PAKISTAN JOURNAL OF ECONOMIC STUDIES

PJES

ISSN 2708-1486 (ONLINE)
ISSN: 2708-1478 (PRINT)

VOLUME 8,ISSUE 1

DECEMBER 2025

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THE ISLAMIA UNIVERSITY OF BAHAWALPUR, PAKISTAN

PAKISTAN JOURNAL OF ECONOMIC STUDIES

PJES VOLUME 8, ISSUE 1

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Pakistan Journal of Economic Studies

ISSN (E) 2708-1486 (P) 2708-1478
Volume 8: Issue 1 March 2025
Journal homepage: https://journals.iub.edu.pk/index.php/pjes/index

Editorial Note
Pakistan Journal of Economic Studies (PJES)
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It is with great pride and commitment that we present to our readers the latest issue of the *Pakistan Journal of Economic Studies (PJES)*—a peer-reviewed, open-access platform dedicated to the dissemination of high-quality research in economics and its related disciplines. PJES continues to serve as a voice for scholars, practitioners, and policymakers who aim to deepen our understanding of economic challenges and propose evidence-based solutions.

In an era marked by rapid global change, economic volatility, and pressing development needs, particularly in emerging economies like Pakistan, the role of academic research has become more critical than ever. This journal seeks to highlight diverse economic perspectives—both theoretical and empirical—on topics ranging from macroeconomic policy and international trade to environmental sustainability and digital transformation.

Our editorial team remains steadfast in its commitment to upholding rigorous peer-review standards and ethical publication practices. We are also actively working to enhance the journal's visibility, indexing, and international collaborations, with the goal of making PJES a reference point for quality research in South Asia and beyond.

I would like to express my sincere gratitude to our esteemed editorial board, reviewers, contributors, and supporting staff, whose dedication and scholarly insight make each issue possible. I also welcome feedback from our readers, as it is your engagement that inspires us to evolve and expand the journal's impact.

We invite researchers, academics, and policymakers to continue contributing to the Pakistan Journal of Economic Studies and join us in building a more equitable and sustainable economic future.

Warm regards,
Dr Abid Rashid Gill
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Pakistan Journal of Economic Studies

ISSN (E) 2708-1486 (P) 2708-1478
Volume 8: Issue 1, January-March 2025
Journal homepage: https://journals.iub.edu.pk/index.php/pjes/index

Assessing Environmental Impacts of ICT integration in Asian Economies

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ARTICLE DETAILS

History:
Accepted: 1 January 2025
Available Online: 22 January 2025

Keywords:
CO_2 emissions
Economic growth
Digitization
Asia
Income groups.

JEL Codes:

ABSTRACT

Objective: This study is intended to explore how integration of ICT with increment in production level alters the environmental quality of a region.
Secondly how the three income groups of Asia region are able to maintain their environmental quality and achieve sustainable development by the adoption of ICT.

Research Gap: No such study exists in literature which identifies the validity of EKC hypothesis in three income groups of Asia by incorporating Variable of ICT and makes comparison of the effects of ICT penetration in three income groups of Asia.

Design/Methodology/Approach: The impact is analyzed for three Asian income groups i.e., lower, middle and higher. Impact of digitization is captured by constructing ICT index using four variables as its proxies i.e., Internet users (IU), mobile cellular subscribed (MCS), fixed broad band subscribed (FBS) and fixed telephone lines subscribed (FTS). The study uses the data for the period of 1990-2016 due to the limitation of data availability of CO_2 which is dependent variable of the study and depicts the quality of environment and hence sustainability. Panel time series estimation procedure is followed by application of second-generation tests such as cross-sectional dependent test (Pesaran CD, Pesaran scaled LM and Breusch Pagan LM test), second-generation unit root tests (CADF and CIPS) test and Westerlund cointegration test.

Findings: This study evidences the existence of EKC hypothesis in middle and high-income groups of Asia, whereas it favors rejection of the theory in low-income countries. Impacts of digitization on environmental quality are diversified. It reduces carbon emissions and significantly improves environmental in low and middle-income countries of Asia. However, it intensifies carbon emissions level in high-income Asian countries. Policies are suggested in the relevant chapter of the study accordingly.

Theoretical / Practical Implications of the Findings: findings of the study can be helpful to formulate policies to improve environmental quality while considering the impact of economic growth and ICT adoption.

Originality value:
The study employees the model with self-created ICT index incorporated in EKC frame work along with control variables chosen from literature.

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Recommended Citation:

Ahsen, A., Majeed, T., & Mazhar, M. (2025). Sustainable Development Through ICT Integration: Assessing Environmental Impacts in Asian Economies. *Pakistan Journal of Economic Studies, 8*(1), 1-17. Available at: https://journals.iub.edu.pk/index.php/pjes/article/view/3549

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1. Introduction

In the present era of increasing digitization and ICT penetration sustainable development is the most debatable issue for policy makers and researchers. According to a report provided by united nations in 1987, sustainability is defined as preservating natural resources which allow future generations to enjoy if not better

then equal standards of living. Maintaining pure and healthy environment and preserving natural resources is one of the major goals among all the goals of sustainability. Undoubtedly ICT adoption and its penetration enables societies to achieve sustainable development goals however production of ICT equipment, their use and disposal is energy intensive process (Charfeddine & Umlai, 2023). Fewer studies are found in literature which explores the link between the two. Ionescu-Feleagă et al., 2023 and Kumar & Jyoti (2023) depicts the positive relation between digitization and sustainable development in the respective area of their study.

In academic discourse, ICT or digitization serves as an extension of the conventionally recognized notion of Information Technology (IT). It prominently grew after World War II, but the actual trajectory of ICT development commenced in the early 2000s. While a universally accepted definition of the term remains elusive. It generally encompasses all entities, elements, networks, and systems facilitating digital interactions among individuals. This overarching concept finds wide-ranging applicability, encompassing entertainment products, household technologies, and including personal electronics devices and not limited to computers, televisions, radios, music and gaming equipment and other communication devices such as cell phones (Ropke & Christensen, 2012).

Digitization serves as a catalyst that fosters greater connectivity among societies, thereby facilitating social, economic and interpersonal communications and transactions. Its significance becomes evident through the lens of the neo-classical growth model, which underscores the pivotal role of technology as a determining factor of output. Proponents of the theory argued that sustained growth cannot be achieve without continual advancement in technology. In the contemporary landscape, ICT has emerged as a vital force in driving economic growth and promoting human development. This technology and its associated tools empower economies to efficiently access and exchange information at a reduced cost, consequently contributing to enhanced production efficiency, increased productivity, improved energy efficiency and hence sustainability. These collective benefits, in turn, catalyze growth across various sectors of economies (Kaplan, 2006).

Moreover, ICT plays an important role in facilitating trade and for creating opportunities to establish new businesses, jobs, and revenue generation (Carayannis & Popescu, 2005). The diffusion of ICT not only fosters market competition but also stimulates both domestic and foreign investments, thereby contributing significantly to economic growth (Gruber & Verboven, 2001). Nevertheless, as ICT contributes to economic growth (Toader et al., 2018 & Latif et al., 2018) which in turn exerts an influence on CO2 emission level (Hossain, 2011; Bengochea-Morancho, 2001). Akin (2014) speculates that economic progress and CO2 discharge level of a region are strongly corelated. Theoretically, this relationship aligns with the Environment Kuznets Curve (EKC) theory, suggesting that during earlier stages of economic growth and development carbon emissions escalate with rise in income per person reaching a peak and exacerbating environmental degradation. However, beyond a certain level called thresh hold level, further increase in income results in reduced CO2 emissions, ultimately purifies the environment (Grossman & Krueger, 1991).

Irrespective of the economic growth pathway, ICT also exerts a direct impact on environmental quality by influencing the environmental burden accompanying to greenhouse gases (GHG) particularly CO2 a major contributor to such discharges (World Bank, 2007). Monzon et al. (2017), Zhang & Liu (2015), Mathiesen et al. (2015) and Chavanne et al. (2015) affirm that digitization within industrial and transport sectors contributes significantly to the management and mitigation of environmental degradation.

However, it is crucial to acknowledge that ICT also exerts a significant and irrefutable effect on quality of environment, primarily through its usage, disposal, and recycling practices which directly contribute to GHG emissions. The disposal of electronic waste (e-waste), including unusable ICT and other electronic devices, represents a substantial contributor to environmental degradation. E-waste monitor report (2017) witnesses of the global generation of 44 Million metric tons e-waste from 2014 to 2017. Gonel & Akinci (2018) assert that ICT accounts for about 2% of global CO2 emissions, thereby playing role in the deterioration of environment. This is primarily attributed to the fact that ICT devices increase energy and fuel consumption during production activities, consequently leading to increased CO2 emissions (Asongu et al., 2017).

In a wider context, the impact of ICT unfolds across two dimensions i.e., economic and environmental. through this study we are intended to examine its environmental aspects in the region of Asia. The choice of Asia as our study area is grounded in the region's prolonged exposure to severe environmental pressures over the past few decades. In the context of carbon emissions, China has consistently held the position of the top emitter whereas India and Indonesia are lying on second and third position (Alam et al., 2016). Despite the region's overall high economic growth rates in recent years, there has been a conspicuous lack of emphasis on preserving environmental quality. Consequently, maintaining environmental integrity poses a significant challenge for policymakers across Asian economies.

Limited research available in which explores the relation between digitization and environmental quality. Lee and Brahmasrene (2014), Zhang et al. (2015), Danish et al. (2018), Majeed (2018), Asongu (2018), Notley (2019) and Raheem et al. (2020) carries out analysis on different regions other than Asia and its income groups. A noticeable gap is however left in literature regarding the impact of ICT on CO2 emissions in Asian countries.

1.2. Contribution in literature:

Our study makes noteworthy addition into the already existing literature. Firstly, it stands as inaugural investigation of its kind that systematically explores the varied impacts of digitization on CO2 emissions within three distinct income groups in Asia i.e., low, middle and high. Secondly, this study incorporates ICT as focused variable of the study along within EKC framework.

The study enables us to compare the sustainability in environment by the three income groups of Asia when they increase their production level with the adoption of ICT.

1.3. Theoretical framework

Neo classical growth model also known as Solow Swan model provides strong theoretical framework to our study which addresses technological improvement as a crucial factor for output level and growth of an economy. According to this model output is obtained by the combination of labor, capital at given level of technology. Technology is kept constant or controlled by some exogenous factor and hence it is also named as exogenous growth model. Diminishing marginal returns of capital and labor due to exogenous technological advancement is limitation of this model which can be overcome by A-K model in which technology is endogenous factor.

1.4. Sequence of the study

Remaining sections of the paper are sequenced as follow: section 2 comprises on comprehensive review about literature relevant to our study. Section 3 provides details pertaining to the data, econometric model, methodology used in our study. Section 4 offers an in-depth discussion of obtained empirical findings, and Section 5 which is last section gives conclusion of the study by summarizing key insights and policy implications.

2. Literature Review

In the contemporary era, heightened spendings on ICT equipment to promote digitization have emerged as a significant cause of economic progress for countries (Nasab & Aghaei, 2009). Concurrently, this period has witnessed a rise in the climatic burden, manifested in the form of GHG emissions. Among these gases, CO2 emissions hold the highest proportion and are thus recognized as a major contributor to the climatic burden. A paramount concern for policymakers in the present age is the pursuit of sustainable development, necessitating a dual focus on both economic and environmental considerations. Theoretically, researchers and scholars have frequently employed EKC theory to investigate the environmental impacts of economic progress. This study is centered on two key aspects of literature: Nexus between CO2 emissions and economic growth through the context of EKC theory, and examination of CO2 emissions level.

2.1. Economic growth and CO_2 emissions linkage

EKC hypothesis links economic progress of a region with its environmental quality through GDP, its quadratic

term and CO2 emissions level as proxies of these indicators and predicts an inverted u-shaped relation of these two variables. After the concept had established theoretically, several researches evidenced it through empirical analysis. Studies of (Grossman & Krueger, 1991) and then (Panayotou ,1993) provided its empirical evidence initially.

Theory of EKC has proved valid for the region of China for the time period of 1975 to 2005 and two-way causality is observed between the two variables being involved (Jalil & Mahmud, 2009). Many other studies exist in literature which are conducted for single economy by applying panel time series analysis. They provided heterogenous results for acceptance or rejection of environment Kuznets curve theory for their focused region of analysis. The theory is proved valid for the region of Malaysia (Saboori et al.,2012) and for the kingdom of Saudi Arabia (Kahia et al., 2021). Sarkodie & Ozturk (2020) confirmed EKC hypothesis for the economy of Keynia for the time span of 1971 to 2013. Economy of Pakistan (Javid and Sharif, 2016) and Azerbaijan (Mikayilov et al., 2018) also exhibit EKC relation. Recently, Mahmood et al. (2023) verified the EKC relation for China.

Contradictory to the EKC theory, GDP and CO2 emissions exhibit u-shaped relation for the Economy of Greenland (Arnaut & Lidman, 2021). This theory is also rejected for the economy of Turkey (Shahbaz et al., 2013), economy of Vietnam Al-Mulali et al. (2015). According to their study increased production leaves environmental degrading and energy exhaustive impacts on the economy. Similarly EKC curve is rejected for the economy of Tunisia (Farhani & Ozturk, 2015), BRICST economies (Dogan et al., 2020) and for BRICS economies (Latif et al., 2018).

Numerous studies conducted panel data analysis and provided heterogenous results regarding the theory's validity. EKC hypothesis is proved for MENA region (Arouri et al., 2012). Apergis & Ozturk (2015) proved it for 14 countries of Asia, Al-Mulali et al. (2015) for Latin American economies and Caribbean countries, (Le & Ozturk, 2020) for 47 emerging markets and developing economies favored EKC hypothesis. Ansari et al. (2020) used ecological footprints as a measure of environmental quality and provided different results regarding acceptance or rejection of EKC theory in Asian sub regions. Environmental Kuznets curve hypothesis is validated for Central and East Asian countries but it is not the case for west and southeast Asian countries. However, when material footprints were used to identify environmental quality EKC proved to be valid for all sub-regions of Asia except Central Asia. This relation is further confirmed by Demissew (2023), Maneejuk et al. (2020), Alam et al. (2016) and Jebli et al. (2016).

2.2. Digitization and Sustainability

Digitization has direct role to enhance the concentration of CO2 emissions and hence we cannot deny its environmental impacts. No doubt increased digitization in production and other activities reduces climatic burden via use of smarter equipment but at the same time they add pollutants in the form of greenhouse gases of which CO2 is a major contributor. Which may be helpful to achieve sustainability or may be an obstacle. The major fact behind, is the huge amount of energy consumption by utilization of ICT equipment and through E-waste. Heterogenous impacts of digitization on environmental quality are observed in literature i.e., positive, negative and insignificant depending upon the level of ICT penetration, its patterns of energy consumption, and the treatment of waste products produced by discarded ICT equipment.

Digitization contributes to much greater extent in greenhouse gases due to increased energy consumption (Pohl et al., 2019); (Belkhir & Elmeligi, 2018); (Lee & Brahmasrene, 2014). Whereas, Avom et al. (2020) discovered increasing impact (direct and indirect) of digitization on CO2 discharge level. The study also proves that ICT usage and CO2 emissions have inverted U shaped relation.

However, several studies explored the decreasing impact of digitization on GHG emissions (Asongu, 2018; Monzon et al., 2017; Zhang & Liu, 2015). According to these studies, digitization is the use of technology with enhanced efficiency and hence it provides a way of living with low carbon consumption which in turn minimizes environmental pollution. A study conducted for top ten Asian high emitter countries for the period

of 1990-2019 using an advanced non-linear panel ARDL approach proved that digitization improves environmental quality. Some more studies confirm the mitigating impact of digitization on carbon emissions level (Brodny and Tutak, 2022; Ma and Wu, 2022; Ramos-Meza et al., 2021; Ullah et al., 2021; Yang et al., 2021). Furthermore, some studies show insignificant impacts of digitization on carbon emissions (Amri et al., 2019; Salahuddin et al., 2016).

3. Data source, Econometric Model and Methodology

The whole data of Asia is divided into three groups based on their income level i.e., low, middle and high income. Disintegration of income is based on the criterion of World Development Indicators data base (2019). Data used for analysis is also extracted from the database of World Development Indicators data base (2019). The analysis are conducted for the time period of 1990 to 2016 due to limited availability of data. CO2 emissions being a broadly accepted proxy of environmental quality and hence an indicator of sustainability is therefore chosen as a dependent variable of the study. It is initially being used in many studies (Amri et al., 2019; Asongu, 2018; Mikayilov et al., 2018). Index of ICT is created through Principal Component Analysis (PCA) in order to incorporate the effect of digitization. We used four indicators of digitization for the construction of index. The proxies being selected includes percentage of internet users IU, percentage of mobile cellular subscribed or purchased MCS, percentage of subscribed fixed telephone subscribed lines FTS, and fixed broadband subscribed in percentage FBS (Amri et al., 2019; Latif et al., 2018; Toader et al., 2018; Pradhan et al., 2015). GDP and the square of GDP are used with the purpose to check the validity of EKC hypothesis. Unit used to measure GDP is US dollars constant 2010 constant 2010 US dollars (Toader et al., 2018; Latif et al., 2018).

Besides above mentioned dependent and independent focused variables, the study also uses few control variables namely urban population measured as percentage from total population and abbreviated as UPP (Al-Mulali & Ozturk, 2016; Farhani & Ozturk, 2015; Zhang & Liu, 2015). Electricity consumption EC measured in kilowatts per hour by (Al-Mulali & Ozturk, 2016; Al- Mulali et al., 2015) and lastly inflation INF measured as percentage of GDP deflator (Ullah et al., 2020; Ahmed et al., 2020). Environmental quality is influenced indirectly by instability in inflation via performance and conditions of capital market (Ahmed et al., 2020). Definitions of all the above mentioned variables with descriptions of their units are present on WDI indicators website. Econometric model of the study is:

$$lCO_2 = \beta_{0+}\beta_1 lGDP_{it} + \beta_2 lGDP_{it}^2 + \beta_3 ICT_{it} + \beta_4 UPP_{it} + \beta_5 EC_{it} + INF + \mu_{it} \quad (1)$$

In the model given above i and t represents cross sections and time span for analysis respectively. U_{it} is the error term. Logarithmic form of GDP, its square and CO2 emissions are used for estimations in order to interpret them accordingly with other variables taken in percentage. β0 represents intercept while β1, … β6 are to be estimated as they are unknown. According to statement of EKC theory we expect positive signs of β1 and negative for β2 to prove the theory valid. Variable of ICT may have positive or negative sign with CO2 emissions which depends on the modes and methods of ICT adoption. Signs of control variables may also be negative or positive it depends upon geographical and social conditions of the selected region though we expect positive signs of electricity consumption with carbon emissions.

3.1. Methodology

For the data of each income group time factor T is larger than the number of cross sections (N) which means the time factor is dominant indicating our data samples are of panel time series type. Hence we will proceed our estimations with panel time series estimation technique and steps involved in it. This technique uses certain steps i.e. determining cross-sectional dependence (CSD), stationarity of variables, their cointegration, and then finding their long run and short run estimates.

Asian countries sharing the same geographical territory hence there is a huge chance of similarity in them in terms of geographical and social conditions and political circumstances as well. Any change in economic indicators of a country may bring change in other country. Hence at first step the data is analyzed for the

presence of CSD by using more recent Pesaran Scaled LM test (2004); Pesaran Cross-sectional dependent test (2004) and Breusch Pagan LM test (1980). Previously used by Haseeb et al., 2019 and suggested to be more suitable for dominant time series.

Secondly, we moved towards the identification of stationarity of variables which is an important step in panel time series estimation procedure. To fulfil the purpose panel unit root tests of second-generation i.e., CIPS and CADF are applied being suggested by (Pesaran,2007). They are robust to heterogeneity and take into account CSD. Therefore, we can get more appropriate results from this test in comparison with first-generation unit root test (Haseeb et al., 2019).

Moving further is to identify cointegration relation of variables. Generally used tests for this purpose are Pedroni's (1999, 2004) previously used by (Pradhan et al., 2018). Co-integration tests of second-generation proposed by Westerlund (2007) recently used in different studies (Haseeb et al., 2019 and Saud et al., 2019). It takes into accounts both types i.e., within and between units CSD and is suitable for samples of small size. In addition to these, cointegration among variables can also be observed through the values of variance ratio statistics. Therefore, Westerlund cointegration test (a second-generation test) is applied to tests co integration among variables (Haseeb et al., 2019 and Saud et al., 2019).

We used FMOLS estimation technique proposed by Phillips & Hansen (1990) to obtain long run estimates lastly. Further this technique is appropriate to encounter the problem of endogeneity (Pederoni, 2001) and also when data is not fulfilling the assumptions of classical linear regression model and hence ordinary least square OLS is inappropriate.

DOLS estimation technique is applied for robustness check (Stock and Watson, 1993; Saikkonen, 1992) is appropriate in our case as we have small sample size having lesser number of cross sections and hence gives asymptotically efficient cointegrating vectors (Salahuddin et al., 2016). This technique uses lags and leads by involving excessive cointegration regressions and hence it is efficient in the case when variables are cointegrated in the long run (Lee & Brahmasrene, 2014).

4. Discussion of Results

Table A: Summary Statistics

Variable name	Observations	Mean	Std. Dev.	Minimums	Maximums
CO_2	452	7.23	8.3	0.1	44
GDP	452	553	1520	3380	9490
FTS	452	22	17	0.4	63
FBS	452	1.2	9.7	0	33
MCS	452	79	52.3	0.26	239
IUI	452	29	27	0.06	100
UPP	452	62	27	15.5	100
EC	452	4508	5131	75	21508
INF	452	6.72	8.5	18.9	53

Source: Author's estimation.

4.1. Cross-sectional Dependence Test Results

The results of these tests are discussed in table 1. Probability values less than 0.05 and value of T- stats greater than two for all the three income groups leads to rejection of null hypothesis of 'no cross- sectional dependence'. Hence our results indicate the existence of CSD among variables. Therefore, we will proceed with this conclusion of existence of cross-sectional dependency among variables.

Table 1: Cross-sectional Dependence Test Results

	Results for LICs		
Variable name	**B-Pagan LM test**	**Scaled LM test**	**Pesaran CD test**
	Statistics	**Statistics**	**Statistics**
CO_2	73.4513***	13.0701***	-1.9165***

GDP	33.3575***	11.1686***	5.4047***
GDP^2	33.4595***	11.210***	5.4047***
ICT index	61.8641***	14.9719***	7.8606***
UPP	189.469***	39.0125***	3.2839***
EC	127.446***	25.1438***	0.9804***
INF	17.2805***	0.5099***	3.0445***
Results for MICs			
Variable name	**B-Pagan LM test**	**Scaled LM test**	**Pesaran CD test**
	Statistics	**Statistics**	**Statistics**
CO_2	5326.47***	158.397***	44.7085***
GDP	10025.24***	312.476***	99.3429***
GDP^2	10051.30***	313.306***	99.4803***
ICT index	4266.998***	123.656***	63.8189***
UPP	9525.577***	296.0915***	57.3132***
EC	3796.329***	135.1396***	35.2656***
INF	1861.645***	44.78125***	28.16438***
Results for HICs			
Variable name	**B-Pagan LM test**	**Scaled LM test**	**Pesaran CD test**
	Statistics	**Statistics**	**Statistics**
CO_2	318.01***	18.7560***	1.6907*
GDP	459.322***	81.123***	21.421***
GDP^2	458.77***	81.0274***	21.407***
ICT index	918.411***	73.14840***	30.2648***
UPP	186.3604***	31.286***	10.462***
EC	804.549***	70.4179***	26.45674***
INF	443.840***	28.2498***	8.32376***

Source: Author's estimation.

4.2. Unit Root Test

Results of unit root tests are provided in table no 2. Where probability values and t-stats value given against each variable indicate about stationarity of variables. Probability values less than one confirm the stationarity of the variable. According to the given results some variables become stationary at level whereas all the variables remaining get stationary at first difference. Hence the order of integration for all the variables is one.

Table 2: Unit Root Test Results

Variables' name	**Probability values**			
	CADF Test Results		**CIPS Test Result**	
Results for LICs				
	Level	**1st difference**	**Level**	**1st difference**
CO_2	0.991	0.01	0.959	0.585
GDP	0.001	-	0.978	0.111
GDP^2	0.000	-	0.978	0.115
ICT index	0.214	0.013	1.000	0.003
UPP	0.082	0.003	0.026	-
EC	0.878	0.004	0.998	0.547
INF	0.000	-	0.881	0.634
Results of MICs				
	Level	**1st difference**	**Level**	**1st difference**
CO_2	0.082	0.000	0.871	0.000
GDP	0.731	0.000	0.921	0.000
GDP^2	0.695	0.000	0.881	0.001
ICT index	0.997	0.591	0.766	0.006
UPP	0.000	-	0.000	-
EC	0.762	0.000	0.999	0.000
INF	0.000	-	0.800	0.000

	Results for HICs			
	Level	**1st difference**	**Level**	**1st difference**
CO_2	0.475	0.000	0.351	0.000
GDP	0.05	0.000	0.121	0.041
GDP^2	0.07	0.000	0.123	0.045
ICT index	0.008	-	0.142	0.000
UPP	0.001	-	0.000	-
EC	0.787	0.000	0.566	0.015
INF	0.038	-	0.722	0.008

Source: Author's estimation

4.3. Panel Cointegration Test Results

Cointegration test results are given in Table 3, where variance ratios and probability values obtained for each income group confirm the existence of cointegration in the data of all the three income groups of Asia with 1% significance level (low income group and middle income group) and 5% significance level (high income group).

Table 3: Westerlund Cointegration Test Results

Regions	**Variance ratio values**	
	Statistics	**Probability**
Results of LICs	5.032***	0.000
Results of MICs	-2.256***	0.012
Results of HICs	-1.582***	0.057

Source: Author's estimation

4.4. FMOLS test results

Long run coefficients are obtained by applying FMOLS estimation technique. First panel of the table comprises the results of lower income countries. Where the sign of GDP and its square with dependent variables CO2 emissions denies the existence of EKC theory for this income group of Asia. These findings are consistence with that of Majeed and Mazhar (2020) for low-income group of the global economy and South Asian countries, Alam et al. (2016), Omojolaibi (2010), Omisakin & Olusegun (2009). EKC curve has proved valid for middle income and high income Asian countries. Our findings are consistent with the study of Alam et al. (2016) which proves it for Indonesian, Chinese and Brazilian economy. Javid and Sharif (2016) obtained such results for Pakistan's economy, Apergis & Ozturk (2015) provided such results for 14 countries of Asia. Jalil &Mahmud (2009) found the same results for the economy of China. These studies provide confirmation for EKC theory for their region of analysis. for the case of high income countries our results match with the results obtained by (Majeed & Mazhar, 2020). Their study proved the existence of EKC for upper-income countries. According to them the existence of EKC in these countries is the evidence of structural transformation in these countries and hence the sustainable level of development is achieved by these countries. Also consistent with Higón et al. (2017) & Al-Mulali & Ozturk (2016), who proved the validity of EKC theory for 27 advanced economies and 26 developed economies correspondingly. However, our finding is in contradiction with the findings of (Al-Mulali et al. , 2015), (Farhani & Ozturk, 2015) also contradict with the findings of (Chandran & Tang, 2013).

Significantly negative impact of ICT adoption and digitization on CO2 emissions is found for low income region and middle income region. These findings are aligned with that of (Asongu ,2018) for low-income African countries. According to the results, increased use of ICT by one percent in low income countries causes reduction in CO2 emissions by 0.116 percent and 0.04432 percent reduction in middle income countries. The reason is, these countries extend the use of ICT to protect their environment as they follow upper income countries. Thus, by making production efficient through ICT adoption in industry and conservation of energy from transport sector environmental quality can be improved. However, in high income countries of Asia ICT adoption and digitization effects positively and significantly the level of carbon emissions. According to the results obtained CO2 emissions are increased by 0.041 percent by one percent

increase in ICT adoption. Nature and situation of these economies justifies this relation of ICT and CO2 emissions i.e., some characteristics of upper-income countries like greater size of their economies, diversity in their production activities, higher consumption and demand of goods and hence production which in turn increases the use of ICT equipment and hence carbon emissions level as well. Advanced technology in these countries is no more advance as these countries came out of their transition period and hence there is more scope of research and advancement in technology in these countries.

Shifting the discussion towards the results of control variables it is observed that urban population insignificantly effects CO2 emission level of low- and middle-income Asian countries. Obtained results are consistent with Zhang & Liu (2015). However it contradicts with the findings of Farhani & Ozturk (2015) and with Al-Mulali and Ozturk (2016). Contrary to the findings we have in case of middle- and low-income countries, urban population significantly effects emission level of high income countries due to high rate of urbanization in these countries. Increased consumption of electricity increases CO2 emissions significantly in all the three income groups (Al- Mulali & Ozturk, 2016; Al-Mulali et al., 2015). These results are consistent with Akadiri et al. (2020). The study predicts that electricity consumption positively impacts the level of carbon emissions which further clarifies that the use of non-renewable sources of electricity production dominates and exerts pressure on the environment. The effect of inflation on carbon emissions is insignificant in all income groups of Asia which contradicts with the conclusions of the study of Ahmed at al. (2020) and Ullah et al. (2020).

Table 4: Results from FMOLS (region-wise analysis)

Results for LICs			
Variable name	**Coefficient values**	**Std. error**	**T-stats**
GDP	-2.837***	0.416	-6.83
GDP^2	0.117***	0.018	6.45
ICT index	-0.116**	0.053	-2.19
UPP	-0.001	0.019	0.044
EC	0.002***	0.000	5.519
INF	0.0012	0.004	0.288
Results for MICs			
Variable name	**Coefficient values**	**Std. error**	**T-stats**
GDP	1.5601***	0.597	2.614
GDP^2	-0.0205*	0.012	-1.686
ICT index	0.0443**	0.019	-2.253
UPP	0.0107	0.008	-1.285
EC	0.0003***	0.000	7.468
INF	0.0004	0.002	0.275
Results for HICs			
Variable name	**Coefficient values**	**Std. error**	**T-stats**
GDP	5.079***	0.855	5.938
GDP^2	-0.106***	0.017	-6.230
ICT index	0.041***	0.009	4.265
UPP	0.006*	0.004	1.715
EC	0.000***	0.000	13.683
INF	0.000	0.000	1.6171

Source: Author's estimation

4.5. DOLS Test Results

Findings of DOLS are provided in table 5. Similarity of the long run estimates of DOLS with that obtained by FMOLS indicate the robustness of these results. EKC hypothesis is again rejected for low income Asian group and accepted for other two groups. The impact of digitization and ICT penetration are also exactly similar as we obtained from FMOLS estimation technique with slight differences in their coefficient values. Shifting our discussion towards the impact of control variables it is evident that we found same results in case of DOLS as we obtained in case of FMOLS.

Table 5: Results from DOLS (region-wise analysis)

Results for LICs			
Variable Name	**Co-efficient values**	**Std error**	**T- stats**
GDP	-2.8735***	0.5193	-5.5336
GDP^2	0.1184***	0.0227	5.2159
ICT index	-0.1565**	0.0669	-2.3471
UPP	0.0037	0.0244	0.1496
EC	0.0020***	0.0005	4.4208
INF	-0.00035	0.0060	0.0588
Results for MICs			
Variable Name	**Co-efficient values**	**Std error**	**T- stats**
GDP	1.4463***	0.5293	2.7325
GDP^2	-0.0203**	0.0109	-1.8647
ICT index	-0.0399***	0.0191	-2.0888
UPP	-0.0029	0.0079	-0.4004
EC	0.0003***	0.0000	8.0990
INF	0.0007	0.0014	0.4752
Results for HICs			
Variable Name	**Co-efficient values**	**Std error**	**T- stats**
GDP	4.1124**	1.9429	2.117
GDP^2	-0.0855**	0.0393	-2.1728
ICT index	0.0163	0.0251	0.6482
UPP	0.0137***	0.0056	2.4326
EC	0.0000***	0.0000	3.7646
INF	0.0006	0.0014	0.4513

Source: Author's estimation

5. Conclusions of Results

Outcomes of the study prove that the EKC relation does not exist for the case of Asian low-income countries. Where U shaped relation is observed between economic growth and environmental quality. However, the study validates hypothesis of environmental Kuznets curve for middle income and also for high income groups of Asia. ICT employed technology negatively and significantly effects emission level of low- and middle-income Asian countries and hence aid them to achieve sustainability. While the impact of such technology is found positive and significant on carbon emissions level in high income Asian countries as these countries are at the stage where disposal and recycling of ICT equipment and e-waist is a major problem.

5.1. Policy Recommendation

In low-income countries of Asia, the environment gets impure and its quality declines in the long term due to increase in their production level. Hence, they should remain focused on finding less energy consuming methods of production. This can be accomplished by adopting smart technology. Therefore, these countries should adopt smart equipment for their production activities such as digitization and ICT adoption has mitigating impact on CO_2 emissions of the region. The policy is also applicable for middle income countries. But the existence of Environment Kuznets curve in these countries suggests that they should attain that particular production level (threshold level) where emission level starts falling with further increase in production.

Use of ICT worsens environmental quality and increases climatic burden in high-income countries of Asia. These countries should encourage the consumption of renewable energy sources by investing more for them. Carbon pricing which is proved as effective strategy to clarify environment by the reduction in climatic burden can be implemented to control the emissions level. Building smart grid systems is another way of mitigating the effects of ICT and digitization on environmental quality in these countries. Such policies should be formed and implemented which are helpful to develop smart cities, efficient transportation and communication system also such production methods with less energy consumption and or equipment as well. Hence emissions level can be controlled on global level. Further research and development in these countries may introduce some other ways for control of carbon emissions level in these countries. Moreover the government should implement taxation system for such activities which pollute environment and make it impure. They should

promote the use of renewable energy resources. The implementation of smart city pilot construction policy as implemented in China from 2013 can be helpful in mitigating the level of CO_2 emissions in other cities and countries.

5.2. Limitations of the Study

Environmental quality is only indicated by its one indicator which is carbon emissions. Undoubtedly carbon dioxide is the major contributor to greenhouse gases but other kinds of emissions such as Nitrogen and Sulphur di and tri oxides are also contributing to environmental degradation. The ability of a region to achieve sustainable growth can also be measured by using other indicators of it like use of renewable energy resources. The time period chosen for analysis is limited up to 2016 due unavailability of data of CO_2 emissions at the time of analysis. Future research needs to focus on more comprehensive measures of environmental quality and different classification of the Asian economies.

Abbreviations:

LICs	Low income countries
MICs	Middle income countries
HICs	High income countries
UPP	Urban population in percentage
EC	Electricity consumption
INF	Inflation
FMOLS	Fully modified ordinary lest square
DOLS	Dynamic ordinary lest square
ICT	Information and communication technology

*Note: ***p<0.01, **p<0.05,* p<0.1* for all tables

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Declarations

Contribution of authors: The idea of the study was provided by Dr. Muhammad Tariq Majeed. He did supervise the whole thesis. Analysis of the data, estimation and drafting all the sections of the paper was done by Amna Ahsen. The introduction section of the paper is written by Maria Mazhar. Literature reviews are written by Maria Mazhar and Amna Ahsen.

Acknowledgement: The authors are grateful to editorial team for their cooperation and support.

Disclaimer: Only the views of authors alone are presented in the paper they are not reflected by any other institute.

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Pakistan Journal of Economic Studies

ISSN (E) 2708-1486 (P) 2708-1478
Volume 8: Issue 1 January-March 2025
Journal homepage: https://journals.iub.edu.pk/index.php/pjes/index

Estimating Liquidity Augmented Three Factor Model for PSX

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ARTICLE DETAILS

History:
Accepted: 20 February 2025
Available Online: 15 March 2025

Keywords:
Asset Pricing Mode
Liquidity
PSX

JEL Codes:
G11
G12

ABSTRACT

Objectives: Several risk factors have been identified as crucial determinants of cross-sectional variations in assets' returns in three, four, and five-factor models. This paper aims incorporates liquidity, in two separate measures with volume and volume as percentage of outstanding shares, in standard three factor model by considering hundred companies from Pakistan Stock Exchange (PSX).

Research Gap: Previous relevant literature for PSX considers other factors but could not found for estimating three factor model with liquidity factor. However, these types of models are developed for other markets.

Methodology: It takes data of 100 selected companies of PSX to estimate standard three factor and liquidity-augmented three factor models. Portfolio construction and estimations are carried out as per the methodology developed by Fama and French in factor models.

The Main Findings: Based on the estimations of these liquidity augmented three factor models, it is concluded that investors in PSX require premium against investment in illiquid portfolios along with the other risk factors such as market, size, and value.

Practical implications of findings: The better choice for risk-avert rational investors is to construct a portfolio with big size, low book to market value, and liquid assets' companies.

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Recommended Citation:

Ahmed, M. F., Raees, A. (2025). Estimating Liquidity Augment Three Factor Model for PSX. *Pakistan Journal of Economic Studies, 8*(1), 16-27. Available at: https://journals.iub.edu.pk/index.php/pjes/article/view/3090

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1. Introduction

Stock exchanges provide opportunities to companies to obtain equity while it hinges upon the investors required rate of return which depends upon going risk free rate and risk factors. More risks lead to higher required rate of return thus lower stock prices. Hence, study and implementation of asset pricing tools remains a popular research theme amongst financial econometricians and practitioners. It leads us to ascertain price of an asset subject to one or more risk factors. Thus, asset pricing models may also be utilized for forecasting price and spotting investment opportunities.

The relationship between risk and return studied by Markowitz (1952), the theory of asset pricing came into limelight with the inception of Capital Asset Pricing Model (CAPM) by Sharpe (1964) and Lintner (1965). Some other popular asset pricing models include Intertemporal Capital Asset Pricing Model of Merton (1973),

Arbitrage Pricing theory (APT) of Ross (1976) and Fama and French (FF) three factor model (1990, 1993), which is an extension of conventional CAPM. Fama and French (1996) showed that their three-factor form is able to capture 96% of the variations in equities listed in New York Stock Exchange (NYSE). Despite higher explanation power, many researchers have extended the work of Fama and French (1990, 1992) by incorporating new factors including Fama and French (2015).

With several international markets, the asset pricing model are also developed for Pakistan Stock Exchange (PSX). In most of the studies pertaining to PSX, asset returns are ascertained through CAPM. However, a sizeable amount of literature in the context of PSX also applied three factors and five factors model. This paper uses the three-factor model with an additional liquidity factor, making it liquidity-augmented three factor model.

The urge of using liquidity stems from the fact that low liquidity is itself a risk and rational investor should require more return as the risk increases. Trading volume for a firm can be taken as a measure of its liquidity (Brennan, Chordia, and Subrahmanyam, 1998). Higher trading volume suggests higher liquidity. One may argue that the trading volume may also depend upon the number of outstanding shares. A company which has large number of outstanding shares may also have higher trading volume and vice versa. Therefore, another measure of liquidity may be trading volume by outstanding shares, also known as turnover (Amihud and Mendelson 1986).

This paper is conceived with an intent to augment the standard three factor model for PSX with another factor of liquidity with its two measures such as average trading volume and trading volume / outstanding shares. Previously, these measures are not used with three factor models for PSX. These measures are used earlier in the studies for other stock markets such as Rahim and Nor (2006), Amihud (2002), Amanda and Husodo (2015). In the context of the PSX, which is a comparatively smaller market than that of the global stock exchanges, the liquidity factor is more concerning to the investors as smaller number of investors / traders make several stocks dry and difficult to liquidate at the given market price. Investors / traders have to bear with this risk and they may require premium against it. This problem, as not explicitly empirically investigated in the earlier literature for the PSX, requires research and understanding of the importance of liquidity risk for the investors / traders in the market, which is contributed by this paper with the following objectives.

1.1 Objectives of the Research

Objectives of this paper are

a. Estimation of the standard three-factor model for selected PSX stocks
b. To estimate the liquidity augmented three factor models, also referred to as four factor models, with volume (model-1) and volume / outstanding shares (model-2)

This paper helps understand the liquidity as an important determinant for explaining the cross-sectional variations in assets' returns. Further, the estimations of three and four factor models also illustrate the behavior towards risk in PSX. Findings of this paper can help investors to construct portfolios by incorporating relevant risk factors.

Rest of the paper consists of four sections. Literature review of comparable studies is presented in next section followed by methodology for the portfolio formation and empirical estimations. The fourth section comprises of empirical results obtained from estimation of models. The last section presents conclusions and recommendations.

2. Review of Literature

This section presents review of relevant studies which have used FF model in the context of PSX. These studies include implementation of FF model and identifying a superior portfolio. It also includes literature that

compares the explanatory power of FF models with the CAPM.

Abbas et al. (2015) tested FF three factor for Pakistani equity market via individually observing the impact of market, size, and value premiums on equity portfolio return for time period of 2004 – 2014. These portfolios are constructed by the intersection of two factors – market capitalization and book to market equity. The study found that market premium, distress and leverage largely hold valid for the securities listed in Pakistani equity market. Despite standing above 62% for all the six portfolios, the coefficient of determination was comparatively low to original results of FF which signifies that predictability of the model is relatively low in case of emerging equity markets.

Shoaib and Siddiqui (2016) applied FF model for PSX using a Panel approach. In this study the FF test was applied on annual basis for all companies listed in PSX during 2001 to 2010. The study held FF model valid for all investigated years. Butt and Sadaqat (2019) applied FF model to investigate that weather the returns while investing into Shariah Compliant stocks are reduced as compared to the conventional stocks. They have carried out screening of all stocks listed in PSX during 2004 – 2016 through the methodology of Ince and Porter (2006) and Griffin et al. (2010). Upon screening they found 85 and 112 Shariah compliant and conventional stocks respectively for the implementation of FF model. Then they have formed eight portfolios for both categories of stocks and concluded that earnings on Shariah compliant stocks are not substantially lower than the conventional stocks.

Hassan and Javed (2011) compared the CAPM and three factor FF model for 250 companies listed at PSX during FY01 to FY07 and found that adjusted R-square values for the FF three portfolios on average stayed above 15% for FF model as compared to CAPM. Latif et al. (2014) also compared the validity of CAPM and FF model for PSX via its implementation on securities pertaining to 21 out of 35 sectors for the period of January 2001 to December 2009. Fama and French model was applied in its typical six portfolio fashion. The results showed superiority of FF model over CAPM, where within six portfolios, S/M exhibited highest predictability. The superiority of FF over CAPM was also established in the work of Iqbal et al. (2017) on a restricted portion of PSX (i.e. 40 companies) for the time period of 1984 to 2012 through Panel least square estimation. Another restricted study, pertaining to exclusive of some 20 banks was carried out by Hamid et al (2012). The time period considered in Hamid et al. spans from January 2006 to December 2010. The study found that intercept values of all standard FF portfolios are insignificant, the R-square values ranged between 43% and 70%, which are comparatively lower than the portfolios of developed economies.

Latif et al. (2014) and Iqbal et al. (2017), Mirza and Reddy (2017) also compared the predictability of excess returns through CAPM, conventional three factor FF model and its four-factor extension on PSX. The fourth factor which was incorporated in their model was momentum as described by Carhart (1997). The time period considered in this study was FY90 to FY15. Using the technique of Liew and Vassalou (2000), they formed 12 portfolios for testing FF three and four factor models. The results revealed that FF four factor model outperform other two models considered in this study, however, the explanatory power of portfolios remained below 40%.

Ghani et al. (2022) extended the CAPM model by incorporating liquidity with systematic risk. Measuring liquidity with market volume it concluded impact of liquidity on risk premiums especially on highly liquid stocks. Khan et al. (2022) uses zero return as a measure of illiquidity and incorporate it with other risk factors and control variables. With a comparatively smaller size of data (thirty companies from Pakistan Stock Exchange and London Stock Exchange each), it concludes insignificant impact of illiquidity on stock returns. Ahmed et al. (2023) also worked on liquidity by employing liquidity ratios such as return to volume and return to turnover ratios. It concluded that the return to turnover is more effective and liquidity is a significant factor in determining stock returns, based on the estimations of alphas.

Despite the superiority of FF models in explaining returns for PSX, it is largely found that predictability of FF

model in the context of PSX has exhibited limited power. Thus, incorporation of liquidity factor may enhance predictability of FF model for emerging markets. Limited literature about liquidity risk exists in previous research with factor modelling and lacks the risk premium estimation associated with it.

3. Methodology

Methodology used in this paper comprises of data formation, construction of portfolios and econometric models. This research is explanatory and mainly concerned with the impact and importance of three factors market premium, size, and value along with the fourth factor of liquidity measured with volume and volume / outstanding shares.

3.1 Data

Total number of listed companies in PSX is five hundred and twenty-five. Daily trading data of all those companies, for the period of July 2009 to June 2020, is taken from the PSX. Data for the years 2021 onwards is not included to save the analysis from extraordinary variations in Covid period. 100 companies are finally selected having less than 5% missing values as large number of missing values contaminates results. It also saved the analysis from the bias of dry market and extraordinary illiquid stocks. Similarly, the daily volume and outstanding shares of all the 100 stocks is taken from the PSX to construct two measures of liquidity, volume and volume / outstanding shares. Further the KSE-100 index data is taken as the representative index.

Financial information of the companies is taken from the State Bank of Pakistan (SBP). It includes data of ordinary share capital used to compute the number of shares by dividing it with par value. This data is taken for the period of July 2008 to June 2019. Values are taken as of June of each year. Further, the data of 3-months T-bills is taken from the SBP. The annualized T-bill values are divided by number of trading days to convert them to the daily risk-free rate.

3.2 Construction of Portfolios

Three models are estimated in this paper. One is the standard three factor model and two are the liquidity augmented three factor models with volume and volume / outstanding shares separately. Variables constructed for the three models are discussed below.

3.3 Three Factor Model

The standard three factor model includes market premium, size, and value factors. The size is measured by the market equity, price times number of outstanding shares. Value is measured by the book to market equity, shareholders' value to the market equity. It constructs six portfolios based on the size and value. First it sorts the companies by size and considers the top 50 percent as big and bottom 50 percent as small. Then it sorts the companies by book to market value and takes top 30 percent companies as high value, bottom 30 percent as low value and middle 40 percent as medium value companies. Intersection of these sorts of size and value makes six portfolios like big size and high value (BH), big size and medium value (BM), big size and low value (BL), small size and high value (SH), small size and medium value (SM) and small size and low value (SL). This process of portfolio construction is repeated at the last day of June for the year t. It uses information available at time t to construct portfolio for time t+1. All the six portfolios are weighted by size. The formula is as follows:

$$\text{Portfolio Return} = \frac{\sum_{i=1}^{n} r_i w_i}{\sum_{i=1}^{n} w_i} \quad (1)$$

After constructing these portfolios, the factors for size and value effects are generated. The size factor SMB is generated by taking difference of average returns of small firms' portfolios (SH, SM, SL) and average returns of big firms' portfolios (BH, BM, BL). Similarly, the value factor HML is generated by taking difference of average returns of high value firms' portfolios (BH, SH) and average returns of low value firms' portfolios (BL, SL).

Table 1: Construction of Portfolios and Risk Factors

Sort	Breakpoints	Factors and their components
Three Factor Model 2 x 3 sort on size and book to market (B/M) value	Size: median size of all companies B/M: 30th and 70th percentile	$SMB = \frac{SH + SM + SL}{3} - \frac{BH + BM + BL}{3}$ $HML = \frac{SH + BH}{2} - \frac{SL + BL}{2}$
Four Factor Model – 1 2 x 3 x 2 sort on size, book to market (B/M) value, and volume	Size: median size of all companies B/M: 30th and 70th percentile Volume: median volume of all companies	$SMB = \frac{SHQ + SMQ + SLQ + SHN + SMN + SLN}{6} - \frac{BHQ + BMQ + BLQ + BHN + BMN + BLN}{6}$ $HML = \frac{BHQ + BHN + SHQ + SHN}{4} - \frac{BLQ + BLN + SLQ + SLN}{4}$ $NMQ = \frac{BHN + BMN + BLN + SHN + SMN + SLN}{6} - \frac{BHQ + BMQ + BLQ + SHQ + SMQ + SLQ}{6}$
Four Factor Model – 2 2 x 3 x 2 sort on size, book to market (B/M) value, and volume/outstanding shares	Size: median size of all companies B/M: 30th and 70th percentile Volume/outstanding shares: median value of volume / outstanding shares of all companies	$SMB = \frac{SHQ + SMQ + SLQ + SHN + SMN + SLN}{6} - \frac{BHQ + BMQ + BLQ + BHN + BMN + BLN}{6}$ $HML = \frac{BHQ + BHN + SHQ + SHN}{4} - \frac{BLQ + BLN + SLQ + SLN}{4}$ $NMQ = \frac{BHN + BMN + BLN + SHN + SMN + SLN}{6} - \frac{BHQ + BMQ + BLQ + SHQ + SMQ + SLQ}{6}$

Source: Authors' compilation

3.4 Four Factor Model – 1

The model – 1 is an extension of the standard three factor model, the three factors include market premium, size, and value factors. The fourth factor in model-1 is volume. The companies are sorted by average daily volume generated in a year and then by volume. Top 50 percent companies are taken as liquid companies shown by 'Q' and bottom 50% are less liquid shown by 'N'. Intersection of sorted companies by size, value, and volume makes twelve portfolios like big size, high value, and liquid companies (BHQ), big size, high value, and illiquid companies (BHN), big size, medium value, and liquid companies (BMQ), big size, medium value, and illiquid companies (BMN), big size, low value, and liquid companies (BLQ), big size, low value, and illiquid companies (BLN), small size, high value, and liquid companies (SHQ), small size, high value, and illiquid companies (SHN), small size, medium value, and liquid companies (SMQ), small size, medium value, and illiquid companies (SMN), small size, low value, and liquid companies (SLQ), and small size, low value, and illiquid companies (SLN). This process of portfolio construction is repeated at the last day of June for the year t. It uses information available at time t to construct portfolio for time t+1. All the twelve portfolios are weighted by size.

After constructing portfolios, the factors for size, value, and liquidity effects are generated. The size factor SMB is generated by taking difference in average returns of small firms' portfolios (SHQ, SHN, SMQ, SMN, SLQ, and SLN) and average returns of big firms' portfolios (BHQ, BHN, BMQ, BMN, BLQ, and BLN). The value factor HML is generated by taking difference in average returns of high value firms' portfolios (BHQ, BHN, SHQ, and SHN) and average returns of low value firms' portfolios (BLQ, BLN, SLQ, and SLN). The liquidity factor NMQ is generated by taking difference in average returns of illiquid firms' portfolios (BHN, BMN, BLN, SHN, SMN, SLN) and average returns of liquid firms' portfolios (BHQ, BMQ, BLQ, SHQ, SMQ, SLQ).

3.5 Four Factor Model – 2

The model – 2 is another extension of the standard three factor model. The fourth factor in model-2 is average volume / outstanding shares along with the three factors. The companies are sorted by average volume / outstanding shares generated in a year. The companies are then sorted by volume / outstanding shares. Top 50 percent companies are taken as liquid companies shown by 'Q' and bottom 50% are less liquid shown by 'N'. The intersection of sorted companies by size, value, and volume / outstanding shares makes twelve portfolios

similar to the model-1. The size, value, and liquidity factors are also developed as same as in the model-1. Construction of portfolios with formulas are shown in Table-1.

3.6 Model Used for Estimations

The model used in the estimation is ordinary least square. It includes six regressions for three factor model and twelve regressions for each of the two four-factor models. Dependent variables are risk premium on constructed portfolios and independent variables are market risk premium and other risk factors as constructed in three factor model based on size and value and in four factor models such as size, value, and liquidity. The estimation models are as follows

For Three Factor Model

$$R_{it} - R_{Ft} = \alpha_0 + \alpha_1(R_{Mt} - R_{Ft}) + \alpha_2 SMB_t + \alpha_3 HML_t + \varepsilon_t \quad (2)$$

For Four Factor Models

$$R_{it} - R_{Ft} = \beta_0 + \beta_1(R_{Mt} - R_{Ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 NMQ_t + \varepsilon_t \quad (3)$$

Where, 'i' represents portfolio 'i'. R_{it} shows return on portfolio 'i' for time period 't', R_{Ft} represents return on risk free asset, treasury security, for time period 't', R_{Mt} indicates return on market portfolio, KSE-100 index, for time period 't', SMB_t, HML_t, NMQ_t are size, value, and liquidity factors for time period 't'.

4. Estimations

Mean and standard deviations of risk premium and risk factors for the three and four-factor models are shown in Table 2. Majority of portfolios' risk premiums are positive showing that taking risk in the market gives more return as compared to risk free rate on average. Risk premium on market as shown by KSE, which is KSE-100 index return minus risk-free rate, is also positive. It shows that average return on small companies' portfolios is higher than big companies' portfolios as shown by positive value of SMB in the three models. Similarly, the average return on high value companies' portfolios is higher than the low value companies' portfolios as represented by positive value of HML in the three models. The fourth factor of liquidity as shown by NMQ in the Four-Factor Model – 1 and Four-Factor Model – 2 are also showing positive mean values indicating that the average return on illiquid portfolios is higher than the average return on liquid portfolios. In addition to this, it also shows that both the measures of liquidity, volume and volume / outstanding shares, are consistent in showing liquidity as an important factor for determining cross sectional variations in return on assets. The consistency found in the mean values of SMB, HML, and NMQ is not evident in the standard deviations of HML and NMQ but in SMB.

Table 2: Mean and Standard Deviation of Risk Premiums and Risk Factors by Portfolios

Three Factor Model			Four Factor Model – 1 (Volume)			Four Factor Model – 2 (Volume / Outstanding Share)		
Portfolio	**Mean**	**St. dev**	**Portfolio**	**Mean**	**St. dev**	**Portfolio**	**Mean**	**St. dev**
SH	0.00023	0.01633	**SHQ**	0.00001	0.02010	**SHQ**	0.00009	0.02001
SM	-0.00016	0.01336	**SHN**	0.00055	0.01527	**SHN**	0.00042	0.01555
SL	0.00031	0.01929	**SMQ**	-0.00056	0.02065	**SMQ**	-0.00051	0.01743
BH	0.00015	0.01530	**SMN**	0.00012	0.01324	**SMN**	0.00011	0.01320
BM	-0.00005	0.01271	**SLQ**	0.00044	0.02881	**SLQ**	0.00050	0.02301
BL	-0.00011	0.01144	**SLN**	0.00055	0.02884	**SLN**	0.00025	0.04428
KSE	0.00020	0.01065	**BHQ**	0.00010	0.01654	**BHQ**	0.00015	0.01912
SMB	0.00013	0.00839	**BHN**	0.00027	0.01873	**BHN**	0.00017	0.01666
HML	0.00008	0.00919	**BMQ**	-0.00008	0.01354	**BMQ**	-0.00017	0.01507
			BMN	-0.00001	0.01272	**BMN**	0.00002	0.01279
			BLQ	-0.00016	0.01327	**BLQ**	0.00022	0.01503
			BLN	-0.00020	0.01115	**BLN**	-0.00030	0.01123

KSE	0.00020	0.01065	**KSE**	0.00020	0.01065
SMB	0.00020	0.00984	**SMB**	0.00015	0.01019
HML	0.00008	0.01051	**HML**	0.00003	0.01263
NMQ	0.00026	0.00918	**NMQ**	0.00007	0.01048

Source: Authors' calculations

Estimations results of the Three-Factor model as shown in equation (2) are presented in the Table 3. The results suggest that all portfolios premium have positive relationship with the market risk premium. Two of the portfolios, SM and BL, are found less risky than market whereas the others are riskier than the market. The factors of size and value are also significantly affecting the portfolios' risk premium.

Interpreting the cross-sectional variations in assets' return due to size, it analyzes if the small portfolios' coefficients of SMB_t (α_2) is higher than the big portfolios' coefficients of SMB_t (α_2) keeping the other factors constant. Similarly, for value factor, it considers if the high value portfolios' coefficients of HML_t (α_3), is higher than the low value portfolios' coefficients of HML_t (α_3), keeping the other factors constant. Table 4 highlights difference in the coefficients of SMB_t and HML_t.

Table 3: Estimation Results of Three Factor Model

Portfolio $R_{it} - R_{Ft}$	Constant α_0	KSE-100 $R_{Mt} - R_{Ft}$ α_1	SMB_t α_2	HML_t α_3	R-sq.	Adj. R-sq.	F-statistic
SH	-0.00019*	1.05858***	1.04070***	0.72731***	0.90	0.90	8365.7***
SM	-0.00045***	0.92168***	0.67194***	0.22732***	0.74	0.74	2597.8***
SL	-0.00005	1.16339***	1.29265***	-0.52222***	0.82	0.82	4110.6***
BH	-0.00015	1.09424***	0.16630***	0.56657***	0.75	0.75	2659.2***
BM	-0.00026**	1.06000***	-0.07533***	0.04971***	0.80	0.80	3585.8***
BL	-0.00028***	0.98943***	-0.08568***	-0.18391***	0.84	0.84	4702.2***

Source: Authors' estimations

The first value in SMB factor, which shows difference in the coefficients associated with size factor of SH and BH portfolios, is 0.874. It indicates that size factor affects SH portfolio higher than BH portfolio by 0.874 units. A similar interpretation can be given for difference in SM, BM and SL, BL. For value factor, the first value is 0.500 which suggests that the value factor affects SH portfolio higher than SM portfolio by 0.500. A similar interpretation can be given for difference in SM, SL and BH, BM and BM, BL.

Table 4: Difference in Size and Value Coefficients of Three Factor Model

Difference in portfolios	Difference in the coefficients of Three Factor Model
SMB Factor	
SH – BH	0.874
SM – BM	0.747
SL – BL	1.378
HML Factor	
SH – SM	0.500
SM – SL	0.750
BH – BM	0.517
BM – BL	0.234

Source: Authors' estimations

Estimations of the four-factor models include liquidity as the fourth factor in addition to the three factors as incorporated in the three-factor model with volume and volume / outstanding shares as Four-Factor Model-1 and Four-Factor Model-2 respectively. Estimation of these two models as per equation (3) are presented in the Table-5 and Table-6.

The model-1, with volume as liquidity factor shows, in Table-5, that all portfolios' risk premiums have positive relationship with market risk premium. However, the quantum of this relationship varies as the coefficient values ranges from 0.85 to 1.32 showing that some portfolios are less risky than the market while the other are risker than the market. A similar pattern is also observed in the estimations of model-2, with volume / outstanding shares. The relationship between portfolios' risk premiums and market risk premium is statistically significant across all portfolios, while the effect ranges from 0.78 to 1.53 showing presence of less risky and risker than market portfolios.

Table 5: Estimation Results of Four Factor Model-1 (Volume as Liquidity Factor)

Portfolio Risk Premium $R_{it} - R_{Ft}$	Constant β_0	KSE-100 $R_{Mt} - R_{Ft}$ β_1	SMB_t β_2	HML_t β_3	NMQ_t β_4	R-sq.	Adj. R-sq.	F-statistic
SHQ	-0.00042 **	1.00335 ***	1.23913 ***	0.75943 ***	-0.30470 ***	0.81	0.81	2870.0 ***
SHN	0.00003	0.95406 ***	0.92021 ***	0.68626 ***	0.36557 ***	0.72	0.72	1738.2 ***
SMQ	-0.00085 ***	1.03713 ***	0.86928 ***	0.35835 ***	-0.45060 ***	0.67	0.67	1344.2 ***
SMN	-0.00026	0.86530 ***	0.55596 ***	0.24452 ***	0.30369 ***	0.58	0.57	910.1 ***
SLQ	0.00039	0.91700 ***	1.07183 ***	-0.47603 ***	-1.24621 ***	0.72	0.72	1761.2 ***
SLN	-0.00042	1.32331 ***	1.61539 ***	-0.77368 ***	1.70888 ***	0.79	0.79	2509.7 ***
BHQ	-0.00012	1.04947 ***	0.29702 ***	0.35100 ***	-0.31544 ***	0.69	0.69	1470.6 ***
BHN	-0.00021	1.12187 ***	0.11450 ***	0.67197 ***	0.67072 ***	0.43	0.43	512.6 ***
BMQ	-0.00025 **	1.06129 ***	-0.06241 ***	-0.02254	-0.13950 ***	0.77	0.77	2189.5 ***
BMN	-0.00028 *	0.97901 ***	0.03899 **	0.08003 ***	0.20733 ***	0.59	0.59	964.6 ***
BLQ	-0.00029 **	1.03189 ***	-0.14409 ***	-0.17140 ***	-0.16690 ***	0.77	0.77	2284.7 ***
BLN	-0.00040 ***	0.85658 ***	0.02670 *	-0.11026 ***	0.12038 ***	0.63	0.63	1148.9 ***

*** significance at 1%, ** significance at 5%, * significance at 10%

Source: Author's estimations

In the two models, to interpret the cross-sectional variations in the assets' return due to size, difference in the small and big portfolios' coefficients of SMB_t (β_2) keeping the other factors constant are crucial. For value factor, difference between the high-value and medium-value portfolios' coefficients of HML_t (β_3) and medium-value and the low-value portfolios' coefficients of HML_t (β_3) are computed keeping the other factors constant. Similarly, for value factor, difference in the coefficients of NMQ_t (β_4) of illiquid and liquid companies' portfolios, keeping the other factors constant, are calculated. Table 7 highlights difference in the coefficients of SMB_t, HML_t, and NMQ_t.

Table 6: Estimation Results of Four Factor Model-2 (Volume/Outstanding Shares as Liquidity Factor)

Portfolio Risk Premium $R_{it} - R_{Ft}$	Constant β_0	KSE-100 $R_{Mt} - R_{Ft}$ β_1	SMB_t β_2	HML_t β_3	NMQ_t β_4	R-sq.	Adj. R-sq.	F-statistic
SHQ	-0.00030 *	1.14177 ***	1.21821 ***	0.56896 ***	-0.49679 ***	0.82	0.82	3065.0 ***
SHN	0.00005	0.97404 ***	0.90706 ***	0.76952 ***	0.30470 ***	0.70	0.70	1564.8 ***
SMQ	-0.00078 ***	0.98294 ***	0.73921 ***	0.15621 ***	-0.59835 ***	0.73	0.73	1855.5 ***
SMN	-0.00013	0.77796 ***	0.50506 ***	0.27768 ***	0.05594 ***	0.49	0.49	644.6 ***
SLQ	0.00025	0.95353 ***	1.03261 ***	-0.28774 ***	-1.18816 ***	0.73	0.73	1788.0 ***
SLN	-0.00037	1.52611 ***	1.93727 ***	-1.11931 ***	1.46421 ***	0.86	0.86	3639.4 ***
BHQ	-0.00011	1.14816 ***	0.38552 ***	0.28806 ***	-0.48462 ***	0.66	0.66	1321.2 ***
BHN	-0.00014	1.12817 ***	0.18565 ***	0.52380 ***	0.52440 ***	0.50	0.50	679.4 ***
BMQ	-0.00039 ***	1.11075 ***	0.07670 ***	-0.02369	-0.27588 ***	0.75	0.75	2063.6 ***
BMN	-0.00019	1.04671 ***	-0.10480 ***	0.01425	0.15966 ***	0.70	0.70	1555.6 ***
BLQ	0.00007	1.01813 ***	-0.14411 ***	-0.32109 ***	-0.41781 ***	0.74	0.73	1864.4 ***
BLN	-0.00047 ***	0.90234 ***	-0.07309 ***	-0.09789 ***	0.02033	0.72	0.72	1751.5 ***

*** significance at 1%, ** significance at 5%, * significance at 10%

Source: Author's estimations

In addition to the market risk premium, other factors include size, value, and liquidity. The size factor, SMB,

shows statistically significant relationship across all portfolios. However, to understand the impact of size, difference in the coefficients of SMB across different small and big companies' portfolios are calculated, as shown in Table-7. All differences in coefficients are found positive reflecting impact of size on companies' return. For instance, the first difference between small size, high value, and liquid companies' portfolio, SHQ, coefficient of SMB is higher than big size, high value, and liquid companies' portfolio, BHQ, coefficient of SMB by 0.942 units. Similar interpretation can be given for other difference in coefficients as well. It can be concluded that similar to Three-Factor Model, Four-Factor Model-1 also confirms the impact of size on companies' return. Likewise, the value factor, HML, also shows statistically significant relationship across all portfolios except for BMQ portfolio. To understand the impact of value factor, difference in coefficients of HML across multiple high and medium value portfolios and medium and low value portfolios is mentioned in Table-7 for Model-1. For example, the first value, 0.401, shows that small size, high value, and liquid companies' portfolio, SHQ, coefficient of HML is higher than small size, medium value, and liquid companies' portfolio, SMQ, coefficient of HML by 0.401 units. All differences are found positive showing that the value factor affects companies return. High value companies have higher return compared to medium value companies and medium value companies have higher return than low value companies.

Table 7: Difference in Size, Value, and Liquidity Coefficients of Four Factor Model-1 and Model-2

Difference in portfolios	Four Factor Model-1	Four Factor Model-2
SMB Factor		
SHQ – BHQ	0.942	0.833
SHN – BHN	0.806	0.721
SMQ – BMQ	0.932	0.663
SMN – BMN	0.517	0.610
SLQ – BLQ	1.216	1.177
SLN – BLN	1.589	2.010
HML Factor		
SHQ – SMQ	0.401	0.413
SMQ – SLQ	0.834	0.444
SHN – SMN	0.442	0.492
SMN – SLN	1.018	1.397
BHQ – BMQ	0.351	0.288
BMQ – BLQ	0.171	0.321
BHN – BMN	0.592	0.524
BMN – BLN	0.190	0.098
NMQ Factor		
SHN – SHQ	0.670	0.801
SMN – SMQ	0.754	0.654
SLN – SLQ	2.955	2.652
BHN – BHQ	0.986	1.009
BMN – BMQ	0.347	0.436
BLN – BLQ	0.287	0.418

Source: Author's estimations

The fourth factor of liquidity in Four-Factor Model-1, which is the contribution of this paper, is shown by NMQ. Coefficients of this factor are found statistically significant across all twelve portfolios. Similar to the difference in coefficients of SMB and HML factors for size and value, difference in coefficients of NMQ, liquidity factor, are also calculated and shown in Table-7. The first value, 0.670, shows that the small size, high value, and illiquid companies' portfolio, SHN, coefficient of NMQ is higher than the small size, high value, and liquid companies' portfolio, SHQ, by 0.670 units. All the other difference in coefficients of NMQ between illiquid and liquid companies' portfolios are positive showing impact of liquidity on companies' return.

Similar to the model-1, the estimation results of model-2, with volume/ outstanding shares as a measure of liquidity factor, also show statistically significant impact of size, value, and liquidity across all portfolios except for the HML coefficient of BMQ and BMN portfolios and for the NMQ coefficients of BLN portfolio. All differences to identify the impact of size, value, and liquidity factors are presented in Table-7 for model-2 as well. Consistent pattern is found for model-2 like model-1 showing positive values of differences across the board. Hence, the size, value, and liquidity factors are important to explain cross-sectional variations in assets' returns.

5. Conclusions and Recommandations

Estimation of the three and four factor models along with an additional factor of liquidity in this paper for the portfolios constructed on the stocks listed in the PSX suggest that size, value, and liquidity are the important determinants of the cross-sectional variations in assets' return. Assets with big size tend to have lower return as compared to assets with small size. Similarly, assets with lower book to market value have lower return compared to assets with higher book to market value. On the liquidity, where the factor is gauged with volume and volume / outstanding shares, it can be concluded that liquidity is another important determinant of cross-sectional variations in assets' return in PSX. Investors require higher return against the liquidity risk. Further, the two measures of liquidity may help understand this phenomenon.

It is also crucial to note that the market and investors in PSX may be treated as rational because they require higher returns against the higher risk stemming from difference in size, value, and liquidity. Further, this approach is found consistent across various portfolios.

Based on the results and conclusion, it is critical to consider size, value, liquidity as important factors while constructing portfolios. An individual investor, fund managers, and wealth managers may evaluate the behavior towards risk and suggest the portfolio accordingly. Return on the portfolios with big size, low book to market value, and / or high liquidity are close to the market return. Hence, a better choice for risk avert rational investors is to construct a portfolio with big size, low book to market value, and liquid assets. Specifically, they should refrain from small size, low value, and illiquid stocks as the estimation suggest that one would need to have comparatively higher premiums on this than the other portfolios. The liquidity risk may be reduced to some extent by encouraging more investments in stocks. The government needs to give incentives in terms of lower capital gain tax as it may result in more investment in market, lowering liquidity risk, and ultimately getting larger collection of capital gain tax.

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Acknowledgments
The authors acknowledge the comments received from evaluators when it was presented in the Mathematics Department, NED University of Engineering and Technology. They are also grateful to the editorial team of the journal.

Disclosure statement
No potential conflict of interest was reported by the authors.

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The views and opinions expressed in this paper are those of the authors alone and do not necessarily reflect the views of any institution.

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Pakistan Journal of Economic Studies

ISSN (E) 2708-1486 (P) 2708-1478
Volume 8: Issue 1 January-March 2025
Journal homepage: https://journals.iub.edu.pk/index.php/pjes/index

Nexus between Corporate Governance and Corporate Social Responsibility in Family-Owned Firms

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ARTICLE DETAILS

History:
Accepted: 14 March 2025
Available Online: 16 March 2025

Keywords:
CSR
CG
Pakistan
FGLS regression model

JEL Codes:
G34
M14
C24

ABSTRACT

Objective: This study investigates the CG-CSR causal relationship among Pakistan family-owned firms.

Research Gap: The research gap identified is the lack of empirical investigation into how specific corporate governance determinants (such as CEO duality, audit committee size, insider shareholders, institutional shareholders, board independence and board size) directly affect CSR disclosure of Pakistan family-owned firms, particularly those engaged in CSR activities between 2013 and 2022.

Design/Methodology/Approach: Data was collected from the annual reports. The heteroskedastic issue is absent in the CG-CSR econometric model, but serial autocorrelation exists; therefore, FGLS regression is run to assess the developed research hypothesis.

The Main Findings: The findings reveal that board size, CEO duality, and institutional shareholding negatively impact CSR, suggesting that more streamlined boards may enhance CSR initiatives. Conversely, board independence, audit size and insider shareholding positively impact CSR, suggesting that effective corporate governance mechanisms significantly influence CSR disclosure in Pakistan family-owned firms.

Theoretical / Practical Implications of the Findings: Practically, firms should enhance board independence and audit committee size to boost CSR transparency, while limiting CEO duality and institutional shareholding to reduce conflicts. Theoretically, the results support agency theory, highlighting the role of governance in aligning family firm goals with socially responsible practices.

Originality/Value: The study's originality lies in its focus on examining the direct impact of specific corporate governance factors on CSR disclosure in family-owned firms listed on the PSX, providing insights into governance-CSR dynamics in Pakistan's unique corporate environment.

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Recommended Citation:

Hassan, M.S. (2025). Nexus between corporate governance and corporate social responsibility in family-owned firms. *Pakistan Journal of Economic Studies*, *8*(1), 28-39. Available at: https://journals.iub.edu.pk/index.php/pjes/article/view/3230

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1. Introduction

Over a decade, several authors have examined family businesses with a stringent corporate governance (CG) system where several generations related by blood, marriage, or adoption exercise control and can steer the firm toward specific objectives (Hassan, 2023; Khan et al., 2022). From the research done by Hassan et al. (2022), the reason why it is relevant to apply good CG practices in a family business is that it fulfills the main objective of enhancing accountability that is coupled with full disclosure of information, transparency and fairness that is crucial for business success. According to Nasir et al. (2023), internal control is one of the most applied CG mechanisms that BODs use to improve CSR disclosure apart from the goal of maximizing shareholder wealth, which is an initiative that surpasses legal requirements. Studies have also indicated that firms which have good

internal controls with mechanisms in place are likely to undertake CSR practices (Khan et al., 2022).

The relevance of understudied variables extend beyond firm-level performance and aligns with the broader global agenda set by the United Nations' Sustainable Development Goals (SDGs) because strong CG mechanisms contribute to SDG 8 (Decent Work and Economic Growth) and SDG 16 (Peace, Justice, and Strong Institutions) by fostering ethical business practices and accountability. Furthermore, CSR initiatives directly support SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action) by encouraging environmental sustainability and community engagement (Sarkar et al., 2023; Toukabri & Mohamed Youssef, 2023). CG has a significant role in defining the direction and management of the firm, particularly the family businesses. This is because of the blend of ownership, management and decision-making functions within the same entity, and this usually makes these firms to have structures of governance that are distinct from other firms (Hassan, 2023). This tightly knit control can bring long-term stability but may be accompanied by problems such as opacity, accountability, or conflict of interests (Padungsaksawasdi & Treepongkaruna, 2024; Qasem et al., 2024). In family firms especially those in Pakistan, governance structures involve a lot of trust and informal structures thus affording strength to decision making or acting as sources of weakness in professional management (Bashir et al., 2020). Notably, the concept of CSR is gaining more attention in the global marketplace specifically family-owned businesses owing to the fact that these firms may have close ties with the community and may have a greater social responsibility towards the community (Qasem et al., 2024). Non-family firms consider CSR as a tool to increase stakeholder value while family firms might see CSR as the continuation of their familistic values such as ethical behaviour and the welfare of the community in the long run (Qasem et al., 2024). CSR activities that may be adopted by family businesses may include charitable activities, environmental conservation, among others. In Pakistan's family-owned firms CSR is perceived as an opportunity to build reputation, improve stakeholders' trust and guarantee longevity of the enterprise. However, managing the tension between short-term financial objectives and CSR programmes is relatively difficult (Abu Afifa et al., 2023). For example, Mustafa et al. (2025) highlighted that nearly 45% of Pakistani family firms face challenges in reconciling immediate profit demands with the long-term investments needed for robust CSR engagement. Further, studies suggest that the inherent trade-offs between short-term financial objectives and sustained CSR initiatives can undermine strategic decision-making in these enterprises (Farooq & Noor, 2023; Irfan et al., 2024).

In the context of Pakistan's family-owned firms, aligning CG and CSR with the SDGs ensures long-term business resilience while addressing critical social and environmental challenges. Hence, understanding the interaction between CG and CSR is crucial to the management of a firm's strategic decisions. Although, it is evident in previous studies that having a good CG reduces conflicts in family owned businesses and thus achieve the overall goals of CSR. However, most studies focus on developed economies or non-family-owned firms, leaving a gap in understanding how these dynamics unfold in Pakistani family-owned businesses (Irfan et al., 2024; Qasem et al., 2024). Research in European countries such as the UK and Australia (Enciso-Alfaro & García-Sánchez, 2023; Vo et al., 2023) as well as other Asian countries like India and China (Bhaskar et al., 2024; Javed et al., 2024) has explored CG-CSR relationships, yet findings may not be directly applicable to Pakistan due to differences in regulatory environments, cultural influences, and ownership structures. Especially since family businesses remain the prevalent form of corporate enterprises in Pakistan, it is necessary to comprehend this relationship in order to foster ethical and socially responsible behavior (Hassan et al., 2022). This study fills this gap by specifically analyzing how CG mechanisms shape CSR initiatives in Pakistan's family-owned firms and offers insights tailored to a developing economy with a strong presence of family-owned enterprises, contributing to both theory and practice by addressing governance challenges unique to this context. Therefore, the empirical importance of the study lies in the investigation of the direct effect of the CG determinants, namely, CEO duality, audit committee size, insider shareholders, institutional shareholders, board independence, and board size on the CSR disclosure by the PSX listed family firms that are involved in CSR activities between 2013 and 2022. Studying this phenomenon, this study provides practical insights for policymakers and business leaders seeking to enhance CSR practices. Moreover, this research aligns with the SDGs, emphasizing the role of governance in driving responsible corporate behavior and long-term sustainability. The remaining paper is arranged as follows: The second section of the paper provides a literature

review, section three focuses on data collection and method, section four is about the findings and section five contains the conclusion of this study.

2. Literature Review

2.1 Theoretical Review

In this research, agency theory and stakeholder theory are used to understand the relationship between CG and CSR in family business in Pakistan. Whereas agency theory explains internal governance structures, stakeholder theory concerns the firm's external obligations and together both broaden the concept of a more socially responsible and ethically managed business.

Agency theory explores that there is a risk of divergence of interest between the owners (principals) and the managers (agents), due to self-interest of the agents (Jensen & Meckling, 1976). Agency costs are also not very significant in family businesses because while ownership is vested in the family, control is also in the hands of the family since most family business are managed by the owners themselves. Nevertheless, there are issues of governance that are apparent especially on issues to do with decision making that would benefit the family rather than other stakeholders (Khan & Mushtaq, 2020; Mariani et al., 2023). This theory therefore calls for good CG structures that ensure the family's interest is well aligned with the sustainable interest of the firm. Therefore, the CG system is significant in addressing the problem of the misinterpretation of CSR as a tool for achieving short-term financial gains or an individual's self-serving agendas. Effective governance structures assist in managing conflicts and making CSR as a strategic element in the firm (Khan et al., 2022).

Stakeholder theory broadens the vision by insisting that firms are responsible not only for shareholders but also all stakeholders such as the suppliers, employees, general public and customers (Freeman, 1984). These firms can be more inclined to get involved in CSR activities that are aligned with the family values and their long-time relations with the society. This theory implies that CSR initiatives should be made to preserve the best self-interest of CG mechanisms and that they ought to be real for various stakeholders (Nasir et al., 2023). Incorporation of CSR in the governance structure can capture the social and environmental goals of the fobs and satisfy the stakeholders hence improving the reputation of the business.

2.2 Hypothesis Development

One of the critical CG elements is the board size responsible to play a vital role in ensuring that a company's operations are effectively managed by its representatives for the benefit of stakeholders (Enciso-Alfaro & García-Sánchez, 2023). From the agency theory perspective, it has been argued that a giant board may lead to more conflicts among board members as communication challenges and the need for consensus on a large board can compromise its effectiveness. Following agency theory, the existing literature contends that a larger board may reduce operational and decision-making efficiency, making businesses less concerned with CSR relevant information disclosure (Abu Afifa et al., 2023; Maswadi & Amran, 2023). On the other hand, considering the perspectives of stakeholder theory, a board with numerous directors is associated with greater managerial control, which ultimately enhances a company's performance through compliance with regulations and guidelines. Consequently, a larger board is expected to play a more significant role in disclosing CSR activities compared to a smaller board, as Lepore et al. (2023) argued that a larger board could benefit from a diversity of information, skills, and experiences, improving its ability to regulate and monitor the company's disclosures and enhance CSR efforts. Due to the contrasting findings in both studies and the theoretical perspectives presented, the researcher anticipates a negative relationship between board size and CSR, in line with the agency theory, as stated in the following hypothesis.

H1: Board size and CSR are inversely related.

Irfan et al. (2024) and Vo et al. (2023) concluded that greater board independence is positively associated with CSR disclosure, arguing that independent directors are more likely to prioritize stakeholders' interests especially environmental regulators. The findings are supported by Qasem et al. (2024) and Lepore et al. (2023), who observed the same outcomes arguing that the companies implemented CSR disclosure as an

effective tool for the goal of strengthening the moral legitimacy of the firms contending that independent directors play a significant role in maintaining strong unbiased relationships with all the stakeholders aiming to work for societal welfare that ultimately leads to urge companies to disclose their CSR practices. These studies followed the stakeholder and legitimacy theory while proposing the outcomes. However, some studies have identified a negative relationship, suggesting that more independent directors may reduce CSR disclosure (Irfan et al., 2024; Padungsaksawasdi & Treepongkaruna, 2024). While putting forth the arguments, the scholars contend that these shareholders may be under the influence of top level executives who do not want to invest in environmental initiatives but in personal wealth maximization. Following the stakeholder theory and studies supporting positive relationship, the researcher has developed the following research hypothesis.

H2: Board independence and CSR are positively related.

Numerous studies have demonstrated a negative association between CSR disclosure and CEO duality, contending that when the leadership is separated, CSR and information disclosure will rise (Bhaskar et al., 2024; Javed et al., 2024). While putting forth the arguments following agency theory, the scholars concluded that because governing powers and decision-making authority are concentrated in the hands of one person when someone holds two positions, the efficacy of BODs in carrying out their governance tasks may be jeopardized that ultimately lead to the less focus on environmental initiatives. The findings are supported by Nasir et al. (2023), who contended that more decision-making authority as a result of this duality make it more difficult for the board to oversee corporate activities and disclosure regulations, such as CSR disclosures and initiatives. While putting forth the arguments, the scholars holds that position duality may be more likely to lead the executive to put his interests first, which could result in conflicts of interest, leading to pay less tension on satisfying the concerns of external stakeholders especially environmental regulators. Following the agency theory and studies, the researcher has developed the following research hypothesis.

H3: CEO duality and CSR are inversely related.

According to Feng et al. (2024), institutional ownership (IO) refers to an investor's practice of holding a certain proportion of shares in a given company to achieve greater returns and lower risks on behalf of their clients, who are in charge of keeping an eye on the management's opportunistic actions. The literature reveals a negative IO-CSR relationship as, according to advocates of agency theory, institutional investors, primarily investment banks and mutual funds, monitor management decisions and press them to reduce or enhance CSR disclosure efforts, which in turn causes a decrease or gain in firm value (Rudiatun & Anggorowati, 2024). However, a different school of thinking influenced by stakeholder theory proposed that the understudy variables had a positive association. It was suggested that while some institutional investors push their owners to gain short-term profits from their investments, most institutional owners are more concerned with long-term profit-making, which can only be achieved through participating in CSR initiatives (Al-Qadasi, 2024; Irfan et al., 2024).

H4: Institutional ownership and CSR are positively related.

Insider shareholders are individuals who possess a substantial stake in a company's shares and possess in-depth knowledge about the company's operations (Hassan, 2023). Many scholars have explored the correlation between insider shareholders and CSR. Irfan et al. (2024) discovered that companies with significant insider ownership levels tend to exhibit more socially responsible conduct contending that insider shareholders are deeply invested in the company's long-term success, motivating them to prioritize CSR initiatives. Likewise, a study by Rudiatun and Anggorowati (2024) revealed a positive connection between CSR practices and insider ownership, arguing that insiders are better positioned to influence and monitor the company's CSR activities, resulting in more socially responsible actions owing a closer relationship with the company and be engaged in its decision-making processes. Farooq and Noor (2023) following stakeholder theory also found a positive relationship between understudied variables contending that insider shareholders, being the owners of the company, exhibit a heightened motivation to ensure the company's sustainable operation and engagement in

socially responsible practices and uphold the company's reputation, thereby enhancing long-term profitability for the benefit of all stakeholders.

H5 : Insider shareholders and CSR are positively related.

It is crucial for the audit committee to effectively allay concerns, monitor, and improve CSR practices to be carried out by the firms as a supervisory tool, as larger audit committees are thought to have a better understanding of the worries of the stack holder regarding society, which aids in the development of their arguments on the disclosure of a company's CSR practices (Abu Afifa et al., 2023). The agency theory's premise that a larger audit committee has a beneficial impact on CSR disclosure activities is also supported by empirical research (Al-Qadasi, 2024; Rudiatun & Anggorowati, 2024). According to their argument, a large audit committee's more profound knowledge and experience encourages the adoption of strong CG practices, strengthening internal control mechanisms within the organization and increasing a company's reporting accountability to the public. The researcher anticipates a favorable association between audit committee size and CSR disclosure based on the discussion above and the agency theory provided below.

H6: Audit committee size and CSR are positively related.

3. Methodology

This study investigates the CG-CSR causal relationship among PSX listed family-owned firms between 2013 and 2022, using annual reports as the primary data source, with five CG proxies namely CEO duality, audit committee size, insider shareholders, institutional shareholders, board independence, and board size. In line with Khan et al. (2022), the current study examined CSR disclosure by taking a firm's CSR expenses natural Log incurred in a given year. Even though the businesses chosen as the sample were inviting expenses on diverse CSR activities, most CSR expenses inviting activities were community development, donations, community welfare, society welfare, social improvements, charity, education, and environmental management.

Table 1: Final Sampled Firms

Category	Number of firms
Total firms	544
Less: Financial institutions	124
Less: Defaulted firms	(11)
Less: Newly established firms	(60)
Less: Firms not involved in CSR activities	(73)
Less: Non-family firms	224
Final firms	**52**

Source: Authors' Compilation

Total 52 family-owned firms are selected excluding financial firms, defaulted firms, newly established firms consistent with Hassan (2023) and firms not involved in CSR practices consistent with Adel et al. (2019). The firms are classified as family-owned firms following the criteria proposed by Hassan (2023).

Table 2: Variable's proxies

Variables	Proxy
Board size	Number of directors in a year
Board independence	Independent directors/total directors
CEO duality	One if the CEO has a dual position; otherwise, 0
Institutional shareholding	Institutional shares/total shares
Audit size	Number of audit committee members
Insider shareholding	Director's shares/total shares
CSR	LN (CSR expenses)
Debt ratio	Debt-to-asset ratio
Financial leverage	Debt-to-equity ratio
Liquidity	Current asset to current liability ratio
Firm age	Ln (established years)

Firm size	Ln (Total assets)

Source: Authors' Compilation

The following econometric model has been developed for this study where CSR is the abbreviation for corporate social responsibility, ACS is audit committee size, BS is board size, INSD is insider shareholding, BI is board independence, and IO is institutional shareholding.

$$CSR_{i,t} = \beta 0_{i,t} + \beta 1\,(ACS)_{i,t} + \beta 2\,(BS)_{i,t} + \beta 3\,(INSD)_{i,t} + \beta 4\,(BI)_{i,t} + \beta 5\,(CEO\ Duality)_{i,t} + \beta 6\,(IO)_{i,t} + \beta 7\,(Controls)_{i,t} + e$$

Hausman test is applied to decide preferable panel data regression model consistent with Hassan (2023). The significant test statistic value leads to choosing a fixed effect model while insignificant test statistic value leads to choosing random effect model. After validating classical regression assumptions, the findings are linked with theories and existing literature to find uniformity between results and propose possible interpretations. The same methodology has also been used in the existing literature (Hassan et al., 2022; Irfan et al., 2024).

3.1 Suitable Regression Model

Two main classical regression assumptions: heteroskedasticity (based on Breusch-Pagan test) and serial autocorrelation (based on Wooldridge test) of which the results are presented in Table 4 are tested to choose preferable panel data analysis model (Hassan, 2023).

Table 3: Suitable regression model

Details	CG-CSR
Heteroskedasticity	No
chi2(1)	0.39
Prob>chi2	0.5309
Autocorrelation	Yes
F (1, 51)	18.375
Prob > F	.0001
Preferable model	FGLS

Source: Authors' Estimation

The heteroskedastic issue is absent in the CG-CSR econometric model, but serial autocorrelation exists; therefore, FGLS regression is run in line with Hassan et al. (2022).

4. Data Analysis and Findings

4.1 Descriptive Statistics

The CSR expenses mean of 15.46 (Table 1) implies that family firms are dedicating resources to CSR, a trend that reflects growing awareness and societal expectations regarding corporate responsibility. This CSR investment aligns with Pakistan's evolving corporate landscape, where businesses increasingly recognize the importance of environmental and social stewardship.

Table 4: Descriptive statistics

Variable	Mean	STD	Min	Max
Liquidity	1.91	1.43	0.14	10.55
Firm Age	3.55	0.50	0.69	4.28
Debt Ratio	0.45	0.17	0.02	0.79
CEO Duality	0.11	0.32	0.00	1.00
Financial Leverage	0.98	0.70	0.02	4.56
CSR Expenses	15.46	2.21	9.21	26.86
Board Independence	0.22	0.16	0.00	0.80
Board Size	8.12	1.69	6.00	18.00
Audit Committee Size	3.50	0.78	3.00	6.00

Institutional Shareholding	20.30	17.34	0.00	64.42
Insider Shareholding	51.69	22.32	18.90	97.77
Firm Size	23.75	1.68	17.76	25.31

Source: Authors' Estimation

Concerning the explanatory variables, the average board size of 8.12 which indicates that the family-owned firms in Pakistan have moderate boards. At the same time, a mean of 0.22 for board independence suggests that independent directors are not common in the companies, which means that external control is weak. For instance, the average institutional shareholding of 20.30 indicates that institutional investors own a number of shares, meaning that they hold a lot of power within those firms. On the other hand, the insider shareholding mean of 51.69 suggests a high degree of ownership by family members or insiders, which results in high family influence over the strategic management of the firm and its governance system.

4.2 Discussion on Results

The study's main aim was to examine the impact of various CG factors on CSR disclosure practices, as revealed in Table 5. The achieved outcomes revealed that the negative board size coefficient of -0.189 *** suggests that an increase in board size is associated with a decrease in CSR with an implication that larger boards may have difficulty reaching consensus or might prioritize other objectives over CSR initiatives. The obtained results confirm the acceptance of the hypothesis is supported by empirical literature (Mohammadi et al., 2021; Orazalin, 2019) and agency theory.

Furthermore, the positive board independence coefficient of 0.436 suggests a potential positive association between board independence and CSR, leading toward the acceptance of the developed hypothesis. The results are consistent with Biswas et al. (2019) and Ebaid (2022), who argued that independent directors are more likely to ensure compliance with environmental regulations and prioritize stakeholders' interests, reducing information asymmetry and fulfilling their societal responsibilities. So, we can infer that having a board with a higher degree of independence might lead to more effective oversight and commitment to CSR activities.

Furthermore, the negative CEO duality coefficient of -0.323 indicates that when the CEO also holds the position of Chairperson, CSR may be negatively affected. It may help prevent conflicts of interest and promote more objective decision-making regarding CSR initiatives. The results are consistent with (Salhi et al., 2020; Voinea et al., 2022), who contend that a CEO who simultaneously holds the chairpersonship may be more likely to put his interests first, which could result in conflicts of interest. This perspective holds that he will only decide what is best for himself and no one else.

Table 5: Hypothesis testing

Variables	Beta coefficients (standard errors)	VIF
Board size	-0.189***	1.08
	(0.0558)	
Board independence	0.436	1.05
	(0.582)	
CEO duality	-0.323	1.02
	(0.290)0	
Institutional shareholding	-0.00656	1.90
	(0.00723)	
Audit size	0.161	1.18
	(0.127)	
Insider shareholding	0.00384	1.97
	(0.00549)	
Debt ratio	1.637	
	(1.213)	
Liquidity	-0.0884	
	(0.0811)	
Financial leverage	-0.753***	
	(0.264)	

Firm age	0.117
	(0.188)
Firm size	0.425***
	(0.0614)
Constant	6.441***
	(1.656)
Wald chi2(11)	72.27
Prob > chi2	0.000

Source: Authors' Estimation

The negative institutional shareholding coefficient of -0.00656 suggests that institutional shareholding has a negative impact on CSR. The result is the evidence of hypothesis acceptance. It is consistent with the agency theory and empirical literature (Barnea & Rubin, 2010), which contend that institutional investors, mostly investment banks and mutual funds banks, monitor management decisions and press them to reduce or enhance CSR disclosure efforts, which in turn cause a decrease or gain in firm value.

Furthermore, the positive beta coefficients of audit size (0.161) and insider shareholding (0.00384) apply that engaging larger audit firms may contribute to better CSR practices. This suggests that organizations carefully choose their auditing partners, as reputable audit firms may provide valuable insights and assurance in CSR reporting, potentially enhancing their reputation and commitment to responsible business practices. Moreover, insiders may have a slight inclination towards CSR activities to improve the company's image or align with their values. Companies might consider involving insiders more actively in CSR initiatives or communication. The empirical evidence of (Al-Qadasi, 2024; Rudiatun & Anggorowati, 2024) and stakeholder theory for audit size, while of (Farooq & Noor, 2023; Irfan et al., 2024), and agency theory for insider shareholding contend the current study results and acceptance of developed hypotheses.

The model is statistically significant as Prob > chi2 = 0.0000 less than 0.05 while Wald chi2(11) = 72.27.

4.3 Summary of Results

Table 6: Results Summary

Explanatory variable	Sign (Decision)
Board size	-ve (Supported)
CEO duality	-ve (Supported)
Institutional shareholding	-ve (Supported)
Board independence	+ve (supported)
Audit size	+ve (Supported)
Insider shareholding	+ve (Supported)

Source: Authors' Estimation

5. Conclusion

The current study examines the direct effect of the CG determinants, namely, CEO duality, audit committee size, insider shareholders, institutional shareholders, board independence and board size on the CSR disclosure by the PSX listed family firms that are involved in CSR activities between 2013 and 2022, using annual reports as the primary data collection source. The current study examined CSR disclosure by taking a firm's natural Log of CSR expenses incurred like community development, donations, community welfare, society welfare, social improvements, charity, education, and environmental management in a given year. The heteroskedastic issue is absent in the CG-CSR econometric model, but serial autocorrelation exists; therefore, FGLS regression was run.

In assessing the CG-CSR causal relationship, the result indicates that the size of the board of directors seems to exert a negative influence, indicating that as the board size increases, CSR initiatives may diminish. Conversely, board independence positively correlates with CSR, meaning that companies with more independent directors are more likely to engage in socially responsible activities, a trend supported by empirical data. Furthermore, CEO duality and institutional shareholding have negative impact on CSR efforts, as supported by research, indicating that companies with higher institutional ownership and giving dual managerial position to an individual tend to prioritize CSR less. On the other hand, audit size exhibits a positive association with CSR

suggesting that larger audit firms may help companies improve their CSR performance while, insider shareholding and CSR are positively related meaning that when insiders have a significant stake in a company tends to enhance their CSR efforts.

5.1 Implications

The study reveals a negative board size and CSR disclosure relationship, indicating that companies may need to consider more streamlined and efficient board compositions to ensure effective CSR initiatives, while the board independence positive impact underscores the importance of having substantial independent directors to ensure the value of diversity and impartial decision-making in shaping CSR policies. The negative impact of CEO duality suggests that keeping these responsibilities distinct can improve CSR and CG while the positive effect of large audit size implies that when audit committee is better suited to guarantee CSR compliance and transparency, corporations may stand to gain from collaborating with them. Lastly, the study's identification of a positive link between insider shareholding and CSR emphasizes the value of involving insiders in CSR initiatives, as their investment in CSR efforts can significantly impact a firm's social responsibility endeavors.

These implications also extend to policymakers, who can use these findings to formulate regulations and guidelines that encourage effective CG practices, fostering CSR to encourage top-level management and shareholders (insider and institutional) to disclose their CSR practices to the concerned stakeholders. Additionally, investors can utilize this information to make more informed investment decisions, considering firm's CG practices and their impact on CSR disclosure when constructing investment portfolios.

5.2 Limitations and Recommendations

Several limitations should be acknowledged when conducting a study on family firms in Pakistan. Given the unique cultural, economic, and regulatory context, the generalizability of findings from international studies to the distinct Pakistani business landscape is a primary concern. The current study employs the natural logarithm of CSR expenses as a CSR disclosure measuring proxy, widely regarded as an effective means to operationalize the target variable in the existing literature. Nevertheless, alternative measures such as CSR disclosure indices and ESG scores also offer valuable avenues for exploration in future research. While this study encompasses family firms without distinguishing between those managed by ancestors and descendants, future researchers could consider this distinction to undertake a comparative analysis of the study model. Moreover, researchers are encouraged to explore alternative proxies for CG, including factors like gender diversity, foreign ownership, and the identity of the top 20 shareholders in diverse international contexts and conduct comparative analyses to resolve the limitation of generalizability. Furthermore, the researchers should explore the underling factors and challenges associated with CG implementation for enhancing CSR practices within the firms. In this regard, the qualitative methodology based on interviews as a primary data collection is recommended to adopt.

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Acknowledgments

The author must acknowledge the support in conducting the research work.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Pakistan Journal of Economic Studies

ISSN (E) 2708-1486 (P) 2708-1478
Volume 8: Issue 1 January-March 2025
Journal homepage: https://journals.iub.edu.pk/index.php/pjes/index

On Exogeneity of Savings in Feldstein-Horioka Equation: The Case of Pakistan

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ARTICLE DETAILS

History:
Accepted: 28 February 2025
Available Online: 16 March 2025

Keywords:
Feldstein-Horioka Puzzle, Exogeneity, Indicator Saturation, Autometrics, Structural Breaks

JEL Codes:
F21, F36, N15, O16, O53

ABSTRACT

Objective: The study aims to estimate the Feldstein-Horioka (hereafter, FH) equation, incorporating data led (both impulse and step) breaks and check the status of exogeneity of domestic savings within the estimated FH–equation in Pakistan.

Research Gap: Considering Pakistan, none of the previous available literature tried to check exogeneity status of savings in FH-equation using appropriate testing procedures. Further, the impact of data led breaks were completely ignored. Therefore, the study tries to fill this gap.

Design/Methodology/Approach: Stationarity and cointegration is checked through the lens of Augmented Dickey-Fuller (ADF) unit root test and Engle-Granger & Phillips-Ouliaris Residual Based Cointegration tests respectively. To avoid any hint of spurious relationship, appropriate methods are applied and then convergence/consistency of the estimated regression coefficients is verified with the help of Cochran-Orcutt GLS procedure. For weak exogeneity (WeExt), the Engle, Durbin-Wu-Hausman and Wu-Hausman tests are applied and the test for contemporaneity of errors is well documented. For strong exogeneity (StExt), in presence of WeExt, Granger Causality test is applied. Lastly, Engle and Hendry, Charemza-Király tests of super exogeneity (SuExt) are applied.

The Main Findings: The estimated coefficient of savings with no breaks indicates a low capital mobility in Pakistan. But, the inclusion of data led breaks reduced the magnitude, showing high capital mobility in Pakistan. The existence of weak, strong and super exogeneity indicates that the observed FH–equation can be used for inference, forecasting and policy simulations.

Theoretical / Practical Implications of the Findings: Pakistan had relatively low domestic savings in comparison with investment for the last fifteen years. Consequently, rates of return on capital have been relatively high. Therefore, the country might regard the persistent trade deficits, as the country remains dependent on external financing. It is concluded that domestic savings is exogenous in FH–equation.

Originality/Value: Testing exogeneity (*e.g.* WeExt, StExt & SuExt) in a regression context by any means considered to be one of the difficult task to perform both in theoretical as well as in applied econometrics. The study tries to simplify these testing procedures in a very simple and understandable manner.

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Recommended Citation:
Jawad, M., Kemal, A, M. & Saleh, M. (2025). On Exogeneity of Savings in Feldstein-Horioka Equation: The Case of Pakistan, *Pakistan Journal of Economic Studies*, *8*(1), 40-55. Available at: https://journals.iub.edu.pk/index.php/pjes/article/view/3254

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1. Introduction

Feldstein–Horioka (FH) puzzle is the mother of all puzzles in international economics. Theoretically, domestic savings finances all investment in a closed economy with minimal capital mobility, while domestic savings

under higher capital mobility would not necessarily finance total investment. Nonetheless, FH-puzzle failed to explain higher correlation between investment and domestic savings that would indicate low level of capital mobility.

The puzzle posited in (Feldstein & Horioka, 1980) not only draws attention towards capital mobility but also towards the optimal savings and the changes in tax incidence (Akkoyunlu, 2020). Increased capital mobility is vital for achieving optimal levels of savings. Countries with higher investment needs and low domestic savings can attract capital from international markets. Pakistan like other developing countries with lower contagion in the global financial markets has lower capital mobility and higher correlation between domestic savings and investments.

Higher correlation between savings and investment is clearly a puzzle, since capital mobility between leading countries has already reached gain a high level (Frankel, 1992; Ghosh, 1995; Obstfeld & Rogoff, 2000; Sachs, 1982). This study is an attempt to envelop the paradox stated above in case of Pakistan using appropriate econometric techniques incorporating data led breaks as explained in (Ericsson, 2012; Johansen & Nielsen, 2008) and the status of exogeneity of domestic savings will be tested through the implementation of proper exogeneity testing procedures, for details (see, Section-III).

The key research questions guiding this study are: to what extent is domestic savings is exogenous in the FH–equation for Pakistan, and how do data-led (impulse and step) breaks influence the estimated relationship between savings and investment? While the FH hypothesis has been widely tested in various economies, existing literature on Pakistan has overlooked the exogeneity status of domestic savings using robust econometric testing procedures. Additionally, the role of structural breaks in affecting the savings-investment relationship remains unexplored. By addressing these gaps, this study aims to rigorously examine the stationarity and cointegration properties of the FH–equation, assess weak, strong, and super exogeneity of domestic savings, and analyze the impact of data-led breaks on capital mobility estimates, ultimately contributing to the existing literature in case of Pakistan.

Testing of exogeneity assumption originates from the fundamental assumptions of classical linear regression models, particularly the requirement that explanatory variables remain uncorrelated with the error term to ensure unbiased and consistent estimation. Violating exogeneity results in endogeneity, introducing bias in Ordinary Least Squares (OLS) estimators, making them inconsistent. Addressing exogeneity concerns is essential for ensuring the validity of causal inferences, thereby enhancing the reliability of policy and economic analyses.

Theory of exogeneity is required to derive policy implications from the cointegration analysis where cointegration exists and when it doesn't exist. So far, the existing literature missed out to determine the exogeneity status of domestic savings in FH–equation. The exogeneity of variable/s depends upon the parameters of interest and the purpose of the model (Favero & Hendry, 1992). The WeExt is being tested when a model is to be used only for statistical inference/analysis. The analysis of StExt will be tested if the purpose of modelling is forecasting. Finally, if the objective of the estimated model is to be used for policy analysis the concept of testing SuExt is more relevant (Engle et al., 1983; Pearl, 2000). This study is an effort to contour and to test all these three types of exogeneity, while modelling FH–equation in case of Pakistan.

In this paper, we test FH hypothesis by observing several features. First, we use the longest available data for annual frequency over the six decades. Second, by applying structural break methods to tackle spurious regression specification, we account for data led breaks that witnessed by several policy changes, financial integration and global crises, wars and military regimes etc. All these breaks significantly capture with the help of automatic break detection using Autometrics introduced by (Doornik, 2009); the consideration of techniques that has never been documented before in this context. Third, following a general-to-specific approach discussed by (Cuthbertson & Taylor, 1990) and (Hendry & Ericsson, 1991), we tried to capture significant lags in order to identify true data generating process (DGP). Fourth, several post estimation diagnostic tests are being performed for all the models which were completely ignored before considering Pakistan.

The structure of the study is outlined as follows: Section II provides a comprehensive review of the literature on estimating the FH equation both domestically and internationally. Section III will present the data, model, empirical methodology, results, and their interpretations. Finally, Section IV will summarize the conclusion and offer policy recommendations for determining an optimal national saving strategy.

2. Review of Literature

The FH-puzzle or paradox becomes a widespread topic of research and debate in international economics literature. A detailed survey of literature on the topic can be found in (Apergis & Tsoumas, 2009) and (Obstfeld & Rogoff, 2000). It is quite valuable to re-examine the FH-puzzle in the wake of saving – investment link by considering developing Asian economies (Bagheri et al., 2012; Horioka et al., 2015). Based on literature, several studies like (Bagheri et al., 2012; Eyuboglu & Uzar, 2020; Irandoust, 2019; Lam, 2012; Tasar, 2017; Yildirim & Orman, 2017) established that association between savings and investment is high and thus, supporting FH-hypothesis for developing economies due to low level of capital mobility (international).

A plethora of literature is available highlighting a weedy relationship between savings and investment taking developing economies into account (Bangaké & Eggoh, 2010; Chang & Smith, 2014; Horioka et al., 2015; Patra & Mohanty, 2020; Raheem, 2017; Shahbaz et al., 2010). A study by (Miller, 1988) for US showed that savings and investment were not cointegrated during the era of flexible exchange rate but were cointegrated amid fixed exchange rate regime. However, (Otto & Wirjanto, 1989) revealed that these two were not cointegrated for the US and Canada. Furthermore, Montiel (1994) addressed the FH hypothesis's susceptibility to an indirect relationship between savings and investment that did not take into account capital mobility. The twin-deficit theory and the FH-puzzle are related in the empirical literature, which presents two threads of arguments. One supporting FH-hypothesis that there is little international capital mobility due to the high correlation between domestic savings and investment (Bagheri et al., 2012; Lam, 2012) and few found to be against this hypothesis based on their results like (Baharumshah et al., 2009; Saeed & Khan, 2012).

The methodology opted in (Feldstein & Horioka, 1980) is well criticized on several grounds: in cross-sectional regressions using time-averaged data often leads to an overestimation or underestimation of the actual relationship; additionally, critics argue that the analysis failed to account for the nature of economic shocks and the structural differences across countries. The study's sample period, which was limited, also did not capture the significant increase in capital mobility that occurred during the latter half of the 1970s. Moreover, several other factors were overlooked, including the presence of outliers, endogeneity, regime changes, bias caused by omitting relevant variables, the intercept, and the non-stationarity of variables in levels. These issues could have been addressed more effectively through cointegration methods (Choudhry et al., 2014; De Vita & Abbott, 2002; Ho & Chiu, 2001; Jansen & Schulze, 1996; Katsimi & Zoega, 2016; Serletis & Gogas, 2007).

Therefore, to overcome the above mentioned drawbacks in a cross-sectional settings; many studies tried to estimate it using time series analysis like (Akkoyunlu, 2020; Ayad & Belmokaddem, 2020; Bineau, 2020; De Vita & Abbott, 2002; Madiha & Hicham, 2021; Sachsida & Cardoso de Mendonça, 2006; Yildirim & Orman, 2017).

So far, the existing literature has tried to contour the puzzle in different methodological framework like (Akkoyunlu, 2020; Ayad & Belmokaddem, 2020; Bineau, 2020; Madiha & Hicham, 2021; Mohsin & Rivers, 2011; Saeed & Khan, 2012; Shahbaz et al., 2010; Yildirim & Orman, 2017). None of them used the impact of data led structural breaks proposed in (Ericsson, 2012; Johansen & Nielsen, 2008), while modelling FH–equation and neither checked the exogeneity status of savings in the equation while modelling the correct form of the equation during the stipulated time frame. A recent study by (Felipe et al., 2024) highlights that analyzing sustainability of current account deficit can be an alternate way to determine a relationship between investment and savings.

The study is an encounter to reveal the correct form of equation under the shade of automatic model selection with break detection using Autometrics and then testing of exogeneity (WeExt, StExt & SuExt) first introduced in (Engle et al., 1983) and later on performed in (Favero & Hendry, 1992; Hendry & Ericsson, 1991; Jawad et

al., 2022; Sachsida & Cardoso de Mendonça, 2006) in order to confirm the (in)validation of Lucas Critique posited in (Lucas, 1976). The main purpose of implementing the exogeneity testing is to determine the exogeneity of domestic savings and the ability of FH–equation for designing economic policies in case of Pakistan.

3. Data, Methodology, Results & Interpretations

The time series data of domestic savings and gross fixed capital formation (proxy for investment) spanning over the sample period (1960-2020) gathered from World Development Indicator (WDI) is used for analysis. The variables used here in the estimation process are transformed into their logarithmic form following (Ehrlich, 1996; Ehrlich & Gibbsons, 1977; Schrooten & Stephan, 2005; Seaks & Layson, 1983).

Table 1 shows descriptive statistics[1] with each having 61 observations, highlighting that more variation occurs in inv_t. The data seems to be right-skewed, as indicated by the fact that the mean is greater than the median, and this observation is further supported by the skewness measure. In terms of dispersion, the majority of the data points fall within the range of $(\bar{x} \pm 3\sigma)$. Additionally, the kurtosis value for both is below 3, with savings showing a negative kurtosis. This suggests that the data has lighter tails compared to a normal distribution.

Table 1: Descriptive Statistics

Descriptive Stat.\Variable	**INV_t**	**SAV_t**[2]
Mean	12.46	8.36
Median	6.95	5.39
Maximum	49.52	25.06
Minimum	0.40	0.26
Std. Dev.	13.18	7.70
Skewness	1.16	0.56
Kurtosis	0.170	-1.12

Source: Author's calculations

Now from Figure 1 (see; Appendix) one can easily see that certainly some similar features are being shared by these two series till 1990 and then a gradual increase from 1990s to 2005. However, the increase in the investment after mid-2000 is more sharp and pronounced than domestic savings Figure 1 (a & b). The lower panel (c) in Figure 1 represents their ratios to GDP. The first two panels in Figure 2 represents both variables in their logarithmic forms (Billion $US). The lower two panels of Figure 2 highlights the fact that after 2000, the changes in the savings are more explosive in comparison with investment.

3.1 Unit Root and Cointegration Analysis

Here we employ the ADF unit root test for order of integration. The critical values for the test have been computed and are readily available in (MacKinnon, 1996). If the ADF test statistic is smaller than the critical value at the 5% significance level, the null will be rejected, leading to the conclusion that the series under consideration is stationary. The results of the ADF unit root test, both at the level and first difference of the variables, are presented in Table 2. From these results, it is clear that the variables are non-stationary in their logarithmic form at the levels but become stationary at their first difference.

Table 2: Results of ADF-Test

Variable/Test Stat.	**Levels**				**First Difference**				
	K	**τ 3**	**τ_μ**	**τ_t**	***K***	**τ**	**τ_μ**	**τ_t**	**Specification**
sav_t[4]	1	2.729	-1.762	- 2.300	0	-6.726*	- 5.891*	- 6.157*	C, No t[5]

[1]Investment is taken as Gross Fixed Capital Formation (Billion $US) while saving is Gross Domestic Savings (Billion $US). For analysis we used ratio of these with Gross Domestic Product (GDP).

[2] Both variables are in Billion $US.

3 τ (No intercept no trend), τ_μ (Intercept), τ_t (Intercept and trend).

[4]Small italic shows variables in their logarithmic form.

[5]While applying unit root test on difference series, we found no significant results for trend in both cases. So, we used a specification of intercept but no trend. The results were further cross check following (Stock & Watson, 1987).

inv_t	1	2.794	-1.437	-3.97	0	-5.284*	- 5.967*	- 6.008*	C, No t

Note: H_0 ($\rho \geq 1$): I(1) against H_a($\rho < 1$): I(0). For lag length *K*, we used Akaike Information Criterion (AIC). Also, * & ** indicate significance level 1% & 5% respectively.

Now in view of above discussion, we conclude that both series found to be non-stationary at levels and stationary at their first difference without time trend. Next, we will check whether these series are cointegrated on not. If the series are cointegrated then we can apply the exogeneity testing procedure as discussed in (Hendry, 1995). It was argued that, if variables are found to be cointegrated, followed by an error correction representation; else, the relationship would be spurious if we used a simple regression in that case as discussed in (Engle & Granger, 1987) and hence suggested a two-step procedure. In this study we used two residual based cointegration tests: i) Engle-Granger Test (EG) ii) Phillips-Ouliaris Test6. The outcomes of these two tests are presented in Table 3 which indicates that the variables found not to be cointegrated. As the residuals test statistics show that residuals are non-stationary at levels without intercept and trend. Since, the variables are not cointegrated, therefore, we can't apply (Hendry, 1995) procedure directly. This leads us not to use indicator saturation technique for DGP of marginal models (6 & 7) but in the conditional model (5) only. So, to implement exogeneity test we need to use some other methods that will be discussed in detail in subsection C.

Table 3: Results of Cointegration Tests
Ho: Series are not cointegrated

Cointegration Test	Test Statistic	Value *[p-val.]*	Residual Test-Stat. *[CVs]*
EG-Test	Tau-Stat.	**-2.548** *[0.27]*	**-2.548** *[-3.37]*
	Z-Stat.	**-12.001***[0.23]*	
Phillips-Ouliaris Test	Tau-Stat.	**-2.572** *[0.26]*	**-2.548** *[-3.37]*
	Z-Stat.	**-12.023** *[0.22]*	

Note: These critical values were calculated by (Engle & Yoo, 1987). The critical values for the case of 2 variables using 100 observations were calculated by (Phillips & Ouliaris, 1990) and can also be obtained from (Hamilton, 1994) page 766, Case 2.

Testing exogeneity remains crucial even when two time series are not cointegrated, as it helps determine causal direction, model specification, and forecasting accuracy. If a variable is found to be weakly exogenous, it can be used as an independent explanatory variable, while if it is endogenous, alternative estimation methods such as Instrumental Variables (IV) or Generalized Method of Moments (GMM) may be required. Additionally, if two series are not cointegrated, their relationship in a long-run equilibrium sense does not exist. However, they may still have a short-term relationship that needs to be examined to cater the concerns about spurious relationships. This discussion is explained in the next sub-section.

3.2 Tackling Spurious Regression

The problem of spurious regression was first coined in (Yule, 1926) and then the criteria to detect it through the lens of R^2 and Durbin-Watson (DW) was discussed in (Granger & Newbold, 1974) and later in (Charemza & Deadman, 1997). However, according to (Hamilton, 1994), the problem of spurious regression can be tackled by using three different ways. In this paper we opt these ways to address the problem of spurious regression with and without structural breaks. First, by adding lagged values of independent as well as dependent variables in the model. The OLS estimates of (1 & 2) will be consistent. Both equations differ with each other due to the inclusion of impulse saturation in the form of impulse and step dummies as pointed in (Ericsson, 2012; Johansen & Nielsen, 2008). However, the F-test for joint hypothesis that the parameters are zero has nonstandard distribution as discussed in (Hamilton, 1994).

$$inv_t = \alpha + \beta sav_t + \sum_{i=1}^{k} \varphi_i sav_{t-i} + \sum_{i=1}^{k} \delta_i inv_{t-i} + \varepsilon_{1t} \quad (1)$$

$$inv_t = \alpha + \beta sav_t + \sum_{i=1}^{k} \varphi_i sav_{t-i} + \sum_{i=1}^{k} \delta_i inv_{t-i} + \sum_{i=1}^{m} \tau_{i,\alpha_2} 1_{\langle t=t_i \rangle} + \sum_{i=1}^{m} \rho_{i,\alpha_1} 1_{\langle t \geq t_i \rangle} \quad (2)$$

Second, is to take difference of the data before estimating any model as in (3 & 4). Since, the regressors and

[6]The test was mainly due to (Phillips & Ouliaris, 1990) and is used to reconfirm the results obtained by EG-test.

error term are stationary when we took the first difference of data. Therefore, the usual t or F-test has the Gaussian or χ^2-distribution respectively, based on differenced regression, the corresponding parameters converge to standard Gaussian variables under the null hypothesis.

$$\Delta inv_t = \alpha + \beta \Delta sav_t + \mu_{1t} \quad (3)$$

$$\Delta inv_t = \alpha + \beta \Delta sav_t + \sum_{i=1}^{m} \tau_{i,\alpha_2} 1_{\langle t=t_i \rangle} + \sum_{i=1}^{m} \rho_{i,\alpha_1} 1_{\langle t \geq t_i \rangle} + \mu_{2t} \quad (4)$$

Last but not least, correct the residual's first order serial autocorrelation by using the Cochran-Orcutt method to estimate the equation. The Cochrane-Orcutt GLS approach is comparable to the differenced equation (3), according to (Blough, 1992). It is crucial to keep in mind that differencing the data can lead to an misspecified regression if the data are truly stationary (Hamilton, 1994).The following Table 4 (Panel A) shows the results of these three different scenarios while (Panel B) reports several post estimation diagnostic tests.

The result of estimating FH–equation at levels without breaks in column (4.1) reveals that estimated coefficients though statistically significant and the high value of the coefficient of domestic savings therein found to be 1.13, indicating low capital mobility. But, estimated model didn't pass any post estimation diagnostic test and even model has DW < R^2 (i.e. 0.36 < 0.85)7. This further indicates that estimating FH–equation at levels will lead to a spurious regression and a poor fit. To avoid this problem, we take log of the series and incorporating lags of both dependent and independent variables. The final model then obtained by using Autometrics explained in (Doornik, 2009) and outcomes are being available in column (4.2). The estimate of domestic savings (in logarithm) reduces significantly to 0.61 but model suffer from normality and heteroskedasticity though it passes the Ramsey's RESET misspecification test of functional form. The elasticity of domestic savings in the estimated FH–equation is found to be significant for the method, we applied. The outcomes are presented in columns (4.2, 4.3 & 4.7). The coefficients of savings estimated based on three methods seem to be very close to each other. Note that the impact of automatic structural break has not been incorporated yet. Furthermore, Table 4 displays the outcomes of the FH–equation estimated without correction in column (4.1).

The impact of structural breaks is well captured in column (4.4) — (4.6) using these three specifications with the help of Autometrics. Column (4.4) below highlights the fact that though data driven breaks i.e. 16 impulse and 9 step dummies were captured but model fail to pass Jarque-Bera normality test and test of functional form. The elasticity coefficient of domestic savings drastically decreases from 0.72 in (4.4) to 0.20 in (4.5) and to 0.22 in (4.6) as the specification changes from levels to logarithmic and then to difference respectively after correction has been made.

By way of comparison, the elasticity of savings estimated using appropriate methods with the one without correction in column (4.1), it is clear that the hypothesis about the relationship among investment and savings would be wholly erroneous, if the bias were not taken into account. If the savings coefficient is interpreted in terms of capital mobility, the biased elasticity without accounting for the effects of breaks specifies low capital mobility, whereas the elasticity assessed by the suitable estimators specifies a high capital mobility as indicated by (4.5) — (4.7) that account for the presence of data-driven breaks. This suggests that the estimated equation accounted for data led breaks might be applied to the development of economic policy.

The estimated coefficient of savings when no breaks were considered in (4.1) — (4.3) indicates a low capital mobility in Pakistan. But, the inclusion of data driven structural breaks reduced the magnitude of savings elasticity from 1.14 in (4.1) to 0.72 in (4.4), 0.68 in (4.2) to 0.20 in (4.5) and 0.63 in (4.3) to 0.22 in (4.6) respectively, and showing high capital mobility in case of Pakistan. The estimate of savings is significant for all the methods applied. Furthermore, the estimated savings elasticities converge to their results while using correction with breaks which can be verified with the equation estimated by using Cochran-Orcutt GLS procedure in (4.7). The savings elasticity coefficients estimated with these methods are found to be very similar. Taking into account (Horioka et al., 2015) explained that developing Asia's economies would have a high level

[7]No other specification fails the criteria of spurious regression other than (4.1).

of global capital mobility despite the low correlation between domestic savings and investment. Due to the high level of capital mobility, these countries are disposed to experience twin deficits, be it fiscal or current account deficit (Bagheri et al., 2012). The following Table 4 also strengthens these arguments as well. Lastly, the coefficient of domestic savings is not equal to unity which implies that there is perfect capital mobility that means there is no FH-puzzle present in Pakistan.

Table 4: Estimated FH–equations

Panel A: Coefficient Estimates for FH–equation							
Model Type	**Without Breaks**			**With Breaks**			
	Dependent Variable			Dependent Variable			
Method	**4.1** ***OLS***	**4.2** ***OLS***	**4.3** ***OLS***	**4.4** ***OLS***	**4.5** ***OLS***	**4.6** ***OLS***	**4.7** ***C.-Orcutt GLS***
Variables	$\mathrm{INV_t}$	inv_t	Δinv_t	$\mathrm{INV_t}$	inv_t	Δinv_t	inv_t
Const.	-3.39**	5.43*	0.05**	2.02*	-	-0.16**	7.78*
Trend	2.07***	0.02*	-	-	-	-	-
$\mathrm{SAV_t}$	1.13*	-	-	0.72*	-	-	-
sav_t	-	0.68*	-	-	0.20*	-	0.66*
inv_{t-1}	-	1.04*	-	-	0.63*	-	-
inv_{t-2}	-	-0.35*	-	-	-	-	-
sav_{t-1}	-	-0.27*	-	-	-	-	-
Δinv_t	-	-	0.63*	-	-	0.22*	0.21**
Δinv_{t-1}	-	-	-	-	-	-	-
Δinv_{t-2}	-	-	-	-	-	-	-
AR(1)	-	-	-	-	-	-	1.25*
AR(2)	-	-	-	-	-	-	-0.54*
AR(3)	-	-	-	-	-	-	0.26***
I:1972	-	-	-	-	0.27*	-	-
I:1974	-	-	-	-	0.70*	-	-
I:1975	-	-	-	-5.74*	-	-	-
I:1979	-	-	-	6.70*	-	-	-
I:1985	-	-	-	6.70*	-	-	-
I:1987	-	-	-	-6.07*	-	-	-
I:1991	-	-	-	-9.41*	-	-	-
I:1993	-	-	-	1.30*	-	-	-
I:1998	-	-	-	-2.47*	-	-	-
I:2000	-	-	-	9.52*	0.34*	0.28*	-
I:2001	-	-	-	7.19*	-	-	-
I:2005	-	-	-	-5.52*	-	-	-
I:2008	-	-	-	7.13*	-	-	-
I:2009	-	-	-	1.77*	-0.15*	-	-
1:2010	-	-	-	-	-0.15*	-	-
I:2015	-	-	-	-1.74*	-	-	-
I:2017	-	-	-	8.85*	-	-	-
I:2018	-	-	-	1.49*	-	-	-
I:2019	-	-	-	7.72*	4.32*	-	-
S1:1965	-	-	-	-	0.17*	0.18	-
S1:1971	-	-	-	-	0.49*	0.31*	-
S1:1973	-	-	-	-	-	-0.72*	-
S1:1974	-	-	-	-1.14*	-0.84*	-	-
S1:1975	-	-	-	-	-	0.27*	-
S1:1979	-	-	-	-1.42*	-	-	-
S1:1980	-	-	-	-	-	0.12*	-
S1:1995	-	-	-	-1.15*	-	-	-
S1:1997	-	-	-	-	0.09*	-	-
S1:1998	-	-	-	1.98*	-	-	-
S1:2002	-	-	-	-	-0.19*	-	-

S1:2004	-	-	-	-1.01*	-0.20*	-0.15*	-
S1:2008	-	-	-	-	-	0.23*	-
S1:2011	-	-	-	-6.24*	-	-0.15*	-
S1:2012	-	-	-	1.56*	-	-	-
S1:2014	-	-	-	-4.44*	-	-	-
S1:2016	-	-	-	1.27*	-0.17*	-	-
S1:2018	-	-	-	-	4.55*	0.25*	-
Panel B: Diagnostic Tests							
R^2	0.86	0.99	0.18	0.99	0.99	0.89	0.99
Adj.R^2	0.85	0.99	0.16	0.99	0.99	0.84	0.99
Log-Like.	-1447.98	39.18	31.09	-1144.8	94.37	70.25	33.48
$JB_{Norm.}$	14.02 [0.00]**	6.81 [0.03]*	5.20 [0.07]	7.89 [0.02]*	7.39 [0.01]*	4.04 [0.13]	5.46 [0.07]
$LM_{Auto.}$	58.64 [0.00]**	1.47 [0.24]	3.90 [0.03]*	0.42 [0.66]	2.19 [0.13]	1.80 [0.18]	-
$WT_{Hetro.}$	7.63 [0.00]**	6.86 [0.00]**	5.0860 [0.01]**	1.22 [0.32]	0.71 [0.72]	1.46 [0.18]	-
RESET	60.52 [0.00]**	1.96 [0.15]	1.85 [0.17]	5.05 [0.00]**	0.76 [0.48]	1.98 [0.15]	2.06 [0.14]

a) Where '*', '**', '***' represents 1%, 5% and 10% significance level w.r.t *t-ratios* respectively.

b) $JB_{Norm.}$, $LM_{Auto.}$, $WT_{Hetro.}$ and RESET are the Jarque-Bera normality test, Lagrange multiplier test Autocorrelation, White heteroscedasticity test and Ramsey's test for correct specification, respectively. Later, three tests are based on $\chi 2$-distribution with 2 *d.f.*

c) While '*', '**' in ***Panel B*** shows the model didn't pass the diagnostic tests at 5% and 1% level of significance respectively.

Note: Author's own calculations

3.3 Exogeneity of Domestic Savings in FH–equation

Based on a rigorous and detailed discussion on non-stationarity and cointegration in last two sub-sections (a) and (b), we came up with these conclusions: i) both investment and savings are non-stationary i.e. I(1) at levels; ii) we found no signs of cointegration among investment and savings; iii) the estimated FH–equation in (4.6) is no more spurious. So, in view of this we can't apply (Hendry, 1995) methodology directly to test exogeneity. Therefore, to perform exogeneity tests in this case, we will use the following equations:

$$\Delta inv_t = \alpha + \beta \Delta sav_t + \sum_{i=1}^{m} \tau_{i,\alpha_2} 1_{\langle t=t_i \rangle} + \sum_{i=1}^{m} \rho_{i,\alpha_1} 1_{\langle t \geq t_i \rangle} + \mu_t \quad (5)$$

$$\Delta inv_t = \sum_{i=1}^{T} \delta_{1i} \Delta sav_{t-i} + \sum_{i=1}^{T} \delta_{2i} \Delta inv_{t-i} + \mu_{1t} \quad (6)$$

$$\Delta sav_t = \sum_{i=1}^{T} \varphi_{1i} \Delta inv_{t-i} + \sum_{i=1}^{T} \varphi_{2i} \Delta sav_{t-i} + \mu_{2t} \quad (7)$$

According to our discussion in subsection-b and in view of the above equations, the equation (5) can be considered as true DGP or correct functional form to estimate FH–equation. We call this equation as conditional process/equation. Whereas, (6) and (7) are the marginal processes/equations. The condition which determines the failure of Granger-Causality of savings on investment is $\delta_{1i} \neq 0$ and $\varphi_{1i} = 0$. Furthermore, since we have unit root in our data, the Granger-Causality test will be biased if we estimate VAR at levels. Therefore, in this case we have to estimate VAR at first difference. At the end, to capture contemporaneous effects we will use the residuals from this differenced VAR model.

3.3.1 Weak Exogeneity and Contemporaneous Test

As mentioned above, both investment and savings series are not cointegrated, we can't apply (Hendry, 1995) methodology to test exogeneity. It is worth noting that the models estimated by a single equation will produce biased results, provided that the right hand side variables are not exogenous. So, to get unbiased estimates, one ought to check the exogeneity status of the variables being modeled in the equation. Furthermore, it is necessary for any statistical inference (Engle et al., 1983; Ericsson, 1991). In order to test the exogeneity of this type, statistical tests of WeExt are available in literature. One is the LM-test of WeExt proposed by (Engle, 1984) and the other one is named as Durbin-Wu-Hausman Test of WeExt mainly due to (Durbin, 1954; Hausman, 1978; Wu, 1973). In order to perform the Engle test of WeExt, we obtained the error of conditional equation (5) and used them in the marginal model of savings equation (6) as an independent variable. The results of this test are

shown in Table 5 below, and as can be seen, the estimate of error term of conditional model is not statistically significant in the marginal model (6). A p-value of 0.482 in Engle's test supports the assumption that domestic savings is weakly exogenous in the FH–equation, meaning it is not significantly influenced by past investment shocks. This allows the variable to be used as an independent regressor in further econometric analysis. On the other side, the Durbin-Wu-Hausman test is a test for the endogeneity of some, or all variables in the model. This test is available for non-panel equations estimated by GMM or TSLS. However, in this study we used GMM technique and based on this test, we can't reject the null hypothesis that domestic savings is exogenous. While estimating test we used lags of differenced variables as instruments. Furthermore, the rejection of H0 highlights the fact that the endogenous regressors have meaningful impacts. The argument about the WeExt of domestic savings is further strengthen by applying another test of endogeneity named as Wu-Hausman test proposed by (Hausman, 1978; Wu, 1973)[8].

Table 5: Tests of Weak Exogeneity[9]

Test Name	**The Engle Test** LM-Stat. H0: Regressor is weakly exogenous	**The Durbin-Wu-Hausman Test** GMM estimation (IV Regression) H0: Regressor is exogenous	**The Wu-Hausman Test** H0: Regressor is exogenous
Test Statistics	Coefficient *(p-value)* = 0.293 *(0.482)*	Diff. in J-stat.[10] *(p-value)* = 1.272 *(0.259)*	t-stat. *(p-value)* = 1.044 *(0.307)*
	Test for Contemporaneity H0: Correlation is zero *i.e.* $Corr.(\mu_t, \mu_{1t}) = 0$ t-stat. *(p-value)* = 0.718 *(0.476)*		

Note: Author's own calculations

For Wu-Hausman test, we estimate (5) first, and run the suspect variable i.e. domestic savings on the instruments (Δinv_{t-1} and Δsav_{t-1}). Then estimate residual from this equation and make these residuals as independent variable in the original estimated equation (5) and check its significance by using usual t-test. The insignificance shows that there is no endogeneity bias in the OLS estimates making domestic savings is weakly exogenous. All outcomes are being accessible above in Table 5.

The test that verify the correlation between the errors of equation (5) and (7) is a test of contemporaneity discussed in (Engle, 1984). This test is used to determine whether the errors of both equations are contemporaneously correlated or not? For that, we first estimate our conditional model (5), estimate its residuals μ_t. Then estimate the marginal model (6) and call its residuals μ_{1t}. After that we performed regression using OLS and the estimated t-test highlighted the fact that we can't reject the null hypothesis and therefore, according to this there is no contemporaneous effect between residuals. The results are being discussed above in Table 5. Based on these results, we can say that the model can be used for statistical inference.

3.3.2 Testing Strong Exogeneity

Whether an econometric model can be used for forecasting purpose or not? The answer lies in whether independent variable is strongly exogenous or not. If it is so, then the estimated model can be used to make better forecasts. Otherwise, it can't be used to makes forecasts (Engle et al., 1983). The StExt of domestic savings depends upon two conditions i) Savings is Weakly Exogenous ii) Investment doesn't cause savings in Granger sense. The Granger Causality (GC) test was introduced in (Granger, 1969). It is worth noting that the GC-test is in-fact not a true sense of causality test but it is just a predictability test as suggested by (Hoover, 2001). Since in last section, we have shown that domestic savings is weak exogenous. Therefore, it is sufficient enough to check the direction of causality only. Now, both the variables are I(1), so VAR at levels will produced biased results (Hamilton, 1994). Therefore, in order to apply GC-test, we first estimate difference VAR with lag length one[11]. After that we will apply GC-test to test the StExt status of savings in estimated FH–equation. The outcomes of GC-test are given below in Table 6. Clearly, it can be seen that domestic savings

[8] This test is only as good as the instruments used and is only valid asymptotically. This may be a problem in small samples and so generally this test is used only when sample size is above 100.

[9] All these estimations have been done in OxMetrics and E-Views (Version 9).

[10] Diff. in J-Stat. = (Restricted J-statistic) – (Unrestricted J-statistic) = 3.044 - 1.771= 1.272

[11] All information criteria report the lag length of one except Final Prediction Error (FPE) for estimating VAR with differenced variables.

granger cause investment but converse is not true. Therefore, the FH–equation can be helpful to make future predictions about Pakistan's economy. The existence of StExt of savings highlights that the model can be helpful for forecasting purpose. The Granger causality findings on savings drive investment suggests that policies should focus on enhancing domestic savings, improving financial sector efficiency, and ensuring stable macroeconomic conditions. This will help boost capital accumulation, reduce reliance on foreign borrowing, and enhance economic growth in Pakistan. In the next section, we will test whether the FH–equation can be used for policy changes or not, will be verified through the lens of SuExt tests.

Table 6. Test for Causality

Equation	Omitted	χ^2	No. of Lags	Prob. > χ^2
Δinv_t	Δsav_t	0.976	1	0.0009
Δinv_t	All	0.976	1	0.0009
Δsav_t	Δinv_t	0.331	1	0.945
Δsav_t	All	0.331	1	0.945

Note: Author's own calculations

3.3.3 Testing Super Exogeneity

The SuExt of the variables of interest ensures valid policy simulations (Engle et al., 1983; Hendry, 1995). In a seminal paper (Lucas, 1976), argued that, the agent changes their behavior whenever a policy maker changes the policy. Therefore, economic policy based on any econometric model faced under rational expectations could not be used. Consequently, the parameter estimate would not be the same before and after the policy/regime change. However, in seminal work by (Davidson et al., 1978) on UK's consumption function named as DHSY model, provided several conditions under which Lucas' critique is invalid. The variables fulfill these conditions were then called super exogenous with respect to parameters of interest against the relevant class of interventions, leads to help in designing economic policies. Two tests of SuExt, first by (Engle & Hendry, 1993) and other by (Charemza & Király, 1990) are used.

These tests examine whether the distribution of savings remains stable despite changes in the policy environment. If savings fails the super exogeneity test, it suggests that policy changes (e.g., capital account liberalization, interest rate deregulation) affect savings behavior, rendering traditional FH–equation estimates unreliable for policy simulation. Thus, applying the Lucas' critique through SuExt testing ensures that the savings-investment relationship remains valid for inference, forecasting, and policymaking in Pakistan.

Now to implement the first testing procedure, we consider the marginal model of savings following the process described in (Engle & Hendry, 1993) with four lags. We used general-to-specific modelling to get the final model along with two significant impulse dummies[12]. After estimating the marginal model (8) we stored its residuals and calculate the square of those residuals.

$$sav_t = 0.723 + 0.809sav_{t-1} + 0.155sav_{t-4} + 0.345IIS2000 - 0.319IIS2008 + \mu_{3t} \quad (8)$$

R2 = 0.98 LMAuto.χ2 (2) = 0.55(0.54) JBNorm.χ2 (2) = 1.05(0.59)
ARCHHetro.χ2(2) = 2.11(0.13) BPGHetro.χ2(4) = 4.83(0.004)
DW stat. = 1.82

Once we get the squared residuals, we use these residuals and their lags as independent variables in our estimated conditional model (5) and check their joint significance. If the squared residuals and its lags were insignificant in (5), then we say that domestic saving super exogenous with respect to parameters of interest. The test of joint significance is being reported below in Table 7, showing that the squared residuals and its lags are insignificant. Therefore, implementing the test proposed in (Engle & Hendry, 1993) showing that the domestic savings are super exogenous.

The other test of SuExt is based on (Charemza & Király, 1990) and unlike to the previous test, this test has the

[12] IIS2000 is for Musharraf era and IIS2008 for Global Financial Crisis.

benefit that it does not necessitate the pre-estimation of the marginal model. The idea behind this test is to calculate a regression in which the forecast error of conditional equation (5) is the dependent variable. Domestic saving's first difference and lags of it, taken as independent variables. These independent variables must be insignificant in order to accept SuExt. Therefore, the test accepts the fact that domestic saving is super exogenous for the estimated FH–equation. The results of both tests are reported below in Table 7. Lastly, this discussion leads us to conclude about the nonexistence of Lucas critique in case if FH–equation for Pakistan. Therefore, the estimated FH–equation can be used for policy models based on simulations. Nonetheless, for more detailed overview, a simulation study on the performance of these tests showing that the test proposed by (Engle & Hendry, 1993) performs better than that of (Charemza & Király, 1990) have been well documented in (Jawad, 2023).

Table 7: Tests of Exogeneity

Name	Engle and Hendry Test	Charemza-Király Test
Test Statistics	F-test (Prob. > F) = 0.22 (0.80)	F-test (Prob. > F) = 0.68 (0.61)

Note: Author's own calculations

4. Conclusion

Unlike other studies in the literature, this research reveals no evidence of cointegration between domestic savings and investment. As a result, it becomes necessary to explore the exogeneity of domestic savings in the FH–equation. Various exogeneity testing procedures were employed to assess this relationship, ultimately concluding that domestic savings are exogenous in the FH–equation. For the past fifteen years, Pakistan has experienced relatively low domestic savings compared to its investment levels. As a result, the rates of return on capital have remained high. This imbalance suggests that the country may have been dealing with persistent trade deficits. The FH hypothesis posits that under perfect capital mobility, domestic savings and investment should be uncorrelated across national boundaries, a theory supported by the contemporaneity test (Subsection C (i), Table 5). An increase in the budget deficit typically leads to a decline in both domestic savings and investments. This, in turn, triggers capital inflows, such as remittances, to help offset the fiscal shortfall. Consequently, foreign currency flows in as international financial assistance, leading to an appreciation of the real exchange rate. This appreciation causes exports to decline and imports to rise, ultimately worsening the current account deficit.

The FH–equation findings provide valuable insights into Pakistan's capital mobility and the relationship between domestic savings and investment. As in the case when breaks were not taken into account, the results indicate low capital mobility–meaning investment is largely financed by domestic savings–Pakistan must focus on strengthening its domestic savings rate. Policies should encourage long-term savings through pension funds, tax incentives, and financial literacy programs to enhance savings behavior. Additionally, financial sector reforms should improve credit allocation efficiency, ensuring that saved capital is effectively funneled into productive investments such as infrastructure, manufacturing, and technology-driven industries. Enhancing the role of capital markets by developing corporate bonds and mutual funds can provide alternative investment avenues, reducing reliance on traditional bank financing.

On the other side, when breaks were considered, the FH–equation results suggest high capital mobility, implying that investment is less constrained by domestic savings, Pakistan should focus on attracting foreign direct investment (FDI) and external financing while managing associated risks. Policies should improve the ease of doing business, strengthen investment protection frameworks, and offer sector-specific incentives to foreign investors. However, excessive reliance on foreign capital inflows can lead to external vulnerabilities, necessitating prudent debt management strategies and exchange rate stability measures to prevent financial crises. Pakistan must also prioritize high-return sectors, such as export-oriented industries and technology, to ensure that foreign capital is utilized efficiently, ultimately driving sustainable economic growth and stability.

This paper serves as a foundation for cross-country analyses of the FH-hypothesis, enabling the examination of regional disparities and their impact on the hypothesis's validity across different geographic areas. While this study provides valuable insights into capital mobility in Pakistan, several limitations should be acknowledged.

The reliance on the savings-investment correlation as a measure of capital mobility could be complemented by alternative approaches, such as gross capital flows or interest parity conditions. Although exogeneity tests confirm the robustness of savings as an independent variable, the potential for reverse causality between savings and investment suggests the need for further analysis using simultaneous equation models like 3SLS or GMM. Future research could also explore sectoral dynamics by distinguishing between household and corporate savings or private and public investment to provide more granular policy insights. Moreover, expanding the sample period or employing rolling regressions may also provide a more dynamic view of how savings-investment dynamics evolve over time.

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Author's Contribution

Conceptualization, M.J., M.A.K. and M.S.; Methodology, M.J. M.A.K; Software, M.J.; Investigation, M.J, M.S.; Writing and Original Draft Preparations, M.J., M.A.K. and M.S.; Review and Editing, M.J., M.A.K and M.S.

Acknowledgments

The author must acknowledge the support in conducting the research work.

Funding

No financial support is being attached in preparing this work

Statement of Disclosure

No potential conflict of interest was reported by the author(s).

Data Availability

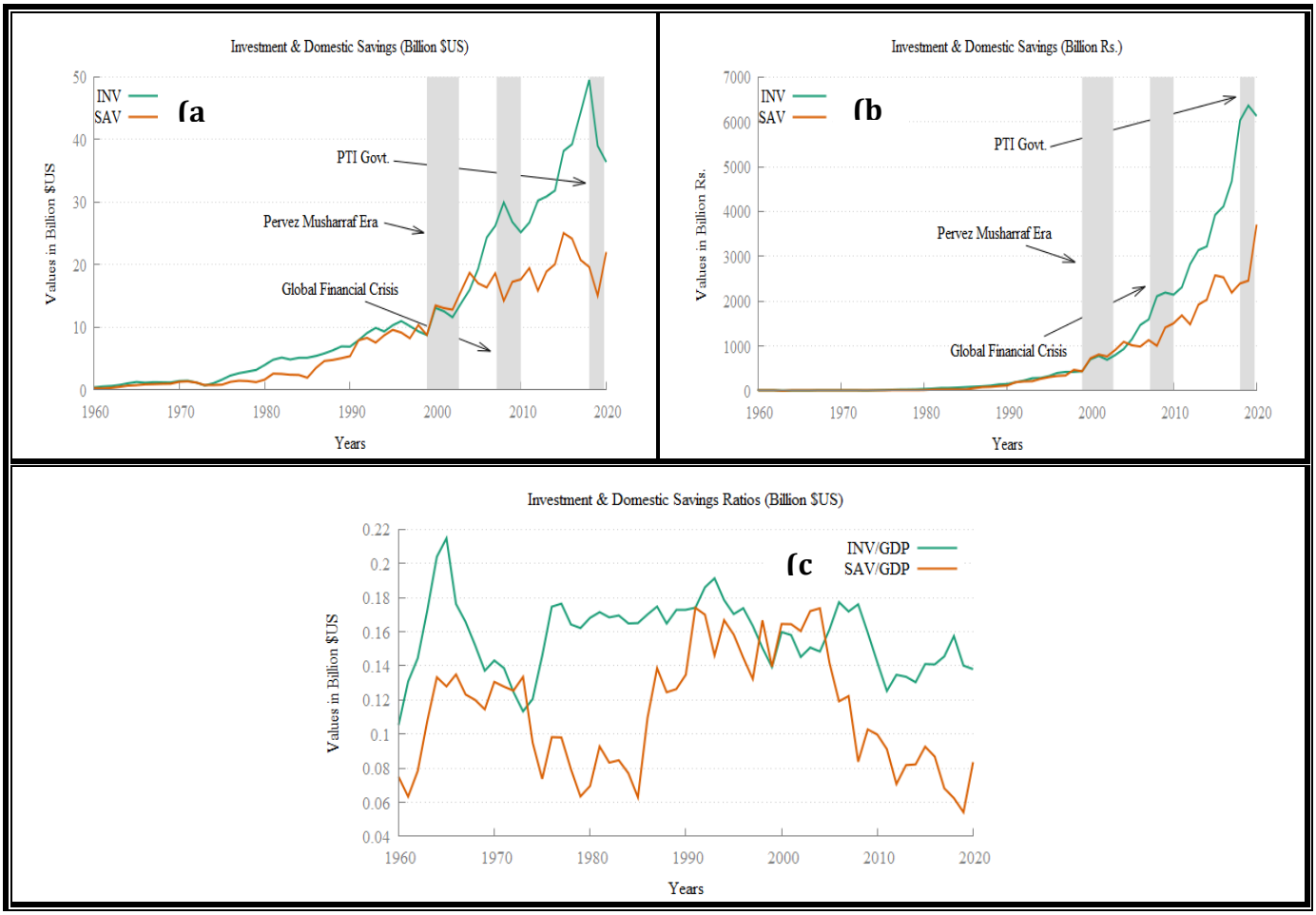
Available on the sources mentioned in the text.

Disclaimer

The views and opinions expressed in this paper are those of the author alone and do not necessarily reflect the views of any institution.

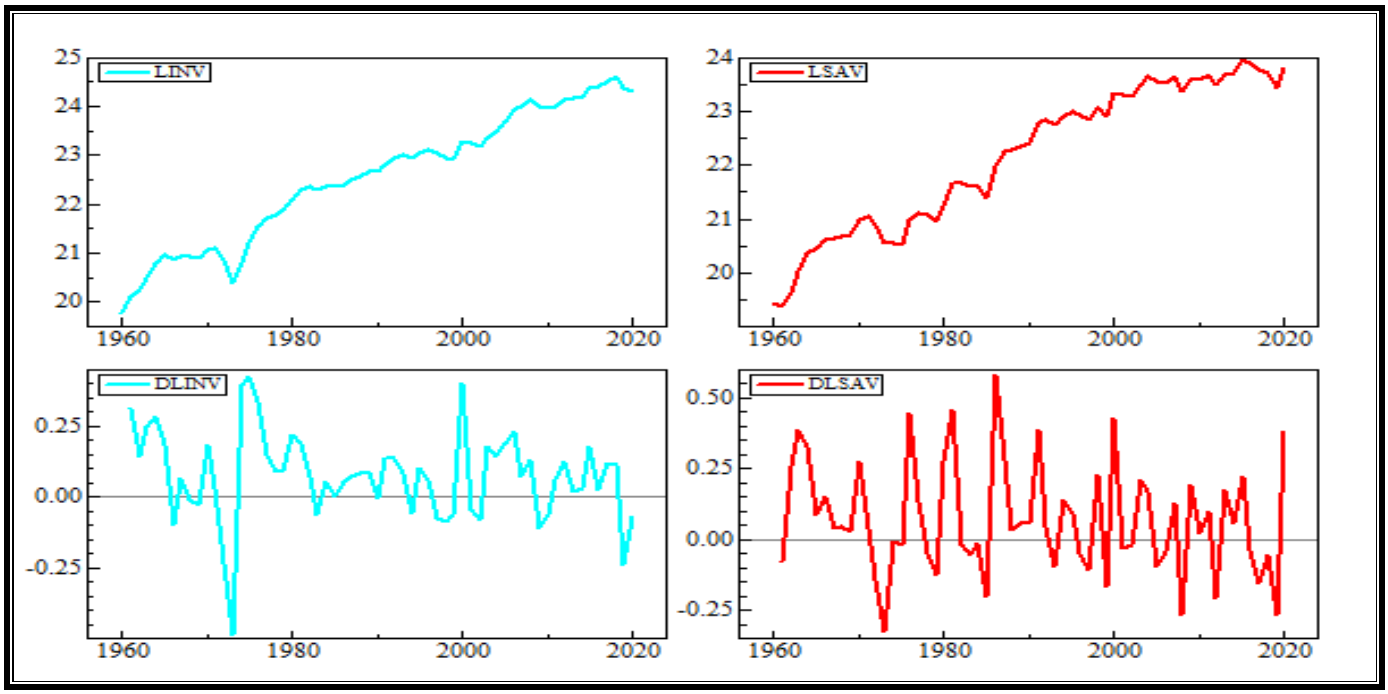
Appendix-I

Figure 1: Investment and Domestic Saving in Levels with Possible Break Regimes



Sources: *World Bank Development Indicator, SPB & PBS*

Figure 2: Investment and Domestic Saving in Logarithmic and Changes



Source: *Author's own calculations*

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Pakistan Journal of Economic Studies

ISSN (E) 2708-1486 (P) 2708-1478
Volume 8: Issue 1 January-March 2025
Journal homepage: https://journals.iub.edu.pk/index.php/pjes/index

Women's Odyssey for Economic and Sustainable Development as Non-Academic Communities: A Photovoice Approach

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ARTICLE DETAILS

History:
Accepted: 20 March 2025
Available Online: 21 March 2025

Keywords:
ECONOMIC
SUSTAINABILITY
PHOTOVOICE
WOMEN
NON-ACADEMICS

JEL Codes:
3-5 JEL Codes as per Keywords
JEL Code 1
JEL Code 2
JEL Code 3

ABSTRACT

Objective: This research explores the perspectives and experiences of women in promoting economic sustainability within non-academic communities.

Research Gap: Employing the photovoice methodology, the study aims to empower women to share their unique insights and identify potential challenges and opportunities. By focusing on non-academic populations, this research challenges the prevailing narrative that sustainability is primarily driven by the educated elite. It highlights the critical role of women in fostering economic resilience and sustainable development among non-educated.

Design/Methodology/Approach: This qualitative research is based on the unique methodology of Art Based Research (ABR), named as photovoice. The objective is to showcase selected photography as a form of art and beauty found in nearby community in all its colors to bridge gaps, connect minds and build consciousness.

The Main Findings: The study's findings, based on women's photographic narratives, reveal a range of challenges and prospects for promoting economic sustainability in non-academic settings. Reflexive Thematic Analysis helped categorize major themes named as Sustainability Challenges in Non-Academic Communities and also Potential Sustainability Achievements in Non-Academic Communities, both further comprises of several categories and codes, providing clearer insights.

Theoretical / Practical Implications of the Findings: These insights can inform targeted interventions and policies aimed at empowering women and fostering economic growth in underserved communities. Findings are worth communicating and considerable for stakeholders and government officials both at national and international level because the community that is educated needs to connect those, where it is really deficient.

Originality/Value: All content is original and intended for research, educational, and non-commercial purposes. Also allowing the scenes to speak for themselves and inviting viewers to find their own connections, narratives and practices.

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Recommended Citation:

Irshad, R., Sarwar, N. & Naeem, M. A. (2025). Women's Odyssey for Economic and Sustainable Development as Non Academic Communities: A Photovoice Approach. *Pakistan Journal of Economic Studies, 8*(1), 56-71. Available at: https://journals.iub.edu.pk/index.php/pjes/article/view/3380

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1. Introduction

Sustained development meets the needs of the present without compromising the ability of future generations to meet their own needs. Therefore, there should be the active participation of all sectors of society in this concept. Women's empowerment is necessary in sustainable development since through them, some voice will be

provided to air their concerns and be part of the decision-making processes (Komuhiimbo 2015). Involving the illiterate population, especially women, demonstrates greater insight into most issues related to their local environments.

Consciously, women's voices are essential in building habits that may benefit sustainable practices, as women are usually the ones facing degradation. In Pakistan, for instance, where most main household roles fall on women, bringing women's thought on board in the provision of environmental education can significantly boost sustainability efforts (Imran et al. 2021). Addressing economic dependencies and inequalities empowers women to be productive and perform more of their part in sustainable community development initiatives (Kimor, 2013).

1.1 Theoretical Framework

This research aligns well with Social Capital Theory and Self-Determination theory, both theories provide a strong theoretical foundation for understanding how women in non-academic communities navigate economic challenges and explains motivation towards sustainable economic and social development.

1.1.1 Social Capital Theory and Women's Economic Empowerment

Social Capital Theory (Putnam, 2000) argues that economic and social well-being are strengthened through relationships, networks, and community engagement. Women in non-academic communities often rely on social networks, mutual support systems, and collective action to achieve financial stability and sustainability These networks enhance women's economic resilience and foster sustainable practices such as cooperative farming, ethical trade, and local sustainability initiatives.

1.1.2 Self-Determination Theory

Self-Determination Theory (SDT) explains how intrinsic and extrinsic motivations drive human behavior. According to SDT, individuals strive for autonomy, competence, and relatedness, which are essential psychological needs for personal growth and well-being (Deci & Ryan, 2000).

Women in non-academic communities strive for autonomy by seeking financial independence and gaining decision-making power within their households and communities. Their engagement in small businesses, community work, or entrepreneurship enhances their competence, allowing them to develop essential skills, build confidence, and contribute meaningfully to economic growth. Additionally, relatedness, as explained by Social Capital Theory, plays a crucial role in their journey, as social connections enable women to collaborate, support each other, and create opportunities for collective success. These three psychological needs—autonomy, competence, and relatedness—drive women's economic empowerment and sustainable development, fostering resilience and long-term financial stability.

This research approach aligns with the principles of participatory research, allowing women to reclaim their narratives and drive the discussions towards the economic and societal changes they seek.

1.2 Research Objective

To examine the perceptions and experiences of women of Bahawalpur, regarding challenges and potential prospects of sustainability, particularly in context of non-academic community.

1.3 Research Question

What are the visual and narrative perspectives of young women of Bahawalpur region on raising awareness of sustainability among non-academic populations?

2. Literature Review

Gupta et al. (2020) further indicate that enhancing the mobility and leadership of women enhances health improvement, most importantly, strengthens the capabilities in communities, thereby improving sustainable development. The above finding is supported by similar conclusions; through collective action, women's collectives engage in sustainable practices and thus address their social realities to embrace grassroots

sustainability (Dhal et al., 2020). Cultural setting further will be supported by literature in relation to availability of resources to women and their role during the undertaking of economic activities.

Moreover, this is further reiterated that what essentially constitutes the role of women in business as an accelerator for better economic activity by pointing out what obstacles are encountered and what strategies need to be devised in order to craft effective ecosystems to facilitate the women entrepreneur (Bhuvaneswari, 2024). The use of mobile technology in women's entrepreneurship enables avenues for enhancing gender equality and long-term economic stability (Karyotaki et al., 2022). Involvement of women in economic development cooperatives has been shown to enhance their agency while also having a positive effect on their economic outcomes.

Raniga (2016), in research on women's experience in economic development cooperatives, shows that this is the same platform that gives women power because of power equalization and creates an amenable space for economic engagement. Also, literature suggests that women entrepreneurs are the ones who play an essential role in promoting sustainable practices. In this respect, Barrachina et al. (2021) contend that female-owned enterprises are even more focused on sustainability-for instance, they reflect their contribution to economic development besides the socio-economic activity.

This statement is even more relevant to the Pakistani context in which women entrepreneurs are increasingly becoming the most important drivers of economic growth. Such engagement in sustainable entrepreneurship may not only meet local economic needs but also contribute to global sustainability aims while perhaps working towards improving the socio-economic fabrics in their communities. Furthermore, Naveed et al. (2023) show that direct relationships exist between women's economic rights and economic growth; therefore, improvements in those rights may be indirectly regarded as having positive effects on the economy. It will, thereby, help promote the policy interventions capable of improving women's economic rights in Pakistan and of facilitating their participation in the different economic sectors, thus becoming a pathway towards sustainable development. Literature also states that involving illiterate ladies of Pakistan is highly essential in sustaining with environmental education and that it is relevant to all the human beings (Imran et al., 2021).

To put it in short words, Sharma et al (2023) also highlights that rural women of Pakistan be integrated in development programs like sustainable development so that the development plan can be made more inclusive and gender-sensitive: Involving both educated as well as uneducated populations. The literature shows that photovoice is an important method in empowering women by allowing them to share their experiences and opinions that contribute to social involvement and activism (Budig et al., 2018; Coemans et al., 2017; Huma et al., 2020). Various researchers found that it is beyond comprehension and understanding through participation, providing an opportunity for those participating to voice their requirements and expectations (Mtuy et al., 2021; Mwalabu et al., 2021, Röger-Offergeld, 2023).

It's an important study because there is a need for increased awareness of sustainable development among the end non-academic populations. A large number of our country belongs to that group, which is not aware of the SDGs. The need lies in taking steps at every level, rather than limiting it only to academics. This article, above all, talks about women's perception regarding raising and nurturing that needs sustainability to every level, from slum to elite.

Findings of studies reveal that photovoice in community-based participatory research strengthens the women's agency and influence over decision-making in sustainable development (Filho et al., 2019; Payne, 2023). Literature depicts the idea that women are empowered through participatory research and it contributes more towards the better understanding of difficulties and solutions concerning sustainable development (Ardrey et al., 2021; Khanal, 2023).

1.4 Research Gap

As discussed earlier, photovoice eventually enables participants to describe and detail their stories and knowledge. By engaging women in the process of capture and storying of their experiences, photovoice can

foster a sense of agency and ownership to the storyline (Lorente-Echeverría et al., 2023), thus identified as methodologic gap in the given area of research. An initiative such as photovoice has been used to positive effect in bringing the contributions of women in environmental stewardship and community resilience to the policy and practice attention of local and national levels (Lorente-Echeverría et al., 2023; Samad & Alharthi, 2022).

3. Methods

3.1 Justification for Unique Methodology

In exploring the unique methodology of photovoice for this research idea, it is essential to articulate the benefits of employing an art-based research methodology. Photovoice, fundamentally rooted in participatory action research (PAR), serves to empower marginalized groups, promoting social change through visual representation, dialogue, and community engagement. Using photovoice as a methodology for studying women's journeys towards economic and sustainable development not only enables participants to express their lived experiences visually but also fosters community dialogue and empowerment.

The methodology is particularly effective due to its participatory nature, allowing participants to actively engage as co-researchers in the process of data collection and analysis. Foster-Fishman et al. (2005) highlight that photovoice facilitates participant empowerment by fostering personal reflection, dialogue, and shared experiences among community members, which is critical for social development. Similarly, Strack et al. (2004) find that engaging youth through photovoice encourages meaningful participation, enabling participants to share their perspectives on issues affecting their communities. The visual aspect of photovoice encourages participants to articulate their experiences and narratives, making their voices visible and influential to stakeholders and policymakers (Breny & Lombardi, 2017).

The ethical framework within which photovoice operates also supports its relevance to the proposed research. Röger-Offergeld et al. (2023) discuss the importance of ethical considerations in community-based participatory research that involves vulnerable populations—something that photovoice addresses through informed consent and co-ownership of the data produced. Furthermore, the flexibility of photovoice allows for adaptations to specific community contexts, ensuring culturally relevant and inclusive research outcomes (Bennett et al., 2019).

3.2 **Participants**

This study is a form of art based research which is actually a community research. Hence considering the requirement of the particular research, population is taken as community members. Volunteer community members were considered the participants. The entire study includes young women only, a total of eight active participants. Out of these, six were community participants and additional two participants were the travelers and researchers, residing in cities of Bahawalpur region, Pakistan.

3.3 Research Design

This cross-sectional study is qualitative in nature, based on the unique methodology of Art Based Research (ABR) because of interest in photovoice as a community approach, best suitable to raise voices of women of the community.

3.4 **Data Collection**

Collected data is in the form of photographs and narrations. Sight photographs were selected for analysis, and were taken by researchers and other participants of the study.

3.5 Procedure

This study was actually planned considering a particular theme of the conference of Bahawalpur region. Theme and methodology of the study was finalized considering the conference areas, interests and expertise of the researchers and willingness of the participants. Many participants were requested as per their interest in the research. Almost 80 % of the participants found the idea and methodology unique and attractive so they readily provided their willingness. The plan was finalized through review of literature, which was initiated by clicking photos first.

Multiple narrations are attached with each photograph as shown by figures; which will be mentioned in next chapter. First narration is original, provided by the one who have taken photograph and also part of narration is provided by another participant, and with a purpose to achieve triangulation. A total of 14 photographs were collected, 11 of which were selected for current study. Three photographs were discarded because of less relevance and mutual concern among all the participants. Out of 11, 8 photographs were selected to be rich in content for further analysis. While three photographs were included in the chapter of discussion for further exploration.

Ethical standards regarding snapping were followed. The participants were properly instructed by a visual art practitioner and guided by taking pictures and narrating well, fulfilling the ethical requirement of photography. Participants were also given trials of photography before photographing for actual study.

Careful dealing with data, made researchers able to title the photographs, and to identify underlying themes from the narrations of the participants. Resulted ideas from the narrations and photographs were thematically analyzed and classified into useful categories of information.

4. Findings of the Study

Research participants received clear instructions on photography and related ethical guidelines. They not only captured images but also wrote accompanying narratives that aligned with the research objectives.

Figure 1: World beyond the Written Words

The picture was taken near Darbar Hazrat Mehboob Subhani R.A (cultural & community engagement center). For those who are unable to read the written messages, we should conduct campaigns that visually explain how to create a healthy environment. Simple language speeches, workshops, videos, and activities can guide and involve this community in practical skills. Engaging the leaders and elderly of this community is crucial for driving positive change.

Figure 2: Invading Sustainability

The picture was taken at *Rainbow Lake, Domel,GB* (public tourist spot). Sustainability is crucial in preserving the beautiful environment depicted in this picture. Plastic waste is one of the biggest threats to our environment, as it takes hundreds of years to decompose. This waste often ends up in oceans, lakes, and rivers, harming wildlife and disrupting ecosystems. By reducing plastic use, and encouraging visitors to respect nature, Sustainable tourism ensures that future generations can enjoy such breathtaking landscapes. It's all about finding a balance between enjoying nature and protecting it!

Figure 3: In the Heart of Desert

The picture was taken in Cholistan Desert (community living settlement). In the heart of the desert, a child stands next to their loyal animal companion, both taking in the breathtaking landscape. The desert ecosystem is also very delicate. The plants and animals living there depend on each other. If we leave plastic waste like cans and bottles behind, it can lead to pollution, which harms the living creatures there and degrades their habitat.

Figure 4: Roadsides

This photo was collected from Chanan Pir Mela, Rohi, Cholistan desert (community engagement event). In the photo, a person stands next to a vibrant pile of sweets and treats. In this picture, a laborer is selling sweet candies and toffees on the roadside. While this is indeed a good source of income for him, it is not beneficial for our environment and health. Open food items on the roadside are exposed to dust and germs, which can be harmful. Additionally, the use of plastic bags contributes significantly to environmental damage. Both of these

practices are detrimental to our environment.

Figure 5: Sweetness to Meet Ends

This photo was collected from Chanan Pir Mela, Cholistan Desert (cultural community engagement event). A significant portion of the population, often unaware of the environmental consequences, overlooks the impact of their daily actions. Excessive use of plastic and low-quality products contributes significantly to a lack of sustainability. These individuals should not only be informed about sustainable development but also provided with alternative methods to promote sustainability.

Figure 6: Perfect Imbalance

The picture was collected form Sadda Bahar plants Narsury near The Islamia University of Bahawalpur. Placing plants in Plastic has more disadvantages than advantages as plastic itself is not safe. For the flowers to grow, it's better to expose them to sunlight as much as you can and remove them from plastic bags for proper ventilation and growth! As this green life is very significant, so using plastic bags is a great contradiction that we face. This picture depicts contradiction, promoting life at the same time limiting life. Plants in the pot shows life whereas plastic around the pots is reducing life at larger end of sustainability. This message needs to be realized by every member of the community as sustainability can never be achieved by efforts of the leaders unless it is conveyed to root level individuals.

Figure 7: Contradiction

The picture was taken near *Tomb of Javindi Bibi*, *Uch Sharif* (shop near market place) .This portrays the unhygienic conditions of rural areas. Everything is scattered, the same utensils are used, open plastic bottles are everywhere, and people are not wearing gloves, all of which increase the risk of unsanitary conditions and negatively impact individual health after consuming such food.

Figure 8: Global Issue

This picture was taken near Kargun Tyube, Bokhtar in southwestern Tajikistan (Sunday Bazar activity) depicts an active Central Asian women's community representation that relies on selling food products or snacks for their livelihood in a Sunday market. However, she may not be aware of the environmental impact their display practices have on both present and future generations. It's the responsibility of the educated community to raise awareness about the disadvantages of plastic and promote the use of eco-friendly products. Canvas or woven bags are readily available, practical alternatives to plastic. Additionally, guidance on plastic bag recycling should be provided.

Given below is the table that is generated by the researchers based on all the narratives provided by the participants. The given table is another form of qualitative research; that relates content analyses. Based on interpretative thematic analyses, major themes of the ideas from narrations were classified into meaningful groups. These groups were then classified into major themes "Problems" and "Solutions".

Table 1: Voice of Women Derived from the Narrations of the Photographs

Problems	Frequency	Solutions	Frequency
Overuse of plastic	5 (Fig. 1, Fig. 2, Fig. 5, Fig. 6, Fig. 8)	Reduce plastic products	7 (Fig. 1, Fig. 2, Fig. 3, Fig. 5, Fig. 6, Fig. 7, Fig. 8)
Unhygienic selling	3 (Fig. 4, Fig. 7. Fig. 8)	Promote sustainability at ignored levels	7 (Fig. 1, Fig. 3, Fig. 4, Fig. 5, Fig. 6, Fig.7, Fig. 8)
Unhygienic food	3 (Fig. 4, Fig. 5, Fig. 7)	Use recyclable packing materials	5 (Fig., 2, Fig. 4, Fig. 5, Fig. 6, Fig. 8
Dusrupting ecosystem	3 (Fig. 3, Fig. 5, Fig. 6)	Incorportae sustaianble businesses practices	5 (Fig. 2, Fig. 4, Fig. 5, Fig. 7, Fig. 8)
People miss sustainability messages	2 (Fig. 1, Fig. 2)	Promote grassroots sustainability	5 (Fig., 3, Fig. 4, Fig. 5, Fig. 7, Fig. 8)
Contradictory life styles of humans	2 (Fig. 2, Fig. 6)	Employ multiple instructional approaches	4 (Fig. 1, Fig. 4, Fig. 5, Fig. 7)
Threatening future generations	2 (Fig. 2, Fig. 5)	Reduce Unhealthy food selling	3 (Fig. 4, Fig. 7, Fig. 8)
Damaging current generation	1 (Fig. 5)	Tae care of life, under water, over land	3 (Fig. 2, Fig.3, Fig. 6)
Selling healthy in unhealthy way	1 (Fig. 1)	Promote plantation	2 (Fig. 2, Fig. 6)
		Approach local community leaders	1 (Fig. 1)
		Promote sustainable tourism	1 (Fig 2)

Table represents the voice of women derived from the narrations of the photographs. Challenges identified from the narrations are sequenced according to the frequency of the theme reported by women. Similarly, prospects are stated as per frequently reported ideas. Moreover, reference of the figures is also given to indicate the said challenge and solution is reflected by the respective narration and photo.

Figure 9: Key Findings of the Study: Classified Sustainable Challenges and Potential Achievements in Sustainability

Source: Generated by AI

5. Discussion

This research aims to increase awareness of sustainable development among the non-academic population, which constitutes a significant portion of our country. By focusing on the perspectives of women, particularly about non-academic backgrounds, we can identify effective strategies for promoting sustainability at all levels of society. Findings of the study were further analyzed thematically and two patterns were generated from the photographs and narrations of the participants. Sustainability Challenges and Potential Sustainability Achievements were further classified into useful groups based upon the principle of similarity.

4.1 Sustainability Challenges in Non-Academic Communities

Here, sustainability challenges mean the issues or problems of non-academic community that our women participants perceived as major barrier in way to achieving sustainability. In other words, sustainability challenges in non-academic communities, particularly as perceived by women participants, encompass a range of barriers that hinder the achievement of sustainable practices. These challenges are further categorized as environmental impact, public health concerns, and societal issues.

4.1.1 Environmental Impact

Environmental impact as a category under the major theme sustainability challenges in non-academic communities is further based on the facts derived from the research participants. These facts are often termed as codes and are here named as overuse of plastic, disrupting ecosystem, and threatening future generations.

The environmental challenges faced by non-academic communities are multifaceted and often stem from a lack of awareness and engagement in sustainable practices. For instance, Plummer et al. (2021) highlight the importance of community engagement in sustainability science, emphasizing that bridging the gap between scientific knowledge and community action is crucial for addressing environmental issues effectively.

Furthermore, Lang et al. (2012) discuss the necessity of transdisciplinary research that includes non-academic stakeholders to tackle sustainability challenges, suggesting that collaborative efforts can lead to more effective solutions.

Previously, it was found that collaboration between universities and local communities can facilitate knowledge exchange and resource sharing, ultimately improving environmental conditions (Mosier & Ruxton, 2018). This aligns with the findings of Jones et al. (2019) who emphasize the importance of local community perceptions in sustainability measurements, indicating that understanding local environmental concerns is vital for effective sustainability initiatives.

4.1.2 Public Health Concerns

Under this category of sustainability challenge, there comes three more specifications, namely non-hygienic selling, non-hygienic food, and damaging current generation. Public health issues are closely linked to environmental challenges, and women in non-academic communities often perceive these as significant barriers to sustainability. Mccollum et al. (2015) illustrate how community health policies can impact sustainability, particularly when community members feel excluded from decision-making processes. This exclusion can lead to a lack of trust and engagement, further complicating efforts to address public health concerns.

Moreover, the role of community health workers (CHWs) is critical in promoting public health and sustainability. It is evident that CHWs can significantly reduce child morbidity and mortality, highlighting the importance of community involvement in health initiatives (Brenner et al., 2011). This suggests that empowering women and community members to take active roles in health and sustainability can lead to improved outcomes.

4.1.3 Societal Issues

Similarly, responses of the research participants like people miss sustainability messages, contradictory life styles of humans, and selling healthy in unhealthy way are the codes that best fits into the category of societal issues which again falls into the major theme sustainability challenges in non-academic communities.

Societal challenges, including gender inequality and lack of education, are perceived as major barriers to sustainability in non-academic communities. Researchers have emphasized the importance of social innovation in addressing systemic societal problems, arguing that engaging women in sustainable development initiatives can lead to more equitable outcomes (Aksoy et al., 2022). This is supported by Ernst et al. (2018) who note that involving women in community programs enhances gender equity and contributes to sustainable programming.

Additionally, the lack of awareness regarding sustainability roles within communities is a significant barrier. Aleksandrova (2024) discusses how cultural factors influence perceptions of sustainability, suggesting that understanding these cultural dynamics is essential for effective communication and engagement. This line up with the previous findings that sustainability should be viewed as an ongoing learning process, emphasizing the need for continuous education and awareness-raising within communities (Wallis et al., 2010). Addressing these barriers requires a multifaceted approach that includes community engagement, education, and the empowerment of women.

It is obvious when there are challenges addressed, there comes solutions too. So did the participants. They not only shared pitfalls but also expressed the relevant resolution required to take at non-academic levels to maximize the sustainability.

4.2 Potential Sustainability Achievements in Non-Academic Communities

Potential Sustainability Achievements in Non-Academic Communities is the second major theme derived from the visual-narrative response of the participants. This theme is crucial for understanding how grassroots initiatives can contribute to broader sustainability goals. This theme can be categorized into four key areas: consumer choices, educational initiatives, business practices, and systemic change. Each category reflects the diverse strategies that non-academic communities can employ to promote sustainability.

4.2.1 Consumer Choices

The category Consumer Choice is one of the significant idea under the theme Potential Sustainability Achievements in Non-Academic Communities, reported by participants. Most frequently reported idea under this research is *reduce the plastic products*, including two other codes, *use recyclable packing materials,* and *reduce unhealthy food selling.*

Consumer choices play a pivotal role in driving sustainability within non-academic communities. Prothero et al. (2010) argue that sustainable consumption is increasingly viewed as a lifestyle choice, where consumers are motivated to make environmentally friendly decisions. This shift in consumer behavior can lead to significant

ecological benefits, as individuals collectively influence market trends towards sustainability. Furthermore, researches have emphasized the importance of transforming consumption patterns through behavior change and systemic initiatives, advocating for a comprehensive approach that addresses the root causes of unsustainable practices (O'Rourke & Lollo, 2015).

4.2.2 Educational Initiatives

Educational Initiatives is another worth attention category that consists of *employ multiple instructional* approaches and *approach local community leaders* as the basic codes.

Educational initiatives are fundamental for fostering awareness and engagement in sustainability practices. Lozano et al. (2016) highlight the role of sustainability reporting in organizational change management, suggesting that educational frameworks can enhance corporate social responsibility (CSR) and sustainability awareness. This finding is consistent with latest findings of the United Nations Educational, Scientific and Cultural Organization (UNESCO) initiative, "The Decade of Education for Sustainable Development," which aimed to integrate sustainability values into educational curricula (Galleli et al., 2022). By embedding sustainability into educational programs, communities can cultivate a culture of sustainability that empowers individuals to take action.

Recently, Mokhtar (2023) further emphasizes the importance of incorporating sustainable education into undergraduate curricula, noting that such initiatives prepare students to become proactive agents of change in their communities. This educational foundation is essential for fostering a generation equipped to address sustainability challenges effectively.

4.2.3 Business Practices

Under the theme Potential Sustainability Achievements in Non-Academic Communities, Business Practices is the only category which is based single idea i.e. *Incorporate sustainable businesses practices.* Although the idea is single but the message and content it covers is the most diverse among all other pieces of information.

Business practices within non-academic communities can significantly influence sustainability outcomes. Lozano and Garcia (2020) discuss how institutional changes in organizations can lead to enhanced sustainability practices, particularly when management prioritizes sustainability in their strategies. Researchers of the past also advocated for the application of systemic methodologies to develop sustainability strategies in organizations, emphasizing the need for businesses to be responsible stewards of resources (Liboni & Cezarino, 2014).

4.2.4 Systemic Change

Finally, the last category suggesting potential sustainability achievements is the systemic change. This category is actually reflecting efforts needed to be taken by the system either at national or at international level. According to the findings of the current research, it included *support and promote sustainable practices at every level, take care of life, under water, over land, promote plantation, and promote grassroots sustainability.*

Systemic change is essential for achieving long-term sustainability goals. Fischer and Riechers (2019) propose a leverage points perspective as a tool for identifying effective interventions in complex systems. Similarly, researchers argued for the need to reconnect people to nature and restructure institutions to facilitate sustainability transformations (Abson et al., 2016).

Additionally, Franco et al. (2018) emphasize the role of higher education in promoting sustainable development through policy, curriculum, and practice. The potential sustainability achievements in non-academic communities are multifaceted, encompassing consumer choices, educational initiatives, business practices, and systemic change. By leveraging these categories, communities can enhance their sustainability efforts and contribute to broader environmental goals.

Figure 10

To achieve sustainability across all educational levels, we must develop organized strategies to promote sustainable development in our society. This image exemplifies the focused, determined, and discerning mindsets and efforts of individuals working together in a structured manner. The various handmade bracelets displayed showcase the exceptional skills acquired through multiple trials and eventual success.

Figure 11

This image showcases the enduring sustainability of our culture and traditions. Consider the intricate and beautiful craftsmanship of these handmade, multicolored boxes, which serve various purposes. Handmade strollers further demonstrate the persistence of our traditional culture and customs at different levels. The gathering of people here reflects our nation's continued appreciation and desire to engage with cultural traditions that embody simplicity, clarity, and intellectual depth.

Figure 12

These dolls represent cottage industry of central Asian artisans, showcasing the women, their attire, and their unique ethnic identities. This display promotes cultural exchange and engagement among people with diverse tastes and backgrounds. Admiring these beautiful dolls allows us to appreciate the sustainable cultures of provinces that are often overlooked.

Importantly, photovoice encourages self-reflection and group discussions that often lead to transformative insights among participants. Budig et al. (2018) emphasize the transformative potential of photovoice, wherein the act of sharing their photographs and engaging in collective storytelling enhances participants' empowerment and self-awareness. This reflective process also aids in identifying actionable solutions to community challenges, further aligning with the goals of economic and sustainable development (MacFarlane et al., 2015).

Moreover, photovoice has proven to enhance critical consciousness among participants, amplifying their

perspectives and needs regarding economic and sustainable development. Robinson and Lee (2022) assert that this methodology empowers participants to illustrate their thoughts and beliefs on social justice issues, facilitating a deeper understanding of community needs. Additionally, photovoice captures the lived experiences of participants and serves as a catalyst for meaningful dialogue about community issues, thus promoting actions for systemic change (Gaboardi et al., 2022).

6. Conclusion

In conclusion, while women face significant challenges in participating in sustainable development, there are also substantial prospects for enhancing their involvement through targeted policies and innovative methodologies like photovoice. By addressing the barriers to women's participation and leveraging their unique perspectives, communities can foster more inclusive and effective sustainable development initiatives. The integration of women's voices in these processes is not only a matter of equity but also essential for achieving comprehensive and sustainable outcomes. These findings are valuable for stakeholders and governments at all levels. Educated communities must play a pivotal role in educating those who lack formal education.

5.1 Implications of the Research

Research findings have implications to inform the development of more inclusive and effective sustainability policies. Moreover, the identified sustainability challenges in non-academic communities highlight the need for targeted interventions to create a more equitable and sustainable environment. Finally, the recognized potential sustainability achievements provide a foundation for future efforts to promote sustainable practices among non-academic populations.

5.2 Recommendations for Future Research

It is recommended for other researchers to replicate this research in other regions and countries to assess the generalizability of the findings. It is also suggested to investigate how factors such as age, socioeconomic status, and ethnicity intersect with gender to influence women's experiences and perspectives on sustainability. Explore the use of additional participatory methods, such as focus groups or interviews, to complement the photovoice approach and gather more in-depth data can further increase the scope of the relevant studies.

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Acknowledgments
The authors strongly acknowledge the support provided by participants of the research in conducting the research work.

Disclosure statement
No potential conflict of interest was reported by the authors.

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