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Correspondence

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

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Does Exchange Rate Volatility Matter for the Effect of Financial Liberalization on the Composition of Capital?

ABSTRACT

This paper aims to investigate the impact of financial liberalization on the composition of capital through the channel of exchange rate volatility. It uses the panel data of 105 developed and developing countries for 1976-2017 and employs the seemingly unrelated regression method for unbalanced panel data developed by Biorn (2004). The paper concludes that both de jure and de facto measures of financial liberalization have a significant direct positive impact on the composition of capital. In contrast, the indirect effect through exchange rate volatility hampers the quality of capital. However, the net effect confirms that the overall impact of financial liberalization on the composition of capital through exchange rate volatility improves the quality of capital stock because of the catalyst role of financial liberalization, as it absorbs the adverse effects of exchange rate volatility. These findings will help policymakers formulate policies to stabilize the exchange rate market after financial liberalization to promote investment, improve capital quality, and economic prosperity.

AUTHORS

Anwar Mughees Alam
Ph.D. Scholar, School of Economics, IIIE, International Islamic University Islamabad, Islamabad
Author's Contributions: 1, 2, 3, 4, 5, 6, 7
anwar.phdeco150@iiu.edu.pk
https://orcid.org/0000-0002-5114-5491

Arshad Ali Bhatti *
Assistant Professor, School of Economics, IIIE, International Islamic University Islamabad, Islamabad
Author's Contributions: 1, 2, 4, 6
arshad_bhatti@iiu.edu.pk
https://orcid.org/0000-0002-5752-6623

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*** Correspondence author**

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

1. INTRODUCTION

There is considerable literature on the relationship between financial liberalization and economic growth, which is far from consensus after more than four decades. Instead, literature produces mixed results that vary across methodologies adopted and the measures of financial liberalization used in the analysis. Some studies cast doubts on the relationship between financial liberalization and economic growth. For example, Rodrik (1998) concludes that countries that impose fewer restrictions on capital movement tend to grow faster or invest more than countries with more significant restrictions on capital accounts.

Similarly, Edison et al. (2002), after controlling for specific financial, economic, and policy variables, find no relationship between financial liberalization and growth. While Gourinchas and Jeanne (2006) argue that removing the distorting effects of capital controls could exacerbate the negative impact of existing distortions, leading to financial liberalization that undermines growth and leads to a loss of welfare. However, some researchers provide evidence of a positive relationship between financial liberalization and growth, but it is subtle to measure financial liberalization (Quinn, 1997; Nicolo & Junenal, 2014; Combes et al., 2019).

The literature on economic growth focuses on factor accumulation and total factor productivity (TFP hereafter) as its major determinants. However, the evidence is mixed; Mankiw et al. (1992) emphasize the role of factor accumulation and argue that it is the key determinant of economic growth. However, the influential study of Hall and Jones (1999) changed the direction of the debate arguing that TFP growth is more important than factor accumulation. Similarly, Kose et al. (2009) analyze the empirical relationship between financial openness and productivity growth rather than output growth. They use de jure and de facto measures of openness and conclude that economies with a higher degree of capital account openness enjoy higher TFP growth.

Similarly, Bonfiglioli (2008) evaluates the association between financial liberalization and two important growth components, TFP, and capital accumulation. She finds a direct and positive effect of financial liberalization on TFP growth. In addition, Bekaert et al. (2011) find both channels as equally important. However, they find that the effect of TFP is higher than factor accumulation on economic growth. Bhatia and Sharma (2019) affirm that financial liberalization affects economic growth through capital accumulation in emerging and developing countries, while developed countries experience growth effects through improvements in productivity levels. However, there is sparse literature on the "composition of capital1" channel through which financial liberalization may enhance economic growth.

Eaton and Kortum (2001) state that the world production of capital goods is almost produced by a specific small group of countries that are highly experienced in R&D activities, whereas the rest of the world imports these capital goods. Caselli and Wilson (2004) construct a theoretical model based on the idea presented by Eaton and Kortum (2001) and investigate the overall differences in the composition of capital stock among countries. They show that the composition and quality of capital can explain an essential share of variations in TFP across countries. They further argue that the composition of capital is to provide a proper channel through which liberalization affects productivity. Additionally, Leblebicioglu and Madariaga (2015) test the implications of Caselli and Wilson (2004) and assess the importance of quality or capital composition channels. They employ de jure and de facto measures of openness and conclude that the quality of capital is positively related to financial openness. In other words, capital inflows help to increase the quality of capital, which enhances productivity.

[1] Composition of capital is a measure of "quality of capital". Composition of capital and the quality of capital are used interchangeably.

Considering the importance of exchange rate, some studies show that countries that open their capital account following a fixed exchange rate with less developed financial markets practice higher economic growth (Bailliu et al., 2003; Husain et al., 2005; Aghion et al., 2009; Kassa & Lartey, 2018; Combes et al., 2019). Prasad et al. (2005) show that capital account liberalization and fixed exchange rate combination frequently ended either forcefully or by shifting policy from fixed to the flexible regime. However, Husain et al. (2005) state that developing countries with unstable financial markets and a low level of financial liberalization benefit from lower inflation following fixed exchange rates.

Correspondingly, Rodriguez (2017) extends Aghion et al. (2009) model and investigates the role of financial liberalization instead of financial development for the relationship between exchange rate volatility and economic growth. They find a negative association between productivity growth and flexibility of exchange rate, and this negative effect is canceled out with the degree of financial liberalization. They conclude that developing nations with a low level of liberalization experience improved productivity growth when following a fixed exchange rate regime (no volatility). However, Levy-Yeyati and Sturzenegger (2003, 2005) use their exchange rate classification and illustrate that a fixed exchange rate regime lowers growth in developing countries while reporting no relationship between exchange rate volatility and growth for industrialized countries. On the other hand, Coudert and Dubert (2005) claim that the fixed regime produces volatile growth results compared to the flexible regime in emerging and major Asian economies. Overall, the literature for the impact of financial liberalization on economic growth is diversified with no consensus.

As disused earlier, the literature on the impact of financial liberalization is unclear. This study fills the gap in the literature by shading light on the quality of capital proposed by Caselli and Wilson (2004)[2]. That is financial liberalization enhances economic growth by improving the country's quality of capital stock, that is financial liberalization helps countries to invest in highly efficient and R&D intensive capital which then alters the course of economic growth. On the other hand, the exchange rate volatility leads to volatility in returns and results in a decrease in the level of investment and economic growth. Further, exchange rate volatility may be affected by any change in financial flows emanating from financial liberalization policies, which in turn may affect the composition of capital as well as economic growth.

This study aims to highlight the impact of financial liberalization on the composition of capital. Based on the theoretical predictions of the neoclassical growth model and the aftermath of the financial liberalization process, we explore whether financial liberalization improves the composition of capital directly and through the channel of exchange rate volatility[3]. We hypothesize that in our simultaneous equations 1 and 2, $\alpha_2 > 0$, because the theoretical literature predicts that financial liberalization exacerbates the volatility in the exchange rate (Dornbusch, 1987); $\beta_2 > 0$, that is financial liberalization improves the quality of capital through increased investment in R&D intensive capital goods; whereas, $\beta_3 < 0$, because the theoretical literature predicts that exchange rate volatility leads to volatility in returns and decreases the level of investment and economic growth. Further, exchange rate volatility may be affected by changes in financial flows emanating from financial liberalization policies, affecting capital composition.

2. DATA AND METHODOLOGY

This study uses the unbalanced panel data with the five-year non-overlapping averages of 105 developed and developing countries for the period 1976-2017[4]. The selection of countries purely depends upon the availability of data on production, imports, and exports of the specific type of capital goods. The data is

[2] See Caselli and Wilson (2004) for detail derivation of composition of capital.
[3] We use the theoretical model of exchange rate volatility developed by Aghion et al. (2009) and extended by Rodriguez (2017)
[4] List of countries is available in Appendix A

taken from the World Development Indicators (WDI), United Nations Conference on Trade and Development (UNCTAD), United Nations Commodity Trade Statistics Database (UNCOMTRADE), Pen World Table (PWT 9.1), and Darvas (2012)[5].

We construct "composition of capital index (QC hereafter)" based on the theoretical model of Caselli and Wilson (2004)[6]. They show that the quality of capital is an essential factor affecting economic growth in any economy and construct a model with capital disaggregation in quality and quantity. We obtain the share of the capital of a particular type in total capital stock, determined by its embodied efficiency. We choose imports for specific capital type because few countries produce R&D specific capital goods, and the rest of the world import them (Eaton & Kortum, 2001; Caselli & Wilson, 2004). However, following Caselli and Wilson (2004) and Leblebicioglu and Maradiaga (2015), we do not focus on only capital importing countries. Instead, we identify investment in a particular type of equipment as a specific capital type gross domestic product minus its export plus its import. By doing so, we expand our sample to capital producing and capital importing countries.

This study uses seven measures of financial liberalization divided into the broad categories of de jure and de facto measures. The reason to include both measures is that these measures are calculated using different sample sizes and information sources, tell a different story regarding the liberalization process, and produce systematic growth results (Quinn et al., 2011). Additionally, we include three different de facto measures of exchange rate volatility — first, Reinhart and Rogoff's (2004) coarse classification of exchange rate regime (ERR hereafter)[7]. Second, the standard deviation of REER (SDER hereafter)[8], and third, Aizenman et al. (2008) exchange rate stability index (FXSI hereafter)[9], we reciprocate this stability index to convert it into volatility index.

According to Dornbusch (1987), financial liberalization disturbs the exchange rate market and intensifies its volatility. Furthermore, Aghion et al. (2009) and Rodriguez (2017) theoretically show that exchange rate volatility hampers economic growth, however, the degree of financial development and openness absorbs the negative shocks of exchange trade volatility and improves economic growth. As far as the composition of capital is concerned, Caselli and Wilson (2004) theoretically show, using the neoclassical growth model, that quality is an essential factor that affects economic growth. So, we can say that economic growth and quality of capital holds the same relationship. In this background, following Hayes and Preacher (2014), we construct our econometric model for the effect of financial liberalization on the composition of capital through exchange rate volatility as follows,

$$ER_{it} = \alpha_1 + \alpha_2 FL_{it} + \alpha'_3 Z_1 + \varepsilon_{1it} \quad (1)$$

$$QC_{it} = \beta_1 + \beta_2 FL_{it} + \beta_3 ER_{it} + \beta_4 QC_{i0} + \beta'_5 Z_2 + \varepsilon_{2it} \quad (2)$$

In the mediation equation (1), ER is the exchange rate volatility, proxied by ERR, SDER, and FXSI. FL is the financial liberalization index, proxied by two de jure measures; capital account openness indexes by Chinn and Ito (2008) [KAOPEN] and Quinn and Toyoda (2008) [QUINN]. Further, we include three de facto measures: the gross external position (GEP), the sum of total foreign assets, and liability as a ratio of total output. Total liabilities (TL) as a ratio of GDP, and the component of total liabilities, namely foreign direct investment (FDI), foreign portfolio liabilities (FPL), and debt as a ratio of GDP (DEBT). Z_1 is the vector of control variables, such as trade openness (TO) and domestic credit to the private sector (PRIV).

[5] The variable definition, construction, and source are provided in Appendix B.
[6] The construction of QC, its formulae and detail, can be obtained from authors on personal request.
[7] See Appendix B for details.
[8] See Appendix B for details.
[9] See Appendix B for details.

In the main equation (2), QC is the composition of the capital index. Z_2 is the vector of control variables, such as TO, PRIV, price of investment relative to output (RPI). Hsieh and Klenow (2007) contend that RPI is a component to understanding the differences in investment rates and income across countries. We also include the initial GDP per capita ($GDPPC_0$) to account for overall development levels in the country, which creates a favorable environment for investment by the private sector. Finally, we include the initial value of the composition of capital index (QC_0) to account for the convergence effect.

Equations (1) and (2) comprise a system of equations that can be estimated by employing the seemingly unrelated regression (SUR) method for unbalanced panel data developed by Biorn (2004). Biorn (2004) uses Monte Carlo simulations and confirms that the SUR model provides more reliable estimates than the single equation estimates by fixed effect (FE) and random effect (RE) models. This method has some apparent advantages, such as controlling the country-level heterogeneity and avoiding biased estimates. Further, it is more efficient because it contains more information and less collinearity due to the large size of data with more scope (Biorn, 2004; Baltagi, 2005; Demirdogen et al., 2016).

After estimating equations (1) and (2), simultaneously, we compute the direct, indirect, and net effects of financial liberalization on the composition of capital. The direct effect is computed by estimating the partial derivation of QC to FL using equation (1):

$$\frac{\partial QC}{\partial FL} = \alpha_2 \tag{3}$$

The indirect effect through ER is obtained by computing the partial derivatives from equations (1) and (2) and using the chain rule:

$$\frac{\partial QC}{\partial FL} = \frac{\partial ER}{\partial FL} * \frac{\partial QC}{\partial ER} = \alpha_2 * \beta_3 \tag{4}$$

If the indirect effect is significant, it means mediation exists; that is, financial liberalization improves the composition of capital through the exchange rate volatility. Finally, we calculate the net effect as follows,

The following equation obtains the net effect:

$$\frac{\partial QC}{\partial FL} = \frac{\partial QC}{\partial FL} + \frac{\partial ER}{\partial FL} * \frac{\partial QC}{\partial ER} = \alpha_2 + (\alpha_2 * \beta_3) \tag{5}$$

The net effect provides a clear picture of the impact of financial liberalization on the composition of capital.

3. ESTIMATION RESULTS AND DISCUSSION

Table 1 encompasses the SUR model results for the impact of financial liberalization on the composition of capital (QC) through the exchange rate regime (ERR), a proxy of exchange rate volatility. Model (1) uses KAOPEN, while model (2) uses QUINN, the de jure financial liberalization measures. Each model comprises the mediation equation (column a) and the main equations (column b). In the mediation equation, model 1a, the KAOPEN elasticity of ERR is negative but insignificant. However, the QUINN elasticity of ERR is positive and significant in model 2a. It elucidates that de jure measures intensify the volatility in the exchange rates. This finding is in line with the theoretical work of Dornbusch (1987) and the empirical work of Calderon and Kubota (2018).

On the other hand, in the main equation, model 1b, the KAOPEN elasticity of investment in quality capital proxied by QC is negative and significant. It implies that allowing cross-border financial transactions

hampers the quality of capital. This is because KAOPEN is a de jure measure calculated using the AREAER[10] information, and it would not include many aspects of the financial liberalization process. Moreover, the de jure measures do not provide the actual figure about the response of financial flows to legal restrictions; because legal restrictions face a lack of enforcement or control imposed on one sector induces the capital flows in some other sectors (Quinn et al., 2011). Contrarily, in model 2b, the QUINN elasticity confirms that countries invest in higher quality capital goods following the policy announcement of free capital movement across borders. These results are in line with Leblebicioglu and Maradiaga (2015). The ERR influences the investment decision in a better quality of capital as indicated in models 1b and 2b, which is consistent with Aghion et al. (2009).

Table 1: Impact of financial liberalization on the composition of capital through exchange rate volatility (ERR) - using the de jure measures of FL

	Model (1)		Model (2)	
	1a	1b	2a	2b
	ERR	**QC**	**ERR**	**QC**
KAOPEN	-0.1037	-0.0461***		
	(0.191)	(0.001)		
QUINN			0.0340*	0.2684***
			(0.100)	(0.000)
ERR		-0.4567***		-0.1908***
		(0.000)		(0.000)
Control Variables				
TO	-0.1239***	0.1217***	-0.2059***	-0.0351
	(0.000)	(0.000)	(0.000)	(0.133)
PRIV	-0.0535***	0.0313*	-0.0833***	0.0846***
	(0.001)	(0.083)	(0.000)	(0.000)
RPI		0.2881***		0.2655***
		(0.000)		(0.000)
$GDPPC_0$		0.2178***		0.1910***
		(0.000)		(0.000)
QC_0		0.0722***		0.0176
		(0.000)		(0.158)
Indirect and Net Effects				
	Indirect Effect	Net Effect	Indirect Effect	Net Effect
KAOPEN	0.047	0.001**		
	(0.110)	(0.030)		
QUINN			-0.006	0.262***
			(0.111)	(0.000)
No. of observations	505	505	505	505
No. of countries	105	105	105	105

Notes: *, **, *** indicate the significance levels at 10%, 5% and 1%, respectively. P-value appears in parenthesis. QC is the composition of capital. ERR is the exchange rate regime used as a proxy of exchange rate volatility suggested by Reinhart and Rogoff (2004). Our dependent variables are ERR and QC. KAOPEN and QUINN are the de jure measures of financial liberalization. We employ different control variables such as trade openness (TO), the relative price of investment (RPI), and the domestic credit to GDP ratio (PRIV) as a proxy of financial development. All variables are in log form. The models are estimated using a seemingly unrelated regression method for unbalanced panel data developed by Biorn (2004).

Table 2 contains the estimation results of three models — model (3) uses the GEP measure, model (4) uses the TL measure, whereas model (5) uses FDI, DEBT, and FPL, the de facto measures of financial liberalization. Models 3a and 5a in Table 2 show that the GEP and FPL elasticities of ERR are positive and significant. However, adding TL, FDI, and DEBT in models 4a and 5a, the elasticity of financial liberalization becomes negative and significant with ERR but insignificant with FDI. It implies that actual

[10] IMF's Annual Report on Exchange Rate Arrangements and Exchange Restrictions (AREAER)

financial inflows lower exchange rate volatility. This result contradicts the theoretical findings of Dornbusch (1987); however, in line with Sutherland (1996) — when there is more government spending in an economy, debt accumulates domestically.

Table 2: Impact of financial liberalization on the composition of capital through exchange rate regime (ERR) - using the de facto measures of FL

	Model (3)		Model (4)		Model (5)	
	3a	3b	4a	4b	5a	5b
	ERR	**QC**	**ERR**	**QC**	**ERR**	**QC**
GEP	0.1676***	0.2454***				
	(0.0001)	(0.0001)				
TL			-0.0773***	0.0124		
			(0.000)	(0.387)		
FDI/GDP					-0.0174	0.0503***
					(0.161)	(0.001)
DEBT/GDP					-0.1016***	-0.0288*
					(0.000)	(0.063)
FPL/GDP					0.0224***	-0.0888***
					(0.000)	(0.000)
ERR		-0.0765***		-0.2273***		-0.4501***
		(0.009)		(0.000)		(0.000)
Control Variables						
TO	-0.2516***	-0.1428***	-0.1403***	0.0741***	-0.0378	0.0262
	(0.0001)	(0.0001)	(0.000)	(0.009)	(0.175)	(0.448)
PRIV	-0.0690***	-0.0275	-0.0555***	-0.0065	-0.1044***	0.0467***
	(0.0001)	(0.122)	(0.000)	(0.687)	(0.000)	(0.000)
RPI		0.2909***		0.2596***		0.2618***
		(0.0001)		(0.000)		(0.000)
$GDPPC_0$		0.2920***		0.1897***		0.2354***
		(0.0001)		(0.000)		(0.000)
QC_0		0.0316		0.0758***		0.0718***
		(0.642)		(0.000)		(0.000)
Indirect and Net Effects						
	Indirect Effect	**Net Effect**	**Indirect Effect**	**Net Effect**	**Indirect Effect**	**Net Effect**
GEP	-0.013***	0.233***				
	(0.000)	(0.000)				
TL			0.018***	0.030**		
			(0.000)	(0.028)		
OL					0.043***	0.010
					(0.000)	(0.162)
FDI					0.007	0.057***
					(0.162)	(0.000)
DEBT					0.041***	0.012
					(0.000)	(0.380)
FPL					-0.009**	-0.098***
					(0.040)	(0.000)
Observations	507	507	508	508	508	508
Countries	105	105	105	105	105	105

Notes: As for Table 1, except for the independent variables, GEP, TL, FDI, DEBT, and FPL as a ratio of GDP (Lane & Milesi-Ferretti, 2007), the de facto measures. All variables are in log form. OL is the combined indirect effect or net effect. We calculate the indirect and net effects as discussed in section 3.

This accumulation of debt under imperfect capital mobility by domestic consumers raises domestic interest rates, resulting in changes in consumer preferences, and future consumption will increase in the short run. In the case of perfect mobility, this effect is more prominent. Therefore, the exchange rate appreciates if the decision to increase output continues. Hence, if financial liberalization is in place, debt levels increase, and volatility in exchange rates would reduce. Variously, in models, 3b, 4b, and 5b in Table 2, the GEP and FDI elasticities of quality investment (QC) are positive and significant but insignificant in the case of TL. It indicates that actual financial flows improve the country's capital stock quality.

Conversely, the DEBT and FPL elasticities of investment in higher quality capital are negative and significant. It implies that debt and portfolio flow curtail the quality of capital. According to the best of our knowledge, the empirical literature on financial liberalization and the composition of capital is minimal. That is why the impact of financial flows on the composition of capital is inconclusive. However, theoretical literature concludes that the quality of capital measured by the composition of the capital index has growth-enhancing effects. So, the composition of capital and economic growth has the same characteristics, where the literature on economic growth shows that debt is negatively correlated with economic growth (Reinhart & Reinhart, 2008; Bordo et al., 2010). In addition, the ERR elasticity of higher quality capital investment is negative and significant. It means that market uncertainty leads to lower investment, leading to lower quality of capital.

As discussed earlier, this study aims to explore the true nature of the relationship among the said variables; we compute the direct and indirect effects. The direct effects presented in models 1b through 5b of Tables 1 and 2 are significant. The indirect effects using the de jure measures are insignificant, as shown in the lower panel of Table 1. On the other hand, when we employ the de facto measures in the lower panel of Table 2, the coefficients of GEP, DEBT, FPL, and the net effect of three different components of total liabilities (OL) confirm the existence of mediation. It explains that the cross-border financial flows increase after countries decide to open asset trade.

It helps them invest in better quality capital goods to compete with the rest of the world. The exchange rate volatility reverses this process; capital quality hampers as investors slow down investments because of uncertainty in the exchange rate market. However, with TL, pure mediation is confirmed.

On the other hand, the net effects are positive and significant with all proxies of financial liberalization except for FPL. It shows that financial liberalization works as a catalyst that absorbs the adverse impact of ERR, thus enhancing the quality of the country's capital stock. This result is consistent with Rodriguez (2017). Besides, the PRIV elasticity of ERR is negative and significant. It elucidates that financially developed countries have stable exchange rates, and financial development absorbs the unfavorable movement in exchange rate aftermath of financial liberalization. This result is consistent with Aghion et al. (2009).

The TO elasticity of QC is positive and significant in models 1b and 4b, while insignificant in 2b and 5b. However, when we employ GEP in model 3, the TO elasticity is negative and significant. This happens because GEP and TL include foreign debt from official sources[11]. It illuminates that TO improves the country's quality of capital. Correspondingly, the PRIV elasticity of QC is positive in models 1b, 2b, and 5b, whereas negative and insignificant in models 3b and 4b. It means that domestic financial development enhances the quality of capital as it absorbs the adverse effects of exchange rate volatility. The RPI elasticity of QC is positive in models 1b through 5b. It shows that investing in expensive R&D intensive capital goods aftermath of financial flows, price of investment relative to output price increased. In addition, the

[11] Bonfiglioli (2008) resolves this issue by using an interaction term of de jure and de facto measure. When we use this approach, the results with GEP, TL, TO, PRIV change in many cases. These results can be obtained from the authors on personal request.

overall economic progress increases the investment in quality capital goods as indicated by the positive $GDPPC_0$ elasticity in all specifications. The positive elasticity of QC_0 rejects the presence of convergence in the model.

In the same way, we estimate the above-cited regressions using SDER and FXSI, the other proxies of exchange rate volatility. The results are almost the same, with a few exceptions[12].

4. CONCLUDING REMARKS

In the current literature, various channels are identified that influence economic growth. A new and unexplored channel is the composition of capital. The idea of this channel was developed by Caselli and Wilson (2004) after exploring that financial liberalization has no direct impact on capital. They suggest that capital must be disaggregated into two parts: capital accumulation and quality of capital to enhance its explanatory power. This channel was first explored empirically by Leblebicioglu and Maradiaga (2015) and suggested that quality of capital is a valuable channel that promotes economic growth following the liberalization process. However, they mainly focus on productivity growth, employ GMM in their analysis, and do not provide any significance of the indirect effect. This study explores the impact of financial liberalization on the composition of capital, direct and through exchange rate volatility. We follow the modeling strategy of Hayes and Preacher (2014) and test the mediating role of exchange rate volatility for the effect of financial liberalization on the composition of capital. For estimation, we employ the seemingly unrelated regression method for unbalanced panel data as developed by Biorn (2004).

Our analysis concludes that both de jure and de facto measures confirm that financial liberalization directly affects the country's quality of capital stock; however, the nature of financial flow matters for its actual impact on the composition of the capital index. For instance, DEBT inflows hamper the quality of capital. Contrarily, the significant indirect effect validates exchange rate volatility as a valuable channel, and financial liberalization abates the quality of capital when it works through the exchange rate volatility using all proxies of exchange rate volatility and financial liberalization. However, the net effect confirms that financial liberalization works as a catalyst and captivates the adverse effects of exchange rate volatility, promoting the country's quality of capital which in turn enhances economic growth. Our conclusion is in line with the hypothesis mentioned above.

In this context, our findings may help the policy makers to take care of exchange rate volatility, and the composition of capital while designing economic policies centered on growth enhancing effects of financial liberalization. The above goal can be realized through maintaining the fluctuations in domestic money market and taking care of international money market shocks that may affect the exchange rate volatility. Similarly, the policy makers may like to improve the legal and institutional framework along with financial development, as it ensures property rights and reduce moral hazard problem. It helps countries to improve the quality of capital through increased investment levels.

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Appendix A: List of Countries

Albania, Algeria, Argentina, Australia, Austria, Bahrain, Bangladesh, Barbados, Belgium, Botswana, Bulgaria, Burkina Faso, Cambodia, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Cyprus, Czech Republic, Denmark, Dominican, Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea Republic , Kyrgyz Republic, Lao PDR, Lebanon, Liberia, Libya, Lithuania, Madagascar, Malaysia, Malta, Mauritius, Mexico, Morocco, Mozambique, Nepal, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Paraguay, Philippines, Poland, Portugal, Romania, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, Slovak Republic, South Africa, Spain, Sri Lanka, Sudan, Suriname, Swaziland, Sweden, Switzerland, Thailand, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Venezuela, Zambia

Appendix B: Variables Definition, Construction, and Source

Variable Name	Definition	Source
Dependent Variables		
Exchange Rate Regime (ERR)	Reinhart and Rogoff (2004) coarse exchange rate regime and classification. It ranges from 1 to 4, from rigid to the volatile regime and calculated as, $ER_{t,t+5} = \frac{1}{5}\sum_{t=1}^{i=5} ERR_{t+i}$	Author self-calculation by taking coarse exchange rate regime data from Reinhart and Rogoff (2004)
Real Exchange Rate Volatility (SDER)	The standard deviation of the exchange rate (SDER). It is calculated by taking the standard deviation of the growth rate of REER	Author self-calculation by taking REER data from Darvas (2012)
Exchange Rate Stability Index (FXSI)	A continuous measure. It is obtained by adjusting monthly variations in the exchange rate between home and base country to annual standard deviation. It ranges from 0 and 1. We reciprocate it to convert it into a Volatility index	Aizenman et al. (2008)
The Composition of Capital (QC)	It measures of quality of capital. It was obtained through standard growth accounting procedure. The empirical measure is expressed in terms of relative capital ratio. It is calculated by; $QC_i = A_1\left[\sum_{p=1}^{P}\frac{K_{ip}}{K_{i1}}\right]^{(\gamma/1-\gamma)}$	Author self-calculation using data of production, import, and exports from UNCTAD and COMTRADE, of specific capital type.
Initial Real GDP per capita (GDPP0)	A proxy to measure overall development in countries. Calculated as real GDP per Capita at 2010 constant prices	World Development Indicator
Explanatory Variables		
Capital Account Openness Index (KAOPEN)	Dejure measure of capital account openness index, constructed through IMF's AREAER categorical table. It ranges between -1.8 to 2.54. The smaller value means a close economy.	Chinn and Ito (2008)
Capital Account Openness Index (QUINN)	The Other de jure measure of capital account openness index, constructed by using AREAER text information. It contains information on strict controls	Quinn and Toyoda (2008)

	on financial transactions by residents and non-residents of a country. It ranges from 0 – 100. 0 refers to closed, while 100 indicated the full open economy	
Gross External Position (GEP)	A de facto measure. It is calculated by using country total assets and liability data, such as FDI, FPI, financial derivatives, foreign debt, and foreign exchange reserves as a ratio of total output	Lane and Milesi-Ferretti (2007)
Total Liabilities (OL)	A de facto measure, the sum of capital inflows	Lane and Milesi-Ferretti (2007)
Foreign Direct Investment (FDI)	A de facto measure. A component of the total liability. Foreign direct investment inflows to total output	Lane and Milesi-Ferretti (2007)
DEBT	A de facto measure and an important component of the total liability. It includes total foreign debt inflows	Lane and Milesi-Ferretti (2007)
Foreign Portfolio Liabilities (FPL)	A de facto measure and an important component of the total liability. It covers all portfolio equity inflows as a ratio of total output	Lane and Milesi-Ferretti (2007)
Control Variables		
Trade Openness (TO)	Trade (sum of imports and exports) percent of total output	World Development Indicator
Domestic Credit (PRIV)	Domestic credit to the private sector by banks refers to financial resources provided to the private sector by banks and other financial institutions, such as loans, purchases of nonequity securities, trade credits, and other accounts receivable as a percentage of GDP.	World Development Indicator
Relative Price of Investment (RPI)	It is the price of investment relative to the price of output	Penn World Table 9.1

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Impact of Macroeconomic Instability on Private Investment: Evidence from Pakistan

ABSTRACT

This paper investigates the effects of macroeconomic instability on private investment. Contrary to the existing studies about Pakistan, which use a single variable as a proxy for macroeconomic instability, we contributed by constructing a Macroeconomic Instability Index (MII) consisting of six variables. The study uses time-series data from 1976 to 2013 and applies the Autoregressive Distributed Lag (ARDL) technique. The empirical findings show an inverse relationship between macroeconomic instability and private investment. This warrants that policymakers should minimize macroeconomic instability as for as possible.

AUTHORS

Babar Hussain
Assistant Professor, School of Economics, IIIE, International Islamic University Islamabad.
Author's Contributions: 1, 2, 3, 4, 5, 6, 7
babar.hussain@iiu.edu.pk
https://orcid.org/0000-0001-7333-3373

Muhammad Naveed Tahir *
Assistant Professor, Forman Christian College (A Chartered University) Lahore
Author's Contributions: 2, 5, 6
naveedtahir@fccollege.edu.pk
https://orcid.org/0000-0001-6179-4607

Saba Ashiq
MPhil Researcher Scholar, University of Sargodha.
Author's Contributions: 2, 5, 6
sabaammar44@yahoo.com
https://orcid.org/0000-0003-0023-3341

Muhammad Iqbal
Assistant Professor, Department of Economics, University of Haripur
Author's Contributions: 2, 6, 8
m.iqbal@uoh.edu.pk
https://orcid.org/0000-0003-1818-4808

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*** Correspondence author**

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

1. INTRODUCTION

The importance of investment cannot be underestimated, especially in the multiplier theory and the incremental capital-output ratio. Levine and Renelt (1992) argue that private investment is a crucial mechanism to improve economic growth and the most critical factor of economic development. Investment accelerates economic growth through an increase in aggregate demand in two ways: an increase in aggregate demand because of investment on the one hand and an increase in consumption and employment on the other hand. However, developing economies like Pakistan, which usually have more population growth that turns into more workers to join the labor force, generally face obstacles in increasing investment to GDP ratio that constrain economic growth. A stable and certain macroeconomic environment, among other things, is necessary to give impetus to investment but developing economies are lacking it. This study attempts to explore the impact of macroeconomic instability on investment in the case of Pakistan while constructing Macroeconomic Instability Index (MII).

Theoretically speaking, saving is of utmost importance; however, the overall macroeconomic situation is also a crucial investment. Between the two primary components of investment - public and private - private investment is more sensitive to macroeconomic uncertainty or instability than public investment. Public investment is autonomous and mostly depends on government decisions, as concluded by (Mohey-ud-din & Siddiqi, 2014) in the case of Pakistan. Perhaps, it is the very reason that studies like (Aizenman & Marion, 1999; Moshi & Kilindo, 1999) used private investment rather than aggregate investment in their analytical work. Arif and Lee (2014) introduced investor sentiment (Azzimonti, 2018) incorporated partisan conflict interest in their study, whereas (Banerjee et al., 2015) reveal that uncertainty about future and expectations play a vital role. Interestingly, (Kopp, 2018) finds that even profit is of second-degree importance relative to expectations about future aggregate demand.

A variety of factors that influence investment has been identified in the literature. For instance, according to (Lucas & Prescott, 1971), it depends on a past decision of investment, present environment, and future expectations, whereas the importance of uncertainty has been highlighted by many studies (Bernanke, 1983; Dixit & Pindyck, 1994; Aizenman & Marion, 1999; Akkina & Celibi, 2002). This study investigates the impact of macroeconomic instability on private investment, both in the long run and in the short run.

The study contributes by constructing and using MII for Pakistan. MII is a multidimensional phenomenon comprising numerous indicators like instability in the exchange rate, unfavorable terms of trade, the vast burden of external debt, inflation rate, and high government budget deficit (Ismihan, 2003; Ismihan et al., 2005; Jaramillo & Sancak, 2007; Ahangari & Saki, 2012; Haghighi et al., 2012).

The remainder of the paper is organized as follows: Section 2 presents a causal relationship between uncertainty and private investment. Section 3 explains the construction of the MII. Section 4 continues with a description of data and econometric methodology. Section 5 presents empirical findings. Finally, the concluding remarks and policy implications are presented in section 6.

2. REVIEW OF LITERATURE

There are three strands of literature regarding the effects of macroeconomic uncertainty on investment. For example, (Demir, 2009) reported no clear-cut relation between macroeconomic instability and investment. Whereas (Abel & Eberly, 1994) and (Hartman, 1972) point out the positive correlation between these two variables as the marginal revenue product of capital is a convex function of output prices when uncertainty increase, it increases the incentives for investors to invest. However, the studies that follow the real options theory stated that investment is irreversible; therefore, increasing uncertainty discourages the investors (Bernanke, 1983; Dixit & Pindyck, 1994; Aizenman & Marion, 1999; Akkina & Celibi, 2002). The

empirical studies use different proxies and methods of macroeconomic uncertainty, and most studies found a negative connection between macroeconomic uncertainty and private investment.

The study by (Rehman et al., 2009) explores the key drivers of private investment from 1972 to 2005and concludes that there is evidence of accelerator theory and crowding-out theory in Pakistan. Traditional factors like Foreign Direct Investment (FDI), inflation, and bank credit are insignificant, whereas nontraditional factors such as entrepreneurial skills, governance, and quality of institutions are critical factors of private investment. On the contrary, (Ahmed & Qayyum, 2007) found the existence of crowding-in. The study also finds that macroeconomic uncertainty as a proxy of inflation rate volatility discourages private investment in Pakistan. Similarly, Ahmad et al. (2008) also observed the negative relationship between uncertainty and investment in the case of agriculture investment. Furthermore, (Sial et al., 2010) found that macroeconomic uncertainty also negatively relates to Pakistan's economic growth. However, none of these studies used an index to capture uncertainty.

The equivalence of change in inflation rate with macroeconomic uncertainty is prone to criticism. The studies related to Pakistan utilize inflation as a measure of macroeconomic instability. To the best of our knowledge, (Ismihan, 2003) is the first empirical study which constructs macroeconomic instability index to divulge the connection between economic uncertainty, investment, and economic progress for Turkey from 1963 to 1999. The study develops the macroeconomic index by incorporating four macro-level variables like the public deficit, inflation rate, exchange rate, and external debt and applies the Johansen cointegration technique. The results show that macroeconomic instability crowd-out capital decreases Turkey's economic growth and seriously impacts public and private investment. A study by (Rathnasiri, 2009) used six macroeconomic variables to study the impacts of economic stability on private investment from 1977 to 2008 for Sri Lanka. The six-macroeconomic variables were as follows: three for internal stability like real economic growth rate, inflation, and the government budget deficit, and three external stability like trade balance, overall balance, and exchange rate. The study suggests that economic stability has a significant positive impact on Sri Lanka's private investment. However, the study does not construct an index of these variables.

However, the study by (Ahangari & Saki, 2012), which shed light on the impacts of macroeconomic uncertainty on private investment, constructs a MII by adding four economic variables: foreign debt, exchange rate, inflation rate, and budget deficit. The study utilized the data from 1963 to 2003 and applied the Johanson cointegration method. The study found that macroeconomic instability has adverse impacts on private investment. Using ARDL technique (Ali et al., 2019) found that inward FDI substitutes domestic investment whereas outward FDI complements it in China. However, (Ali et al., 2018) explores the impact of outward FDI on economic growth and concluded asymmetric relationship for China. The study uses life expectancy as human capital that demands attention.

According to (Awad et al., 2021) there is negative relationship between interest rate and investment in Palestine. According to (Ayeni et al., 2020) exchange impacts investment negatively through cost channel. Furthermore, the study also finds that credit to the private sector does not boost private investment due to insufficient credit in Gambia. For Vietnam (Dang et al., 2020) investigated the relationship between monetary policy and private investment at provincial level. The study used GMM technique to estimate the coefficient. The study divides the variables in three blocks – monetary policy, investment activities, and local economic developments. Broad money, credit to private sector and interest rate turned out to be positive while exchange rate remained statistically insignificant. According to (Zahra et al., 2020) there is crowding-in hypothesis in the long run in Pakistan.

Similarly, (Haghighi et al., 2012) explore the effects of macroeconomic instability on economic development in Iran by constructing the MII, which consists of the inflation rate, exchange rate, budget deficit, and term of trade over the period 1974 to 2008 from the Central Bank of Iran. The authors apply the Johansen Co-integration technique and find that macroeconomic instability adversely impacts economic growth.

It is evident from the literature review that though multivariable macroeconomic instability indices have been developed and used yet, none of them covers the scope that is being adopted in the present study. For example, some proxied just one variable equivalent to macroeconomic instability, and others used four variables. The contribution of this study is that it constructs a comprehensive macroeconomic instability index by incorporating six variables. Moreover, no study has used the macroeconomic instability index as a determinant of private investment in Pakistan. Therefore, this work aimed to estimate whether macroeconomic instability discouraged private investment in Pakistan or not.

3. MACROECONOMIC INSTABILITY

Macroeconomic instability is a notion of the disequilibrium of the economy. This concept is widely described in policy-oriented literature and refers to the overvaluation of currency, high inflation rate, the deteriorating balance of payments, growing fiscal deficit, and fluctuation in the exchange rate. Every type of economic instability demands actions to bring the economy back of a stable path (Azam, 2001). Moreover, a less predictable local economic environment makes more volatile macroeconomic variables and increases uncertainty in their behavior (Jalil et al., 2012).

However, in the past, macroeconomic stability was a mixture of external and internal balance accompanied by a low level of inflation that implied full employment level and sustained economic growth. After that, during the 1970s, 1980s, and 1990s, the center of attention regarding macroeconomic instability moved to fiscal and trade balance. However, recently, the economists shifted their focus on long-term sustained and equitable growth (Ocampo, 2005). In the words of Fischer (1993a, 1993b) and (Bleaney, 1996), macroeconomic instability is an augmentation in the macroeconomic policy indicators like inflation, deficit to GNP ratio, and external debt to GNP ratio. More instability means more fluctuation in the way of economic development. However, macroeconomic instability is a phenomenon of developing countries due to more volatile economic growth, low investment (Servén, 2003), mismanagement of the economy, income inequality, and vulnerability to external shocks (Dornbusch & Edwards, 1990).

3.1 Measurement of Macroeconomic Uncertainty

In literature, different studies have used other proxies to capture macroeconomic certainty. For example, (Servén, 1998) uses five variables to measure macroeconomic uncertainty like inflation, real GDP growth rate, the relative price of capital goods, trade terms, and real exchange rate and applies the GARCH model. Similarly, (Rathnasiri, 2009) uses inflation, economic growth rate, government budget as a proxy of internal stability and trade balance, exchange rate, and external debt for external stability (Mohey-ud-din & Siddiqi, 2014) using the standard deviation of GDP. Output and exchange rate volatility were used to measure macroeconomic uncertainty (Chowdhury & Wheeler, 2015) using the GARCH method.

Nonetheless, some studies developed MII by using external debt, inflation, exchange rate, and government budget deficit (Ismihan, 2003; Ismihan et al., 2005; Ahangari & Saki, 2012), and some studies include trade balance instead of external debt (Jaramillo & Sancak, 2007; Haghighi et al., 2012). In the case of Pakistan, the studies that investigated the impact of macroeconomic stability on private investment were scarce and did not employ any multivariable measure of instability index. For instance, (Ahmed & Qayyum, 2007; Sial et al., 2010) used inflation volatility in a similar investigation. To the best of our knowledge, no study used the macroeconomic instability index in the case of Pakistan. Against this backdrop, the rationale of

the current paper is to determine the impacts of macroeconomic instability on private investment by using the MII, which incorporates six macroeconomic variables.

3.2 Macroeconomic instability index

MII has been developed by following the Human Development Index (HDI) methodology of the United Nations Development Program (UNDP). The construction of an index is better to capture the simultaneous and combined effects of macroeconomic policies on economic growth. Undoubtedly, it is more appropriate to use a composite indicator because a single variable just shows the partial effects. Our index is based on three internal instability indicators - percentage change in the inflation rate, the percentage change in real GDP, and government budget deficit as a percent of GDP - and three external instability indicators - percentage change in the exchange rate, external debt as a percentage of GDP and percentage change in the trade balance.

MII is developed in two steps. In the first step, minimum and maximum are calculated, but they cannot simply summarize because each variable has a different range and units.

$$Z_t = \frac{I_t - I_{min}}{I_{max} - I_{min}} \tag{1}$$

Z_t is the index value of the variable I_t, a macroeconomic instability indicator. It is the actual value of hand I in year t. I_{min} (I_{max}) is the I indicator's minimum (maximum) value over a study time. The standard range of the I indicator of sub-indices lies between 0 and 1. Therefore, the value of MII also lies between zero and one. In the second step, Previous studies use a simple average of the indicator, but the present study follows the technique of (Haghighi et al., 2012), in which weights are given to the variables equivalent to their standard errors.

$$MII_t = \lambda\left(\frac{rgdp_t - rgdp_{min}}{rgdp_{max} - rgdp_{min}}\right) + \alpha\left(\frac{bd_t - bd_{min}}{bd_{max} - bd_{min}}\right) + \beta\left(\frac{inf_t - inf_{min}}{inf_{max} - inf_{min}}\right) + \varphi\left(\frac{ed_t - ed_{min}}{ed_{max} - ed_{min}}\right) + \delta\left(\frac{ex_t - ex_{min}}{ex_{max} - ex_{min}}\right) + \gamma\left(\frac{to_t - to_{min}}{to_{max} - to_{min}}\right) \tag{2}$$

The weighted sum of sub-indices is equal to 1.

$$\lambda + \alpha + \beta + \varphi + \delta + \gamma = 1 \tag{3}$$

The value of MII is bounded between 0 and 1. A higher value means more macroeconomic instability. The increase in the value of MII means either there is an increase in the volatility of one variable or more variables in the index.

4. DATA DESCRIPTION AND METHODOLOGY

The present study estimates the impacts of macroeconomic instability on private investment from 1976 to 2013, and data sources are World Development Indicator, World Bank (2015), and statistical handbook of Pakistan, State Bank of Pakistan (2015).

The study uses the following econometric model.

$$lnPI_t = \alpha_0 + \alpha_1 MII_t + \alpha_2 lnPIV_t + \alpha_3 lnBC_t + \alpha_4 lnFDI_t + \alpha_5 GNS_t + \alpha_6 RIR_t + \varepsilon_t \tag{4}$$

Whereas, PI, PIV, BC, FDI are private investment, public investment, bank-credit to the private-sector, and foreign direct investment respectively, and all these variables are in log form. MII, GNS and RIR are macroeconomic instability index, gross national saving as a percent of GDP, and Real Interest Rate (Nominal Interest Rate – Expected Inflation), respectively and ε_t is the error term. Furthermore, in the equation 4, MII is a variable of interest, RIR and PIV are policy variables, and the rest are control variables.

The present study applies the ARDL bound testing method to estimate the long-term and short-term relationship between private investment and macroeconomic instability.

4.1 Autoregressive-Distributed-Lag (ARDL) Method

We applied bounds testing procedure to cointegration within an ARDL approach (Pesaran & Shin, 1999; Pesaran et al., 2001) to examine the association between the MII and private investment in Pakistan from 1976 to 2013.

The general form of ARDL formulation is specified below for the abovementioned equation (4).

$$\begin{aligned}\Delta LnPI_t = {} & \gamma_0 + \sum_{i=1}^{l} \beta_1 \, \Delta LnPI_{t-i} + \sum_{j=0}^{l} \beta_2 \, \Delta MII_{t-j} + \sum_{j=0}^{l} \beta_3 \, \Delta lnPIV_{t-j} + \\ & \sum_{j=0}^{l} \beta_4 \, \Delta lnBC_{t-j} + \sum_{j=0}^{l} \beta_5 \, \Delta lnFDI_{t-j} + \sum_{j=0}^{l} \beta_6 \, \Delta GNS_{t-j} + \sum_{j=0}^{l} \beta_7 \, \Delta RIR_{t-j} + \\ & \lambda_1 lnPI_{t-1} + \lambda_2 MII_{t-1} + \lambda_3 lnPIV_{t-1} + \lambda_4 lnBC_{t-1} + \lambda_5 lnFDI_{t-1} + \lambda_6 GNS_{t-1} + \\ & \lambda_7 RIR_{t-1} + u_t \end{aligned} \quad (5)$$

The definition of variates in equation (5) is abovementioned. The estimated short-run coefficients represented by β_j and long-run coefficients are denoted byλ_i, and $l$is display optimal lag length. The null hypothesis of bound testing indicates that variables involved in the model don't have a long-run association, and all the long-run parameters have zero explanatory power. At the same time, the alternative hypothesis ratifies that all examined variables have a long-run relationship.

4.2 The Long-run Coefficients of ARDL Model

After confirming cointegration among examined series, the long-run parameters are estimated in the second step of the ARDL method, and appropriate lags are selected based on AIC or SBC. The long-run model is described below.

$$\begin{aligned} lnPI_t = {} & \chi_0 + \sum_{i=1}^{l} \beta_1 \, \Delta lnPI_{t-i} + \sum_{j=0}^{l} \beta_2 \, \Delta MII_{t-j} + \sum_{j=0}^{l} \beta_3 \, \Delta lnPIV_{t-j} + \sum_{j=0}^{l} \beta_4 \, \Delta lnBC_{t-j} + \\ & \sum_{j=0}^{l} \beta_5 \, \Delta lnFDI_{t-j} + \sum_{j=0}^{l} \beta_6 \, \Delta GNS_{t-j} + \sum_{j=0}^{l} \beta_7 \, \Delta RIR_{t-j} + \varepsilon_t \end{aligned} \quad (6)$$

4.3 The Short-run ARDL Model

To analyze the short-run parameters, the lag dependent variable and UECM coefficient is considered in the model to differentiate the long-run and short-run coefficient.

$$\begin{aligned}\Delta lnPI_t = {} & \lambda_0 + \sum_{i=1}^{l} \beta_1 \, \Delta lnPI_{t-i} + \sum_{j=0}^{l} \beta_2 \, \Delta MII_{t-j} + \sum_{j=0}^{l} \beta_3 \, \Delta lnPIV_{t-j} + \\ & \sum_{j=0}^{l} \beta_4 \, \Delta lnBC_{t-j} + \sum_{j=0}^{l} \beta_5 \, \Delta lnFDI_{t-j} + \sum_{j=0}^{l} \beta_6 \, \Delta GNS_{t-j} + \sum_{j=0}^{l} \beta_7 \, \Delta RIR_{t-j} + \\ & \gamma(ECM_{t-1}) \end{aligned} \quad (7)$$

Where γ is the error-correction coefficient that shows the speed of adjustment to long-run equilibrium because of a shock in the short-run.

4.4. Stability Test

To observe the reliability of short-run and long-run coefficients, the CUSUM and CUSUMSQR stability tests are implemented. The results of the stability test show that all variates are cointegrated. Likewise, the results indicate that CUSUM and CUSUMSQR statistics exceed the critical values.

4.5. Diagnostic Test

The reliability of the results is confirmed from the diagnostic tests. The diagnostic tests revealed the non-existence of serial correlation and heteroscedasticity by employing serial correlation Lagrange Multiplier (LM) and autoregressive conditional heteroscedasticity (ARCH) tests. The normality of the error term is confirmed by using the Jarque-Bera test. Similarly, the Ramsey RESET test revealed that the model has correctly specified the functional form. Moreover, the normality of residuals is verified by the Skewness-Kurtosis test.

5. EMPIRICAL RESULTS

The outcome of the Augmented Dicky Fuller (ADF) and Phillips Perron (PP) tests are presented in Table 1. It indicates that the macroeconomic instability index and gross national savings are stationary at a level. The notable point is that both tests explain bank credit and foreign direct investment differently. According to the ADF test, FDI and BC are stationary at level, whereas the PP test described that both variables are first-difference stationary.

Table 1: Results of "PP-test and ADF-test" with Intercept and Trend

	ADF test		Phillip-Perron test	
Variables	Level	1st Diff.	Level	1st Diff.
$lnPI$	-2.52	-5.30*	-2.63	-5.29*
MII	-6.60*	-6.06*	-6.59*	-32.99*
$lnPIV$	-2.32	-5.09*	-2.53	-5.19*
$lnBC$	-4.12**	-4.42*	-2.40	-4.37*
$lnFDI$	-3.78**	-4.88*	-2.71	-4.88*
GNS	-4.08**	-6.76*	-4.08**	-6.99*
RIR	-4.15**	-8.75*	-4.15**	-9.66*

Where *, ** and *** point to1%, 5% and 10% significance level respectively.
Source: Authors' estimations.

However, ADF and PP both test suggest that private and public investment and interest rates are integrated of order 1. The current work applies the ARDL technique because few variables are stationary at a level, and few are integrated at first difference.

5.1 ARDL Approach

The first stage of the ARDL process measured the cointegration among variates. For this point, F-statistic is counted, and an appropriate lag length of 2 maximum range is used as suggested by Schwarz-Bayesian-Criterion (SBC).

Table 2: Results based on ARDL "Bounds-Testing" technique

Model	Lag length	F-Tabulated		F-Calculated	Result
		I(0)	I(1)		
F($lnPI$ / MII, $lnPIV$, $lnBC$ $lnFDI$, RIR, $lnGNS$)	2	2.87	4.00	4.77** [.001]	Cointegration

** show that calculated "F-statistic "exceeds tabulated "F-statistic" upper bound at the 5% level.
Source: Authors' estimations.

The empirical result of Table 2 confirms cointegration among variables at the 5% level of significance as the calculated F-value is above the upper critical bounds. Thus, the null hypothesis is declined, suggesting the presence of cointegration.

5.2 Long-run Result

The long-run results presented in Table 3 show significant adverse effects of MII on private investment consistent with the third strand of theoretical and empirical studies (Ismihan et al., 2005; Ahangari & Saki, 2012). These results warrant that macroeconomic stability demands high priority.

This study finds that investment by the government has a positive link with private investment since the public investment generates complementarities, as it was found by (Akkina & Celibi, 2002; Ahmed & Qayyum, 2007). Bank credit to the private sector has a positive and significant relation with private investment. This is contrary to the results by (Rehman et al., 2009). Their study explains that sick units are responsible for this empirical anomaly. We contend that directed credit to different sectors and the not-so-huge problem of sick units in Pakistan demand a positive relationship, as is in our study. Furthermore, the ill unit phenomenon is not prevalent over a long period.

Gross national saving and FDI positively impact private investment, the former is statistically significant, and the latter is insignificant. The insignificance of FDI in the case of Pakistan is not queer one. Since the impact of FDI on domestic investment can be ambiguous, theoretically speaking, because of opposing forces. For instance, adding to the domestic stock of capital and bringing spillover affects one hand and pulls out the less competitive domestic firms from the business on the other hand. In our case, the coefficient is insignificant; the reason might be a low level of FDI as a percent of GDP. It remained as low as 0.87 percent of GDP from 1976 to 2013.

The insensitivity of investment to the interest rate is not peculiar to our study. Literature provides mixed evidence, and there are examples of insensitivity (Sharpe & Suarez, 2014). Furthermore, the relationship between interest rate and investment demands a firm-level data set since firms' investment in the real interest rate also depends on the firm's size. The bank-based or market-based firms, large or small, are the features to be investigated to uncover the genuine relationship between interest rate and investment.

Table 3: Results of Long-run Coefficients of "ARDL-Method"

ARDL (1-0-0-0-0-0-0) using Schwarz-Bayesian-Criterion (SBC), dependent variable $lnPI$			
Variables	Coeff.	S. E.	t-value [Prob]
MII	-0.3413	0.1592	-2.1431** [.041]
GNS	0.0300	0.0105	2.8608* [.008]
$lnFDI$	0.0958	0.0580	1.6530 [.110]
$lnBC$	0.5708	0.2016	2.8317 *[.009]
$lnPIV$	0.3039	0.1616	1.8808*** [.070]
RIR	-0.0015	0.0083	-0.1869 [.853]

Where *, ** and *** imply 1%, 5% and 10% significance level respectively.
Source: Authors' estimations.

5.3 Short-run Results

Table 4 shows the short-run results of ARDL. It indicates that MII also has significant adverse effects on private investment in the short run. Gross national saving, FDI, public investment, and bank credit positively relate to private investment. The negative coefficient of ECM is very significant demonstrates a more incredible speed of adjustment, almost 76 percent of disequilibrium resulting from shock in the past year is converged toward long-run equilibrium in the current year.

Table 4: Results of "Error-Correction"

ARDL (1-0-0-0-0-0-0) using Schwarz-Bayesian-Criterion, dependent variable is *lnPI*			
Var.	Coeff.	S.E.	t-Value [Prob]
ΔMII	-0.2603	0.1145	-2.2736* [.008]
ΔGNS	0.0229	0.0084	2.7358* [.010]
$\Delta lnFDI$	0.0730	0.0426	1.715*** [.097]
$\Delta lnBC$	0.4355	0.1726	2.5227* [.018]
$\Delta lnPIV$	0.2318	0.1372	1.6891 [.102]
ΔRIR	-0.0012	0.0087	-0.1878 [.852]
$ECM(-1)$	-0.7628	0.1279	-5.9647* [.000]
R- Squared	0.9923	Adj.R-Squared	0.9902
$F(7, 27)$	454.33[.000]	DW-Statistic	2.0639

Note: *, ** and *** shows 1%, 5% and 10% significance-level respectively.
Source: Authors' estimations.

5.4 Diagnostic Test

The results of the diagnostic test are documented in Table 5. This reflects that the model is free from the problem of heteroskedasticity serial correlation. Furthermore, the model is correctly designed, and data is usually distributed.

Table 5: Results of different "Diagnostic-Test"

	Test-Applied	Stat. [Probability]
Serial Correlation	Breusch-Godfrey LM Test	1.3117 [0.624]
Functional Form	Ramsey Reset Test	0.1762 [0.678]
Normality	Jarque-Bera Test	2.2436 [0.349]
Heteroskedasticity	ARCH Test	0.2393 [0.887]
DW-Statistic = 2.0639	DH –Statistics = -1.3550[0.175]	

Note: Authors calculations based on Eviews-9.

5.5 Stability Test

If cointegration is verified, then the reliability of regression coefficients is essential. The CUSUM and CUSUMSQ test of (Brown et al., 1975) are utilized to study the stability of short-run and extended-run parameters. The null hypothesis of this test is that all the regression parameters remain stable over the study time. In addition, the chart of both CUSUM and CUSUMSQ lies within the critical limits at a 5% significance level.

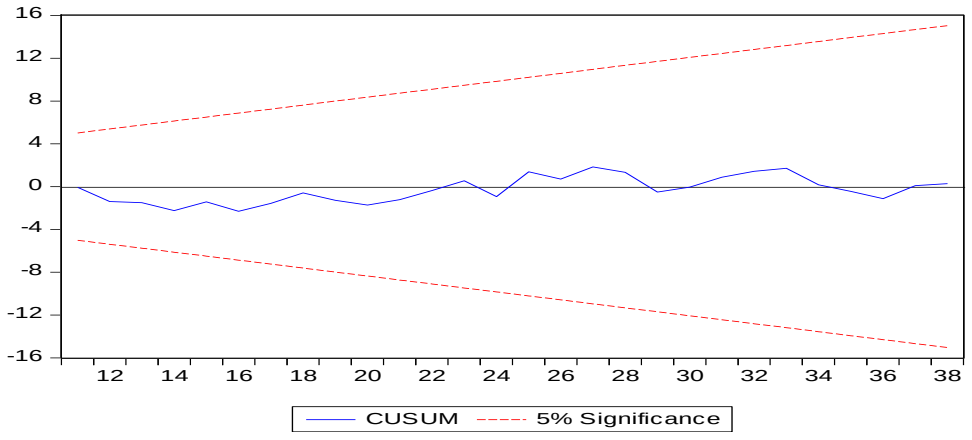

Figure 1: Plot of CUSUM

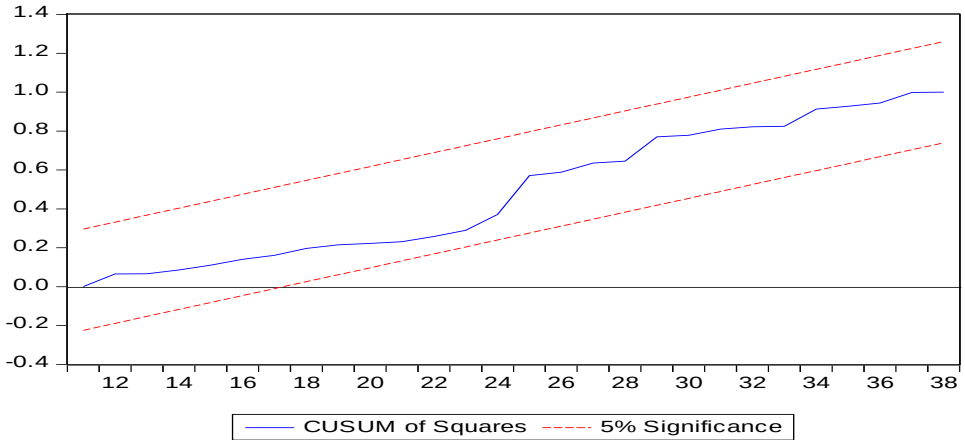

Figure 2: Plot of CUSUMSQ

6. CONCLUSION AND POLICY IMPLICATIONS

This study investigated the impact of macroeconomic instability on private investment in Pakistan by utilizing the ARDL co-integrated approach during the period of 1976-2013. Contrary to the earlier studies about Pakistan that used a single variable to gauge macroeconomic instability, this study developed a macroeconomic instability index following the methodology of the Human Development Index. Our index consists of six macroeconomic variables: internal instability like real GDP growth rate, inflation rate, and government budget deficit and external instability such as real effective exchange rate, external debt, and trade term.

The results showed that macroeconomic instability bore crucial negative impacts on private investment in the case of Pakistan. The results were consistent with (Bernanke, 1983; Pindyck, 1988; Dixit & Pindyck, 1994; Aizenman & Marion, 1999; Akkina & Celibi, 2002; Ismihan et al., 2005). Moreover, public investment, gross national savings, and foreign direct investment showed a positive connection with private investment, though FDI is insignificant, which is not unusual.

The positive and statistically significant effect of bank credit and private investment, whereas the insignificant association between real interest rate and investment highlighted that availability of credit (volume) is more important than the price effect. The insensitivity of investment to the interest rate is in line with (Sharpe & Suarez, 2014). Khan and Khan (2007) also find less interest sensitivity in the case of Pakistan.

The most apparent policy implications are that macroeconomic instability is detrimental for private investment; thus, the government should focus on ensuring macroeconomic stability ineffectiveness of monetary policy due to revealed insensitivity of investment to the interest rate. However, the importance of monetary policy cannot be discounted, as inflation and exchange rate are constituents of MII. Since the MII includes both monetary and fiscal-related variables, thus the study concludes that fiscal and monetary policy can boost private investment.

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Nexus Between Unemployment and the Size of the Informal Economy in the Case of Pakistan and its Comparison with the Subcontinent

ABSTRACT

Despite the government's efforts to reduce the shadow economy in Pakistan to raise revenue, workers' involvement in the shadow economy continues to rise, explained via the labour force participation in the shadow economy. The debate regarding the estimation of the shadow economy and its relation to unemployment is highly celebrated in literature. It is not hard to find a few studies while taking Pakistan a particular case that explains the relationship between Unemployment and the size of the Informal Economy, but no study channelizes properly how and through which channels unemployment affects the size of the informal sector. Additionally, this study contributes to filling this void by demonstrating how unemployment is linked to the size of the shadow economy and how unemployment fuels the informal economy's growth in Pakistan. Further, it provides possible economic consequences for public policy decisions. The study posits that changes in the unemployment rate positively contribute to the size of the shadow economy. Due to the unavailability of legal opportunities, workers who work in the shadow economy continue to stay, while other unemployed labor force also tends to participate in informal economic activities.

AUTHORS

Ashiq Hussain
MPhil Scholar, School of Economics, Quaid-i-Azam University, Islamabad
Author's Contributions: 1, 4, 6
amir52453@gmail.com
https://orcid.org/0000-0001-7220-2048

Amanat Ali *
Assistant Professor, School of Economics, Quaid-i-Azam University, Islamabad
Author's Contributions: 2, 5, 6
amanat@qau.edu.pk
https://orcid.org/0000-0003-0112-7428

Muhammad Naeem Akram Abbasi
Ph.D. Scholar, School of Economics, Quaid-i-Azam University, Islamabad
Author's Contributions: 3, 4, 6
naeemaitaabbasi@gmail.com
https://orcid.org/0000-0003-3403-8114

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*** Correspondence author**

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

1. INTRODUCTION

Determining the informal economy's exact size (IE) is complicated. Any significant effort and contribution are required to measure the spectrum of shadow activities. All activities that generate income are included in this category, but it is challenging to include all private income-generating activities. Many types of research have concentrated on some (SE) activities, and these studies have provided estimates of the informal sector that reflect the real-world condition in any economy. Those Researchers who attempt to assess the size of the informal economy (IE) face the challenge of determining how to define it. In literature, there are many definitions, and a few of them are in Table 1. For the sake of simplicity, one working definition includes all present unrecorded economic processes that would otherwise contribute to the official Gross Domestic Product. Because there is a contradiction that the informal economy (IE) is either complementary or contradictory to the formal economy, the informal economy (IE) is a complex and dynamic phenomenon for the entire world (FE). Few studies have been conducted to assess if the informal sector is a source of progress or a threat to economic and social development. The underground economy is a conundrum, especially for the developing world, because it accounts for a considerable share of GDP in developing countries. This heavy reliance on the underground economy provides an opportunity for unemployed individuals due to a lack of legal employment opportunities. Furthermore, unemployment is always high in most developing countries.

Although there are various reasons why workers are attracted to shadow economy activities. However, the most important and frequently cited reasons are an increase in the level of taxes and regulations in the formal sector (FS), particularly in labor market regulations; pressuring employees to work fewer hours and retire earlier, which raises the unemployment (UE) rate and reduces loyalty to public institutions (Schneider & Enste, 2000).

Although there have been various studies on the size of the shadow economy, researchers have paid less attention to how unemployment affects the shadow economy compared to other crucial links. There are a few studies in the literature on the relationship between unemployment and the scale of the shadow economy, but to my knowledge, none explain this critical relationship in the context of the subcontinent. As a result, the purpose of this research is to look into the relationship between unemployment and the magnitude of the informal economy (IE). Understanding the connections between unemployment and the informal sector may help us better understand how unemployment affects the informal economy (IE). All countries in the subcontinent, including Pakistan, India, Bangladesh, and Sri Lanka, have historically been developing countries. Most people have decided not to report their entire or partial income to their respective revenue institutions over their independence. As a result, the informal economy accounts for a more significant percentage of the economy. According to 2015 data, the informal sector contributed 30.16, 17.8, 27.7, and 35.4 percent of GDP in Pakistan, India, Bangladesh, and Sri Lanka, respectively (Medina & Schneider, 2018). However, the statistical data proves that the informal economy exists all over the subcontinent. But the exciting thing is that in all those countries of the subcontinent, the informal economy (IE) decreases except Pakistan, but still, the informal sector (IS) accounts for an essential share of the official economy.

However, people involved in the informal economy cheat the system and shift the burden to the rest of the country's residents. Therefore, these activities are referred to as the "informal economy". Business people's wage and salary earners are among those who participate in the underground economy. They work and earn income from the underground economy and cover their income from the revenue collection authority. Furthermore, it has been empirically proven that business sector participation accounts for less than half of informal activities, while the household sector accounts for the remainder (Bajada, 2002).

The question now is: what are the many pathways via which the unemployment rate influences the size of the informal economy (IE)? From a policy standpoint, it's essential to determine whether shadow economy activities expand or decrease when the unemployment rate changes. Therefore, there is a positive association discovered between the rate of unemployment and the underground economy it can be said that: firstly, change in unemployment is generating an employment cycle in the informal sector and play a vital role as an automatic stabilizer that reduces the volatility of casual business cycle, and secondly, the government requires more effective surveillance of those who pretend to be unemployed and receiving welfare assistance but working in the informal economy (Bajada and Schneider, 2005). Moreover, policies formulated by policymakers who use government figures to make their policies don't know about the actual volatility produced by the informal economy. This study explores how the change in the unemployment rate influences the size of the shadow economy.

1.1. Shadow Economy in Subcontinent Countries

An economy cannot be managed effectively without knowing the magnitude of the economic activities running along with the formal economy. Therefore, considering the above statement, we can understand that the informal economy can be viewed as the national economy's actual parameter. In the presence of SE, redistribution of income, trade, inflation, tax system economic growth, society's social and economic perspective, and most macroeconomic indicators are affected. This issue is critical in developing and developed countries (Schneider, 2005).

The Subcontinent economy consists of formal and informal sectors, producing approximately the same good. In the legal economy where firms run productive activities, the self-employed people run productive activities. On the other side is the illegal economy. Furthermore, skilled workers are constantly getting employment because they are assumed to work in a competitive market, but unskilled workers might be unemployed due to wage rigidities. Besides, the only difference between goods and services is the degree of risk. In the informal sector, we can supply goods and services without risk, but there is a risk to providing goods and services (Bental et al., 1985).

The failure of Pakistan's economic system is due to low tax to GDP ratio, questionable increase in energy requirements, an upward trend in inflation, especially in food items, etc. the upward trend in Pakistan's shadow economy (SE) due to many reasons, including geographical and geopolitical boundaries especially Pak-Afghanistan and Pak-India relations and Pakistan logistic relationship with NATO forces in the War against terrorism. The demolishing of the 2005 Earthquake and the situation of the 2010 flood became the reasons for the enlargement of the shadow sector. In the light of the socio-economic point of view, upward jump in the process, especially in the consumer durable and food items prices, the implementation of new GST/VAT system and increase in the energy sector prices may force the peoples to enter the informal economy.

Pakistan is an underdeveloped country and facing many challenges, according to the estimates of UNCDP 2004-15, 38.3% of people are classified as poor, and 4 out of 10 Pakistanis live in multidimensional poverty. Therefore, if we want to make the policies that policies must be effective, they should be unbiased, and only those policies should be acceptable in which macroeconomic indicators are accurate to improve the economic conditions and speed of growth. Furthermore, to make effective and precise policies about improving Pakistan's economy, we need to understand and estimate the actual size of black and white economies. After calculating the substantial scale of the informal economy, the government will be able to improve the economic system and increase its revenue. Like most other developing countries, Pakistan demolishes bureaucratic formalities and complex processes required for all critical services. These complications turn the economic agents into a path with tax evasion (Mughal & Schneider, 2018). In Pakistan, the government has extensive control over the economy, and the launching of the automation process is a recently emerging trend in public office. But still, Pakistan is the most challenging country to run the business due to regulations and overlapping procedural formalities. In 2017 Pakistan was placed at

147 positions out of 190 countries in ease of doing business. This position reflects extensive formalities in various processes in the case of Pakistan and forces us to make one window operation to start a business in Pakistan.

Although India, Sri Lanka, and Bangladesh are also developing countries placed in Subcontinent. In India, there is a declining trend in the share of the informal economy to GDP after 2000. But still, there is a significant share of the shadow sector to the official calculated GDP, around 22 percent on average. Furthermore, official calculated GDP is also based on the legal and illegal sectors in the case of Sri Lanka. In the case of Sri Lanka, there is also a declining trend in the size of the shadow economy (SE) like India that we have seen above. The share of the shadow economy falls around 48 percent to 35 percent from 1996 to 2015. But still, the average size of the shadow economy (SE) of Sri Lanka is roughly about 44 percent from 1996-15. Bangladesh's economy consists of the legal and illegal sectors. In the case of Bangladesh, there is also a decreasing trend in the size of the informal economy. These figures are calculated from the data collected from World Governance Indicators.

1.2. Unemployment and Informal Economy

In literature, many studies have been made to explain the link between the rate of unemployment (UE) and the size of the informal economy. There are two possibilities in the relationship between unemployment and the size of the informal economy, either directly or indirectly. According to the study in which the size of the informal economy is a direct function of unemployment, the link is found very relevant in countries with high unemployment and less relevant with a moderate level of unemployment. Unemployment's contribution to the shadow economy is proving to be necessary, especially in economic downturn years such as 2008. The financial crises of 2008 were the worst economic disaster after the great depression of 1929. The financial disaster happened despite many attempts by the Federal Reserve and Treasury department to stop it. The financial disaster leads to a decrease in housing prices by about 31.8 percent. The unemployment was still above 9 percent after the 2008 recession. Furthermore, government expenditure, bank credit, and inflation rates are also positively related to the informal economy (Tran, 2021).

About the shadow economy of Pakistan, different studies have been made to estimate the informal economy's size, different underground economy dynamics, and the effect of the shadow economy on various economic variables. Pakistan is a developing country. Like most developing countries, Pakistan's economy is also divided into formal and informal sectors. In the Pakistan economy, there are some vital shreds of evidence on the growth of the informal sector. The informal sector plays a crucial role in creating job opportunities for unemployed people and rising GDP growth. We ignore the importance of the shadow economy even though the shadow economy has a significant contribution to the GDP and employment. In Pakistan, the bureaucratic model of development, despite heavy reliance on state foreign aid to provide the human development service, has failed to provide adequate job opportunities in the formal sector of an economy.

However, the informal sector of Pakistan absorbs 67% of the urban employed person. Out of 67 percent, 91 percent of people have no formal training in the informal. In the informal sector, there is 80 percent of women work. On average, the earnings of unskilled workers are lower than the similar worker in the formal sector of an economy. In the Pakistan economy, the wage of an educated person is higher in the formal sector than in the informal sector. Due to the importance of the informal sector of Pakistan's economy, several policy recommendations are made regarding the education and training of workers, access to credit facilities, tax exemption to encourage self-employment, management, and technological developments. The formal and informal sectors should coexist to support each other for the overall growth level of an economy (Bodla & Afzal, 1997). The shadow economy encompasses many activities that affect government policies and the official economy either directly or indirectly. The average shadow economy of Pakistan from 1973-2015 as a percentage of GDP is around about 26.41 (Mughal & Schneider, 2018). However, we can say that the informal sector plays a significant role in economic activities.

However, India, Sri Lanka, and Bangladesh are also developing countries, and they are facing the problem of the difference between the actual labor force and demand labor force. Therefore, with a high population rate, the developing countries can't employ all workers looking for a job. Over the last decade, India maintained an average growth rate of 7 but has not been accompanied by growth in job opportunities. In the case of India, the development of new job opportunities does not fulfill the growing demand for jobs. India's annual market for a new job is approximately 12 to 15 million. Therefore, there is an annual shortage of about 4 to 7 million jobs. Furthermore, in India, 300 million working-age individuals are outside the labor force. Most developing countries like Sri Lanka and Bangladesh have faced problems due to low employment opportunities or a mismatch between potential and actual labor force.

As this study has discussed above, in the case of Sri Lanka, the share of the shadow economy has a decreasing trend over time. This is happing because Sri Lanka has been creating employment opportunities to reduce unemployment. Therefore, one of the most important reasons behind the decreasing trend in the share of the informal economy is the drastic reduction in unemployment. There has been a drastic reduction in the unemployment rate throughout 19900-2010 government improved the working environment, especially for women. Furthermore, structural transformation happens during this period, and the economy goes away from the agricultural sector towards the services and manufacturing sector (Byiers et al., 2015).

Since the independence of Bangladesh in 1971, some essential strategies towards growth and poverty alleviation have been made. But still, two of the fifth population is live below the poverty threshold and still among the lowest in the world as per capita income (Muqtada, 2003). Bangladesh's total labor force is about 56.7 million. Therefore, 69.6 percent of the overall labor force is male, and 30.4 percent are female. Furthermore, out of 30.4 percent, most females are employed in household work which is not paid employment. That's why not included in the official calculated GDP.

2. REVIEW OF LITERATURE

Unemployment and shadow economy both are common issues all over the world. In the case of the USA, there is also exist some unemployment. The average unemployment rate from 1948-to 2015 was about 5.8 percent in the case of the USA economy. Shadow economy has great importance because it reduces unemployment in an economy. However, increasing the shadow economy creates a problem for implementing government policies. For example, if the government wants to improve the provision of goods and services for people but persons who are employed in the shadow economy will be a free rider of government goods and services and will reduce the quantity and quality of goods and services for persons who work in the formal sector and pay taxes. But at the same time, the shadow economy absorbs unemployment from the informal economy. Therefore, various research has been conducted to determine the link between unemployment and the shadow economy. One of the research projects conducted from 1970 to 2004 looked into the relationship between unemployment (UE) and the size of the shadow economy (SE) in the U.S. The findings demonstrate a positive relationship between unemployment (UE) and the size of the informal economy (IE) through the use of the structural equation method (Dell'Anno & Solomon, 2008).

Informal agriculture accounts for a significant portion of the agricultural sector. Because the majority of people employed in the informal economy are illiterate. There are two significant consequences: first, the rural agricultural informal sector drains a significant portion of government revenue; second, because they are ignorant, they are unaware of how to employ modern agricultural equipment, leaving them impoverished. According to Ali et al. (2021), technology in the agricultural industry has a favorable impact on farmer income and welfare. As a result, we can conclude that this is one of the most critical variables that can help reduce the informal economy's size.

One of the most important measures of growth and development is institutional quality. If institutional quality improves, the country's growth and development will also improve. Institutional quality, along with growth and development, is one of the most important markers in determining the size of the informal sector. If all of the metrics of institutional quality are functioning correctly, the informal sector's size can be reduced. However, because not all metrics of institutional quality increase in the same direction in Pakistan, institutional quality is positively associated with the extent of the informal economy (Ali & Hussain, 2021).

Two competing factors decide the association between informal economy (IE) and unemployment (UE). On the one hand, an upward rise in the unemployment (UE) rate decreases the informal sector of an economy because, under the Okan law, it is positively linked to the GDP and negatively related to unemployment (UE). If the informal economy is positively related to GDP, it must fall when GDP decreases. On the other side, an increase in the rate of unemployment (UE) leads to a rise in the shadow economy because now people have more time to work in the informal economy (Giles & Tedds, 2002).

Various studies focus on the conceptual question and empirical research, looking at the literature. An economy has two sector frameworks, formal and informal sectors, with the general equilibrium. We want to investigate the impact of government expenditure and unemployment compensation on employment in the formal and informal sectors on real wage and relative commodity prices. The relationship between the shadow economy and the problem of unemployment has become one of the most severe issues of debate. There is a dilemma which faces by the policymaker. On one side, the shadow economy is illegal, and on the other side, it employs the country's labor force. Our labor force is divided into two categories: skilled and unskilled labor. When the government increases its expenditure on development or non-development projects, it leads to mainly an increase in demand for skilled labor. However, the informal sector of an economy uses capital and an unskilled labor force (Saracoglu, 2015).

3. METHODOLOGY

3.1. Theoretical Framework

Consumers get utility from formal and informal sectors. In literature, some studies confirm the growing tendency into informal sectors in many countries, especially in developing countries. Therefore, different hypotheses about the presence of informal sectors in economic modernization, dependence, neoliberalism, and structuralism have been developed by researchers.

3.2. Modernization

Rostow (1960), in their titled book, The Stages of Economic Growth: A Non-Communist Manifesto in the aftermath of World War II, proposes a modernization approach to national development. In which he discusses the Rostow stage of economic development. Rostow criticizes underdevelopment as a social and economic issue caused by backward social-economic structures. However, according to Rostow, the policy recommendation was to acquire new legal systems, modern achievement, modern capital list economies, and a democratic system. The word contemporary is considered a synonym of the capitalist in recent times. However, capital exploitation doesn't underdevelop third-world countries, but these countries have not been fully integrated into the industrialized world. However, third-world nations need to take off to catch up with the advanced world. The informal sector was seen by the exponents of modernization theory as the elimination of traditional, pre-capital modes and to cut off rural people. As a result of all these factors, the unemployment rate rises, and the informal sector is becoming a viable source of income for them and their families. Furthermore, other reasons that forced the workers to work in the informal economy were the low level of education, skills, and value orientations. According to the national development prescription, which

the modernists prepare, the urban surplus would gradually vanish with the emergence of the modern or industrial world.

3.3. Structuralism

According to the structuralism approach, informality comes from more regulation and excess labor supply, but the central idea of the structuralism approach is that informality comes from the exploitation of labor by capitalists. While on the other side, Maloney (2000) says the association of informality with labor is not just happening accidentally, but the capitalist prepares this mechanism. Capitalists attract the formal reserve labor to the informal sector and employ them as a cheap labor force.

There are two key contributions to the informal economy of structuralism in literature. The first contribution is that the informal economy has the function of supporting the capitalist system. Furthermore, globalization is the biggest supporter of the capitalist system. According to the context of capitalism and globalization, preserving the market competition as manufacturers seek to produce production costs and wages (Castells & Portes, 1989). To clarify, he considers Guatemala's research and uncovers how many U.S. clothing companies provide local contracts, but those companies don't provide social security. Most contracts are signed with women because they join for significantly lower wages than the market value.

A second contribution by the structuralisms is that the growth of the shadow economy is crucial for development. Compared with the formal economy, a more significant number of jobs are included in the informal economy. A more substantial number of workers are working in the informal economy. Because an individual considers that their utility from income is higher in the informal economy than in the formal economy. There is a wide range of markets of cheaply manufactured goods and services in the informal economy. To make a further profit, using organized labor, capitalists often use casual labor to minimize cost.

3.4. Theoretical Background of Model

In general, workers will choose to either be in the formal sector or the informal sector at any point in time. Workers who work in the formal sector tax is deducted from their income used to finance government expenditure, but tax revenue can also be wasted because of misuse, while on the other side, informal sector workers pay a proportional fraction of their income as penalties.

3.5. A model with Formal and Informal sector

There are two types of labor force work in the economy: formal and informal. Therefore, we will include only one labor category in the first neoclassical production function: formal labor. The second model will discuss neo-classical production function technologies with informal and formal labor forces.

3.6. The Model with Formal Sector

There is a very effective approach to calculating TFP levels in the neo-classical literature. In this method, we assume that the GDP is a function of factor endowment and productivity at time t is denoted by Y_t and this function follows a constant return to scale Cobb-Douglass technology as follows:

$$Y_t = (kt)^a (AtLt)^{1-a} \qquad (1)$$

Where productivity, stock of capital, and the input of labor are represented by A_t, k_T and L_t respectively. Here, productivity is assumed as labor augmenting by the production technology, and this assumption is a standard approach because it will make the productivity measures. The productivity measures will be determined using the following equation based on the production technology given in the above equation:

$$A_t = \left(\frac{Yt}{(Kt)^a\,(Lt)^{1-a}}\right)^{\frac{1}{1-a}} \quad (2)$$

The above equation shows that productivity is negatively associated with capital and labor while positively associated with output.

3.7. The model with the informal and formal sector

We will give a new shape to neoclassical production technology by introducing the informal labor force into production function. Therefore, different ways to incorporate the informal sector into production technology. One of them is as follows:

$$Y_t = (K_t)^{\sigma}\left[(A_t^F L_t^F)^{\sigma} + (A_t^I L_t^I)\right]^{(1-\alpha)/\alpha} \quad (3)$$

Here in equation (3), L_t^F represent formal labor force in the economy, and L_t^I represent the informal labor force in the economy while A_t^F represent the productivity of formal sector contributed to the official economy and A_t^I represent the productivity of the informal sector contributed to the official GDP. Moreover, σ represent the level of the productiveness of a worker in the formal or informal economy. The elasticity of substitution will be measured by 1/(1- σ). Furthermore, informal economy σ = 1 means that the more productive workers will be selected for employment in an economy, while σ >1 means less productive workers will be employed. In practice, the formal sector employs more productive workers because the formal sector has the availability of skilled workers. In this way, the less productive workers do not include in the production function. In the case of σ = 1, the above production reduces form, known as the Cob-Douglas production function (Elgin & Sezgin, 2017). However, when unskilled workers have less productivity, they are ignored from the formal sector. Resultantly, less productive workers move to the informal sector and earn money to survive because they don't have other options.

However, the money obtained from penalties is used to brides to government officials and partially to finance the regulatory mechanism of government but not used for public services. An informal agent has fractional access to government services due to their illegal status. Therefore, for workers that belong to these two sectors, their net tax/penalty income is given by

$$y^F = (1-t)A\left(\frac{G}{Y}\right)^a ki, \qquad 0 < t < 1 \quad (4)$$

$$y^I = (1-\pi)A\left(\frac{\S G}{Y}\right)^a ki, \qquad 0 < t < 1 \quad (5)$$

Where t represents tax rate, π represents the penalty rate, $\S$ is the fraction of public services available to informal agents, F and I represent the formal and informal sector, respectively. It depends on workers working in the informal sector and paying penalties and getting fractional access to public services, or works informal sector pay proportional income tax and get full access to public services. The rate of penalty depends on the government enforcement system.

$$\pi = \pi(\lambda, I), \qquad 0 < \lambda < 1 \qquad \frac{d\pi}{d\lambda} > 0 \qquad \frac{d\pi}{dI} > 0 \quad (6)$$

Here λ measure the strength of the government enforcement system. If there is an increase in the enforcement system, there will be a reduced penalty, which means fewer people will think about working in the informal sector because there is more chance of conviction for illegal work, and I measure the relative size of the informal sector. The size of the informal sector depends on the rate of penalty. If there is an increase in the rate of penalty will lead to a decrease in the informal sector and vice versa.

3.8. Informal Economy and Unemployment

This section will discuss the division of labor, either employed or unemployed, and whether there is a structural relationship between informal economy and unemployment through a model derived by Hall (1979).

Consider a closed economy where L shows the total labor force in an economy and assumes that the labor force is constant. Moreover, the labor force is divided into UE (U) and employment (E):

$$L = U + E \tag{7}$$

Equation (7) represents the total labor force divided into unemployed and employed workers in an economy. Here U/L will be the UE rate. Further, there are two concepts of job separation and job finding. The rate of workplace separation is the rate at which a worker leaves a job, and on the other hand, the rate of job determination is the rate at which w worker finds a job (Dell'Anno & Solomon, 2008).

In addition, at the study state level, the number of workers who lose their job will be equal to the number of workers who find their job and become employed. In the term of mathematics, we can show the equilibrium will be:

$$\begin{aligned} s &= f \\ sE &= fU \end{aligned} \tag{8}$$

Solving equation 7 for E,

$$E = L - U$$

Substituting the value of E into equation 8,

$$\begin{aligned} fU &= s(L - U) \\ fU &= sL - sU \end{aligned}$$

We will divide the whole equation by L to obtain the UE rate.

$$\begin{aligned} fU &= \frac{sL - sU}{\mathrm{L}} \\ fU/L &= \mathrm{s}(1 - \tfrac{U}{\mathrm{L}}) \end{aligned}$$

To get U/L to solve the above equation,

$$\begin{aligned} \tfrac{fU}{L} &= \mathrm{s} - \tfrac{sU}{\mathrm{L}}) \\ s &= \frac{fU}{L} + \frac{sU}{L} \\ s &= \tfrac{U}{L}\,(f + \mathrm{s}) \\ \tfrac{U}{L} &= \frac{s}{(f+s)} \end{aligned} \tag{9}$$

However, equation (9) represents that a higher job separation rate (s) will lead to an increase in the unemployment rate because these two are positively related to each other while a higher job-finding rate (f) will lead to a decrease in the rate of unemployment. The fundamental purpose of the above equation is to derive the relationship between the shadow economy and unemployment. Therefore, the above derivation

reveals a positive relationship between the shadow economy and the unemployment rate. The above equation shows an exciting channel of how the job separation rate affects the shadow economy size. When more workers lose their job in the formal sector, the unemployment rate leads to an increase in the size of the shadow economy.

3.9. Econometric Model

The following econometric model is used for the estimation:

$$LSE_t = \beta_0 + \beta_1 UE_t + \beta_2 II_t + \beta_3 GI_t + \beta_4 TO_t + \beta_5 LGDP_t + \mu_t \quad (10)$$

Where SE_t represents the log of the shadow economy, UE_t represents unemployment rate, II_t represents the institutional index, GI_t represents the Gini Index, TO_t represents the trade openness that is equal to share of export plus a share of import, $LGDP_t$ represents the log of GDP per capita, and μ_t represents the error term

4. DATA

This research study examines Pakistan and other countries in the subcontinent (including India, Sri Lank, Bangladesh). This study collects data from different sources. This study is not dealing with the estimation of underground economic activities. However, this study takes the underground economy data from Medina and Schneider (2018). Furthermore, unemployment, trade openness (share of export plus import), the Growth rate of Gross Domestic Product per capita (GDP), and inflation are downloaded from World Development Indicators while institutional quality indicators including voice and accountability, the rule of law, government effectiveness, control of corruption, and regulatory quality collected from the World Governance Indicators. The econometric techniques depend upon the behavior of variables. In this study, the variables are mixed order of integrated so that the auto-regressive technique is used for empirical analysis.

The market-based legal production of goods and services that is deliberately withheld from public authorities for the following purposes constitutes the shadow economy:

- to stop paying wages, value-added, or other taxes,
- to stop having to pay into the social security system,
- to avoid following a formal labor market requirement and to complete such administrative tasks, such as filling out organizational forms.

Institution Quality is a broad concept. There are different indicators to measure the institution's quality, like the rule of law, government effectiveness, and protection of individual rights. For development, institution quality is the most critical variable because institution quality and economic development reinforce each other in the longer term. We use the governance index as a proxy for institutional quality when assessing institution quality. This study makes the index of six governance indicators for institutional quality as follows:

Voice and accountability: a review of the political process and democratic rights.
Government effectiveness: measuring the government's ability to develop and execute politics successfully. Government effectiveness refers to the government's ability to develop and enforce successful policies that benefit the public good.
Political stability: this indicator tests perception of the probability of destabilizing the government.
Regulatory quality: this measure focuses more on regulations, such as the effect of business policies and perception of the burden imposed by excessive regulation.

Rule of law: There are different indicators to measure the agent's confidence level, but one of the most important indicators is the rule of law. Therefore, this indicator measures how far society has progressed in establishing an ecosystem where blameless and predictable laws govern economic and social interactions.
Control of corruption: The power to control corruption is a public power used for private gain.

All scores estimated by the word governance indicator lie between -2.5 to 2.5. Therefore, a higher score means that institutions are working well and vice versa.

The unemployment rate is calculated by dividing the number of unemployed people by the total number of people in the labor force. The labor force also includes the number of employed people and the number of unemployed people. Therefore, both employment and unemployment are important to calculate the unemployment rate. All workers of working age who are unemployed during the reference time are counted as unemployed. For example, if a worker can work and is willing to work and doesn't get any paid employment in the reference period, they are included in the unemployed labor force.

The Gini index measures the income distribution across a population. The Gini coefficient in 1992 by Corrado Gini, an Italian statistician. This index may also verify the income or wealth distribution within a population. The coefficient ranges from 0 to 1, with perfect equality as 0 and perfect inequality as 1.

Small countries are involved more in trade than large countries. Countries located away from large markets usually have lower export shares. Factors that determine the trade volume are population, culture, geography, and trade policy in a country. Furthermore, trade openness is a complicated term that requires the country's trade policy orientation and a collection of domestic policies that make the country outward-oriented (Huchet et al., 2018). Trade openness is measured through the share of export to GDP plus a share of import to GDP. If there will be an increase in the share of export plus a share of import to GDP, we can say that trade openness is increasing and vice versa

GDP is a metric that calculates the total value of all goods and services produced in a country over a specified time. Furthermore, the GDP is an important indicator of economic growth. This report looked into the relationship between the size of the shadow economy and GDP per capita growth. Inflation is a quantitative measure of the rate at which the overall average price level of goods and services increases over a specific time. This study uses the annual inflation rate for empirical analysis.

5. RESULTS AND DISCUSSION

Table 1 shows the descriptive statistics for the time series analysis in the case of Pakistan. The second column of Table 1 shows the shadow economy descriptive analysis. The mean value of SE is 28.3815; the median is 28.24, the maximum value is 41.37, and the minimum value is 19.27. The standard deviation value 6.2269 shows the variation in the data from the mean value. Furthermore, the value of skewness should be zero for the normal skewness. Therefore, the skewness value is 0.2732, which shows that the shadow economy mirrors normal skewness.

Moreover, data is normally distributed informal economy the value of Kurtosis will be 3. In this case, the value of Kurtosis 2.25 is less than three. Therefore, we can say that data is platykurtic, meaning that more values are less than the mean value. The Jarque-Bera test also shows the normality of data. In the case of the shadow economy, the value of Jarque-Bera is greater than the probability value, which means that data is normally distributive. However, we can explain all the other variables as we have done for the shadow economy.

Table 1: Descriptive Statistics

	Shadow Economy	Unemployment Rate	Trade Openness	Gini Index	Gross Domestic Product	Institutional Index
Mean	28.3815	6.4250	32.9728	30.0100	2.8733	-0.7788
Median	28.2450	6.0000	32.8922	31.4000	2.8785	-0.7892
Maximum	41.3700	8.3000	38.3301	34.4000	3.1324	-0.6899
Minimum	19.2700	5.2000	27.6546	2.5000	2.6573	-0.8631
Std. Dev.	6.2269	1.0602	2.7230	6.6284	0.1732	0.0545
Skewness	0.2732	0.7084	0.0380	-3.8188	0.0776	0.1412
Kurtosis	2.2558	1.9436	2.6839	16.4593	1.3879	1.6545
Jarque-Bera	0.7103	2.6027	1.0880	199.5742	2.1858	1.5749
Probability	0.7010	0.2721	0.9569	0.0000	0.3352	0.4549
Observation	20	20	20	20	20	20

4.1. Lag length Selection

In Table 2, there are different methods to select the lag length selection criteria, but AIC and SC are most preferable. FPE, AIC, SC, and HQ all suggest two lags. Therefore, we include two lags indicated by lag length selection criteria.

Table 2: Different Methods to the Lag selectionw

Lag	AIC	SC
0	2.9244	3.2227
1	0.3569	2.4447
2	7.8347*	3.9576*

4.2. Bond Test

Table 3: F statistic for the Bond-test

Computed F-statistic 14.0785		
Critical bound	Lower bound	Upper bound
Critical bound value 5 percent	2.39	3.38

The long-run relationship in the model is extremely sensitive to the lag-length choice (Bahmani-Oskooee & Bohal, 2000). The computed F-statistics are presented in Table 3 to determine whether long-run co-integration exists. As a result, at 5%, the lower and upper bound values are 2.39 and 3.38, respectively. Table 3 shows that the estimated value of F-statistics indicates the existence of a long-term relationship. As a result, we can conclude that F-statistics support the long-run relationship between variables.

4.3. ARDL Long Run Results

Table 4 shows the long-run association between dependent and independent variables. In this study, the dependent variable is the Shadow Economy (SE), and independent variables are unemployment (UN), Institutional Index (II), Gini Index (GI), Trade Openness (TO), and GDP per capita (LGDP). On the other hand, unemployment is inversely proportional to the scale of the informal economy. This assumes that as unemployment grows, the scale of the informal economy will grow as well, and vice versa. This positive relationship demonstrates that a change in the unemployment rate causes a job loop in the Shadow Economy (SE), which acts as an automatic stabilizer. The empirical result indicates that a 1% rise in unemployment leads to a 0.2426 increase in the size of the informal economy, which corresponds to the findings of a previous study by Adriana (2014). However, there are many reasons behind the positive link between

unemployment and the Informal Economy (IE) size. Some of the reasons are low employment opportunities, slow process appointments, the mismatch between actual and demanded labor force because the rate of employment creation is lower than the population rate, and lack of proper planning to improve the employment generation process.

Table 4: ARDL Long Run Results (The dependent variable is shadow economy)

Regression	Coefficient	Standard Error	t-Value
UN	0.2426	0.0503	4.8234
II	3.2480	1.1726	2.7697
GI	-1.1337	0.0366	-3.6492
TO	-0.0375	0.0125	-2.9836
LGDP	1.0124	0.3537	2.8619

R^2 = 0.9739, Adjusted-R^2 = 0.9507, DW = 2.8127, F-Statistics = 8.25

Furthermore, current research indicates that institutional efficiency and the scale of the informal economy have a negative relationship. As a result, differing from established literature, this study shows a positive relationship between institutional efficiency and the size of the informal economy, which is a novel finding in the literature. There are many reasons behind the positive relationship in the case of Pakistan. However, the most important reasons are: low level of institutional infrastructure development, complex regulations, and institutional formalities, rise in literacy rate, less priority by government to the institutional sector, strong informal economy, ineffective policies mean that on one side government wants to increase tax filer and on the other side increases tax rate, and lack of proper planning to improve institutional quality means that when the government wants to improve institutional quality, it focuses on one indicator and ignores all other indicators. Furthermore, current literature supports the assertion that a higher level of education combined with poor institutions extends the shadow economy (Buehn &Farzanegan, 2013). The informal economy's option is driven by the increased regulatory burden and registration costs (Loayza et al., 2005).

Furthermore, a lack of institutional infrastructure contributes to the growth of the shadow economy. Pakistan has a low level of institutional infrastructure development so that the elected government increases voice and accountability and controls corruption progress. Resultantly, corruption is increasing because of the low level of institutional infrastructure. According to the Corruption Perception Index (2019), Pakistan got 32 points and ranked 120 in 180 countries.

Openness to trade is measured precisely by the share of exports plus imports to GDP. Therefore, trade is a good thing for the consumer because, after an increase in trade openness, consumers have more options to buy commodities with different levels of prices. Trade openness and complementary policy reforms decrease corruption (Majeed, 2014). However, some studies show a positive effect of trade on corruption. The absence of trade increases rents and provides more opportunities for corruption. But in this situation should avoid corruption because it's good for society and an increase in voice and accountability (Ades & Di Tella, 1999).

Furthermore, trade liberalization increases the opportunities for corruption, while extensive trade liberalization leads to a decrease in opportunities for corruption. However, data shows that trade openness declined from 30.9 to 27.6 between 2014 and 2015, while the scale of the shadow economy grew from 24.2 to 30.1. Finally, empirical findings indicate that, in the case of Pakistan, trade openness hurts the scale of the shadow economy. One of the literature's most important and complicated problems has been assessing the relationship between IE and GDP in recent decades.

The correlation between the informal sector and official growth can be positive and negative (Lv, 2020). the negative association of the informal economy with economic growth comes from unfair market competition. Informal activities create unfair competition and interfere negatively with market allocation,

and this inefficient allocation slows down economic growth. In addition, a positive GDP shock has a statistically significant positive effect on the scale of the shadow economy. In Pakistan's economy, however, GDP is positively related to the size of the shadow economy. Therefore, Pakistan is a developing country, and Pakistan's economy is a growing economy. When there is an increase in people's per capita income, they have opportunities to invest in the ever-increasing economy.

4.4. Panel Data Estimation

This test was used to select panel data models between fixed effect and random effect models. Therefore, the Hausman test has the Null hypothesis and the alternative hypothesis. The Null hypothesis is that the Random effect model is appropriate for panel estimation. At the same time, the alternative hypothesis suggests that the fixed effect model is best for panel regression. The Hausman test's probability value is less than 0.05, which rejects the Null hypothesis and accepts an alternative hypothesis that shows that the fixed effect model is best for panel estimation.

Table 5: Results of Fixed Effect Model

Variables	Coefficient	Standard E	P-value
Constant	1.4728	.0481	0.000
UN	.3533	.0677	0.000
II	.1652	.0579	0.006
TO	-.0038	.0006	0.000
Inflation	.0024	.0016	0.143
Within R-square		0.4992	
F-statistic		184.36 (0.0000)	

In the case of panel data analysis, the dependent variable is shadow economy, while the independent variables are UN, II, TO, and inflation. The result shows that unemployment is positively related to the size of the shadow economy. One percent increase in the unemployment rate will lead to an increase of 1.4728 in the size of the shadow economy. Therefore, unemployment is positively and significantly related to the size of the shadow economy. Furthermore, the institutional index is positively associated with the size of the shadow economy means that an increase in the size of the institutional quality will lead to an increase in the size of the shadow economy. In the subcontinent, the situation is similar as we have seen in the case of Pakistan. However, this is a novelty in the existing literature.

Furthermore, trade openness is negatively related to the size of the shadow economy. Therefore, the results are similar as we have seen in the case of Pakistan. The reason behind the similar results both in Pakistan and in the case of the Subcontinent is the existence of similar situations all over the subcontinent.

6. CONCLUSION AND POLICY IMPLICATIONS

The underground economy (UE) offers an atmosphere where economic agents can avoid government restrictions and inspection. As a result, a massive underground economy (UE) has severe consequences. As a result, this research aims to see how institutional efficiency relates to the Underground Economy (UE) scale. The main aim of this model is to inform policymakers about how the scale of the shadow economy is influenced by institutional efficiency (SE). This study's research question is whether or not institutional efficiency affects the scale of the Underground Economy (UE).

The findings of this study, which looked at the relationship between unemployment and the underground economy (UE), show that unemployment is positively associated with the scale of the underground economy (IE). However, this result is consistent with the existing literature. A high degree of unemployment enables individuals to express their interests to participate in the underground economy.

However, there are many reasons behind the positive link between unemployment and the size of the underground economy (IE). Some of the reasons are low employment opportunities, slow process appointments, the mismatch between actual and demanded labor force because the rate of employment creation is lower than the population rate, and lack of proper planning to improve the employment generation process. Therefore, to reduce the size of the shadow economy, the government should enhance the job creation process and try to minimize the mismatch between the actual and demanded labor force by controlling the population rate. Alongside the government, the private sector should play an essential role in reducing the size of the underground economy by getting themselves registered with revenue collection authority and generating employment for workers as much as they can cause. Through this collective effort, the size of the underground economy may reduce over time.

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Agriculture Technology Adoption Determinants; Panel Data Analysis

ABSTRACT

The agriculture sector of Pakistan has a key role in the economy because it has a major share in the country's GDP. Faisalabad district has also an important role in the agriculture sector and most traditional methods are used in the district. The new and improved methods are being introduced in the province. The current study investigates the sources and determinants of improved agriculture technologies in the district by using primary panel (2006-07 & 2018-19). The logistic approach is used to determine influencing factors in both periods separately with marginal effects. The major factors responsible for agriculture technology adoption are the age of the farmer's head, family size, farmer education, higher education of family members, household member employment, livestock ownership, number of visits to agriculture extension officers, and media access.

AUTHORS

Muhammad Ali *
PhD Scholar, Department of Economics, Federal Urdu University of Arts, Science and Technology (FUUAST), Islamabad Campus
Author's Contributions: 1, 2, 3, 4, 5, 6, 7
m_aliqamar@yahoo.com
https://orcid.org/0000-0003-1784-5117

Adiqa Kausar Kiani
Associate Professor, Department of Economics, Federal Urdu University of Arts, Science and Technology (FUUAST), Islamabad Campus
Author's Contributions: 2, 5, 6
adiqa.kiani@fuuast.edu.pk
https://orcid.org/0000-0002-1261-6000

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

1. INTRODUCTION

Food demand is increasing over time in developed as well as in developing countries due to continuous increase in population growth. It also puts pressure on agriculture production. In Pakistan, the food demand is increasing over time with an increase in population growth. The agricultural culturable land is also reducing over time due to urbanization and other factors which makes it challenging for policymakers to increase its yield over time. It is in dire need of the current era that the country should focus on new agriculture technology adoption to increase its production to meet the demand. The agriculture sector mostly depends upon technological change. It also shapes and improves the agriculture sector by reducing poverty and improving living standards through increased productivity (Bandiera & Rasul, 2006; Barrett et al., 2010).

The agriculture sector is an important sector that leads toward economic development and growth. It has the potential to contribute even more if there would be tech-based agriculture practices. The country must adopt a fourth-generation technology approach to the traditional and old techniques. Although research institutes in the country introduce new varieties and techniques for better and high productivity adoption is very limited. It is a dire need to adopt new techniques throughout the country to increase the productivity of ordinary farms.

The conservative agriculture system is less productive with low yield and high cost of production. The system relates with no-tillage or minimum tillage and direct planning is important. The modern and improved methods are more environmentally friendly as compared to other conservation methods. Under this system, to prevent water and wind erosion, this system is a kind of cultivation system in which at least 30 percent of the arable land surface is covered by crop residue. This system has various economic and other benefits. This system saves labor, energy time, cost of machinery, prevention of soil erosion, conserves soil, and increases organic matter. Due to crop residue on soil surface reduces water and wind erosion, energy, and cost leads toward the problem in establishment of seed and its germination. The pioneering work on agriculture technology adoption has been investigated in the USA where the effects of improved hybrid cord have been explored (Griliches, 1957). The previous studies related to adoption have been concerned with answering different questions of producer's technology adoption, determination pattern of technology diffusion among potential adopters.

It is fact that new improved agriculture technology plays an important role in accelerating and deepening agriculture growth. There is a need to streamline inadequate organized research systems for innovative solutions to sort out issues related to agriculture. The farmers further receive a low return due to usage of uncertified or local seed varieties, substantial pesticides, and traditional techniques. The current study explains the existing technology and innovation system in this sector and compares it with new technology and innovation.

The current study has investigated the factors responsible for agriculture technology adoption in the area based upon panel data. These agriculture technologies include improved seed adoption to social/internet access for agriculture technology adoption determinants. the earlier studies conducted consists of one or two agriculture technologies, but the current study deals with seven various agriculture technologies and their determinants. Further, the study not only used single time analysis but panel data for two time (base line & end-line) to show variations in adoption determinants in the area. The Faisalabad city has important role in economic activity of Pakistan economy and well-known agriculture research institutes working in the city. The other contribution is that is there any role of these research institutes in agriculture technology adoption determinants.

The main objective of the study is the investigation of agriculture technology adoption determinants in both periods and change over time (2006-07 & 2018-19) respectively.

2. REVIEW OF LITERATURE

Technological advancement has an immense impact on the agriculture sector through various channels. The current revolution in technology has placed agriculture at the top and leads toward another revolution that not only affects the variety and yield but also climatological and social outcomes. The technologies of the internet, artificial intelligence, and robotics have enabled data-driven and automated agriculture. The study cover review of current and emerging agriculture technologies (Charania & Li, 2020).

The green revolution in Asia as well as new agriculture technologies leads toward significant productivity and low productivity to high productivity (Bank, 2008). Household well-fare is positively related to high yield varieties adoption (Menodola, 2007). Further, the study investigates that new agriculture technology increase farm household income and increase employment and wage rates of landless laborer and lower the price of food staples.

There is a new debate on technology definition. Some has considered technology as a way of producing goods and services through organized methods as well as physical technique. Others have defined technology as the knowledge or information that permits some tasks to be completed more easily, some service to be rendered, or the manufacture of a product (Loevinsohn & Sumberg, 2012). They have also explored that farmers' decision to adopt new technology is conditioned by a dynamic interaction between characteristics of the technology itself and the array of conditions and circumstances. Technology itself is aimed at improving a given situation or changing the status quo to a more desirable level. It assists the applicant to do work easier and saves time and labor (Bonabana-Wabbi, 2002).

For developing countries' economic progress, technology is an essential prerequisite factor. The integration of innovation into farmers' normal farming activities over an extended period is called adoption (Feder et al., 1985). Adoption is a mental process an individual passes from first hearing about an innovation to final utilization of it. Adoption has two categories, rate of adoption and intensity of adoption. The rate of adoption is the relative speed of farmers' adoption of a specific technology with time element while the intensity of adoption refers to the level of use of a given technology at any time. Some studies classify these factors into different categories. The determinant of agricultural technology adoption has been grouped in three categories; these are economic, social, and institutional factors. The influencing technology adoption categories are economic, social, and physical (Kofi-Lavison, 2013). The study by (Huffman & Mercier, 1991) categorized influencing factors as farmer characteristics, farm structure, institutional characteristics, and managerial structure.

Technology characteristics are a precondition of adopting it. The study finds out trialability or a degree to which a potential adopter can try something out on a small scale first before adopting it (Doss, 2007). The other study related to rice varieties adoption in the region depends upon farmers' perception of characteristics of modern rice variety. They have a significant role in adoption decisions (Adesina & Zinnah, 1993). The improved agricultural technologies have been investigated as a driving force for technology adoption because it reduces poverty level by increasing productivity, income, and asset accumulation. The findings show a positive and significant impact on household per capita income and asset ownership respectively (Manda et al., 2019).

Farm size has a positive impact on new technology adoption. Various studies confirm its role in determining technology adoption. Some studies are scale-dependent because it has an important role in

technology adoption. Various studies confirm its relationship with agriculture technology adoption (Haggblade, 2003; Mignouna et al., 2011; Maruod et al., 2013).

The off-farm income has a positive and significant impact on technology adoption. It has an important strategy for overcoming credit constraints that are faced by rural households in many developing countries. It plays as a substitute for borrowed capital in rural economies where credit facility is either missing or dysfunctional. On the other hand, it also works as liquid capital for purchasing productivity-enhancing inputs such as improved seed and fertilizers (Ellis & Freeman, 2004; Diiro, 2013). The quest for off-farm income by farmers may demoralize their adoption of modern technology by reducing the amount of household labor allocated to farming activities (Goodwin & Mishra, 2004).

The credit facility is also an important and positive factor in technology adoption. It encourages technology adoption (Mohamed & Temu, 2008). The access to credit facilities promotes the adoption of risky technologies by relaxation of the liquid constraint as well as boosting of household's risk-bearing ability. Access both formal and informal sources of credit facility increase new technology adoption significantly (Simtowe & Zeller, 2006).

Farmers' human capital plays an important role in farmer's decisions of new technology adoption. The farmer's human capital is mostly measured by its education. Farmer's education is positively linked with farmers' decisions regarding new technology adoption (Conor et al., 2010). Farmer education increases the ability to obtain, process, and uses information related to the adoption of new technology (Namara et al., 2003). Many studies confirm that higher education influences respondents' attitudes and thoughts making them open, rational, and able to analyze the benefits of the new technologies (Okunlola & Akinwalere, 2011; Adebiyi & Okunlola, 2013).

The age factor of the household head also plays an important role in farmer technology adoption behavior. It influences farmers' information access and shapes their ability to change the available information into action. The farmer's experience and own resources allow them more possibilities for trying new technology. The younger farmers are more likely to adopt new technology due to higher education. The technology adoption varies accordingly. Some studies investigated that the older farmers have more knowledge and experience over time and are better able to evaluate technical information than younger ones (Kariyasa & Dewi, 2011). While other studies negated the results because as farmers grow older, there is a risk aversion factor that decreases interest in long-term investment in the farm while the younger farmers are less risk-averse and adopt to try new technologies (Mauceri et al., 2006).

The other study investigated the impact of improved varieties on household food security and income effect, respectively. By applying the propensity score matching method, the treatment effect model, and the Tobit selection model, the study shows that the adoption of improved varieties has a positive and significant impact on food security and income. Females are more adopters than males in the region (Sinyolo, 2020).

3. RESULTS AND INTERPRETATION

The consistent model to investigate the technology adoption determinants is the logistic model, frequently used in literature. The logistic model has been used to determine the technology adoption determinants (Griliches, 1957). The logistic approach is used in this study to assess and determine the influencing factors in agriculture technology adoption. The variable used in the model is binary form, representing 1 as adopters and 0 otherwise. The model is more efficient as compared to other ones in the sampled data set that consists of the dichotomous outcome variable. It is an extremely flexible and easily used model from a mathematical point of view (Huffman & Mercier, 1991). Further, the results obtained from this

model have a meaningful interpretation. It does not require normally distributed variables. The cumulative logistic probability model is econometrically specified as follows in equation 1:

$$P_i = F(Z_i) = F(\gamma + \sum \lambda_i \times_i) = \frac{1}{1+e^{-Z_i}} \quad (1)$$

Where P_i is the probability that a farmer will adopt improved agriculture technology or not given X_i; e represents the base of natural logarithms, X_i is the i^{th} explanatory variables and γ and λ are parameters to be estimated.

For interpretation of the coefficients, the logit model can be written in terms of the odds and log of odds. The odds ratio shows the ratio of the probability (P_i) that a farmer adopts to the probability $(1 - P_i)$ that the farmer is non-adopter. The following regression model in equation 2 is used:

$$Y_i^n = \beta_o + \beta_i X_i + U_i \quad (2)$$

Where Y_i is for the dependent variable in binary form 1 for adopters while 0 for non-adopters while n represents many agriculture technologies used for the study. Here n is equal to seven as we have used seven agriculture technologies. X_i relates to independent or explanatory variables.

U_i indicates error term which is an independently distributed random variable with a mean of zero.
Based upon equation (1), the general logistic model has been estimated for each type of agriculture to estimate adoption determinants for 2006-07 and 2018-19. In this paper, we have adopted the following agriculture technology to find out its determinants at the farm level. Farmer adoption of agriculture technology depends upon various factors e.g., demographic, financial, institutional, socioeconomic, etc. The technologies used for the current study consists of:

1) Improved Seed Varieties
2) Farm Mechanization
3) Water Irrigation Technologies
4) Fertilizer Usage
5) Access to Improved Electricity
6) Internet/social media Access
7) Mobile Phone Access

In this paper, we have estimated the determinants of these technologies for both years (2006-07 and 2018-19) respectively. For this paper, we have used the main crops for their technology usage by considering wheat, rice, sugarcane, cotton, and maize. The data collected from field interviews consists of 2006-07 as a baseline while 2018-19 as end-line to assess the changeover the time in the region covering 360 farmers in each period. The micro-panel data was collected in the wheat harvesting season.

Faisalabad is the most populated city of Pakistan, and its land is fertile. For our analysis, we have selected this city as the main study area because of its third-largest district of the country as well as its important role in the agriculture sector of the economy. Further, the agricultural land is fertile and various research institutes exist in the district related to new agriculture technologies. Different crops are cultivated in this area. The main crops are wheat, rice, sugarcane, and fodders. The area under different crops depends upon future market prices of the selected prices and profit margin. In this section, we will discuss the descriptive analysis of data collected from the field during 2006-07 and 2018-19. A comparison/change over the period from 2006-07 and 2018-19 would be drawn of their demographic, social, perception, education, net margin from crops, adoption of new agriculture technologies, their views, and perception upon new agriculture technology introduced by the government.

In these union councils, the farmers mostly grow sugarcane, wheat, cotton, and rice in some areas. The source of income of these villages is the agriculture sector and a large portion of the population is attached to this profession. From these four unions' councils, we further analyzed 12 villages by selecting three villages from each union council, respectively. From each village, we have randomly selected sixty (60) farmers for agriculture technology adoption-related information in different crops and possible constraints to adopting these agriculture technologies. The randomly selected villages' details are presented in Table 1.

Table 1: Randomly Selected Villages Demographic Change

Sr. No.	Village No.	Village Name	1998		2017	
			Population	No. of Houses	Population	No. of Houses
1	103 JB	Barnala	5829	931	7212	1152
2	106 JB	Khachiean	3654	572	5670	887
3	109 JB	Nanilian Wala	1965	267	3089	420
4	20 JB	Khankay	2987	455	3062	466
5	23 JB	Bhattian	6152	731	6318	943
6	467 JB	Jahllaran	968	136	1150	198
7	468 GB	468/GB Raghbirpura	4362	646	5419	803
8	470 GB	470 GB/Kishanpura	5501	735	8762	1309
9	472 GB	472 GB/Hargobind	2631	348	3649	482
10	168 GB	Siraj/ Babrian	2756	372	3268	441
11	438 GB	Bhart	2048	274	2396	377
12	463 GB	Haryal	4472	704	9007	1418
Chak Jhumra selected villages total			21555	3091	26050	3966
Samundri selected villages total			21770	3079	32501	4830
Overall Change (%age)-1998-2017					20.9%	28.3%

Source: Population census 1998 & 2017 by Bureau of Statistics (BSP), Pakistan

4. RESULTS AND DISCUSSION

The study investigates the agriculture technology adoption influencing factors in the region. For each technology, a separate analysis has been carried out. The estimation of agriculture technology adoption has been performed using logistic methods to explore the main determinants of each technology in the area for both years (2006-07 base-year, 2018-19 end-line). The marginal effects also have been estimated to observe the change to each factor for each agriculture technology. The seven agriculture technologies have been estimated with various influencing factors of each technology, respectively.

The result shows that household member employment, livestock ownership, knowledge of agriculture extension officer, agriculture extension officer contact during the season, participation in local agriculture discussion, radio ownership, Television ownership, farmers newspaper reading habit, and internet access has significant on these technology adoptions in the area. The detailed results are shown in Table 2.

The improved seed varieties adoption rate has increased Pakistan significantly over the period for better yield and productivity. The current study reveals the influencing factors of its adoption in district Faisalabad, Pakistan in panel data 2006-07 and 2018-19 respectively. In improved seed technology adoption, family member specialization, household member employment, and many visits to agriculture extension officers for consultancy have a positive and significant role in determining its adoption during 2018-19. While tenancy status has a negatively significant impact on improved seed technology adoption during base period 2006-07 while soil type has negatively impacted its adoption. Soil fertility has a positive significantly role in determining improved seed technology adoption in the district.

The farm mechanization technology adoption has also been estimated to determine influencing factors responsible for its adoption for 2006-07 and 2018-19 respectively. In farm mechanization technology adoption, various factors are responsible for its adoption that varies in our analysis. Tenancy status, Knowledge of agriculture officers, and radio ownership have a positive significant role in determining farm mechanization technology adoption. The radio is the main source of information in the local area to assess information regarding farm mechanization and subsidy on these technologies. The main negatively impacting factor of its adoption is television ownership in the area.

Water irrigation technology adoption is the need of the current period as there exists a water crisis both for drinking and agriculture purposes. The current study also investigated the influencing factors of its adoption in the district of Faisalabad, Pakistan. The positive significant factors responsible for its adoption are farmer education and farm size. The farmer education factor is positive and significant at 5 percent in 2006-07 while significant at 1 percent during 2018-19 respectively. The other positive and significant factor of its adoption is farm size that is significant at 1 percent in both years (2006-07, 2018-19). The other positive significant factors during 2018-19 are household member employment (10% level of significance), livestock ownership (1% level of significance), soil type (10% level of significance), and agriculture extension officer contact (1% level of significance).

The significant negatively impacting its adoption in the area is farmer specialization (5% level of significance, 2018-19) and television ownership (10% level of significance) respectively. The recommended fertilizer usage adoption in crops has also an important role in agriculture yield and productivity. The positive and significant factors influencing its adoption are farmer education level (1% level of significance), farmer specialization (10% level of significance), and farm size (5% level of significance) during 2018-19 while there is not any positive significant factor during 2006-07.

The negatively impacting factors are soil fertility (5% level of significance) during 2006-07 while tenancy status (5% level of significance) and radio ownership (1% level of significance) respectively. Electricity in the local area and specific to Pakistan is the main other source after canal irrigation for the agriculture sector. The positive and significant factors of this technology adoption are the age of farmer's head (10% level of significance), family size (10% level of significance), household member employment (5% level of significance), tenancy status (5% level of significance), soil type (1% level of significance), soil fertility (1% level of significance), number of visits to agriculture extension officer (5% level of significance) and participation of local discussion (10% level of significance) during 2018-19 while there is no any positive significant factor during 2006-07.

The negative significance factors are far size (1% level of significance) during 2018-19 while soil fertility (1% level of significance) significantly negatively affecting its adoption during 2006-07, respectively. Internet and social media access adoption has also an important role in the agriculture sector. The main influencing positive significant factors are farmer education level (1% level of significance), family member specialization (1% level of significance), farm size (1% level of significance), and soil fertility (1% level of significance) during 2018-19 while there is not any positive significant factor found during 2006-07 period due to less or limited availability.

On the other side, no negative significant factor was responsible for its adoption reduction in the study. In Pakistan, mobile phone access is considered a major source of information and agriculture information (improved seed information, weather package (information), etc.). The current study also investigated the factors responsible for its adoption. The positive significant determinants of its adoption are farmer education (1% level of significance), family member specialization (10% level of significance), soil type (5% level of significance), and television ownership (5% level of significance) during 2018-19 while no positive significant factor found during 2006-07. On the other hand, no negative significant factor is responsible for its adoption reduction.

Table 2: Determinants of Agriculture Technology Adoption (2006-07 & 2018-19)

Variables	Improved Seed Adoption		Farm Mechanization Adoption		Water Irrigation Adoption		Fertilizer Usage Adoption		Access to Improved Electricity Adoption		Internet/Social Media Access Adoption		Mobile Phone Access Adoption	
	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19
Age of farmer head	-0.004	-0.001	-0.01	-0.001	0.006	-0.006	-0.01	0.01	-0.033***	0.015*	-0.020	0.005	0.01	-0.029
	0.021	0.007	0.018	0.012	0.011	0.007	0.008	0.01	0.012	0.009	0.020	0.008	0.043	0.017
	0.864	0.889	0.562	0.923	0.603	0.434	0.186	0.315	0.006	0.093	0.322	0.507	0.815	0.091
Family Size	0.22	0.101	-0.088	-0.012***	0.067	0.105	-0.018	0.001	-0.167*	0.52***	0.175	-0.053	0.192	0.016
	0.201	0.074	0.11	0.069	0.122	0.073	0.09	0.098	0.087	0.154	0.223	0.071	0.362	0.099
	0.275	0.172	0.425	0.866	0.583	0.148	0.839	0.991	0.055	0.001	0.431	0.456	0.595	0.875
Farmer Education	0.11	0.013	-0.06	-0.118**	0.075**	0.104***	0.017	0.156***	0.059	-0.041	0.048	0.148***	0.019	0.772***
	0.068	0.03	0.042	0.033	0.030	0.040	0.044	0.030	0.044	0.036	0.031	0.074	0.045	0.176
	0.106	0.656	0.153	0.000	0.012	0.009	0.695	0.000	0.182	0.246	0.126	0.045	0.672	0.000
Famer Specialization	0.036	0.139	-0.532	-0.414***	-0.367	-0.449**	0.096	0.645*	0.195	0.076	-0.149	-0.018	-0.860	-0.018
	0.418	0.223	0.395	0.209	0.256	0.22	0.22	0.384	0.286	0.247	0.382	0.215	0.533	0.338
	0.932	0.533	0.178	0.048	0.153	0.042	0.662	0.093	0.496	0.757	0.697	0.935	0.107	0.957
Higher	-	-	0.167	0.362***	-	-	-	-	-	-	-	-	-0.060	-0.100**
Education of	-	-	0.026	0.033	-	-	-	-	-	-	-	-	0.174	0.044
Family Member	-	-	0.000	0.000	-	-	-	-	-	-	-	-	0.730	0.025
Family member Specialization	0.102	1.055***	-	-	-0.056	0.054	-0.047	-0.096	0.336	-0.460***	-0.177	0.877***	-20.302	0.486*
	0.139	0.383	-	-	0.206	0.14	0.166	0.187	0.233	0.165	0.146	0.290	2555.34	0.280
	0.463	0.006	-	-	0.784	0.702	0.779	0.608	0.148	0.005	0.224	0.003	0.994	0.082
Experience of	-	-	0.011	0.000	-	-	-	-	-	-	-	-	0.009	0.019
Farming	-	-	0.018	0.012	-	-	-	-	-	-	-	-	0.044	0.018
	-	-	0.548	0.982	-	-	-	-	-	-	-	-	0.844	0.283
Household	0.318	4.246***	0.03	-1.228***	0.523	0.394*	0.181	1.324***	-0.763*	0.762**	0.154	2.103***	1.072	0.11
Member	0.217	0.694	0.244	0.288	0.329	0.22	0.312	0.262	0.432	0.306	0.232	0.537	2.435	0.329
Employment	0.142	0.000	0.903	0.000	0.112	0.073	0.563	0.000	0.077	0.013	0.507	0.000	0.66	0.738
Livestock	-0.139	0.268	-0.282	0.284	0.191	2.127***	-0.484	-0.06	0.003	0.348	1.358	-0.006	1.391	-0.366
Ownership	0.756	0.238	0.344	0.203	0.247	0.634	0.336	0.332	0.502	0.292	0.93	0.255	1.424	0.349
	0.854	0.26	0.414	0.163	0.438	0.001	0.15	0.857	0.995	0.233	0.144	0.982	0.328	0.295
Farm Size	0.035	0.007	-0.022	-0.001	0.072***	0.060***	-0.016	0.074**	0.01	-0.053***	0.008	0.069***	0.014	0.01
	0.027	0.016	0.014	0.013	0.016	0.018	0.013	0.029	0.02	0.018	0.016	0.025	0.032	0.024
	0.191	0.636	0.122	0.908	0.000	0.001	0.227	0.010	0.612	0.003	0.618	0.006	0.67	0.692
Tenancy Status	-1.059*	-0.258	0.083	0.373*	-0.34	-0.048	0.147	-0.499**	-0.199	0.551**	-0.676	0.21	-0.505	-0.055
	0.562	0.183	0.177	0.205	0.272	0.183	0.187	0.223	0.308	0.257	0.546	0.186	0.965	0.254
	0.059	0.159	0.638	0.069	0.211	0.795	0.433	0.025	0.519	0.032	0.216	0.259	0.601	0.827
Soil Type	-0.395	-1.146**	0.043	-0.278	-0.122	0.466*	0.005	-0.297	-0.396	1.249***	-1.187	-0.454	-0.827**	2.278*
	0.723	0.325	0.379	0.292	0.436	0.278	0.289	0.355	0.479	0.474	1.085	0.340	0.334	1.262
	0.585	0.000	0.909	0.341	0.78	0.093	0.986	0.403	0.408	0.008	0.274	0.182	0.013	0.071
Soil Fertility	1.113*	0.827***	-0.104	0.152	0.503	0.358	-0.533**	0.07	-1.401***	1.781***	-0.339	0.932***	1.165	0.747*
	0.574	0.241	0.329	0.255	0.306	0.24	0.257	0.319	0.493	0.445	0.601	0.235	0.84	0.403
	0.053	0.001	0.751	0.55	0.101	0.136	0.038	0.826	0.004	0.000	0.572	0.000	0.165	0.064
Knowledge of	-	-	0.072	1.116*	-	-	-	-	-	-	-	-	-	-
Agriculture	-	-	0.349	0.651	-	-	-	-	-	-	-	-	-	-
Officer	-	-	0.837	0.086	-	-	-	-	-	-	-	-	-	-

Continue Table 2:

Agriculture Extension Officer Contact	0.435	0.359	-	-	-0.11	2.227***	-0.09	0.509	-0.836	0.069	0.27	-0.053	0.218	-0.192
	0.868	0.366	-	-	0.477	0.489	0.391	0.545	0.567	0.438	0.679	0.365	0.741	0.653
	0.616	0.327	-	-	0.817	0.000	0.819	0.35	0.141	0.875	0.691	0.884	0.768	0.769
Visits to agriculture extension Officer	-	2.159***	-0.401	-0.526	-	-	-2.611	0.292	-0.716	1.233**	-	-	-	-
	-	0.670	0.587	0.499	-	-	1.837	0.817	0.584	0.604	-	-	-	-
	-	0.001	0.494	0.291	-	-	0.155	0.72	0.22	0.041	-	-	-	-
Participation of Local Discussion	-1.851	-1.521	-	-	1.73	0.294	1.702	-0.76	-1.918	2.211*	-	-	-	-
	6.313	1.178	-	-	1.425	1.401	1.336	1.26	1.279	1.306	-	-	-	-
	0.769	0.197	-	-	0.225	0.834	0.203	0.547	0.134	0.09	-	-	-	-
Radio Ownership	0.482	0.282	-0.383	0.469*	0.248	-0.198	0.014	-1.217***	-0.188	0.461	0.78	0.149	0.701	0.647
	0.679	0.287	0.514	0.283	0.376	0.297	0.304	0.412	0.406	0.355	0.596	0.298	0.936	0.499
	0.477	0.326	0.456	0.097	0.509	0.504	0.962	0.003	0.643	0.194	0.191	0.616	0.454	0.195
TV Ownership	-0.614	-0.274	-0.307	-1.059***	-0.616*	-0.057	-0.097	0.195	0.126	0.014	-0.42	-0.068	0.504	0.984**
	0.639	0.248	0.241	0.393	0.363	0.251	0.254	0.343	0.362	0.308	0.583	0.259	0.647	0.465
	0.336	0.268	0.203	0.007	0.090	0.819	0.703	0.57	0.728	0.964	0.471	0.792	0.436	0.034
Newspaper Reading	0.41	-0.551	-0.907	-0.291	-0.669	-0.263	0.095	0.068	-0.152	0.604	0.017	-0.363	0.778	-0.183
	0.718	0.34	0.593	0.328	0.508	0.354	0.348	0.499	0.518	0.483	0.71	0.363	0.677	0.498
	0.568	0.105	0.126	0.376	0.187	0.458	0.786	0.892	0.769	0.212	0.981	0.318	0.251	0.712
Constant	-1.262	-8.763***	-0.574	-1.913*	-5.451***	-2.57***	0.996	1.512	0.518	-3.962***	-4.219***	-2.845***	-14.376***	3.754*
	0.775	2.065	0.775	1.019	1.205	0.768	0.838	1.005	1.45	1.232	2.090	0.801	3.323	2.262
	0.103	0.000	0.459	0.061	0.000	0.001	0.235	0.132	0.721	0.001	0.044	0.000	0.00	0.097

Source: Own Estimation Result, 2006-07 & 2018-19, The values in each variable represents coefficients, standard error (SE) and p-value while asterisks describe significance level (*, 10%), (**, 5%), (***, 1%)

The overall logistic results of determining factors of technology adoption are age of the farmer's head, family size, farmer education level, farmer specialization, higher education of family member, family member specialization, household member employment, farm size, tenancy status, soil type, soil fertility, knowledge of agriculture officer, agriculture extension officer contact, number of visits to agriculture extension officer, participation in local discussion, radio ownership, and television ownership. The study has also investigated the marginal effects from the logistic model which are presented in Table 3.

Results indicate that marginal effects significantly vary across technology adoption. The household member employment, livestock ownership, knowledge of agriculture extension officer contact, radio ownership, television ownership, and newspaper reading has positive significant effects on the probability of agriculture technologies adoption.

The positive significant factors on the probability of improved seed technology adoption during the base period 2006-07 are household member employment, agriculture extension officer contact, radio ownership, and newspaper reading while during 2018-19, household member employment, livestock ownership, agriculture extension officer contact, radio ownership increases the probability of its adoption in the district Faisalabad, Pakistan. On the other hand, during 2006-07, livestock ownership reduces the probability of its adoption while farmer participation in the local discussion also reduces its adoption probability during 2018-19.

The farm mechanization technology adoption factors that increase its probability of adoption are household member employment, livestock ownership, knowledge of agriculture extension officer contact, and radio ownership. The base period (2006-07) indicates that only knowledge of agriculture extension officers increases its adoption probability while household member employment, livestock ownership, radio ownership, television ownership, and newspaper reading reduce the probability of its adoption in the area. The end line period (2018-19) measures the changes in probability adoption factors. The positive significant adoption probability factors are household member employment, livestock ownership, knowledge of agriculture officers, and radio ownership. While the negative significant probability adoption factors are television ownership and newspaper readings during 2018-19.

The factors that increase the adoption probability of irrigation technologies in the area are household member employment, livestock ownership, agriculture extension officer contact, participation in local discussion, and radio ownership. The factors that increase irrigation technologies adoption vary across technologies and periods (2006-07 & 2018-19). Household member employment, livestock ownership, and participation in local discussions have positive effects on the probability of adoption of irrigation technologies in both years (2006-07 & 2018-19). While agriculture extension officer contact has positive effects on this technology adoption during 2018-19 and radio ownership during 2006-07. Radio ownership has negative effects on the probability of technology adoption during 2018-19 while television ownership and newspaper reading in both years, respectively.

Under access to improved electricity adoption, various factors affect the probability of its adoption. Livestock ownership and radio ownership have positive significant effects on the probability of this technology adoption in both years respectively (2006-07 & 2018-19). During 2006-07, participation in local discussion has significant positive effects on its adoption probability while household member employment, agriculture extension officer contact, radio ownership, and newspaper reading have positive significant effects on its adoption probability in 2018-19, respectively.

Table 3: Marginal Effects of Agriculture Technology Adoption (2006-07 & 2018-19)

Variables	Improved Seed Adoption		Farm Mechanization Adoption		Water Irrigation Adoption		Fertilizer Usage Adoption		Access to Improved Electricity Adoption		Internet/Social Media Access Adoption		Mobile Phone Access Adoption	
	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19	2006-07	2018-19
Age of farmer head	0.000	0.000	-0.001	0.000	0.001	-0.001	-0.003	0.001	-0.003	0.002	0.000	0.001	0.000	-0.003
Family Size	0.002	0.025	-0.011	-0.003	0.007	0.026	-0.005	0.000	0.039	-0.021	0.002	-0.010	0.000	0.001
No. Of Adult Members	-	-	-	-	-	-	-	-	-	-	-	-	0.000	-0.031
Farmer Education	0.001	0.003	-0.008	-0.029	0.011	0.019	0.039	0.002	0.004	-0.005	0.002	0.009	0.000	0.002
Famer Specialization	0.000	0.035	-0.068	-0.100	-0.038	-0.112	0.024	0.073	0.015	0.010	-0.002	-0.003	0.000	-0.002
Highest Edu. of family member	-	-	0.046	0.041	-	-	-	-	-	-	-	-	0.000	-0.009
Family member Specialization	0.008	0.025	-	-	-0.006	0.013	-0.012	-0.011	0.025	-0.057	0.012	-0.035	0.000	0.046
Experience of Farming	-	-	0.001	0.000	-	-	-	-	-	-	-	-	0.000	0.002
HH-Member Employment	0.175*	0.079*	-0.125*	0.007*	0.061*	0.098*	0.316*	0.020*	-0.049*	0.082*	0.059*	0.031*	0.000*	0.010*
Livestock Ownership	-0.001*	0.066*	-0.039*	0.070*	0.122*	0.048*	-0.120*	-0.007*	0.000*	0.046*	-0.001*	0.012*	0.000	-0.032*
Farm Size	0.000	0.002	-0.003	0.000	0.007	0.015	-0.004	0.008	0.001	-0.007	0.001	0.002	0.000	0.001
Tenancy Status	-0.008	-0.064	0.048	0.020	-0.035	-0.012	0.036	-0.057	-0.015	0.069	-0.009	0.041	0.000	-0.005
Soil Type	-0.003	-0.286	0.006	-0.067	-0.013	0.116	0.001	-0.034	-0.030	0.156	-0.016	-0.089	0.000	-0.078
Soil Fertility	0.009	0.206	-0.013	0.037	0.052	0.089	-0.133	0.008	-0.106	0.222	-0.005	0.184	0.000	0.070
Knowledge of Agri. officer	-	-	0.192*	0.017*	-	-	-	-	-	-	-	-	-	-
Agri. extension officer contact	0.004*	0.089*	-	-	-0.011*	0.440*	-0.022*	0.049*	-0.048*	0.008*	-0.010*	0.004*	0.000	-0.019*
Visits to Agri. extension Officer	0.017	-	-0.051	-0.127	-	-	-0.649	0.033	0.094	-0.089	-	-	-	-
Participation of Local Discussion	-0.007*	-0.311*	-	-	0.310*	0.073*	0.363*	-0.112*	0.367*	-0.390*	-	-	-	-
Radio Ownership	0.004*	0.070*	-0.045*	0.110*	0.027*	-0.049*	0.004*	-0.182*	-0.014*	0.052*	0.016*	0.030*	0.000*	0.052*
TV Ownership	-0.004*	-0.068*	-0.106*	-0.075*	-0.055*	-0.014*	-0.024*	0.021*	0.010*	0.002*	-0.005*	-0.013*	0.000*	0.072*
Newspaper Reading	0.004*	-0.133*	-0.088*	-0.072*	-0.056*	-0.065*	0.024*	0.008*	-0.011*	0.062*	0.000	-0.066*	0.000*	-0.018*

Source: Own Estimation Result, 2006-07 & 2018-19 Marginal Effects dy/dx

The negative significant effects of its adoption probability are household member employment, agriculture extension officer contact, radio ownership, and newspaper reading during 2006-07. While there are no negative significant factors found during 2018-19. Household member employment and radio ownership have positive effects on the probability of adoption of internet/social media access in both years (2006-07 & 2018-19). Livestock ownership and agriculture extension officer contact have positive effects on this technology adoption probability during 2018-19.

Television has a significant negative factor of technology adoption probability in both periods (2006-07 & 2018-19). The other negative effects of technology adoption probability are livestock ownership and agriculture extension officer contact during the base period (2006-07) in the district. Mobile phone access adoption is also an important technology tool for the agriculture sector including timely information as well as weather and other crops-related information with minimum or no cost. Household member employment, radio ownership, and television ownership have positive effects on the probability of technology adoption in the area for both periods (2006-07 & 2018-19). The negative significant technology adoption probability factors are livestock ownership, agriculture extension officer contact, and newspaper reading that reduces technology adoption.

5. CONCLUSION AND POLICY IMPLICATIONS

This study uses primary data collected from two time periods 2006-07 and 2018-19 respectively to assess the potential factors determining agriculture technology adoption in the district of Faisalabad, Pakistan. The seven agriculture technologies were considered for analysis for both periods. In this study, the logistic regression analysis used to determine the factors responsible for technology adoption and marginal effects also estimated accordingly. There are various socio-economic, financial, and other factors responsible for its adoption over time.

The micro panel data was collected from a field survey conducted in tehsil Chak Jhumra and Sammundari district Faisalabad, Pakistan for two years (2006-07 and 20018-19). From these two tehsils, twelve villages were randomly selected with six villages from each tehsil and sixty respondents from each village. There are an estimated seven technology adoption factors responsible for its change over time.

Results show that significant factors determining technology adoption during 2006-07 are farmer education, farm size, soil type, and television ownership. On the other hand, the factors responsible for technology adoption probability are household member employment, livestock ownership, and knowledge of agriculture officer, agriculture officer contact, and participation in local discussion, radio ownership, television ownership, and newspaper reading. These factors affect technology adoption probability accordingly.

The positive and significant factors responsible for technology adoption in the district during end line period 2018-19 are the age of farmer's head, family size, farmer education, farmer specialization, higher education of family member, family member specialization, household member employment, livestock ownership, farm size, tenancy status, soil type, soil fertility, knowledge of agriculture officer, agriculture officer contact, number of visits to agriculture extension officer, participation of local discussion, radio ownership, and television ownership. These are potential and positive influencing factors in determining agriculture technology adoption in the area. The factors vary across technologies adoption.

Our findings have important policy implications in the district of Faisalabad, Pakistan. The results suggest that farmer pieces of training regarding new and improved technologies are necessary to increase its adoption rate in the area because the adapters don’t have any opportunity of training in the area that needs to be developed and promoted to increase the adoption rate in the area. The study is based on short (only

two rounds) of panel datasets that need to be extended to capture fully dynamics and long-run effects of multiple agriculture technologies adoption in the area. The study also suggests that government facilitate the farmers to avail credit facility at the doorstep as no one has any credit facility availing. Therefore, future research should focus on adoption dynamics by taking multiple agricultural technologies using nationally representative longitudinal panel datasets.

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Consumption Pattern of Male and Female Headed Households: Evidence for Pakistan

ABSTRACT

This paper aims to investigate the consumption patterns of male and female-headed households in Pakistan. According to the findings, both types of households spend about half of their total expenditure on food and drinks. Furthermore, compared to their male counterparts, female-headed households spend a higher percentage of their income on education and healthcare. On the other hand, male-headed households spend a larger share of their expenditure on food and drinks and entertainment than female-headed households. The budget shares for food and drinks, fuel and lightning, and clothing and footwear decline, while that of education, durables, healthcare, and entertainment rise with the increase in total expenditures in case of both types of households. The aged heads are found to be more diet and health-conscious; and thereby, with the increase in age, the expenditures on food and drinks, healthcare and education increase. Results also reveal that with the increase in the dependency ratio, the budget share increases more on food items than non-food items. Finally, with a higher level of education, the budget shares of education, entertainment, durables, healthcare, and fuel and lightning increase.

AUTHORS

Malik Muhammad *
Assistant Professor, IIIE, International Islamic University Islamabad, Islamabad
Author's Contributions: 4, 5, 6
malikmuhammad@iiu.edu.pk
https://orcid.org/0000-0002-7798-6440

Yumna Azeem
MS Economics Student, IIIE, International Islamic University Islamabad, Islamabad
Author's Contributions: 1, 2, 3,
yumnaazeem78@yahoo.com
https://orcid.org/0000-0003-4786-6250

Nasim Shah Shirazi
Professor, CIS, Hamad Bin Khalifa University, Qatar
Author's Contributions: 2, 8
nshirazi@hbku.edu.qa
https://orcid.org/0000-0001-5174-9335

Talah Numan Khan
Assistant Professor, Department of Economics, Forman Christian College University, Lahore
Author's Contributions: 2, 4, 8
talahkhan@fccollege.edu.pk
https://orcid.org/0000-0002-7614-8066

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*** Correspondence author**

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

1. INTRODUCTION

Although male members of a household play a significant role in decision-making, especially in developing nations, the role of females has received more attention from researchers in recent decades. Females may become household heads for various reasons, including the temporary absence of a male head (defacto household) or the permanent departure of a male partner from the house (dejure household)[1]. Furthermore, in male-dominated societies, female-headed households are increasing due to economic structures and changes in societal attitudes in favor of women's role in society (Buvinic et al.,1978; Dwyer & Brauce, 1988; Buvinic, 1991).

Responsibilities, expectations, and social relationships of males and females are not the same, and differences within and between cultures. Similarly, needs and priorities regarding their families are different, and, therefore, the two groups of households have different consumption patterns (Bernardino, 2011; Donkoh & Amikuzuno, 2011; Henry et al., 2012). The consumption pattern determines the household's status and predicts future human capital accumulation. Households who invest more in education accumulate more human capital and have a higher future income. Furthermore, people also emphasize the self-concept cultural values that force them to buy luxuries even though they may not be required.

Pakistan's traditional culture restricts women and often places the male as the main decision-maker (Hakim & Aziz, 1998). However, recent efforts have been made on women's empowerment, which has changed their social lives considerably. As a result, the country has witnessed a significant improvement in the roles of females not only within their households but also outside the households. More women are currently participating in the job market, and the number of households headed by females is increasing. As a result, it is important to investigate the differences in consumption patterns between male and female-headed households.

As gender influences how people buy goods and services, therefore it is crucial to understand how male and female-headed households allocate their resources to various commodities and services. This will help policymakers to design welfare policies based on the consumption difference between male and female-headed households. Moreover, the income, education, age, and occupation vary across the consumers; therefore, they are different in allocating their budgets to different goods and services to satisfy their needs. Share of expenditure assigned to various commodities determines their relative importance and reflects the household's economic position and living standard. Usually, the rich spend a smaller percentage of income on necessities and relatively allocate more to luxuries. On the other hand, consumers with low income spent a higher proportion of their income on food and drinks (Kinsey, 1988). Therefore, the study aims to investigate the factors affecting the patterns of households' consumption of both types of households using HIES-2013-14. The specific objectives of the study are as follows:

1) to find out the differences in the consumption patterns of male and female-headed households.
2) to investigate the impacts of regional, socioeconomic, and demographic variables on the consumption patterns of male and female-headed households.

2. LITERATURE REVIEW

A plethora of literature is available on male and female-headed households' consumption patterns for developed and underdeveloped countries. Among these, Houthakker (1957) is one of the first studies that use 40 different surveys of 30 countries to analyze households' consumption patterns. The study

[1] In defecto households, male partner is either absent in most of the time due to migration or present but does not play a vital role in the contribution of household's economic resources. In dejure households, because of the divorce or death of the male partners, females are alone permanently heads (Kazi *et al*., 1988, Khan & Khalid, 2012).

finds that share of food expenditures decrease as income levels increase. Furthermore, the study also finds housing as a necessity, clothing as luxury items, and transportation, in some countries, as a necessity. Hoddinott and Haddad (1995) show that shares of expenditure on food, fuel, jewelry, and clothing are larger for females, while male-headed households devote more expenditures to food away from home, alcohol, cigarettes, and entertainment in West Africa. Also, the World Bank (2006) reports a similar difference between male and female-headed households in Uganda. Male-headed households spend a larger share of consumption on cigarettes and alcohol, while the households headed by females spend more on food and children's schooling. For Tanzania, Seebens (2009) shows that female-headed households devote more of their expenditures to education, child clothing, and food and spend less of their income on goods related to adults. The findings of Olubukunmi et al. (2016) for southeast Nigeria depict that households headed by females allocate, on average, a larger proportion of income to food and non-food items than the male-headed households. Further, results also depict that the poor households' expenditures are smaller on non-food items like clothing, fuel, education, electricity, water, and transportation.

Apart from gender, consumers' preferences vary with occupational status, age, level of education, race, and region of residence of the household (Ketkar & Cho, 1982). White-collar occupational groups allocate a more significant share of their income to education, entertainment, and housing material. In contrast, households headed by blue-collar occupational groups generally spend more on food, transportation, personal care, and personal insurance (Cage, 1989). For US households, Ding (2007) shows that households headed by individuals with age greater than 55 years spend more on household insurance, domestic services, and medicines while those headed by individuals with less than 55 years of age spend more on food eaten out, household textiles, tobacco, and smoking. On the other hand, more educated people spend a smaller share of income on smoking and tobacco and a larger share on furniture, reading materials, healthcare services, etc. A one- or two-person family spends more on food away from home, personal care services, telephone equipment, and reading material. Families with more than five members, on the other hand, choose food at home, kitchen, appliance, domestic textiles, maintenance, and repair. Travassos et al. (2021) show that food, healthcare, and transportation consumption are more price-sensitive for elderly-headed households and increase in income raises health-care expenditures in elderly-headed households to a larger extent than in younger-headed households.

Few studies have looked at the consumption patterns of male and female households in Pakistani literature. Among these, Burney and Khan (1991) utilize data of HIES 1984-85 and find that compared to the urban households, the expenditures of rural households are higher on food and drinks and smaller on housing material, transportation, education, etc. entertainment. The study also reports a decline in the share of food and drink expenditure as the income of the household increases. With an increase in rural household income, the share of transportation and communication rises, while the shares of clothing, fuel, and lighting fall. Shamim and Ahmed (2007) use the data of HIES- 2001-02 and find healthcare, grains, and housing as luxuries in urban regions, while in rural regions, entertainment, electricity, and durables are found as luxuries. Khan and Khalid (2012) use the data of HIES-2007-08 and find that households headed by females spend more on fuel and lighting, housing, education, footwear, and clothing, and less on food and drinks, and transport and communications than the households headed by a male. For both female and male-headed households, the study classifies clothing and footwear, food and drinks, personal effects, fuel and lighting, and healthcare as necessities, while transport and communications, education, household effects, entertainment, and durables are classified as luxuries.

The studies related to Pakistan are suffering from several problems. They are outdated and have covered only a few commodity groups that do not provide female and male-headed households' consumption behavior. The present study is an effort to fill this gap by using the survey data of HIES-2013-14. This study will not only look at the disparities in consumption patterns between male and female-headed households in Pakistan, but it will also investigate the effects of other regional, socioeconomic, and demographic characteristics on their consumption habits.

3. METHODOLOGY

Using constraint utility maximization problem, we can derive the following demand function[2]:

$$EXP_j^i = \alpha_i + \beta_i I_j + \mu_j \quad (1)$$

Where EXP_j^i is expenditure on i^{th} good made by j^{th} household, I_j is the level of income of the jth household and μ_j is the stochastic error term.

Total expenditures are preferred as welfare indicators in developing countries like Pakistan over household income since household consumption expenditures are smoother. Individuals do not report their income correctly and there are more chances of measurement errors in income[3]. Moreover, due to the seasonal pattern of cropping, income is vulnerable to large fluctuations in rural regions of developing countries. Therefore, we employ the Working-Lesser model proposed by Working (1943) and Lesser (1963) to assess the difference in budget shares of different consumption categories of male and female-headed households. In this specification, the share of expenditure allocated to a certain good is regressed on the log of total expenditures as given below:

$$SEXP_j^i = \alpha_i + \beta_i \ln TEXP_j + X\gamma + \mu_j \quad (2)$$

where $SEXP_j^i$ is the j^{th} household share of expenditure on i^{th} commodity, $\ln TEXP_j$ is the log of total expenditures j^{th} household, and X is the vector of other control variables.

The ***level of education*** plays a crucial role in changing the traditional attitudes towards spending (Jerome, 2002), and differences in educational levels are important in determining how household expenditure decisions are made (Simister & Piesse, 2002). More educated people are more conscious about their standard of living. Therefore, to improve the living standard, new needs are developed. ***The age*** of the household head influences his consumption pattern (Ding, 2007) as it captures the variations in consumption patterns due to the changes in the biogenic and psychogenic demands of the consumer over the life cycle (Blisard *et al*., 2003). Furthermore, the environments surrounding one's occupational settings and job field influence one's expenditures on various goods. In general, white-collar workers spend more of their income on housing, and entertainment, whereas blue-collar workers spend more on necessities (Cage, 1989). Consumption of household is also affected by the ***number of dependent members***. Spending on schooling, childcare, and healthcare may be higher in a household with more dependent members. A lower dependency ratio ensures that more resources are available to each household member. These resources would result in improved nutrition, health, and well-being of households (Hadley *et al*., 2011).

On putting the variables mentioned above, equation (2) takes the form:

$$SEXP_j^i = \alpha_i + \beta_i \ln TEXP_j + \theta_i lnAG_j + \rho_i ED_j + \tau_i OC_j + \lambda_i lnDR_j + \varepsilon_j \quad (3)$$

Where *AG*, *Ed*, and *OC* are the age, educational level, and occupation of the j^{th} household's head, respectively, and *DR* is the jth household's dependency ratio.

Consumption patterns can also be different across the ***regions***. The consumption behaviors and priorities of rural households are different from those living in urban areas. Likewise, households living in the more developed province have easy access to major facilities than other provinces. To capture the regional effects, dummy variables can be introduced to urban-rural and province-level differences. Hence, equation (3) can be written as:

[2] Equation (1) is well known Engle curve, and its detail derivation is given in Khan and Khalid (2010)
[3] Usually, income is under reported

$$SEXP_j^i = \alpha_i + \beta_i \ln TEXP_j + \theta_i lnAG_j + \rho_i ED_j + \tau_i OC_j + \lambda_i lnDR_j + \pi_i UR_j + \sigma_{i1} PP_j + \sigma_{i2} PS_j + \sigma_{i3} PB_j + \varepsilon_j \quad (4)$$

Where, UR, PP, PS, and PB are dummy variables used for rural regions, Punjab, Sindh, and Balochistan, respectively. Urban region and KP are taken as reference categories.

The gender of a household head plays a vital role in the decision-making process of expenditures made on goods and services. Handa (1996), Panda (1997); Seebens (2009); and Khan and Khalid (2012), among others, have investigated the differences in consumption patterns of male and female-headed households in developing countries. The consumption patterns of male and female-headed households differ because their needs, wants, lifestyles and behaviors are different. Therefore, this study will analyze and compare the consumption patterns of households headed by males and females. First we will estimate equation (4) for female and male-headed households separately and then for testing differences in the consumption behavior of these two types of households, we will apply the following F-test:

$$\mathrm{F}\,(\mathrm{K}+1, N_1+N_2-2\mathrm{K}-2) = \frac{(RSS_R - RSS_{UR})/(\mathrm{K}+1)}{(RSS_{UR})/(N_1+N_2-2\mathrm{K}-2)} \quad (5)$$

Where RSS_R is residuals sum of squared restricted, RSS_{UR} is residuals sum of squared un-restricted, N_1 and N_2 represent the numbers of female and male-headed households, respectively, and K represents the number of parameters of the model[4].

4. DATA SOURCE AND CONSTRUCTION OF VARIABLES

We use the Household Integrated Economic Survey (HIES-2013-14). Data on all variables relevant variables are extracted for the sample of 17810 households. Among these, 90.30 percent (16087) are male-headed, and 9.70 percent (1723) are female-headed households. Rural households are 65.35percent, while the percentage of urban households is 34.65 of the total sample[5]. Of the total households, 42.23 percent are from Punjab, 28.97 percent are from Sindh, 19.58 percent are from KP, and 9.22 percent are from Balochistan.

The expenditure on each commodity is calculated by summing the imputed value and amount spent on that commodity. Total expenditures include all the household expenditures on eight different commodity groups under consideration[6]. The budget share of a particular consumption category is obtained by dividing expenditures on a particular category by the households' total expenditures. Level of education is categorized into four groups, i.e., Below primary, primary, secondary, and intermediate and above.

Data on occupations are provided for 398 occupational categories in the HIES survey. These 398 occupations are merged into ten major groups according to Pakistan Standard Classifications of Occupations as: managers, professionals, technicians and associate professionals, clerical support workers, service and sales workers, skilled agricultural, forestry and fishery, craft and related trade workers, plant and machine operators, elementary occupations, and armed forces. After dropping the last, armed force category, the remaining nine groups of occupations are further categorized into four groups based on the level of skills required for each occupation provided by the Pakistan Bureau of

[4] First, we will estimate separate regressions for male and female headed households and obtain RSS_{UR} (RSS_M+RSS_F). For the restricted model, both groups of households will be combined and will obtain RSS_R. The F-test will next be used to test the hypothesis that no differences in consumption patterns exist between male and female headed households.

[5] The percentage of male headed and female headed households in rural and urban regions are almost same.

[6] Detail of groups of commodities is given in Appendix A.

Statistics (2015)[7]. However, we introduce a new category (skill0) for household heads who do not work in any profession. The dependency ratio is calculated by using the formula:

$$Dependency\ ratio = \frac{household\ members\ below\ age\ 15 + household\ members\ above\ age\ 64}{Total\ number\ of\ household\ members\ between\ 15\ to\ 64} * 100$$

The household head's age is reported as complete years in the survey. For Regional and Provincial analysis, dummy variables are introduced.

5. RESULTS AND DISCUSSION

Two different methods are used in this study to assess differences in the consumption patterns of households headed by males and females. To evaluate the difference in budget shares allocated to eight consumption categories by male and female-headed households, we first utilize a two-sample t-test. After this, we use regression analysis and apply FGLS to equation (4) for male and female-headed households separately and then apply F-test to test the differences in consumptions of different categories by these two types of households[8].

Table 1 below shows the average budget shares of male and female-headed households allocated to different consumption categories, as well as two-sample t-tests.

Table 1: Male and Female-headed households' shares of expenditure on different commodities

Commodity Groups	Male-Headed	Female-Headed	t-test	Probability
Education	0.037	0.053	-11.0	0.00*
Clothing and footwear	0.068	0.077	-10.0	0.00*
Durables	0.003	0.005	-5.30	0.00*
Healthcare	0.035	0.042	-3.90	0.00*
Entertainment	0.0039	0.0034	1.40	0.15
Food and drink	0.510	0.460	12.6	0.00*
Fuel and lighting	0.081	0.089	-7.50	0.00*
Miscellaneous	0.260	0.268	-0.80	0.30

Note: * P < 0.01, ** P < 0.05, *** P < 0.1

Results reveal that food and drink is the most crucial category because both households spend a larger share of their expenditures on this category. Results also depict that the share of expenditure allocated to food and drink by male-headed households is larger than the female-headed households. Moreover, shares of expenditures made on clothing and footwear, fuel and lighting, healthcare, education, and durables by female-headed households are greater than their male counterpart. However, the differences in the shares of entertainment and miscellaneous expenditures are insignificant. These results are aligned with Panda (1997) and Khan and Khalid (2012).

Next, we use regression analysis to find the strength of factors affecting the consumption of different commodities in the case of male and female-headed households. For this purpose, we estimate equation (4) separately for the data of male and female-headed households, using FGLS. Results are presented in Table 2:

[7] HIES survey does not contain data on armed forces.
[8] We apply FGLS to overcome the problem of heteroscedasticity in our model.

Table 2: FGLS estimates

	Expenditures	Age	Dependency Ratio	Primary Education	Secondary Education	Graduates and above	Skill1	Skill2	Skill3	Skill4	Rural	Punjab	Sindh	Balochistan
Female-Headed Households														
Education	0.050*	0.016*	0.0079*	0.025*	0.031*	0.032*	-0.02	-0.003	-0.002	-0.001	0.001*	0.0009	0.0011	-0.0006*
Clothing and footwear	-0.0028	0.0035	0.0062	0.0008*	0.0037	0.003	0.0016	-0.005	-0.018	-0.002	-0.0071	0.0163*	-0.02*	-0.0141*
Durables	0.0082	-0.0006*	-0.0025*	0.0010*	0.0069	0.0081	0.0002	0.0007	0.0024	0.0027*	-0.0089*	0.0026*	0.0058*	0.0064*
Healthcare	0.0014*	0.0078*	-0.0034*	0.0013	0.0028	0.0064	0.0031	0.0034	0.0067	0.0090	-0.010*	0.0001	-0.017*	-0.024*
Entertainment	0.0068*	-0.0019	-0.0014*	-0.0005	-0.0002	0.0025	-0.0071	-0.0031	-0.0017	-0.0007	-0.0011*	0.0009	0.0011	-0.0006*
Food and drink	-0.099*	0.0433*	0.0395*	-0.011	-0.012	-0.019*	0.013*	-0.026*	-0.022	-0.0241*	-0.059*	-0.063*	-0.014	-0.016
Fuel and lighting	-0.017*	0.0024	-0.0020	0.004	0.0024	-0.0076	-0.0020	-0.0055	-0.0051	-0.000	-0.010*	0.0042	-0.024*	0.0436*
Miscellaneous	0.060*	-0.0078*	-0.045*	-0.0043	-0.0075	-0.0094*	-0.003*	-0.0067*	-0.019*	-0.0028	0.0719*	0.017*	-0.063*	-0.030*
Male Headed Households														
Education	0.027*	0.0045*	0.0052*	0.0062*	0.014*	0.024*	-0.0033*	-0.0024*	0.0037*	0.012*	0.012*	0.0041*	-0.009*	-0.019*
Clothing and footwear	-0.0057*	0.0031*	0.0050*	0.0009	0.0008	-0.0016*	0.009*	-0.0013*	-0.0003	-0.0037*	-0.0038*	0.0150*	0.0136*	-0.0058*
Durables	0.0015*	-0.0005*	-0.0021*	0.0007*	0.0011*	0.0019*	0.001	0.0037*	0.0090	0.0086*	-0.0084*	0.0017*	0.0024*	0.0025*
Healthcare	0.0020*	0.0050*	-0.0005	-0.0004	0.0020	0.0052*	0.0010*	0.0010	0.0013	0.0034*	-0.010*	0.0040*	-0.014*	-0.022*
Entertainment	0.0081*	-0.0018*	-0.0020*	0.00046	0.0010*	0.0033*	-0.0019	0.0007*	0.0007	0.0010	-0.0013*	0.0016	0.0091	-0.0040*
Food and drink	-0.0739*	0.0132*	0.0345*	-0.0179*	-0.0328*	-0.0490*	0.0075*	0.0095*	-0.0099*	-0.0128*	-0.0640*	-0.0437*	0.0311*	0.0027
Fuel and lighting	-0.013*	0.0003	-0.0016*	0.0021*	0.0020*	-0.0003	-0.0011	-0.0038*	-0.0012	-0.0013	-0.0057*	0.0052*	-0.018*	0.0219*
Miscellaneous	0.057*	-0.012 *	-0.041*	-0.0135*	-0.0015*	-0.0026*	-0.010*	-0.0002	-0.016*	-0.018*	0.067*	0.019*	-0.025*	0.02*

Note: where* P < 0.01, ** P < 0.05, *** P < 0.1

Results of Table 2 support Engel's law showing that with the increase in the total expenditure, the budget share on food and drink decreases in the case of both male and female-headed households[9]. The decrease is relatively more prominent in the case of female-headed households. Similar results are found by Siddique (1982). Furthermore, the budget shares of clothing, and fuel and lighting are negatively related to total expenditures in the case of both types of households. Findings also reveal that the budget shares of other non-food commodities increase with total expenditures. Among these, the shares of expenditures on education, durables, and miscellaneous relatively increase less in the case of households headed by a female, while the budget shares of entertainment, and healthcare increase more with the increase in total expenditures for male-headed households.

Findings also reveal that budget shares of food and drinks, and healthcare increase with the increase in age of household head. This may be due to the fact that a person becomes more diet and health-conscious when his/her age increases. These impacts are relatively larger for female-headed households. Similarly, we also find an increase in the budget shares of clothing and footwear, fuel and lighting, and education. On the other hand, the budget shared of entertainment, durables, and miscellaneous are found negatively related to the age of household head in the case of both types of households. Similar findings are reported by Ding (2007) for the US.

In both male and female-headed households, the dependency ratio has a positive impact on the budget shares of food and drink, clothing and footwear, and education. In all three categories, the effects are greater for female-headed households than their male counterparts. In both types of households, however, the dependency ratio has a negative impact on the budget shares of fuel and lighting, entertainment, durables, healthcare, and miscellaneous[10]. In female-headed households, the decrease in budget shares of healthcare, durables, and miscellaneous is greater than in male-headed households, while the decrease in budget shares of entertainment is smaller.

Educational attainment plays a vital role in the consumption pattern of male-headed households. In the case of male-headed households, the budget shares of education, durables, healthcare, entertainment, and fuel and lightning increase with the increase in the level of education. For food and drinks, the results demonstrate that budget shares in both types of households decrease as the level of education of the household head increases. The decrease in budget shares for male and female-headed households increase significantly as the head moves from below primary to a higher level of education. The reason behind decrease in share of food and drinks is that usually more educated households have more income. They spend more on luxuries and a smaller share on necessities. Increases in educational attainment raise the shares of expenditure on education, and durables in female-headed households. However, the impact on entertainment is insignificant. This could be because female-headed households earn less than male-headed households with the same educational level and they choose less entertainment and spend more on productive activities like education.

The household head's occupation has a considerable effect on the budget shares of different consumption categories[11]. In both male and female led households, the budget share for food and drinking is smaller for households with higher status occupations. The earnings of heads with high status occupations are higher; therefore, their shares of budget are smaller, as predicted by Engle's law. The shares of

[9] Results of F test given in Appendix B show that there are significant differences in the consumption patterns of male headed and female headed households in case of all 8 categories as the values of computed F is greater than critical F and thus reject the null of similar pattern.

[10] In case of female headed households the impact of dependency ration on fuel and lighting is statistically insignificant.

[11] In most of the cases results show that impacts of occupational status are insignificant in case of female headed households.

expenditure on durables are larger for households with employed heads than for households with jobless heads, owing to the obvious fact that employed heads have more income to spend on durables than unemployed heads. The findings for male-headed households also demonstrate that households with skill1 and skill2 levels of occupations have smaller budget shares on education while those with skill3 and skill4 levels of occupations have larger budget shares on education than households with no occupations.

Furthermore, shares of expenditure on clothing and footwear, fuel and lighting, and miscellaneous decrease when the household head moves to high-status occupations[12]. Results also reveal that budget shares for healthcare are higher for households with their heads' occupations of skill1, skill2, skill3, and skill4 relative to households without any occupation. This demonstrates that household heads with higher-paying jobs earn more money and better care of their health.

In the case of both male and female-headed households, the results of the regional dummy show that rural families have greater budget shares for education, and miscellaneous while urban households spend more on food and drinking, clothing and footwear, fuel and lighting, healthcare, durables, and entertainment. Due to their lack of easy access to educational institutions, rural households spend less on necessities (food, fuel and lighting, and clothing) and more on productive goods (education). The findings also suggest that households in Punjab spend a larger percentage of their budget on non-food items than KP. Compared to KP, households in Sindh and Balochistan have smaller budget shares on various commodities.

6. CONCLUSION AND POLICY IMPLICATIONS

This study used HIES-2013-14 data to examine the consumption patterns of male and female-headed households. The results of annual average expenditure share revealed that female-headed households had a larger budget share for clothing and footwear, healthcare, education, durables, fuel and lighting, and miscellaneous. Only in the categories of food and drinks, and entertainment do male-headed households spend more.

The regression-based analysis supported Engel's law by showing a decrease in the food and drinks budget share with the increase in total expenditures. We also found a negative relationship of budget shares of fuel and lighting, and clothing and footwear with total expenditures. However, the budget shares of education, entertainment, healthcare, durables, and miscellaneous were found positively related to total expenditure. The study also found an increase in budget shares of food and drinks, clothing and footwear, fuel and lighting, healthcare, and education and decrease in budget shares of entertainment, durables, and miscellaneous with the increase in age in case of both types of households. Furthermore, the budget shares of food and drinking, clothing and footwear, and education were found to increase while, on the other hand, the budget shares of fuel and lighting, healthcare, durables, miscellaneous, and entertainment were found to decrease with the increase in dependency ratio. Budget shares of education, entertainment, and durables responded positively to the level of education of household heads. Results also revealed that household heads with higher skill levels have smaller shares on food and drinks, clothing and footwear, fuel and lighting, and miscellaneous in their budgets while they have larger budget shares on education, and healthcare.

Based on the above findings, it is suggested that policies be implemented to boost household income. This will enhance household demand for goods. Investment and economic development will increase, increasing households' income levels and living standards. Furthermore, motivational strategies for people

[12] though insignificant in most of the cases of female headed households

to achieve a high level of education should be used. A high level of education leads to prestigious jobs and higher earnings, resulting in a better quality of life. To live a better life, special measures should be taken to increase the income of those who work in elementary and clerical occupations.

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Appendix A: Detail of Commodity Groups

Commodity Group	Description
Education	Books and exercise notebooks/copies, School/college fees and private tuition fees, stationery, etc., other education expenses.
Clothing and footwear	Clothing, clothing material and services, footwear, and repair charges.
Durables	Motorcycle, car, air coolers, air conditioners, electric/ oil fans (ceiling, pedestal, table, exhaust), freezers, refrigerators, boiler, heater, geyser (electric, gas, oil), house and property expense
Healthcare	Hospitalization expenses, Purchase of medicine, laboratory and physician's charges, medical fees.
Entertainment	Recreation & reading, expenditure on hobbies, toys, photography, games, lodging charges, etc., radio and musical instruments, personal transport, and traveling
Food and drinks	Vegetables and fruits, pulses, meat, milk, juices, and drinks.
Fuel and lighting	Gas, electricity, fire-wood, kerosene oil, other household effects (bulbs, tubes, switches, battery cells, lampshades, etc.)
Miscellaneous	Stationery supplies such as pen, pencils, stapling machine, pin, etc. (other than education purpose), crockery & cutlery for daily use, taxes & fines, Transport expenditures, housing, and personal care.

Appendix B: F-test of Equality of Parameters of Two regressions

Commodity Groups	Computed F	Critical F
Education	$F = \frac{(43.9177664-42.49982898)*(17782)}{42.49982898*(13+1)} = 42.3$	2.13
Clothing and footwear	$F = \frac{(15.0895896-15.03310435)*(17782)}{15.03310435*(13+1)} = 4.77$	2.13
Durables	$F = \frac{(4.04108214-4.03118486)*(17782)}{4.03118486*(13+1)} = 3.11$	2.13
Healthcare	$F = \frac{(34.0765245-34.0085213)*(17782)}{34.0085213*(13+1)} = 2.54$	2.13
Entertainment	$F = \frac{(16.1391633-15.63756608)*(17782)}{15.63756608*(13+1)} = 40.7$	2.13
Food and drink	$F = \frac{(168.541766-167.0988593)*(17782)}{167.0988593*(13+1)} = 8.63$	2.13
Fuel and lighting	$F = \frac{(29.8874273-29.8180482)*(17782)}{29.8180482*(13+1)} = 2.95$	2.13
Miscellaneous	$F = \frac{(47.79417-47.58584)*(17782)}{47.58584*(13+1)} = 5.55$	2.13

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Interest Rate, Exchange Rate, Terms of Trade and Current Account Dynamics: Empirical Evidence from Pakistan

ABSTRACT

Since the early 1980s, the intertemporal approach to the current account (ICA) has acquired much attention and has become a standard instrument for determining the current account situation. The current study analyzes the ICA's consistency and relevance for Pakistan. To achieve this goal, we employ the present value model of the current account for the period 1960 to 2016. The empirical findings highlight the statistical consistency of the prediction of the intertemporal model in Pakistan. Furthermore, when supplemented with external sector variables such as the stochastic global interest rate, real exchange rate, and terms of trade, the present value model does a reasonable job of illuminating Pakistan's historical current account movements.

AUTHORS

Tahir Mukhtar *
Associate Professor, Fatima Jinnah Women University, Rawalpindi.
Author's Contributions: 1, 2, 3, 4, 5, 6
tahir.mukhtar@fjwu.edu.pk
https://orcid.org/0000-0001-6686-2744

Zainab Jehan
Assistant Professor, Fatima Jinnah Women University, Rawalpindi
Author's Contributions: 2, 4, 6
zainabjehan.fjwu@gmail.com
https://orcid.org/ 0000-0002-8668-1059

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*** Correspondence author**

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

1. INTRODUCTION

One of the fundamental aims of open economy macroeconomics is the theoretical and empirical investigation of the current account balance (CAB), and a significant number of research endeavors have been undertaken in this field using various methodologies. The modeling and the ramifications of the Current Account Deficit (CAD) have evolved, particularly in the post-World War II era (Edwards, 2001). The post-World War II period observed debates and strategies regarding CAB derived from the traditional approaches to balance of payments proposed by the Keynesian and the Monetarists and the intertemporal approach to the current account (ICA).

A thorough investigation of the conventional Keynesian and Monetarist approaches reveals that both of these focus on a macroeconomic framework based on trade and current account balances. Even though these approaches provide helpful guidance for macroeconomic policies, they are deficient in incorporating the microeconomic foundations and optimizing the behavior of the forward-looking economic agents in the analysis. The ICA adequately tackles such shortcomings of these approaches. Like the Mundell–Fleming model, this approach presupposes perfect capital mobility and high economic interdependence among nations. The rise of this approach in the early 1980s paved the way for the advancement of the models in two critical ways: by providing microeconomic foundations for analyzing the behavior of economic agents; and by utilizing the intertemporal optimization theory to scrutinize an array of interconnected macroeconomic challenges relating to international trade flows, CAB, external debt sustainability and the equilibrium exchange rates, particularly in a forward-looking framework (Singh, 2007).

In essence, the ICA is a restatement of the permanent income hypothesis (PIH) (Friedman, 1957; Hall, 1978). When an economy experiences a difference between its current and permanent income levels, an incentive for the economic agents to get engaged in lending and borrowing activities at the world capital market to accommodate the temporary variations emerges. An expectation of a temporary gain in future income drives economic agents to raise their current consumption spending, increasing the CAD. Conversely, a decline in anticipated future income is expected to condense the magnitude of the CAD. Applying a present value link between CAB and changes in net output, referred to as the basic present value model of the current account (PVMCA), is a well-known method for empirically testing the ICA. Later, advances in the relevant literature, on the other hand, established a more refined version of the PVMCA that took into account the effects of predicted relative prices – real interest rate (RIR), a real exchange rate (RER), and terms of trade (TOT). The PVMCA is based on the methodology of two critical empirical studies, namely, Campbell (1987) and Campbell and Shiller (1987), which facilitate in deriving the optimum current account value of an optimizing agent by employing the VAR technique.

With few exceptions1, Pakistan's economy has been plagued by recurrent external sector deficits since the 1960s. Various factors have historically contributed to the deterioration of external accounts. However, the low rates of domestic saving, recurrent budget, trade deficits, and exchange rate fluctuations remained the significant factors in dampening the external sector position of Pakistan. Pakistan's chronic CAD, along with mounting foreign debt and volatile private consumption, necessitates an inquiry into the dynamics of the CAB. This is noteworthy because economic theory says that governments should smooth consumption by using the tool of the CAB (Sachs et al., 1981).

Thus, the primary purpose of the present research is to analyze the dynamics of the CAB in Pakistan using the intertemporal model, which includes time-varying world real interest rate (RIR), the real exchange rate (RER), and terms of trade (TOT). The contribution of this study is apparent from two aspects. It is the first

[1] Historically, Pakistan experienced current account surplus only in few fiscal years i.e. 1960-61, 1983-84, 2001-02, 2002-03 and 2003-04.

attempt in Pakistan and other developing nations in South Asia to estimate an intertemporal model that integrates the world RIR, the RER, and the TOT. Secondly, the study not only follows the existing literature in using consumption-based interest rate (CIR), which comprises the world RIR, the RER, and the TOT, but it also investigates the isolated effects of three components of CIR within the PVMCA methodology to determine their relative contribution in generating fluctuations in the CAB of Pakistan.

The research is planned into five sections. Following the brief introduction, a critical review of the literature on the ICA's validity in various nations is presented in section 2. Section 3 discusses the theoretical model, construction of variables, data sources, and estimation technique. The results and discussion are given in section 4. Finally, section 5 presents the concluding remarks and some policy recommendations.

2. LITERATURE SURVEY

Using the framework of the ICA, a large body of research has been produced over the last three decades to scrutinize the dynamics of the CAB across various sets of countries. To this end, the PVMCA surfaces are a standard tool in the researchers' hands to test the ICA's consistency with the real-world data. To date, the relevant literature fails to yield decisive empirical evidence in support of the PVMCA framework. For instance, several studies show the inability of the basic PVMCA for various countries (Sheffrin & Woo, 1990; Otto, 1992; Milbourne & Otto, 1992; Makrydakis, 1999; Ogus & Niloufer, 2006; Goh, 2007; Khundrakpam & Ranjan, 2008; and Machi, 2013) while contrary evidence is recorded by Ghosh and Ostry (1995) and Agénor et al. (1999) among others. Bergin and Sheffrin (2000) pioneering work introduce refinements in the PVMCA by incorporating the role of stochastic RIR and the RER. They succeed in showing the better performance of their model than the basic PVMCA and contend that the effect of external shocks is transmitted to the CAB, in the case of small open economies, through the channels of the world RIR and the RER. According to Gruber (2004), fusing habit formation in a basic PVMCA enhances its better match with CA data. Nonetheless, Kano (2009) demonstrates that habit formation is similar to the world RIR as its influence on consumer behavior. Hence, the PVMCA with the world RIR can be an alternative to its habit formation counterpart. Similarly, according to Nason and Rogers (2006), excluding the stochastic world RIR is a crucial factor behind the poor performance of the basic PVMCA.

The Bergin and Sheffrin's model created a great appeal, and numerous empirical endeavors have demonstrated its better performance vis-à-vis the basic PVMCA (for instance, Adedeji, 2001; Landeau, 2002; Saksonovs, 2006; Darku, 2008; Campa & Gavilan, 2011; Mukhtar & Khan, 2011). To extend the framework laid out by Bergin and Sheffrin (2000), and Adedeji (2001) includes expected change in the TOT to estimate the model empirically. Their study aimed to determine the relative performance of four versions of the PVMCA using data for Nigeria from1960 to 1997. The results identified that the model augmented with the TOT and the time-varying world RIR and the RER does not perform better relative to the version of the PVMCA that incorporates changes in the world RIR and the RER only. However, it outperforms a basic PVMCA that ignores the transmission mechanisms through which an external shock affects the CAB.

Similarly, Bouakez and Kano (2008) have undertaken a critical study to inspect the actual CAB explaining the ability of the PVMCA model augmented with a TOT variable. Incorporating this variable tries to test the Harberger-Laursen-Metzler (HLM) effect, which asserts a favorable impact of a temporary rise in the TOT on the CAB. The study tests the PVMCA by utilizing the quarterly data from four advanced economies, namely, Australia, Canada, and the United Kingdom (1972Q1 to 2001Q4, 1962Q2 to 2001Q2, 1971Q1 to 2001Q4, respectively). By and large, the study's findings recommend the insignificant influence of shocks pertaining to the TOT in instigating CA fluctuations.

Ghosh and Ostry (1995) provided the pioneering work examining the ICA about Pakistan. The authors used data from 1960 to 1991 to show that the ICA is incompatible with the country's data. Mukhtar and Khan (2011) examine Pakistan's CA trends using annual time series data from 1960 to 2009. They discover that the basic intertemporal model continues to be ineffective in explaining Pakistan's overall CA vacillations. The Bergin and Sheffrin type model, on the other hand, does an excellent job of describing the CA's behavior. Apart from these two studies, we cannot locate any further research relevant to Pakistan that focuses on investigating CA dynamics within the ICA framework.

Because of the integration of the stochastic world RIR and the RER, the Bergin and Sheffrin model is deemed substantially more practicable. In any event, an alternative fundamental international relative price, namely, the TOT, is missing from the Bergin and Sheffrin investigation, which is appropriately acknowledged as one of the critical transmission routes of external shocks by the relevant literature. The primary goal of the present study is to test whether the TOT plays any significant role in improving the fit of the Bergin-Sheffrin model with Pakistan's data. Bouakez and Kano (2008) disregard the use of CIR by Bergin and Sheffrin in their analysis. They contend that this series in the research depends on the structural parameters. So, it is better to get more reliable results by explicitly disentangling the effects of the world RIR from the effects originating from the RER movements.

The primary goal of this study is to examine the dynamics of the CAB in Pakistan using an intertemporal model that incorporates time-varying world real interest rates (RIR), real exchange rates (RER), and terms of trade (TOT). The basic research question at hand is to determine the ICA's ability to predict the behaviour of Pakistan's CA balance in order to derive appropriate policy options for better managing the external balance. To this end, the study will assess the validity of the ICA in Pakistan using a modified version of the Bergin-Sheffrin model. Furthermore, in order to get more concrete results, the study will not only work with consumption-based interest rate (CIR), which comprises the world RIR, the RER, and the TOT, but it will also gauge the separate effects of three components of CIR within the PVMCA methodology to identify their relative importance in engendering fluctuations in Pakistan's CAB. This type of strategy has never been employed in any study based on the ICA related to a developing country, including Pakistan.

3. ANALYTICAL FRAMEWORK

3.1. The Model

This section presents a modified version of Bergin and Sheffrin (2000) PVMCA, incorporating the stochastic TOT. We borrow our PVMCA from Adedeji (2001). This model is constructed on the assumption that the consumption bundle of a representative household, which lives in a small open economy, consists of both tradable and non-tradable goods. It implies that the representative household can consume exportable, importable, and non-tradable. The household's expected lifetime utility can be expressed as:

$$E_t U = E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{*(1-\sigma)}}{1-\sigma} \qquad (1)$$

β refers to the subjective discount factor, σ indicates the relative risk aversion coefficient (or the reciprocal of the intertemporal elasticity of substitution), and an index of the total consumption is represented C^*. Finally, the functional form for C^* is assumed to be a Cobb-Douglas:

$$C^* = C_N^{\alpha} C_M^{1-\alpha}, \qquad 0 < \alpha < 1 \qquad (2)$$

Where, C_N is the consumption of non-traded goods, C_M refers to the consumption bundle of imported goods. Moreover, the term α symbolizes the share of traded goods in the total consumption index. Net holdings of foreign assets (i.e., international bonds) evolve according to the budget constraint:

$$A_{s+1} - A_s = Y_{Xs} + r_s A_s - P_s Y_{Ns} - Q_s C_{Ms} - P_s C_{Ns} - I_s - G_s \quad (3)$$

Where Y_x represents exportable' output, Y_N shows the production of non-tradable, P indicates the price of non-tradable for exportable, and Q refers to the relative price of importable concerning exportable. So, both P and Q are interpreted as the RER and the TOT, respectively. A, I, and G represent net foreign assets of a country, total investment, and government expenditures, respectively. All the selected variables are stated in terms of exportable goods. As a result, total expenditures, as measured in units of exportable C_S, is equal to $Q_s C_{Ms} + P_s C_{Ns}$ and total output, Y_S, equates to $Y_{Xs} + P_s Y_{Ns}$.

To solve the agent's problem, as an initial step, the consumption-based price index P^*, is explained as the minimum quantity of consumption spending required to purchase one unit of C^*, given P and Q. The agent's intertemporal problem is solved to derive P^*, maximizing $C_{Ns}^{\alpha} C_{Ms}^{1-\alpha}$ subject to $C_s = Q_s C_{Ms} + P_s C_{Ns}$. The derivation of P^*yields:

$$P_s^* = \frac{P_s^{\alpha} Q_s^{1-\alpha}}{\alpha^{\alpha}(1-\alpha)^{(1-\alpha)}} \quad (4)$$

We next proceed to reformulate the optimization problem of an economic agent in terms of the single compound good C^*. In addition, the budget constraint for one period (3) is explained by employing the definitions of total output and total expenditures and by incorporating the fact that $P_s^* C_s^* = C_s$. The outcome is:

$$P_s^* C_s^* = Y_s + (1 + r_s) A_s - A_{s+1} - I_s - G_s \quad (5)$$

The intertemporal problem then faced by the economic agent is to optimize (1) conditional to (5). An appropriate mathematical exercise results in the following first-order condition:

$$E_t \left[\beta (1 + r_{t+1}) \left(\frac{P_t^*}{P_{t+1}^*} \right) \left(\frac{C_t^*}{C_{t+1}^*} \right)^{\sigma} \right] = 1 \quad (6)$$

Substitution for C^* and P^* from (2) and (4) we get:

$$E_t \left[\beta (1 + r_{t+1}) \left(\frac{C_t}{C_{t+1}} \right)^{\sigma} \left(\frac{P_t^{\alpha} Q_t^{(1-\alpha)}}{P_{t+1}^{\alpha} Q_{t+1}^{(1-\alpha)}} \right)^{(1-\sigma)} \right] = 1 \quad (7)$$

Failure to get an overt solution of Euler equation (7) leads us to an approximation of this expression. In this regard, the joint log normality for all variables results in the following specification of (7):[2]

$$E_t \left[ln\beta + r_{t+1} - \sigma \Delta C_{t+1} + (1-\sigma) ln P_t^{\alpha} Q_t^{(1-\alpha)} - (1-\sigma) ln P_{t+1}^{\alpha} Q_{t+1}^{(1-\alpha)} \right] + \frac{1}{2} Var(lnX) = 0 \quad (8)$$

where $X = \beta (1 + r_{t+1}) \left(\frac{C_t}{C_{t+1}} \right)^{\sigma} \left(\frac{P_t^{\alpha} Q_t^{(1-\alpha)}}{P_{t+1}^{\alpha} Q_{t+1}^{(1-\alpha)}} \right)^{(1-\sigma)}$, $\Delta C_{t+1} = lnC_{t+1} - lnC_t$, and the approximation $\ln(1 + r_{t+1}) \approx r_{t+1}$ has been utilized. Furthermore, we have assumed that variances and covariances between all variables remain constant, expression (8) turns as:

[2] If X is log-normally distributed with the property that $E_t(x) = E_t(\log x) + \frac{1}{2} Var(\log x)$

$$E_t \Delta C_{t+1} = E_t[\gamma r_{t+1} - \alpha(\gamma - 1)\Delta p_{t+1} - (1-\alpha)(\gamma - 1)\Delta q_{t+1}] + Constant \quad (9)^3$$

Where, $\Delta p_{t+1} = lnP_{t+1} - lnP_t$, $\Delta q_{t+1} = ln\, Q_{t+1} - lnQ_t$, and $\gamma = \frac{1}{\sigma}$ (the elasticity of intertemporal substitution). Thus, we can rewrite (9) for showing the evolution of optimal consumption profile as:

$$E_t c_{t+1} = \gamma E_t r^c_{t+1} \quad (10)$$

where, r^c is the consumption-based interest rate expressed as:

$$r^c_t = r_t - \left[\alpha\left(\frac{\gamma-1}{\gamma}\right)\right]\Delta P_t - \left[(1-\alpha)\left(\frac{\gamma-1}{\gamma}\right)\right]\Delta q_t \quad (11)$$

Now an important task is to derive the required econometric form of the modified PVMCA for testing its implications. In this case, we linearize the intertemporal budget constraint around the steady-state, where the net foreign assets are set equal to zero as an essential requirement of the model. A long derivation task ends at:

$$\widehat{CA}_t = -E_t[\sum_{s=t+1}^{\infty} \beta^s\, (\Delta no_s - \gamma r^c_s] \quad (12)^3$$

The expression (12) demonstrates the influence of both domestic and external shocks on the CAB. A rise in the CAB accompanies a fall in expected net output, while the expected CIR will condense the CAB. It implies that domestic and foreign factors will affect the CAB differently. For empirical examination of (12), we set the following framework:

$$\begin{bmatrix} \Delta no_t \\ CA_t \\ r^c_t \end{bmatrix} = \begin{bmatrix} \phi_{11} & \phi_{12} & \phi_{13} \\ \phi_{21} & \phi_{22} & \phi_{23} \\ \phi_{31} & \phi_{32} & \phi_{33} \end{bmatrix} \begin{bmatrix} \Delta no_{t-1} \\ CA_{t-1} \\ r^c_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \quad (13)$$

Using (13) and the other conditions that $E_t(X_{t+j}) = \Omega^j X$, $E(\varepsilon_{1t}) = E(\varepsilon_{2t}) = E(\varepsilon_{3t}) = 0$ and Ω is the 3×3 matrix of coefficients ϕ_{ij}. The restrictions on (12) can be stated as:

$$hy_t = -\sum_{s=t+1}^{\infty} \beta^{s-t}\, (g_1 - \gamma g_2)\Omega^{s-t} y_t \quad (14)$$

Where, $y_t = (\Delta no_t \quad CA_t \quad r^c_t)'$, $g_1 = [1 \quad 0 \quad 0]$, $g_2 = [0 \quad 0 \quad 1]$, and $h = [0 \quad 1 \quad 0]$. For a given y_t, the right-hand side of (14) can be expressed as:

$$\widehat{CA}_t = k y_t \quad (15)$$

Where $k = -(g_1 - \gamma g_2)\beta\Omega(1 - \beta\Omega)^{-1} = [\Phi_{\Delta no} \quad \Phi_{CA} \quad \Phi_{r^c}] = [0 \quad 1 \quad 0]$. The expression (15) sets a statistical restriction of the modified PVMCA within the VAR framework, i.e., and actual CAB is analogous to its PVMCA's predicted counterpart ($\widehat{CA}_t = CA_t$) employing the Wald test. Apart from this formal test, following Adedeji (2001), the validity of the modified PVMCA will also be judged from some informal tests derived from (12). Briefly, these tests are: (i) the predicted CAB series of the model (or optimal CAB) appears stationary at the levels, i.e., I(0); (ii) fluctuations in the net output and CIR are Granger caused by the CA series;(iii) equality exists between the actual CAB and the model's predicted CAB; and (iv) if both the series are similar, the stationarity of the one series also indicates the stationarity of the other series.

[3] The lower case letters indicates the logs of the upper case counterparts

In light of Bouakez and Kano's (2008) concerns about the use of CIR, we must investigate the separate roles of the world RIR, the RER, and the TOT in determining Pakistan's CAB behavior. Therefore, following Bouakez and Kano (2008) and the procedure presented above, the optimal CAB can be expressed as:

$$\widehat{CA}_t^* = -E_t[\sum_{s=t+1}^{\infty} \beta^s (\Delta no_s - \gamma r_s + \alpha(\gamma-1)\Delta p_s + (1-\alpha)g_4(\gamma-1)\Delta q_s)] \quad (16)$$

For estimating (16), the VAR model consists of five variables, and the constraints imposed on the model are expressed as:

$$hy_t = -\sum_{s=t+1}^{\infty} \beta^{s-t} (g_1 - \gamma g_2 - (1-\alpha)(1-\gamma)g_3 - \alpha(1-\gamma)g_4)\Omega^{s-t} y_t \quad (17)$$

where $h = [0 \quad 1 \quad 0 \quad 0 \quad 0]$, $g_1 = [1 \quad 0 \quad 0 \quad 0 \quad 0]$, $g_2 = [0 \quad 0 \quad 1 \quad 0 \quad 0]$, $g_3 = [0 \quad 0 \quad 0 \quad 1 \quad 0]$, and $g_4 = [0 \quad 0 \quad 0 \quad 0 \quad 1]$.

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For a given y_t, the expression on the right-hand side of (17) can be stated as:

$$\widehat{CA}_t^* = ky_t \quad (18)$$

Hence, the vector of the parameter $k = -(g_1 - \gamma g_2 - (1-\alpha)(1-\gamma)g_3 - \alpha(1-\gamma)g_4)\beta\Omega(1-\beta\Omega)^{-1}$.

3.2. Data Sources and Explanation of Variables

This study utilizes annual time series data from 1960 to 2016 for Pakistan to accomplish the empirical objectives. Data on the selected variables, namely, consumption spending, public sector spending, investment spending (comprises of the gross fixed capital formation and variations in inventories), GDP, and CAB are accessed from International Financial Statistics published by the International Monetary Fund, Pakistan Economic Surveys (various issues) published by the Government of Pakistan, and World Development Indicators by the World Bank.

We deviate from the common tradition in the relevant empirical research regarding the construction of the CAB series4 by subtracting private consumption, public sector spending, and investment expenditures from the national income (gross national product). We computed the net output series by deducting the public sector expenditure and private investment spending from GDP. The world RIR is calculated from the weighted averages of the real interest rates of G-7 countries. As foreign trade of Pakistan is denominated in the US dollar, the current study uses the RER by taking the US dollar as a benchmark currency. The TOT variable is constructed by following the standard practice, i.e., taking the ratio of the export prices to the import prices. Finally, all the selected variables are used in the real per capita form.

The value of elasticity of intertemporal substitution γ varies between 0 and 1[5]. We have followed Ostry and Reinhart (1992) and Darku (2008) using the value γ = 0.45. About the value of the share of traded goods in the total consumption index α, like Bergin and Sheffrin (2000), we select the value of this index 0.5.

[4] We deviate from the traditional approach of constructing current account series from gross national product less private consumption expenditure less private investment less government consumption spending because of a visible mismatch between the current account series given in balance of payment data of Pakistan and current account series constructed by following the method suggested in intertemporal model that is traditional way of constructing current account series. Therefore, it is quite plausible to use current account series given in BoP data of Pakistan. See, for instance, Ghosh and Ostry (1995), Bergin and Sheffrin (2000), Adedeji (2001), Darku (2008) and Mukhtar and Khan (2010), among others.

[5] See, for example, Hall (1988), Ostry and Reinhart (1992), Kydland and Zarazaga (2003), Bergin and Sheffrin (2000), Adedeji (2001), Landeau (2002), Uribe (2002) and Darku (2008).

Finally, for the value of the discount factor β, first, we obtain the mean of the world RIR, $\bar{r}$ using the formula $1/(1+\bar{r})$, we compute the value of β, which is equal to approximately 0.96.

4. RESULTS AND DISCUSSION

4.1. Unit Root Test

Considering that testing stationarity of variables is a prerequisite for applying a VAR model, the study has used the Dickey-Fuller Generalized Least Squares (DF-GLS) unit root test for selected time series. Table 1 depicts that all the four variables, i.e., actual CAB, optimal CAB, change in net output, and CIR are stationary at a level that implies they are $I(0)$. The findings of the stationarity test concerning the actual and optimal CA series lend favorable support in applying the PVMCA to Pakistan's data. In the next step, a VAR model of order one is selected as proposed by the AIC and the SBC lag selection criteria to carry out the empirical exercise.

Table 1: Results of Unit Root Test

Variable	Level	Mackinnon Critical Values for Rejection of Hypothesis of a Unit Root			Decision
		1 %	5 %	10 %	
Δno_t	-4.56	-3.76	-3.18	-2.88	*I* (0)
CA_t	-3.98	-3.76	-3.18	-2.88	*I* (0)
$\widehat{CA}_t$	-6.38	-3.76	-3.18	-2.88	*I (0)*
r_t^c	-6.38	-3.76	-3.18	-2.88	*I* (0)

4.2. VAR Estimates and Tests of Restrictions of the Modified PVMCA

Table 2 presents the estimated coefficients of three equations within the VAR model and different modified PVMCA tests. The Granger causality test in (Panel B of Table 2) indicates unidirectional causality between the CAB and variations in the net output, and it is running from the former to the latter. However, no causal pattern is found between the CAB, and the CIR. Hence, the outcome of this informal test yields partial support to the modified PVMCA. Next, the parameters of the VAR model, presented in Table 2, are used to derive a series for the optimal CAB, and then a graphical comparison amongst the actual and the optimal CA series is structured. A visual inspection of the plots of both series is displayed in figure 1, revealing that the model fits reasonably well with the data. Moreover, by including the stochastic world RIR, the RER, and the TOT in the model, an improvement is observed in the modified PVMCA to predict the general trend of the actual CAB in Pakistan. Nevertheless, it is also evident that the actual CAB demonstrates relatively more instability than its optimal counterpart, which is a usual occurrence when a consumption smoothing model is used for analyzing the case of a small open economy (Adler, 2002).

We have employed another informal test of the intertemporal model, which is carried out by taking the ratio of two CA balances, namely, the proportion of optimal CAB's variance to the variance of its actual counterpart. The PVMCA and the assumption of high capital mobility support a value of unity for this ratio (Ghosh & Ostry, 1995; Agénor et al., 1999). From panel C of Table 2(column 2), it is evident that this ratio is less than unity, i.e., 0.744, indicating a moderate level of capital mobility to Pakistan through the selected period of the study. It also casts doubt on the validity of the ICA for Pakistan's data. Our final informal test of the intertemporal model is based on the correlation coefficient value between the two CA series. We obtained the value of the correlation coefficient as 0.815 (panel C of Table 2, column 2), suggesting that the modified PVMCA has a reasonably good power to describe the behavior of CAB of Pakistan during the sample period. Figure 1 displays a close association between the two series.

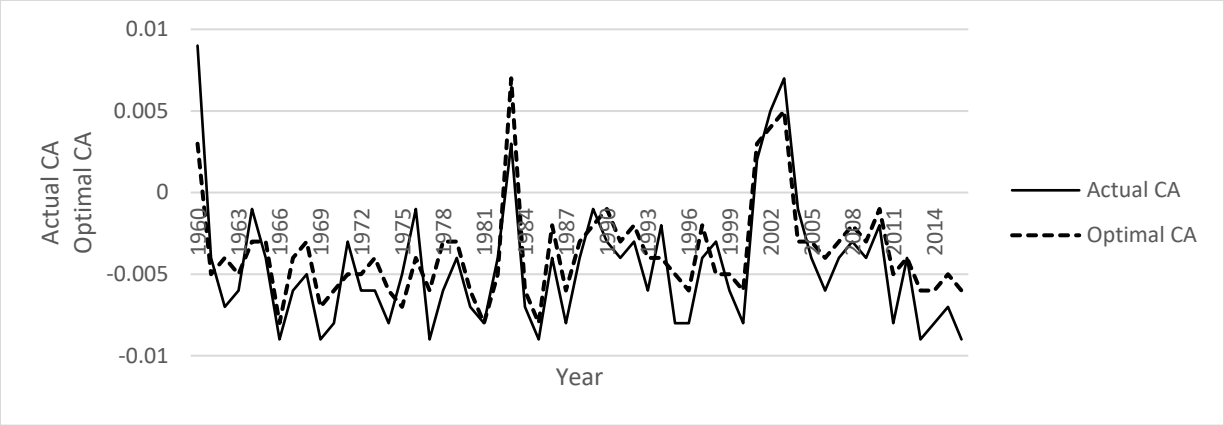

Figure 1: Plots of Actual and Optimal Current Account Balances

The next step is to go over the results of the formal tests used in the study, presented in Table 2 (Panel C, column 1). The *k* vector coefficients on change in net output, CIR, and CAB are –0.124, –0.028, and 0.547, respectively. Individually, the values of all three coefficients are statistically indistinguishable from 0, 1, and 0, which corresponds to their theoretical values in the modified PVMCA. This finding forms our expectation regarding the strength of our estimated model to pass through the stringent statistical restriction implied by the expression (12) in section 3.1. The outcome of the Wald test reflects that, as a whole, the restriction of the modified PVMCA is not rejected by Pakistan's data. It implies that including the world RIR, the RER, and the TOT significantly improves the intertemporal model's ability to explain CA behavior in Pakistan. The results for different diagnostic tests, namely, serial correlation, functional form, heteroscedasticity, and normality, in Table 2, reveal that the residuals conform to the Gaussian assumptions.

Table 2: VAR Estimates and Tests of Restrictions of the Modified PVMCA

Panel A: VAR Estimates

Dependent Variable	Regressor			Diagnostic Tests: χ^2 (*P*-values are in the parentheses)			
	Δno_{t-1}	CA_{t-1}	r^c_{t-1}	S.Correlation	F.Form	Heteroscedasticity	Normality
Δno_t	0.175	-0.518***	-0.057	0.379	0.089	0.541	0.726
	(0.169)	(0.143)	(0.042)	(0.581)	(0.911)	(0.439)	(0.339)
CA_t	-0.172	0.665***	-0.039	0.684	0.097	0.999	1.077
	(0.154)	(0.101)	(0.222)	(0.348)	(0.899)	(0.311)	(0.301)
r^c_t	-0.719	0.038	0.318**	1.114	0.278	0.674	0.888
	(0.631)	(0.039)	(0.148)	(0.273)	(0.667)	(0.354)	(0.317)

Panel B: Granger Causality Test: F statistic (*P*-values are in the parenthesis)

CA does not Granger Cause Δno	8.517	(0.004)
Δno does not Granger Cause CA	1.145	(0.376)
CA does not Granger Cause r^c_t	0.359	(0.552)
r^c_t does not Granger Cause CA	1.348	(0.251)

Pane C: Tests of Restrictions		**Pane C: Ratio of Variance and Correlation Coefficeint**
Δno_t	-0.124 (0.212)	$var(\widehat{CA})/var(CA)$ = 0.744
CA_t	0.547 (0.413)	$Corr(CA, \widehat{CA})$ = 0.815
r^c_t	-0.028 (0.214)	
	χ^2 = 3.317; *P*-value = 0.357	

Notes: As all the three variables used in the model are stated as deviations from their respective means, the VAR model is estimated without a constant term. The values in parentheses represent the standard errors. *** and ** indicate significant at 1% and 5% significance levels, respectively.

4.3. Estimates of Basic PVMCA and Bergin and Sheffrin's Model

It seems imperative to present the findings of two other versions of the intertemporal model, known as the basic PVMCA6 and Bergin and Sheffrin's model. The results of different versions of the intertemporal model can be compared to establish the relative implications of domestic and external shocks in causing variations in the CAB of Pakistan. The overall findings indicate the strong rejection of the basic PVMCA by data under formal (statistical) and informal tests (see Table 3 and figure 2). One of the primary reasons for the weak performance of this model may be its restrictive nature, so it is expanded to incorporate the influence of exogenous shocks in changing the CAB. When Bergin and Sheffrin's model is applied, we find a tremendous improvement in the intertemporal model's performance in fitting the CAB data of Pakistan. According to informal and formal tests, the extended PVMCA not only successfully captures the pattern of most of the actual current account swings, but its constraints are also not statistically rejected by the current account data (see Table 4 and figure 3). Hence, this result points towards the important role of the stochastic world RIR and the RER in inducing variations in the country's CAB. A comparison among the three versions of the intertemporal model indicates that no doubt the performance of the model, which includes external shocks, namely, the world RIR, the RER, and the TOT is far better than that of the basic PVMCA on the ground of both the formal and informal tests. Nonetheless, through informal tests, it appears that this empirical model, in relative terms, does not perform better than the model proposed by Bergin and Sheffrin (2001), which excludes the TOT variations. Hence, our findings suggest fewer effective contributions of the TOT shocks regarding the oscillations in the CAB of Pakistan.

Table 3: VAR Estimates and Tests of Restrictions of the Basic PVMCA

Dependent Variable	Regressor		Diagnostic Tests: χ^2 (*p* values are in the parentheses)			
	Δno_{t-1}	CA_{t-1}	S.Correlation	F.Form	Hetero.	Normality
Δno_t	0.109	-0.384***	1.266	0.009	0.072	0.664
	(0.221)	(0.095)	(0.250)	(0.989)	(0.923)	(0.417)
CA_t	0.011	0.414***	0.804	1.517	0.053	0.446
	(0.027)	(0.049)	(0.319)	(0.238)	(0.962)	(0.792)
Granger Causality Test: F statistic (P-values are in the parenthesis)						
CA does not Granger Cause Δno				9.448	(0.009)	
Δno does not Granger Cause CA				1.667	(0.342)	
Tests of Restrictions						
Δno_t	-0.163	(0.139)	$var(\widehat{CA})/var(CA)$ = 0.607			
CA_t	0.415***	(0.105)	$Corr(CA, \widehat{CA})$ = 0.513			
χ^2 = 26.855; *P*-value = 0.000						

Notes: The variables entering the model are expressed as deviations from their means, so the VAR model is estimated without a constant term. The numbers in the parentheses are the standard errors. *** indicate significant at 1% level.

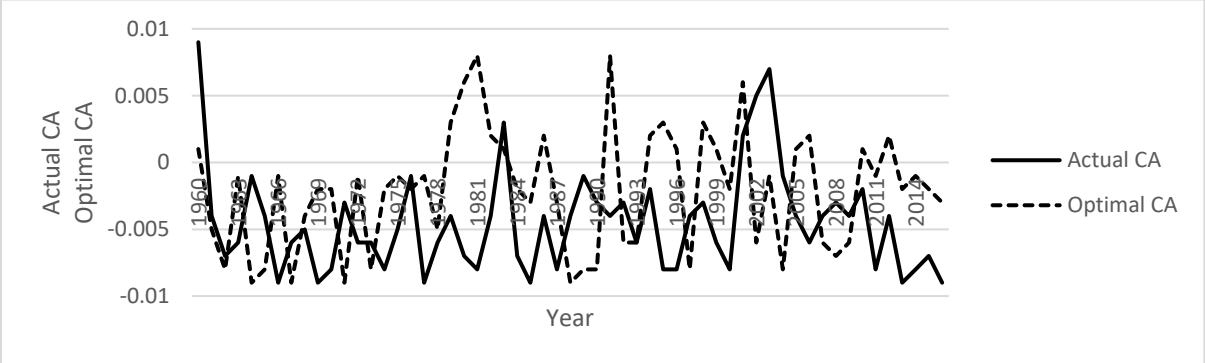

Figure 2: Plots of Actual and Optimal Current Account Balances

[6] Assuming constant world interest rate of 4% we have estimated the optimal current account series under the basic PVMCA.

Table 4: VAR Estimates and Tests of Restrictions of the Bergin and Sheffrin Model

Dependent Variable	Regressor			Diagnostic Tests: χ^2 (*P*-values are in the parentheses)			
	Δno_{t-1}	CA_{t-1}	r^c_{t-1}	S.Correlation	F.Form	Heteroscedasticity	Normality
Δno_t	0.345	-0.167***	-0.029	1.366	0.114	0.049	0.656
	(0.297)	(0.027)	(0.108)	(0.253)	(0.684)	(0.938)	(0.387)
CA_t	-0.995	0.736***	-0.182	0.559	0.902	1.399	0.602
	(0.749)	(0.101)	(0.146)	(0.428)	(0.303)	(0.241)	(0.396)
r^c_t	-0.201	-0.086	0.612**	0.611	0.101	0.739	0.492
	(0.189)	(0.097)	(0.245)	(0.384)	(0.864)	(0.317)	(0.468)

Granger Causality Test: F statistic (*p* values are in the parenthesis)

CA does not Granger Cause Δno	18.294	(0.000)
Δno does not Granger Cause CA	1.158	(0.382)
CA does not Granger Cause r^c_t	1.187	(0.374)
r^c_t does not Granger Cause CA	1.057	(0.425)

Tests of Restrictions

Δno_t	-0.028	(0.097)	$var(\widehat{CA})/var(CA)$ = 0.931
CA_t	0.449***	(0.011)	$Corr(CA, \widehat{CA})$ = 0.966
r^c_t	0.028	(0.031)	
	χ^2 = 2.984; *P*-Value = 0.447		

Notes: As all the three variables entering the model are expressed as deviations from their means, the VAR model is estimated without a constant term. The numbers in parentheses are standard errors. *** and ** indicate significant at 1% and 5% levels, respectively.

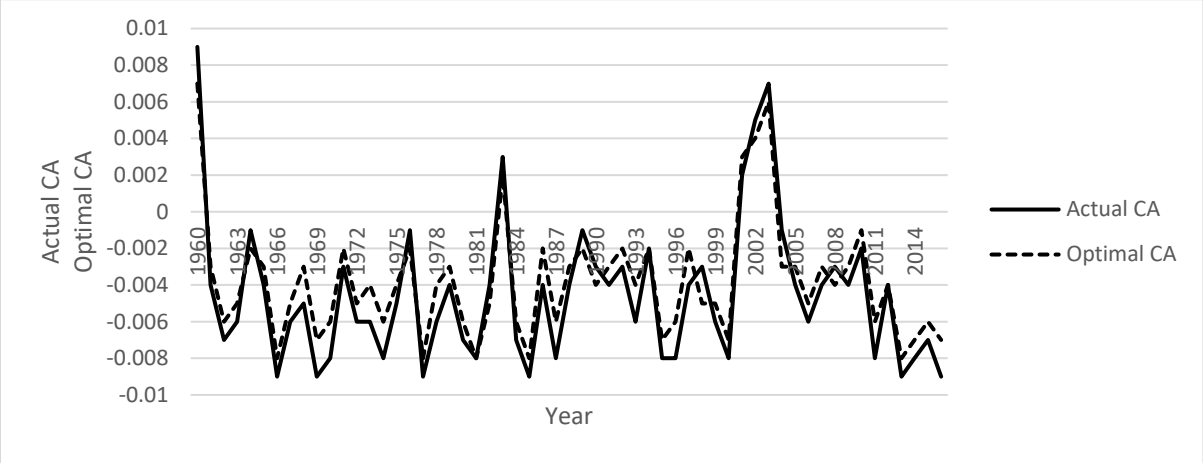

Figure 3: Plots of Actual and Optimal Current Account Balances

The use of CIR, which embraces the world RIR, RER, and TOT, is criticized by Bouakez and Kano (2008). Problems with the application of this variable are: firstly, its construction depends upon the values of the structural parameters, namely, the elasticity of intertemporal substitution (γ) and the share of traded goods in the total consumption index (α); secondly, it fails to reflect the different effects of the world RIR, the RER, and the TOT. Therefore, to test for the robustness of our empirical endeavor for the PVMCA, we also estimate a model separating the effects of all the three international relative prices from one another.

As a first step, for testing the modified intertemporal model, the CAB and the world RIR should appear as stationary at levels, whereas the net output, the RER, and the TOT should appear as integrated of order 1 (stationary in their first differences). Table 5 reports the findings of the stationarity tests for each selected time series using the DF-GLS test. It can be observed from the table that CA_t and r_t are integrated of order zero (stationary at levels) and no_t , p_t and q_t are stationary at their first differences as expected. So, their first difference form is taken for empirical analysis. The optimal CA series also appears stationary at level, which constitutes favorable evidence for the modified PVMCA. Further, we have employed the AIC and

the SBC tests of lag length criteria to determine the VAR model's order. Both of which suggest one period lag as optimal.

Table 5: Results of Unit Root Test

Variables	Level	Mackinnon Critical Values for Rejection of Hypothesis of a Unit Root			Decision
		1 %	5 %	10 %	
Δno_t	-4.56	-3.76	-3.18	-2.88	*I* (0)
CA_t	-3.98	-3.76	-3.18	-2.88	*I* (0)
$\widehat{CA}_t^*$	-4.22	-3.76	-3.18	-2.88	*I* (0)
r_t	-3.94	-3.76	-3.18	-2.88	*I* (0)
Δp_t	-8.06	-3.76	-3.18	-2.88	*I* (0)
Δq_t	-6.61	-3.76	-3.18	-2.88	*I* (0)

Concerning the results of the formal and informal tests, we focus on Table 67. For the Granger causality test, we can observe that the unidirectional causality exists, which runs from the CAB to the change in net output and towards change in the RER. However, we have found evidence for the absence of any causal relationship of the CAB with the world RIR and the change in the TOT. Hence, these findings advocate that the modified model gets partial support. The proportion of the variances of two current accounts (the predicted CA variance to the actual CA variance appears as 0.691(column 2, Table 6), which is slightly lower than the model where the CIR is used (see Table 2 above). It refers to the fact that the extent of the fluctuations in the actual CA series relatively increases in Pakistan when we decompose the CIR into different components in a model. The correlation coefficient value is 0.727(column 2, Table 6), while it was 0.815 previously.

As far as the formal test is concerned, Table 6 reports that the k vector coefficients of variation in net output, the CA, the world RIR, change in the RER, and variations in the TOT are –0.179, 0.635, 0.044, 0.847, and 0.126, respectively instead of their respective theoretical values of 0, 1, 0, 0 and 0 (column 1, Table 6). The null hypothesis of no difference between the estimated and theoretical values cannot be rejected for all variables except for TOT, which indicates that the role of this variable is against the expectation of the intertemporal model. This finding suggests that the external sector shocks are mainly transmitted to Pakistan's economy through the world RIR and the RER channels, with the TOT channel playing no significant role in inducing any fluctuation in the CAB in response to external shocks. Hence, the well-known HLM effect does not get any support from Pakistan's data within the framework of the ICA.

Nonetheless, the Wald test result displayed in Table 4 uncovers that we fail to reject the statistical restriction implied by the modified PVMCA as given in the expressions (17) and (18) in section 3.1. This outcome corroborates our earlier finding where we have used CIR for capturing the effects of the stochastic world RIR, the RER, and the TOT as given in Table 2. Hence, it appears that the use of CIR or its segments does not affect the consistency of the modified PVMCA with Pakistan's data.

The above analysis points out convincingly towards the non-existence of the HLM effect (that constitutes a significant association between the TOT and the CA) in Pakistan over the selected time of this study. Thus, the TOT shocks are not quantitatively imperative for stimulating the CA fluctuations in the country. This outcome is analogous for the majority of the countries for which this (HLM) effect has been empirically scrutinized within the intertemporal approach's framework. For instance, employing the modified methodology for the intertemporal approach given by Glick and Rogoff (1995) and Iscan (2000) fails to find substantial evidence for the significant influence of the TOT on the CAB of the G-7 countries.

[7] For VAR model estimates and diagnostic tests see table A1in appendix.

Similarly, Adedeji (2001) documents the insignificant effect of the TOT in creating any movements in the Nigerian CAB by using an intertemporal model wherein the stochastic variations in the world RIR, the RER, and the TOT are simultaneously introduced. In a study, Bouakez and Kano (2008) cannot find any significant relation between the TOT and the CAB for Australia and Canada, contrary to the HLM effect. Nonetheless, they report favorable outcomes for the effect of HLM on the United Kingdom. Interestingly, on empirical grounds, studies by Khan et al. (1992) and Otto (2003) provide evidence against the prevalence of the HLM effect in Pakistan by using different methodologies, which corroborates the findings of the modified intertemporal model in the present study.

Table 6: Granger Causality and Tests of Restrictions of the Modified PVMCA

Granger Causality Test: F statistic (*p* values are in the parenthesis)		
CA does not Granger Cause Δno	8.517	(0.004)
Δno does not Granger Cause CA	1.145	(0.376)
CA does not Granger Cause r	0.551	(0.461)
r does not Granger Cause CA	0.871	(0.355)
CA does not Granger Cause Δp	4.820	(0.049)
Δp does not Granger Cause CA	0.171	(0.251)
CA does not Granger Cause Δq	0.212	(0.251)
Δq does not Granger Cause CA	0.069	(0.792)

Tests of Restrictions			**The ratio of CA and Correlation Coefficient**
Δno_t	-0.179	(0.371)	$var(\widehat{CA})/var(CA)$ = 0.691
CA_t	0.635	(0.515)	$Corr(CA, \widehat{CA})$ = 0.727
r_t	0.044	(0.182)	
Δp_t	0.847	(0.966)	
Δq_t	0.126***	(0.042)	
χ^2 = 3.891; *P*-Value = 0.316			

Notes: The numbers in parentheses are standard errors. *** indicates significant at 1% level.

Table 7: Decomposition of Variance for the Current Account Series[8]

		Percentage of variance due to						
Period	Standard Error	World Real Interest Rate	Terms of Trade	Real Exchange Rate	Net Output	Current Account	Substitution Effect	Income Effect
1	0.08	0.88	0.09	1.14	1.60	96.28	2.11	97.88
2	0.47	0.99	0.65	3.82	11.59	82.94	5.46	93.53
4	1.77	4.07	1.81	4.02	16.23	73.85	9.90	90.08
6	2.34	5.36	1.85	6.91	14.19	71.68	14.12	85.87
8	1.99	8.13	1.78	6.74	13.17	70.17	16.65	83.34
10	2.32	9.22	1.67	6.08	12.99	70.03	16.97	83.02

At this point, it appears to be appropriate to show the CA's variance decomposition to quantify the relative contribution of the income effect and the substitution effect in illuminating the CA's variance. Table 5 presents the variance decomposition of the current account series. The influence of the world RIR, the RER, and the TOT innovations are pooled to form the substitution effect, while the effects of CAB and net output innovations are assembled to yield the income effect.

For the Cholesky decomposition, the following recursive ordering is used to do the variance decomposition analysis: firstly, because the intertemporal model is constructed for a small open economy, the world RIR, the TOT, and the RER are ordered ahead of the remaining variables; secondly, all the external variables

[8] In keeping view the objective of the study only the variance decomposition analysis for the current account series is presented.

namely, the world RIR, the TOT, the RER, and internal sector indicator, i.e., net output are preset concerning the CAB, as evidenced by the modified PVMCA's theoretical formulation. Thus, the CA series is ranked the last; thirdly, there is a lack of a clear argumentation regarding the predetermination of one variable for the other, specifically, when the relative ordering of real exchange rate and net output is to be determined, thus the study considers both the orderings.

The decomposition is taken in percentage form at different horizons. As we find virtually no difference in the results of whether the RER is ordered before or after the net output, Table 7 only reports the outcome of the decomposition where we place the RER ahead of the net output. It is evident from Table 7 that net output and CA's innovations remain a dominant source of inducing variations in CA for the short, medium, and long run. At the one year-horizon, nearly 98 percent variation in the external balance of Pakistan is explained by the income effect, while the share of the substitution effect is only 2 percent. At a longer horizon, however, even though the contribution of the substitution effect improves, the share of the income effect still dominates as its contribution in the CA variance appears as 83 percent. Hence, while the substitution effect, to some extent, appears significant for explicating the dynamics of the CA, the income effect remains dominant.

Concerning the role of the individual components of the substitution effect, both the world RIR and the RER contribute relatively more significantly than terms of trade in the CA variance. This implies that the global shocks significantly influence Pakistan's CAB mainly via the world RIR and the RER compared to the TOT. This finding follows the results obtained by the study for the intertemporal model, as given in Table 6.

5. CONCLUSION

Since the early 1980s, the intertemporal approach to the current account has gained considerable attention from researchers and policymakers and is considered a standard tool in determining the current account balance. This approach describes that the current account balance is determined through the domestic saving and investment decisions by the optimizing agents with forward-looking expectations. This research aims to see if the intertemporal approach is appropriate for analyzing the dynamics of the current account balance over the period from 1960 to 2016 in Pakistan. The version of the PVMCA used by the study incorporates the stochastic world real interest rate, the real exchange rate, and the terms of trade for measuring the effects of external sector shocks in inducing current account dynamics in Pakistan.

The results indicate that the cross-equation restrictions that the model uses are not overruled by the current account data under formal tests. Similarly, through informal tests, it appears that the model's fit is reasonably good. Hence, our findings suggest the influential role of domestic and foreign shocks in explaining the fluctuations in the current account balance of Pakistan. Nonetheless, we also find the insignificant impact of the terms of trade in influencing the current account balance by separately investigating the effects of the stochastic world real interest rate, the real exchange rate, and the terms of trade. Thus, we find no statistical support in favor of the HLM effect in Pakistan within the framework of the intertemporal model. Therefore, it appears that intertemporal substitution effects arising from the movements in the world real interest rate and the real exchange rate play a significant role in augmenting the performance of the intertemporal model.

Given Pakistan's accelerated trade openness and financial sector liberalization trajectory, the study's overall findings are particularly relevant for policy purposes. Because the modified PVMCA appears to be a theoretically sound framework for determining current account balance, Pakistan's government ought to first comprehend the private sector's response to external shocks before taking any policy actions to address them. Any methodology the government proposes for assessing the current account balance should take

into account the channels via which external shocks can alter this balance. Furthermore, the government should maintain policies that encourage Pakistan's economic integration with the global economy so that the current account balance can survive external sector shocks while reflecting consumers' unfettered optimum choices. Finally, the policy targeted at further liberalizing capital flows, including inflows and outflows, will assist economic agents in smoothing out their consumption to the desired optimal level, allowing for a higher current account deficit to achieve potentially higher economic growth without fear of insolvency.

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Appendix A: VAR Estimates and Diagnostic Tests

Dependent Variable	Regressor					Diagnostic Tests: χ^2 (p values are in the parentheses)			
	Δno_{t-1}	CA_{t-1}	r_{t-1}	Δp_{t-1}	Δq_{t-1}	S.Correlation	F.Form	Hetero.	Normality
Δno_t	0.164	-0.644***	0.035	-0.084*	0.012	0.362	0.191	0.567	0.742
	(0.142)	(0.117)	(0.031)	(0.046)	(0.013)	(0.595)	(0.763)	(0.424)	(0.323)
CA_t	0.152	0.591**	0.041	-0.097	0.014	0.697	0.174	0.913	0.977
	(0.137)	(0.224)	(0.038)	(0.117)	(0.131)	(0.324)	(0.778)	(0.337)	(0.301)
r_t	0.076	0.098	0.253**	0.048	0.017	0.257	0.282	0.217	0.708
	(0.214)	(0.187)	(0.107)	(0.128)	(0.259)	(0.682)	(0.657)	(0.746)	(0.321)
Δp_t	-0.149*	-0.168**	0.029	0.138**	0.018	0.088	0.097	0.384	0.098
	(0.082)	(0.072)	(0.152)	(0.062)	(0.077)	(0.917)	(0.905)	(0.583)	(0.907)
Δq_t	0.099	0.035	0.055	0.094*	0.167	0.448	0.293	0.466	1.116
	(0.183)	(0.088)	(0.226)	(0.051)	(0.089)*	(0.529)	(0.649)	(0.515)	(0.266)

Notes: The numbers in the parentheses are the standard errors. ***, ** and * indicate significant at 1% , 5% and 10% levels respectively