126 districts across Pakistan. Climate data on temperature and precipitation have been compiled from various provincial development statistics and environmental compendiums (Government of Pakistan, 2004, 2010, 2015, 2020). These government publications provide district-representative climate data using station-wise data provided by the Pakistan Meteorological Department. To construct the long-run climate variables, we use climate variable data spanning a 60-year period from 1961 to 2020.

3.2 Model and estimation methods

To analyze how climate change affects household income, we develop an economic model following the approach of Azzarri and Signorelli (2020). Our model is specified as follows.

$$Income = f(Climate, Human\ capital, Physical\ capital, Household\ characteristics, \varepsilon) \quad (1)$$

This model shows that household income depends on climate, human capital, physical capital, and household characteristics. The econometric model of this equation is specified as follows.

$$Y_{id} = \alpha + \beta_1 Temp_d + \beta_2 {Temp_d}^2 + \beta_3 Prec_d + \beta_4 {Prec_d}^2 + \beta_5 Tempsd_d + \beta_6 Precsd_d + \beta_7 Temp_d \times Agri_{id} + \beta_8 {Temp_d}^2 \times Agri_{id} + \beta_9 Prec_d \times Agri_{id} + \beta_{10} {Prec_d}^2 \times Agri_{id} + \beta_{11} Tempsd_d \times Agri_{id} + \beta_{12} Precsd_d \times Agri_{id} + \beta_{13} Agri_{id} + \gamma X_{id} + \varepsilon_{id} \quad (2)$$

The dependent variable is the natural logarithm of household income, which represents the total household income from various sources. Among the explanatory variables, climate variables include average temperature, average temperature squared, average precipitation, average precipitation squared, standard deviation of temperature, and standard deviation of precipitation. *Agri* is a dummy variable, which equals 1 if at least one of the household members earns income from the agriculture sector, and 0 otherwise. *X* includes human capital, physical capital, and other household characteristics. Human capital is the average education level of earning members, while physical capital is the market value of household assets. Household characteristics encompass household size, average age of earning members, average age squared, the number of earning persons in the household, and a region dummy variable, which equals 1 if the household lives in a rural area, and 0 otherwise. Short definitions of these variables are provided in Table 1.

Based on the specified model, we estimate the multiple linear regression model using the ordinary least squares (OLS) method. Given indications of heteroskedasticity in the error term, we employ robust standard errors for statistical inferences.

4. Results and Discussion

Table 1 presents descriptive statistics and definitions for each variable used in the regression model. The average household income is PKR 426 thousand, with a relatively high standard deviation of PKR 670 thousand, indicating income inequality among households. The average temperature is 23.41 degrees Celsius, and annual precipitation averages 45.12 decimeters. Earning members of households have an average education level of 5.5 years. The average market value of household assets is PKR 3.6 million, but with a notable standard deviation of PKR 11.69 million, reflecting wealth inequality. The average family size is 5.44 members, with a standard deviation of 2.6. The average age of household members who earn income is 39 years old. On average, households have 1.41 earning members. Additionally, 29 percent of households have at least one member working in the agriculture sector.

We use regression analysis to isolate the impact of climate change from other variables because there are many factors that may affect household income. Table 2 presents the regression results for two models. Model 1 is a base model without interactions between climate variables and dummy indicating household from agriculture sector. As the impact of climate change may be different in the agricultural sector and the non-agriculture sector, we estimate model 2 by including the interaction between climate variables and dummy variable indicating household from agriculture. As the coefficient estimates of the interaction terms are statistically significant, model 2 is a complete model without omitting the interaction variables. Therefore, we interpret below only the regression results of model 2.

The regression results illustrate how variables such as climate, human capital, physical capital, and household characteristics influence household income. The findings reveal that changes in the mean values of temperature and precipitation, as well as the variability of these climate variables, have a statistically significant impact on household income. We find that the relationship between household income and temperature is quadratic, which means that as temperature rises, household income rises initially, peaks, and then falls. For this nonlinear relationship, we compute the marginal effect of temperature on household income by taking the derivative of equation (2) with respect to temperature. The results show that, on average, a one-degree Celsius rise in average temperature leads to a 3.3%

decrease in income for households in the agricultural sector and a 0.4% decrease for those in non-agricultural sectors. The variability in temperature, indicated by a one-degree increase in its standard deviation, similarly results in a 4% income reduction for households across both sectors.

We find that the relationship between household income and precipitation is quadratic, which means that as precipitation rises, household income rises initially, peaks, and then falls. For this nonlinear relationship, we compute the marginal effect of precipitation on household income by taking the derivative of equation (2) with respect to precipitation. Results show that a one-decimeter increase in average precipitation is associated with a modest income increase of 0.33% and 0.19% for the agricultural and non-agricultural sectors, respectively. This shows precipitation is beneficial for households that are working in the agriculture sector. The quadratic relationship between revenue and climate variables is shown in previous studies, and these results are consistent with the theory (Lohano, 2018; Felbermayr et al., 2015; Ayindea et al., 2011). However, the results show that greater variability in precipitation, indicated by a one-decimeter increase in its standard deviation, adversely affects income in both sectors.

Both human capital and physical capital contribute significantly to household income. One-year increase in education of earning household members leads to 5 percent increase in household income, on average. Similarly, one percent increase assets value results in 1.1 percent increase in household income. Results show that the average age has statistically significant effect on household income. Family size has a positive and statistically significant impact on household income, which shows that as the number of family members increases, more pressure is placed on adult earning members to earn more to fulfill family needs. There is a positive and statistically significant relationship between the number of employed family members and household income. As the number of employed people in the household increases, the flow of income also goes up. On average, rural household earn 15.5 percent less than urban households. Urban area is used as a reference category, and rural area is a dummy variable in 0/1 form.

Diagnostic tests for the model have been performed. In Table 2, F-test values show that models are significant overall. The value of R-squared shows how much of the model's variation can be explained. This ranges from 0.305 to 0.308. Further tests for heteroskedasticity and normality are also performed, and their results are as follows. For heteroskedasticity, we use the Breusch-Pagan test. The Chi-Square statistics with p-value 0.000 indicate the presence of heteroskedasticity. To tackle this issue, we use heteroskedasticity robust standard errors. Further testing for normality (Jarque-Bera test) shows that the probability values of 0.121, and 0.122 for each of the two models show that the error term is normally distributed.

Table 1: Descriptive statistics

Variable	Definition of variables	Mean	Std. Dev.
Income			
Household income (thousand PKR) (annual)	Household income from all sources[1]	426.20	670.05
Climate			
Temperature (°C)	Average temperature of last 60 years	23.41	3.71
Precipitation (decimeters)	Average annual precipitation of last 60 years	45.12	39.45
Human capital			
Education (years)	Average education level of all earning members in household	5.50	5.21

[1] Household income includes income from all sources, such as income from a job, agricultural income, non-agricultural income, rent from shops, a house or agricultural land, and local and foreign remittances.

Physical capital			
Assets value (million PKR)	Market value of household assets	3.60	11.69
Household characteristics			
Family size (numbers)	Total number of family members in the household	5.44	2.60
Age (years)	Average age of earning members in the household	39.52	11.43
Earning persons in household (number)	Total number of earning persons in household	1.41	0.76
Agriculture (dummy variable)	It is defined as a dummy variable. Equals 1 if at least one of the family members earns from agriculture sector otherwise 0.	0.291	0.454
Rural (dummy)	1 if household lives in rural area, 0 otherwise	0.687	0.464
Observations		156,440	

Source: Authors' computations using data from Government of Pakistan (2020)

Table 2: Regression results

Model:	**(1)**	**(2)**
Dependent variable: ln (Household income)		
Climate		
Temperature	0.0809***	0.0624***
	(0.00789)	(0.00963)
Temperature squared	-0.00200***	-0.00141***
	(0.000184)	(0.000223)
SD of temperature	-0.0273***	-0.0401***
	(0.00206)	(0.00256)
Precipitation	0.00380***	0.00299***
	(0.000336)	(0.000393)
Precipitation squared	-0.00183***	-0.00123***
	(0.000212)	(0.000248)
SD of precipitation	-0.000455***	-0.000512***
	(0.00429)	(0.00522)
Temperature × Agriculture		0.0579***
		(0.0166)
Temperature squared × Agriculture		-0.00186***
		(0.000389)
Precipitation × Agriculture		0.00370***
		(0.000743)
Precipitation squared × Agriculture		-0.00252***
		(0.000469)
SD of temperature × Agriculture		0.00341
		(0.00914)

SD of precipitation × Agriculture		0.0363***
		(0.00432)
Human Capital		
Education	0.0502***	0.0499***
	(0.000572)	(0.000564)
Physical Capital		
Asset's value	0.0109***	0.0108***
	(0.00130)	(0.00129)
Household Characteristics		
Family size	0.0409***	0.0412***
	(0.000868)	(0.000867)
Age		
	0.0410***	0.0407***
Age squared	(0.00108)	(0.00107)
	-0.000392***	-0.000390***
Employed persons in household	(0.00129)	(0.00129)
	0.314***	0.312***
Household's earning members share in non-agriculture sector (reference)	(0.00248)	(0.00248)
Agriculture		
Rural (dummy) (urban reference)		
	-0.0544***	-0.496***
Constant	(0.00575)	(0.164)
	-0.171***	-0.155***
Observations	(0.00458)	(0.00457)
R-squared	10.00***	10.15***
Diagnostic tests	(0.0811)	(0.0990)
Overall significance	156,440	156,440
F-stat	0.305	0.308
p-value		
Jarque-Bera test for normality of error term		
p-value	4712.35	3326.22
Breusch-Pagan heteroskedasticity test	0.000	0.000
Chi-square stat		
p-value	0.121	0.122

Notes: The t-statistics based on robust standard errors are in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.
Source: Authors' computations using data from Government of Pakistan (2020)

5. Conclusions and Policy Implications

The study reveals that climate change has a discernible impact on household incomes in Pakistan. Changes in the mean values of temperature and precipitation, as well as the variability of these climate variables, have a significant impact on household income. A one-degree Celsius increase in average temperature results in a 3.3% income reduction for agricultural sector households and a 0.4% decrease for non-agricultural sectors. Increase in temperature variability similarly reduces income by 4 percent across both sectors. Changes in precipitation patterns show a modest income increase for agricultural

and non-agricultural households. However, greater variability in precipitation adversely affects income in both sectors. These findings highlight the differential vulnerability of sectors to climate change, underscoring the need for sector-specific adaptation strategies to mitigate these impacts. In light of these results, it is imperative for policymakers to devise and implement targeted policies that bolster the resilience of households, particularly those within the agricultural sector. Strategies should focus on promoting climate-resilient agricultural practices, enhancing infrastructural resilience, and facilitating income diversification to reduce climate-related income volatility. Engaging a broad range of stakeholders in the policy development process will ensure that these measures are effectively aligned with the needs of those most impacted by climate change, thereby contributing to the economic stability of Pakistan in the face of ongoing environmental challenges.

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Data Availability Statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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