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Lahore School of Economics

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Political Dynasties and Service Delivery: Evidence from Rural Health Clinics in Punjab Pakistan

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Abstract: Research suggests that politics plays a pivotal role in public service provision in contexts of scarce resources. However, there is limited evidence available on how dynastic politicians influence public service delivery. We examine this question in the context of the health sector in Punjab, Pakistan. By employing a representative sample of rural health clinics, we develop measures to capture doctors' outcomes at the clinic level. These data are then matched with provincial constituency-level data to study the impact of having a dynastic member of the parliament (MP) on doctors' assignment, attendance, and tenure in their respective constituencies. Our findings show that having a dynastic MP has no discernible impact on the assignment and attendance of doctors. However, clinics in constituencies with a dynastic MP have relatively experienced doctors. Furthermore, our suggestive evidence from the Pakistan Household and Living Measurement Survey (PSLM) shows that individuals living in districts with a higher proportion of dynastic MPs report lower improvements in clinic services and are less satisfied with those services. Our main findings remain robust to various alternative explanations.

Keywords: Political Dynasties, Public Goods Provision, Pakistan, PSLM

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Political Dynasties and Service Delivery: Evidence from Rural Health Clinics in Punjab Pakistan

1. Introduction

In the developing world, the public looks to the government to provide basic public goods (Devarajan & Reinikka, 2004). However, these governments are perpetually constrained by resources, which is why public expenditures on public goods, as a percentage of GDP, are historically low. Low government spending leads to spatial inequality in the distribution of public goods across regions of a country. The relevant question in this scenario is: what explains why a specific region receives more public services than others?

The political economy literature argues that politics plays a pivotal role in shaping public goods provision. For instance, one strand of literature shows that political competition affects public goods provision and local development (Besley et al., 2010; Boulding & Brown, 2014; Gottlieb & Kosec, 2019; Kosec et al., 2018; Nye & Vasilyeva, 2015). Similarly, another strand of literature argues that political connections and access to governing-party politicians enhance public support for the provision of public goods (Albouy, 2013; Ansolabehere & Snyder Jr., 2006; Azulai, 2017; Baldwin, 2013; Fisman, 2001). Nevertheless, most of the existing debates have no say on the effects of candidate-specific characteristics (such as political capital and family networks) on mobilizing resources for their respective constituents.[1] In this paper, we attempt to fill this gap by documenting the effects of having a dynastic member of the parliament (MP) on public service delivery, with a focus on public health in Punjab, Pakistan.

The paper begins by arguing that dynastic politicians differ from non-dynastic politicians in several respects. On the one hand, dynastic politicians acquire higher political capital from their ancestors. On the other hand, dynastic politicians also enjoy a disproportionate electoral advantage. Theoretically, the former predicts that dynastic MPs will outperform non-dynastic MPs in mobilizing resources and public service delivery for their respective constituents. However, the latter predicts that

[1] Pande (2003) and Besley et al. (2004) are the exception in this regard and find that a politician's group identity matters for public goods provision.

dynastic MPs have less incentive to deliver because of their brand-name advantage.

In principle, the net effect of having a dynastic MP on public service delivery is ambiguous. We examine the impact of having a dynastic MP on public service delivery in the context of a developing country: Punjab, Pakistan. To do so, our study uses geo-tagged primary data on public health officials (i.e., doctors) working in Basic Health Units in rural Punjab. Furthermore, this primary panel data on clinics is combined with novel data identifying the familial links of members of the Punjab assembly to ascertain the impacts of having a dynastic MP on the quantity and quality of public health services received by constituents.

Our study is based on Punjab, particularly the public health sector, for two reasons: Punjab is the largest province of Pakistan, with more than 110 million people (53% of Pakistan's total population), and the health department is devolved to the provincial government after the 18th Amendment to Pakistan's Constitution.[2] The primary data on the health sector comprises a representative panel survey of 850 Basic Health Units (34% of the total clinics in Punjab), primarily located in rural areas of Punjab, collected by Callen et al. (2018). In each of the three rounds of the panel survey, enumerators made unannounced visits to determine doctors' attendance at the clinics. Using this information, we construct three outcome variables: whether a doctor was assigned, whether the doctor was present during the visit, and the doctor's tenure (in months).[3] The data on political dynasties reveal that relatives of 51% of the MPs elected in the 2008 Punjab assembly had previously served in the provincial or national assemblies of Pakistan.

The empirical strategy in the paper uses two approaches to examine the effects of a dynastic politician on public service delivery. First, ordinary least squares (OLS) is used to identify the effects of interest. OLS allows us to account for a range of covariates that could otherwise lead to omitted-variable bias. Second, leveraging geo-referenced information on clinics and political constituencies, the geographic regression discontinuity design (GRDD) based on the distance

[2] "The 18th constitutional amendment has been considered a milestone in the history of Pakistan as it has devolved major legislative and executive authorities alongside departments from federal to provincial level, including health." (Khan et al., 2014)

[3] By quantity, we mean whether a given clinic in the constituency has a doctor assigned. However, by quality, we mean whether a given clinic in the constituency has an experienced doctor (measured by tenure of the doctor).

(proximity) of a clinic to constituency boundaries is used to estimate the causal effects of political dynasties on public health.

The results of both methods show that having a dynastic MP has no discernible impact on the doctor's assignment and doctor's attendance in clinics within the given constituency. Nonetheless, doctors working in clinics located in dynastic constituencies are, on average, more experienced than those working in clinics in non-dynastic constituencies. Furthermore, suggestive evidence from the Pakistan Household and Living Measurement Survey indicates that individuals from districts with a higher share of dynastic MPs tend to report fewer improvements in health clinics and express lower satisfaction with clinic services. Our results are aligned with Asako et al. (2015) and Nazir (2020), who show that although dynastic politicians attract more development funds for their respective regions, the additional funds do not guarantee higher public goods provision in those regions. Additionally, these findings corroborate those of Ali (2016), who shows that dynastic politicians fail to mobilize higher resources for their constituencies.

Our paper also analyzes several competing explanations that support our baseline evidence. First, it finds that experienced dynastic MPs, those who previously served a term in the provincial or national assembly, do not provide additional public services to their constituents. Second, the results show that dynastic MPs from the governing party do not mobilize additional public services for their areas. Finally, the paper determines that political competition fails to motivate dynastic MPs to provide additional services to their constituents. These estimated effects of political dynasties can be taken as causal for two reasons: first, reverse causality is highly unlikely because our outcome (doctor's assignment, doctor's attendance, and doctor's quality) has no plausible influence on the electability of dynastic MPs. Second, we incorporate a battery of confounding variables to mitigate the possibility of endogeneity stemming from omitted-variable bias.

This study makes several contributions to various strands of literature intersecting politics and economics. First, it contributes broadly to the political economy of development literature by addressing the political dimension of service delivery. Second, it also contributes to the relatively nascent but emerging literature on dynastic politics and its impact on local development.

The rest of the paper proceeds as follows: Section 2 discusses the study's context, focusing on theory and evidence related to political dynasties and economic development, the political landscape of Pakistan, and the health department of Punjab, Pakistan. Section 3 highlights the study's identification strategy. Section 4 explains the data and the construction of the variables used for the empirical analyses. The results and subsequent discussion are presented in Section 5. Section 6 concludes the study.

2. Context of the Study

2.1. Political Dynasties and Economic Development: Theory and Evidence

This section presents theoretical predictions and empirical evidence on how the performance of dynastic politicians can differ from that of non-dynastic politicians in terms of economic development and the provision of public goods.

Theoretical Predictions: Existing theoretical research on dynastic politics identifies at least two mechanisms that shape the behavior of dynastic politicians. On the one hand, politicians with familial links accumulate more political capital, which they acquire from their family (Dal Bó et al., 2009; George & Ponattu, 2018). Higher political capital inherited by dynastic politicians suggests that, theoretically, dynastic politicians might outperform the non-dynastic politicians as higher political capital is 'useful at the local level, such as local political connections or name recognition as opposed to talent or drive' (Dal Bó et al., 2009, p. 112). On the other hand, dynastic politicians enjoy a disproportionate electoral advantage over non-dynastic politicians (Dal Bó et al., 2009; Feinstein, 2010). The disproportionate electoral advantage predicts that dynastic politicians will underperform because performance is not associated with re-election (Geys & Smith, 2016). It is evident that both these mechanisms have a counter-acting effect on the overall behavior of dynastic politicians. If the political capital mechanism outweighs the electoral advantage mechanism, it is predicted that dynastic politicians will supply more public goods to the constituents. Likewise, if the electoral advantage mechanism dominates, the prediction is that the dynastic politicians will deliver fewer public goods to his/her constituencies. Henceforth, the overall impact of having a dynastic politician is ambiguous.

Literature Review: The existing empirical work on political dynasties and economic development is nascent and unable to resolve the puzzle of how dynastic legislators affect economic development and public goods provision. In this respect, Besley and Reynal-Querol (2013) are pioneers in this literature by studying the impact of political dynasties on economic growth. It finds that dynastic executives outperform non-dynastic legislators when executive constraints are weak. Braganca et al. (2015) also find that dynastic mayors from Brazil spent more resources on healthcare, infrastructure, and sanitation in their areas. Likewise, Mendoza et al. (2016) find a positive association between dynastic persistence and the prevalence of poverty in the Philippines.

By contrast, Asako et al. (2015) find that the economic performance of districts with dynastic legislators is worse than that of their counterparts, even though they bring more resources to their home districts; these additional assets in their home districts did not enhance economic growth. Similarly, dynastic politicians also 'under-perform in terms of economic growth, crime, utilization of development funds, and parliamentary performance' in the case of India (Tantri & Thota, 2015). For Pakistan, Ali (2016) explores the effects of dynasties on economic development in flood-affected districts. It finds that dynastic politicians mobilize 10.9% fewer development expenditures for their flood-affected constituencies than non-dynastic politicians. Also, Rehman et al. (2022) show that economic activity (measured by nighttime lights) is significantly lower in constituencies with dynastic legislators than in those with non-dynastic legislators. In a similar vein, Rahman (2013) shows that dynastic politicians underperform in parliamentary affairs and tend to have criminal records in Bangladesh. In another study, Mendoza (2012) finds that "jurisdictions of political dynasties are characterized by lower standards of living, lower human development, and higher levels of deprivation and inequality" (p. 132). Finally, George and Ponattu (2018) also comprehensively study the impact of political dynasties on economic development in India and find that dynastic MPs under-deliver public goods compared to non-dynastic MPs.

2.2. Political Landscape of Pakistan

Pakistan is a relatively nascent democracy with a history of several coup d'état.[4] After the general elections of 2008 and the subsequent democratic government, Pakistan seems to have gained pace towards a

[4] The most recent was on the 12th of October 1999, when General Pervez Musharraf overthrew the democratic government of Pakistan Muslim League-Nawaz (PML-N).

democratic state.[5] In 2018, Pakistan witnessed the third consecutive democratic regime transition through elections.

In terms of organization, Pakistan has a parliamentary democracy. At the national level, the parliament (*also known as Majlis-e-Shoora*) of Pakistan is divided into two organs: The Senate (the upper house) and the National Assembly (the lower house). The Senate has 104 members, elected indirectly by the provincial assemblies. However, 272 members of the National Assembly are elected directly under universal adult suffrage.[6]

There are also four provincial legislative assemblies, one in each of the four provinces of Pakistan. The total number of legislative seats in the provinces is 577. Our focus in this study is on Punjab province, which has 371 seats, with 66 positions reserved for women and eight reserved for non-Muslims. The Constitution of the Islamic Republic of Pakistan bids three major powers to the members of provincial assembly: (1) To make the laws [See, Article 141 and 142 of the Constitution of the Islamic Republic of Pakistan]; (2) To manage the national exchequer [Article 123 (3) of the Constitution of the Islamic Republic of Pakistan]; and (3) To have a vigilant eye on the policies of the Government [Article 130 of the Constitution of the Islamic Republic of Pakistan].

In addition to the de jure powers delegated by the Constitution of the Islamic Republic of Pakistan, provincial assembly members also exercise the de facto power to influence the design, location, and allocation of programmatic and non-programmatic policies (Ali, 2016; Kosec et al., 2018; Mirza, 2012). The role and importance of provincial MPs accrued after the approval of the 7th National Finance Commission (NFC) award and subsequent 18th Amendment to the Constitution of the Islamic Republic of Pakistan, where the former is a financial settlement in which provinces were entitled to have a greater share from the federal divisible pool and the latter devolves 17 major federal departments to provincial government (Shah, 2012). Public health, the focus of our study, was also devolved to provincial governments after the 18th Amendment (Nishtar et al., 2013).[7]

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[5] Pakistan showed significant improvement in various global democracy indices. For instance, the country had the lowest rating of 3.92 in 2006 on the Economist Intelligence Unit's Democracy Index but it has shown continuous improvement over time. In 2019, Pakistan scored 4.25 on the Democracy Index. https://www.eiu.com/topic/democracy-index/.

[6] Total seats in the National Assembly of Pakistan are 342. Sixty seats are reserved for women and 10 seats are held for non-Muslims, as per Article 51 of the Constitution of the Islamic Republic of Pakistan.

[7] While the Constitution de jure assigns service delivery responsibilities to local governments, the absence of empowered local institutions in much of Pakistan has meant that provincial assembly

2.3. Public Health in Punjab

As mentioned above, public health was devolved to provincial governments after the 18th amendment to the Constitution of the Islamic Republic of Pakistan.[8] In Punjab province, public health provision is administered by the Department of Health, which works under the Ministry of Health, headed by a provincial minister. Primarily, public healthcare is divided into five types of facilities: (1) Basic Health Units (BHUs); (2) Rural Health Centers (RHCs); (3) Tehsil Headquarter Hospitals (THQs); (4) District Headquarter Hospitals (DHQs); and (5) Teaching Hospitals (Punjab Development Statistics, 2013).

The focus of this paper is Basic Health Units (BHUs)[9]. BHUs are located at the Union Council level in rural areas and serve around 25,000 people in their periphery. The 36 districts of Punjab have 2,496 BHUs, which deliver both preventive and curative healthcare services at the lowest administrative unit in Pakistan (Majrooh et al., 2014). Each clinic has one doctor (also known as the Medical Officer), who is accompanied by support staff. Doctors, like other public servants, are recruited by the Punjab Provincial Service Commission (PPSC) on either a temporary or a permanent basis. However, if required, the district administration can also hire a doctor on an ad hoc basis by bypassing the PPSC. Moreover, the Department of Health does not have a transparent tenure-based transfer and posting policy. This loophole provides significant leverage to politicians to influence the transfer and posting of doctors. Doctors with political connections can get posted in their home stations. They can also seek protection via their political links against under-performance (Callen et al., 2018). In return, doctors are reportedly found to be campaigning for politicians (Free and Fair Election Network [FAFEN]).

3. Empirical Strategy

This section explains the empirical strategy for identifying the causal impact of dynastic Members of Parliament (MPs) on public service

members exercise significant de facto influence over administrative matters, including personnel decisions and resource allocation in sectors such as public health. This gap between de jure mandates and de facto practices shapes the political economy of service provision in the country.

[8] There is considerable variation across Pakistan's provinces in political institutions, competition, and governance capacity. Our focus on Punjab is driven by data availability, but these results should be interpreted with caution when applied to other provinces or public sectors.

[9] Our paper uses the terms 'clinics' and 'Basic Health Units (BHUs)' interchangeably and as referred to the lowest level of healthcare facility provided by provincial government.

delivery in Punjab. In estimation, omitted-variables bias is a potential threat that can mask the true impact of having a dynastic MP on service delivery in the public health sector. For instance, constituencies with a dynastic MP can be different in other respects from those with a non-dynastic MP, and one cannot split out the causal effect unless one controls for covariates that capture those differences. Moreover, reverse causality is less likely to emerge in our analysis because our outcome variables measure short-term public service delivery. It is highly unlikely that doctors' assignments, attendance, and experience affect the electability of dynastic politicians.

Our study exploits two empirical strategies to overcome the problem of omitted variable bias.[10] First, we estimate the effect of dynastic MP on service delivery using the ordinary least squares (OLS) technique with various controls and covariates. To substantiate the findings obtained using the first strategy, the geographical regression discontinuity design (GRDD), with constituency boundaries as natural cut-offs, is employed to assess the effects of having a dynastic MP on public health service provision.[11] The details of both strategies are provided below:

3.1. Ordinary Least Squares Estimation

As discussed above, the potential threat to the causal interpretation of our findings is due to omitted variable bias. To tackle this, a large set of confounding factors is to be isolated to obtain the true impact of having a dynastic MP on public goods. Thus, the empirical analysis uses the following baseline regression equation:

$$Y_{icjt} = \beta(Dynastic\ MP)_c + \delta_j + \gamma_t + X_g + Z_e + W_i + \epsilon_{icjt} \quad (1)$$

where Y_{icjt} represents the outcome variable at the i^{th} clinic in constituency c in tehsil j at survey wave t. $(Dynastic\ MP)_c$ is a dummy variable whose

[10] One can also think of using the close-elections regression discontinuity design, as used by George and Ponattu (2018) to find the causal effect of having a dynastic politician on economic development. However, in our case, most of the constituencies have a dynastic winner as well as dynastic runner-up, making it difficult for us to exploit the quasi-random variation offered by close-elections regression discontinuity design.

[11] The GRDD approach identifies a Local Average Treatment Effect (LATE) that is specific to clinics located near the boundaries between dynastic and non-dynastic constituencies. While this strengthens causal inference by exploiting local quasi-random variation, the estimated effects may not generalize to all clinics across the province. We therefore interpret the GRDD results as providing robust evidence for the effect in border areas, complementing broader OLS analyses that cover the full sample.

value is unity when an MP in the given constituency c is dynastic. δ_j and γ_t capture the (sub-district) tehsil-level and survey-wave fixed effects. Similarly, $\boldsymbol{X_g}$, $\boldsymbol{Z_e}$, and $\boldsymbol{W_i}$ are the vectors of geographic location, election, and clinic-level controls, respectively. Finally, ϵ_{icjt} is the error term.

Equation 1 shows that β, the effect of having a dynastic MP on the outcome variable is the coefficient of interest in the analysis. The subsequent regressions also incorporate a set of available covariates discussed in the section below. Sub-district (tehsil-level) fixed effects capture the unobservable characteristics specific to the tehsils (tehsils are the administrative boundaries). Equation 1 also includes geographic location variables to control for time-invariant clinic-specific characteristics. Similarly, Equation 1 controls for election-specific covariates, such as electoral competition, political alignment, and vote share, to capture the influence of major political parties. Finally, doctor-specific controls are included in the regressions to account for possible influences on the outcome variables (such as the doctor's attendance). These controls are whether a doctor knows a politician and the distance between the doctor and his/her home.

It is also worth noting that, instead of adding multiple confounding variables at once, our analysis progressively includes a set of similar control variables in the baseline regression. The underlying advantage of this approach is that it serves as a robustness check to see how the coefficient of our outcome variable behaves when a different set of variables is included in the regressions.

3.2. Geographic Regression Discontinuity Design

As the data on basic health units and constituencies are geo-referenced, we exploit this advantage to estimate treatment effects by comparing health clinics in dynastic constituencies with otherwise similar clinics in non-dynastic constituencies.[12] The strategy used to isolate the impact of dynasties on public service delivery is based on the geographic regression discontinuity design developed by Dell (2010) to study the long-run impacts of the mining *mita*, an extensive bonded mining labor system. Our analysis is based on the following equation:

[12] Figure A1 provides a visual overview of the GRDD setup, showing the 1km × 1km grid cells and the geographic distribution of Basic Health Units (BHUs) across the boundary.

$$Y_{ibt} = \alpha + \beta(Dynastic\ MP)_c + f(x_{ib}, y_{ib}) + \delta_j + \gamma_t + \epsilon_{ibt} \quad (2)$$

where Y_{ibt} refers to the outcome variable at the i^{th} clinic that lies closest to the constituency boundary b at survey wave t. $(Dynastic\ MP)_c$ is a dummy variable whose value is unity if an MP in the given constituency c is dynastic. δ_j and γ_t capture the sub-district tehsil-level and survey-wave fixed effects. Moreover, $f(x_{ib}, y_{ib})$ is the control function based on the latitudes and longitudes of clinics. Following Callen et al. (2018), our GRDD regressions use "cubic polynomial in latitude and longitude" as a control function in the regression.[13] Finally, ϵ_{ibt} is the error term. When estimating the effects of having a dynastic MP on public health service provision using geographic RDD, it is assumed that clinics in dynastic constituencies do not differ systematically from those in non-dynastic constituencies. We also make use of certain bandwidths using the triangular kernel, which gives more weight to the near-border clinics as compared to clinics distant from the border, and limit our analyses within these bandwidths to obtain the desired coefficient (i.e., β). "This regression discontinuity approach estimates a Local Average Treatment Effect (LATE) that should be interpreted as being local to clinics that lie on the boundary of two constituencies" (Callen et al., 2018, p. 18).

4. The Data

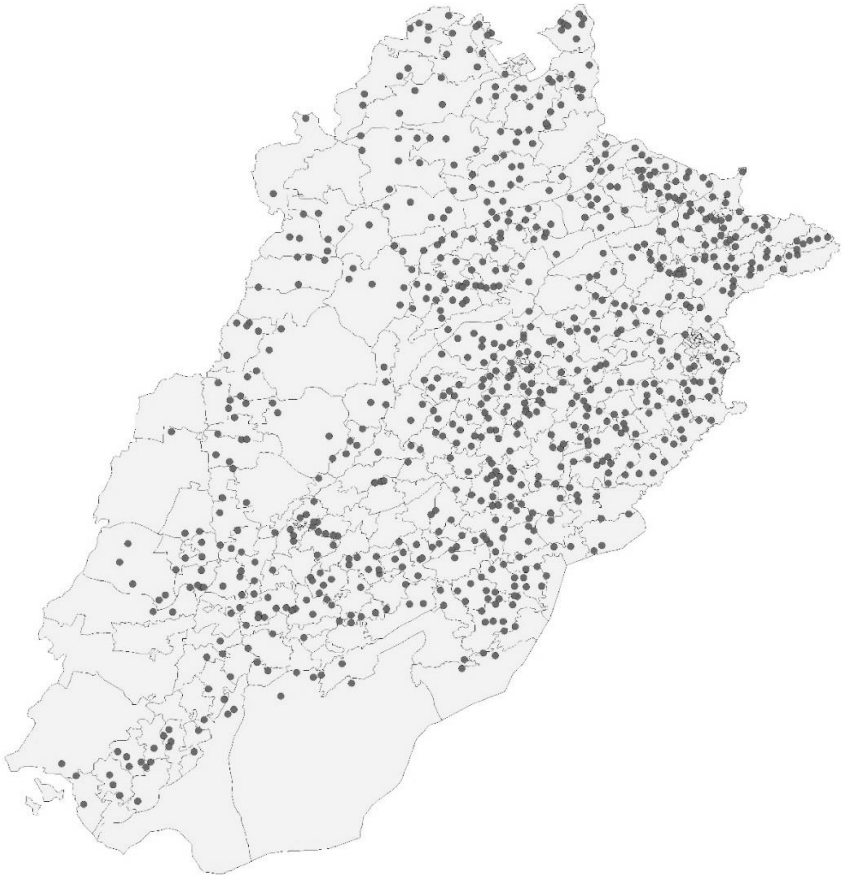
4.1. Outcome Variable(s)

We obtain primary panel data on rural healthcare units from Callen et al. (2018). It provides data on 850 clinics out of the 2,496 basic health units in rural Punjab. These data record three aspects of each clinic: (1) whether a doctor is assigned; (2) if assigned, whether he/she was present during the enumerator's visit; and (3) tenure length of the assigned doctor. Enumerators gathered these data between November 2011–October 2012 by making three unannounced visits to the clinics. These data cover all the districts of Punjab except Khanewal.[14] Table 1 provides descriptive statistics of outcome variables. It shows that doctors are assigned to about 66 percent of clinics. Similarly, 31 percent of the doctors were present during the visits, and the average tenure was 6.1 months.[15] Figure 1 provides the geographical distribution of sampled

[13] The linear and quadratic control functions are also used as a robustness check.
[14] It is excluded because the pilot survey was conducted in Khanewal.
[15] Measured as antilog of 1.46, minus 1.

clinics in Punjab. Each dot in the figure represents a clinic, and each polygon is a provincial constitutional assembly.

Figure 1: Spatial Distribution of Sampled Clinics Across Punjab



Note: Each dot on the map shows the geographical distribution of 'sampled' clinics across Punjab province. The polygons represent provincial constituency boundaries.
E bub!Tpvsdf; Callen et al. (2018)

Table 1: Descriptive Statistics of Outcome Variables

	N	Mean	Std. Dev.	Min	Max
Doctor Assigned	2,204	0.66	0.47	0	1
Doctor Present	2,191	0.31	0.46	0	1
Doctor's Tenure (logged)	2,206	1.46	2.03	0	5.95

Notes: Doctor Assigned and Doctor Present are the dummy variables indicating the doctor's assignment and the doctor's attendance in the given clinic, respectively.
***Source*:** Callen et al. (2018)

4.2. Treatment Variable: Dynastic Member of the Parliament (MP)

The study's explanatory variable is categorical and equals 1 if the winner in the given constituency is dynastic. This study characterizes a politician as dynastic if at least one family member[16] was a member of the provincial assembly or national assembly of Pakistan.[17]

We exploit the ancestry information of members of the 2008 Punjab Assembly to construct a dummy variable that distinguishes dynastic and non-dynastic MPs. Information on the political backgrounds of the members is publicly accessible on the Punjab Assembly website.[18] We also use the information presented in Cheema and Naseer (2013) to cross-verify the dynastic/non-dynastic status of the MPs. Finally, we also contacted the district newspaper correspondents to cross-check the identified data on political dynasties.

Table 2 provides the descriptive statistics of dynastic MPs in the 2008 Punjab Assembly.[19] It shows that 51 percent of the MPs are identified as dynastic. About 18 percent of the MPs who are dynastic were also elected in previous legislative assemblies and are thus labeled as experienced dynastic MPs. Finally, 11 percent of the MPs are dynastic and affiliated with the ruling party in Punjab. Figure 2 shows the geographical distribution of dynastic MPs in the 2008 Punjab Assembly. Each polygon represents a provincial assembly constituency. Constituencies in dark (light) color have dynastic (non-dynastic) MPs. Moreover, two maps are drawn in Figure 3 that trace the constituencies with experienced dynastic MPs and ruling party dynastic MPs, respectively.

[16] By family, we mean both blood and marriage relations. Thus, family includes: grandfather, grandmother, father, mother, uncle, brother, sister, father-in-law, and mother-in-law.

[17] Our definition excludes the Senate because senators are elected indirectly by legislators. There are chances that they might not have any vote bank. Yet, they were nominated for the seat because of party loyalty or other possible financial and political reasons.

[18] https://www.pap.gov.pk/members/listing/en

[19] It is worth mentioning that the analysis presented below is based on 214 constituencies of the Punjab assembly. However, the Punjab assembly has 297 constituencies. This is mainly due to the following three reasons. First, some of the data on clinics are lost while matching them with constituencies through ArcGIS. Second, it was not possible to access the information on the dynastic background for some MPs. In some constituencies, the winner of 2008 elections either died or resigned from the seat. Finally, as mentioned by Callen et al. (2018), Khanewal district is excluded from the data collection which resulted in the loss of 8 constituencies from the analysis.

Table 2: Descriptive Statistics of Explanatory Variables

	N	Mean	Std. Dev.	Min	Max
Dynastic MP	214	0.51	0.50	0	1
Dynastic MP (Experienced)	214	0.18	0.39	0	1
Dynastic MP (Ruling Party)	214	0.11	0.32	0	1

Notes: The table provides descriptive statistics of identified dynastic MPs in the 2008 Punjab Assembly. Rows 2 and 3 report dynastic MPs who are experienced (served in previous tenures) and dynastic MPs who belong to the ruling party, respectively.
***Source*:** Author's own calculations using data from Cheema et al. (2013) and the Punjab Assembly website.

4.3. Controls

As mentioned above, the potential threat to the validity of estimating the causal effect of having a dynastic MP on service delivery is omitted variable bias. Our empirics include a number of covariates in the OLS regressions to diminish endogeneity stemming from omitted variable bias. These covariates broadly fall under the following three categories:

Geographical Controls: As the geography of a given clinic can potentially affect doctors' attendance, a quadratic function of latitude and longitude, and distance to the district headquarters are used to account for geographic influences on the outcome variable.

Election Controls: The regressions are also controlled for election-specific variables such as political competition (measured by Herfindahl Index), political alignment (indicator variable to capture whether the given MP is affiliated to the ruling party), and vote shares of major political parties (Pakistan People's Party Parliamentarians (PPP), Pakistan Muslim League Quaid-i-Azam (PML-Q), and Pakistan Muslim League Nawaz (PML-N)).

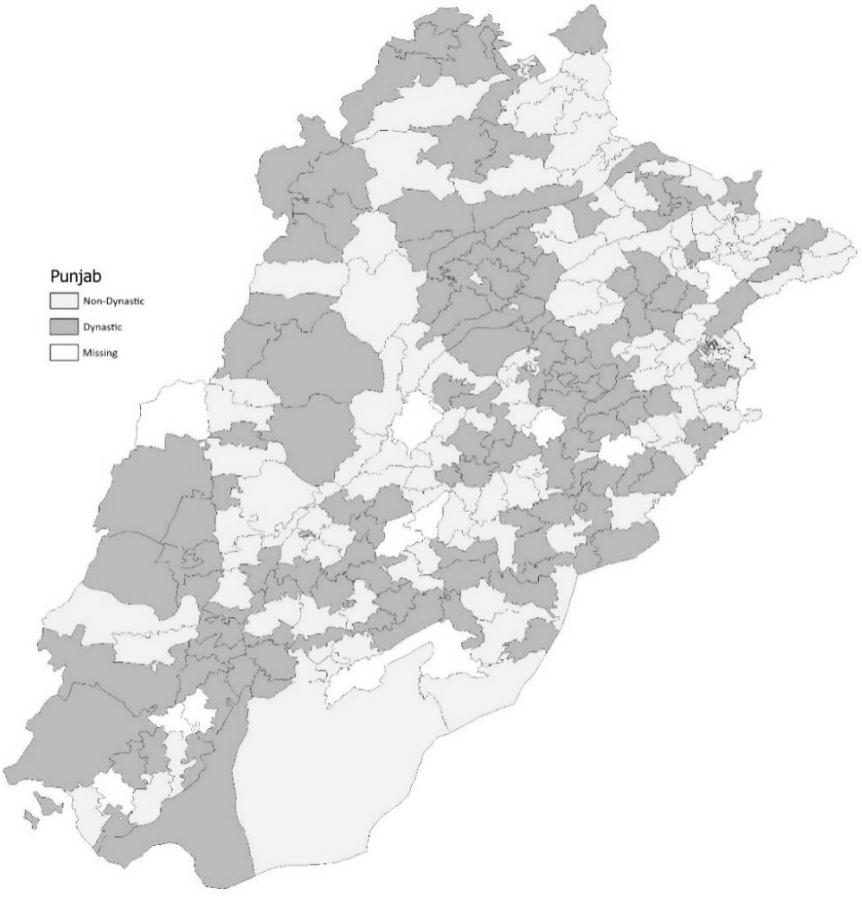
Individual Controls: Existing research shows that employees' political connections encourage absenteeism (Callen et al., 2018). Likewise, political connections can also be used to expedite the transfer process.[20] Therefore, our analysis includes three indicator variables: whether the

[20] This observation comes from first-hand experience of one of the authors. While working in the public education sector, he saw many such cases in which politically connected teachers easily get transferred to their desired colleges whereas those who do not have this luxury serve at distant colleges (also called, *hard stations*).

given doctor is connected to a politician, whether this connection is direct, and the distance to home.[21]

Table 3 presents the descriptive statistics for the control variables in the analysis. Panel A of the table reports statistics of geographical controls (such as latitude, longitude, latitude-squared,

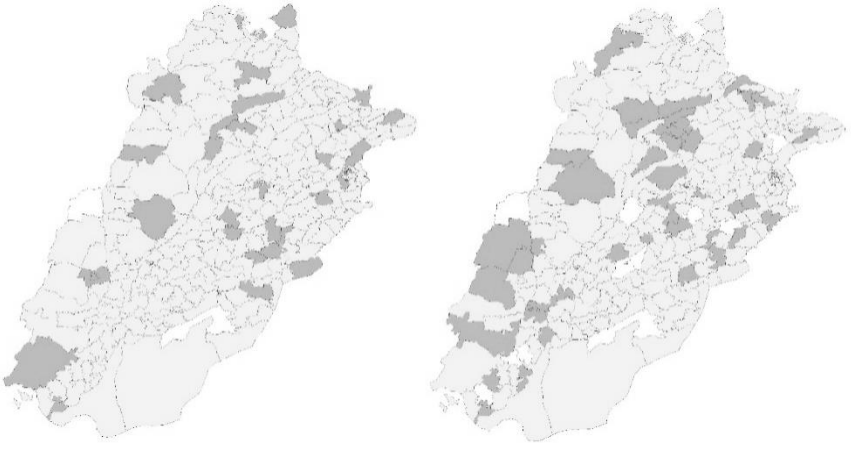
Figure 2: Dynastic MPs in Punjab Assembly in 2008



Note: This map distinguishes constituencies with dynastic MPs from the constituencies with non-dynastic MPs. The darker polygons posit that the MP in the given constituency is dynastic.
Data Source: Author's own calculations.

[21] The doctors who remained absent during the visits of enumerators were also traced out to acquire this information.

Figure 3: Experienced Dynastic MPs (left) and Ruling Party Dynastic MPs (right) in 2008 Punjab Assembly



Note: These maps distinguish constituencies with experienced or ruling-party dynastic MPs, and otherwise. The darker polygons in the first map show that given constituencies have experienced dynastic MPs. On the second map, darker polygons indicate ruling-party dynastic MPs.
Data Source: Author's own calculations.

Table 3: Descriptive Statistics of Control Variable

	Mean	Std. Dev.	Min	Max
Panel A: Geographic Location Controls				
Latitude	31.30	1.26	28.21	33.95
Longitude	72.84	1.15	69.73	75.29
Latitude Squared	981.01	78.71	795.71	1152.35
Longitude Squared	5306.59	167.39	4862.67	5669.02
Latitude×Longitude	2280.25	114.11	1971.55	2494.70
Distance to Tehsil Headquarter (in KM)	48.57	29.42	4	198
Panel B: Political Controls				
HH Index	0.86	0.11	0.53	1.00
Vote Share (Federal Ruling Party)	0.26	0.15	0	0.64
Vote Share (Provincial Ruling Party)	0.25	0.16	0.004	0.65
PPP Winner	0.31	0.46	0	1
PMLN Winner	0.27	0.45	0	1
PMLQ Winner	0.29	0.45	0	1
Panel C: Individual Controls				
Doctor's Distance to Home (in KM)	3.72	1.49	0	7.43

Notes: The table is based on the descriptive statistics of control variables. Panel A of the table reports descriptive statistics of geographical controls related to clinics. Similarly, Panels B and C of the table report descriptive statistics of political and individual controls,

respectively. All these control variables are used in the OLS regressions reported in the sections below.
***Source*:** Callen et al. (2018) and Election Commission of Pakistan (2018)

longitude-squared, Latitude×Longitude, and Distance to Tehsil Headquarters). On average, clinics are 48.57 kilometers away from the tehsil headquarters. Panel B presents political controls obtained from the Election Commission of Pakistan (2018). This information revealed that the 2008 provincial assembly elections were fairly competitive, with the average HH index of 0.86.[22] The average vote share of the ruling party in federal and provincial governments is 26% and 25%, respectively. Also, 31%, 27%, and 29% of the provincial assembly seats are won by PPP, PML-N, and PML-Q, respectively.[23] Moreover, panel C of Table 3 shows that doctors' average distance from home is 3.72 kilometers.

5. Results and Discussion

This section presents the results of ordinary least squares (OLS) and geographic regression discontinuity design (GRDD) regressions. First, we present and discuss the OLS results in detail for three outcome variables used in the analysis: doctor assigned, doctor present, and tenure of the doctor. Second, we present the GRDD results to substantiate the OLS findings. Finally, we explore alternative explanations of when dynastic politicians are most efficient in providing services.

5.1. OLS Results

The OLS results are presented in Table 4-6, obtained by estimating Equation 1.[24] Column 1 of each Table 4-6 shows the results when only a focused explanatory variable and a constant are included in the regression. In addition, columns 2 to 5 progressively include tehsil-fixed effects, wave-fixed effects, geographic controls, election controls, and individual controls, respectively. Our results suggest that the quantity and quality of service delivery are not significantly different in constituencies with a dynastic MP compared to those with a non-dynastic MP.

[22] Herfindahl-Hirschman index of political concentration lies between 0 and 1, with 1 means perfect competition.
[23] As mentioned above, our analysis covers 214 of the total 297 constituencies. The complete results of 2008 elections reveal that 27.76%, 21.29%, and 38.89% of the seats are won by PPP, PML-N, and PML-Q, respectively.
[24] For robustness, we present the Probit and Logit regressions for doctor assigned and doctor present outcome variable in Appendix B.

Doctor Assigned: First, the paper estimates the effect of having a dynastic MP on the assignment of doctors to a clinic in a given constituency. Table 4 shows that a dynastic MP does not significantly affect the assignment of doctors at rural health clinics in Punjab. All specifications indicate that political dynasties are not significantly associated with the provision of public services. It is worth noting that the number of clinics during the study period remained unchanged (Punjab Development Statistics, 2013, p. 190).

One more institutional detail, worth documenting here, is that allocation/assignment can have two meanings in the context of public-sector departments in Pakistan. One way of assignment is the inclusion of new "sanctioned" posts, which are to be approved by the Finance department after budgetary allocation. On the other hand, "filled" post refers to assigning a civil servant (i.e., doctor) to the "sanctioned" post. The former type of assignment requires a lengthy bureaucratic process, while the latter is done by recruiting new doctors or by assigning in-service doctors to vacant posts through transfers. Luckily, there was a temporary ban on new recruitment during the analysis period of the study, so assignments only denote transfers of doctors between clinics.

The appointment of doctors to a vacant post is carried out by the autonomous organization, the Punjab Public Service Commission, through testing and interviewing of candidates on the basis of merit. The ban on new recruitments during the period of analysis helped us, as 'assignment' is the only part that can be influenced by politicians. The null impact of dynastic MPs on doctors' assignment means these MPs did not use their influence to allocate more doctors to their constituencies.

Doctor Present: Second, our study examines whether the doctor's attendance at the clinic is affected by the MP's dynastic nature. Surprisingly, dynastic MP has no effect on a doctor's attendance at the clinic level. Although results presented in columns 1-5 of Table 5 show that the doctor's attendance in dynastic constituencies is low compared to the non-dynastic constituencies, this finding is also statistically insignificant.

Doctor Tenure: The results indicate that clinics in dynastic constituencies have more experienced doctors than those in non-dynastic constituencies (Table 6). However, this finding loses significance in the fully specified model.

The overall results show that having a dynastic MP has a mostly null effect on service delivery. This result is contrary to the existing literature on political dynasties. For example, Mendoza et al. (2016) find that a dynastic incumbent worsens poverty in the Philippines. Ali (2016) and George and Ponattu (2018) show the negative effects of political dynasties on economic development in Pakistan and India, respectively. However, the results of this paper are consistent with those of Braganca et al. (2015), who found no effect of dynasties on public service delivery.

5.2. Geographic RD Results

This study also examines the effects of a dynastic incumbent on public service delivery using a Geographic Regression Discontinuity (GRDD) design. Tables 7-9 show regression results obtained by estimating Equation 2. The GRDD findings corroborate the OLS results. For example, Table 7 shows that dynastic MPs have no impact on the doctor's assignment for all the bandwidths. Similar results can also be found for doctors' attendance, presented in Table 8. Finally, Table 9 shows that constituencies with dynastic MPs have experienced doctors compared to constituencies with otherwise similar. These results are significant for 5KM and 10KM bandwidths. While estimating this impact, our GRDD regressions use cubic "polynomial in latitude and longitude" as a control function.[25]

5.3. Complementary Explanations

This section presents results from various specifications that substantiate the baseline finding of a null effect of dynasties on public service delivery. First, we estimate whether senior dynastic MPs, with more than one term of experience, have any impact on service delivery. Then, we examine whether dynastic MPs from the governing party have any influence on public service delivery in their constituencies. Finally, we show how dynastic MPs influence public service delivery in constituencies with higher electoral competition.

[25] We also use linear and quadratic control functions, and these results are available for interested readers on request.

Table 4: Impact of Dynastic MP on Doctor's Assignment (OLS)

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Assigned=1				
Dynastic MP	-0.015	-0.014	-0.016	-0.026	-0.038
	(0.031)	(0.031)	(0.031)	(0.031)	(0.027)
	[0.636]	[0.648]	[0.622]	[0.409]	[0.170]
Observations	2,124	2,124	2,033	2,033	2,033
R-squared	0.332	0.336	0.350	0.356	0.461
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor assigned*. The explanatory variable of interest is Dynastic MP. The unit of analysis for the study is a clinic. Columns 2-5 progressively expand the model by adding tehsil-fixed effects, wave-fixed effects, geographic controls, election and individual controls, respectively. Geographic controls include a quadratic function of latitude and longitude, and distance to the district headquarters (in KM). Election controls include political competition (measured by the Herfindahl Index), political alignment (an indicator variable to capture whether the given MP is affiliated with either the federal or provincial government), and vote shares of major parties (PPP and PML-N). Individual controls include the logged distance to the doctor's home.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. *** < 0.01; ** < 0.05; and * < 0.10.

Table 5: Impact of Dynastic MP on Doctor's Attendance (OLS)

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Present=1				
Dynastic MP	-0.022	-0.022	-0.015	-0.021	-0.035
	(0.030)	(0.030)	(0.030)	(0.030)	(0.028)
	[0.473]	[0.478]	[0.611]	[0.496]	[0.217]
Observations	2,112	2,112	2,022	2,022	2,022
R-squared	0.198	0.199	0.209	0.213	0.372
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor present*. The explanatory variable of interest is Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 6: Impact of Dynastic MP on Doctor's Tenure (OLS)

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Tenure (log)				
Dynastic MP	0.240*	0.240*	0.239*	0.146	0.125
	(0.138)	(0.138)	(0.144)	(0.148)	(0.137)
	[0.084]	[0.083]	[0.098]	[0.328]	[0.360]
Observations	2,126	2,126	2,035	2,035	2,033
R-squared	0.179	0.189	0.191	0.200	0.341
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor tenure (logged)*. The explanatory variable of interest is Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

5.4. Does Prior Experience of Electoral Politics Matter for Service Delivery?

In this section, our focus is on the dynastic politicians who have prior experience of electoral politics (i.e., served before 2008 either in the provincial or national assembly). Besides familial links, politicians' own experience in the political arena can also play an important role in delivering services to the constituents. However, senior politicians also have a lower incentive to deliver because of their brand-name advantage. Tables 10-12 provide the results when our analysis uses senior dynastic MP as an explanatory variable. Results show that the seniority status of the dynastic candidate has no effect on assignment, attendance, or tenure of the doctor.

Table 7: Impact of Dynastic MP on Doctor's Assignment (GRDD)

	Outcome: Doctor Assigned=1				
Bandwidth in KM (+/-)	**1**	**2**	**IK=2.46**	**5**	**10**
Dynastic MP	0.122	0.115	0.085	0.042	-0.012
	(0.138)	(0.094)	(0.078)	(0.056)	(0.047)
	[0.378]	[0.225]	[0.280]	[0.459]	[0.793]
Mean of Dependent Var.	0.696	0.682	0.679	0.673	0.669
Constituencies	106	141	160	200	214
Observations	433	737	885	1,532	2,035

Notes: Outcome variable in the analysis is *doctor assigned*. The explanatory variable of interest is Dynastic MP. The unit of analysis for the study is a clinic. For all bandwidths, our GRDD regressions use a cubic "polynomial in latitude and longitude" as a control function.

In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 8: Impact of Dynastic MP on Doctor's Attendance (GRDD)

Outcome: Doctor Present=1					
Bandwidth in KM (+/-)	**1**	**2**	**IK=2.77**	**5**	**10**
Dynastic MP	0.067	-0.054	-0.072	-0.058	-0.033
	(0.137)	(0.116)	(0.086)	(0.060)	(0.041)
	[0.628]	[0.644]	[0.404]	[0.338]	[0.430]
Mean of Dependent Var.	0.305	0.298	0.304	0.312	0.314
Constituencies	106	141	169	200	214
Observations	427	730	955	1,523	2,023

Notes: Outcome variable in the analysis is *doctor present*. The explanatory variable of interest is Dynastic MP. The unit of analysis for the study is a clinic. For all bandwidths, our GRDD regressions use a cubic "polynomial in latitude and longitude" as a control function.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

5.5. Does Dynastic MPs from the Ruling Party Affect Service Delivery?

There is a vast literature which shows that voters who elected the ruling party candidates are served disproportionately (Baldwin, 2013; Blakeslee, 2018; Panda, 2015). Callen et al. (2018) exploit the same data used in this study to examine whether constituencies with governing-party candidates receive higher levels of public services. In this section, our analyses examine whether the dynastic MPs from the governing party could mobilize higher public service for their constituencies. By doing this, our analysis combines the two forces: political capital acquired by the dynastic politician from his family and support from the governing party.

Table 9: Impact of Dynastic MP on Doctor's Tenure (GRDD)

Outcome: Doctor Tenure (log)					
Bandwidth in KM (+/-)	**1**	**2**	**IK=3.13**	**5**	**10**
Dynastic MP	0.130	0.420	0.420	0.410*	0.298*
	(1.610)	(0.754)	(0.382)	(0.244)	(0.163)
	[0.936]	[0.579]	[0.272]	[0.094]	[0.070]
Mean of Dependent Var.	1.529	1.532	1.542	1.530	1.508
Constituencies	106	141	181	200	214
Observations	433	737	1,086	1,534	2,037

Notes: Outcome variable in the analysis is doctor tenure (logged). The explanatory variable of interest is Dynastic MP. The unit of analysis for the study is a clinic. For all bandwidths, our GRDD regressions use a cubic "polynomial in latitude and longitude" as a control function. In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Tables 13-15 present the results of regressions when ruling party dynastic MPs is used as an explanatory variable. As in previous results, Table 13 shows that dynastic MPs from the ruling party do not significantly affect doctors' assignments in the clinics in their constituencies. Similarly, Table 14 shows that ruling-party dynastic MPs have no effect on doctors' attendance. Nevertheless, Table 15 shows that doctors serving in clinics in constituencies of ruling-party dynastic MPs tend to have more experience than those serving in other constituencies.

5.6. Does Competition in Dynastic Constituencies Matter for Service Delivery?

Finally, the paper also explores whether dynastic MPs perform better when they face competition. Existing evidence shows that political competition has a positive impact on public goods provision (Besley et al., 2010; Boulding & Brown, 2014; Gottlieb & Kosec, 2019; Kosec et al., 2018; Nye & Vasilyeva, 2015). We argue, while documenting the theoretical predictions, that dynastic MPs have lesser incentive to perform better because of brand-name advantage (Dal Bó et al., 2009).

The results of our regressions, when competition is interacted with dynastic MP, are reported in Tables 16–18. Table 16 finds that political competition does not drive dynastic MPs to improve doctor assignment in clinics within their respective constituencies. Similarly, Table 17 shows that doctors' attendance, though negatively associated, is statistically insignificant in most specifications. Therefore, we conclude that dynastic MPs do not significantly influence doctors' presence either way. Finally, Table 18 presents regression results where the outcome variable measures doctors' tenure. The results indicate that clinics in dynastic constituencies have more experienced doctors than those in non-dynastic constituencies. This finding is robust across most specifications but loses significance in the fully specified model.

Table 10: Experienced Dynastic MP and Doctor's Assignment

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Assigned=1				
Experienced Dynastic MP	0.014	0.016	0.012	-0.006	-0.014
	(0.043)	(0.043)	(0.041)	(0.042)	(0.038)
	[0.737]	[0.715]	[0.772]	[0.883]	[0.702]
Observations	2,124	2,124	2,033	2,033	2,033
R-squared	0.332	0.336	0.349	0.355	0.460
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls Election			✓	✓	✓
Controls Individual Controls				✓	✓
					✓

Notes: Outcome variable in the analysis is *doctor assigned*. The focused explanatory variable is Senior Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 11: Experienced Dynastic MP and Doctor's Attendance

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Present=1				
Experienced Dynastic MP	0.002	0.002	0.007	-0.002	-0.012
	(0.036)	(0.036)	(0.035)	(0.038)	(0.034)
	[0.954]	[0.948]	[0.839]	[0.947]	[0.718]
Observations	2,112	2,112	2,022	2,022	2,022
R-squared	0.197	0.199	0.208	0.213	0.372
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls Election			✓	✓	✓
Controls Individual Controls				✓	✓
					✓

Notes: Outcome variable in the analysis is *doctor present*. The focused explanatory variable is Senior Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 12: Experienced Dynastic MP and Doctor's Tenure

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Tenure (log)				
Experienced Dynastic MP	0.147	0.145	0.125	0.083	0.004
	(0.179)	(0.179)	(0.181)	(0.206)	(0.206)
	[0.411]	[0.419]	[0.489]	[0.688]	[0.985]
Observations	2,126	2,126	2,035	2,035	2,033
R-squared	0.178	0.188	0.189	0.200	0.340
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls Election			✓	✓	✓
Controls Individual Controls				✓	✓
					✓

Notes: Outcome variable in the analysis is *doctor tenure (logged)*. The focused explanatory variable is Senior Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4. In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 13: Ruling Dynastic MP and Doctor's Assignment

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Assigned=1				
Dynastic MP (Ruling)	0.033	0.034	0.039	0.059	0.062
	(0.039)	(0.040)	(0.038)	(0.058)	(0.044)
	[0.397]	[0.391]	[0.308]	[0.308]	[0.164]
Observations	2,124	2,124	2,033	2,033	2,033
R-squared	0.332	0.336	0.350	0.355	0.460
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor assigned*. The focused explanatory variable is Senior Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 14: Ruling Dynastic MP and Doctor's Attendance

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Present=1				
Dynastic MP (Ruling)	0.011	0.011	0.021	0.044	0.029
	(0.033)	(0.033)	(0.032)	(0.055)	(0.050)
	[0.734]	[0.730]	[0.509]	[0.426]	[0.559]
Observations	2,112	2,112	2,022	2,022	2,022
R-squared	0.198	0.199	0.209	0.213	0.372
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor present*. The focused explanatory variable is Dynastic MP from Ruling. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 15: Ruling Dynastic MP and Doctor's Tenure

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Tenure (log)				
Dynastic MP (Ruling)	0.035	0.031	0.020	-0.007	0.020
	(0.165)	(0.165)	(0.171)	(0.292)	(0.234)
	[0.831]	[0.850]	[0.908]	[0.980]	[0.931]
Observations	2,126	2,126	2,035	2,035	2,033
R-squared	0.177	0.188	0.189	0.202	0.342
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor tenure (logged)*. The focused explanatory variable is Dynastic MP from Ruling. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 16: Competitive Dynastic MP and Doctor's Assignment

	(1)	(2)	(3)	(4)	(5)
		Outcome:	*Doctor Assigned=1*		
Dynastic×Competition	-0.008	-0.007	-0.010	-0.029	-0.042
	(0.036)	(0.036)	(0.036)	(0.035)	(0.031)
	[0.833]	[0.843]	[0.790]	[0.413]	[0.181]
Observations	2,124	2,124	2,033	2,033	2,033
R-squared	0.332	0.336	0.349	0.355	0.461
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor assigned*. The focused explanatory variable is Dynastic×Competition. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 17: Competitive Dynastic MP and Doctor's Attendance

	(1)	(2)	(3)	(4)	(5)
		Outcome:	*Doctor Present=1*		
Dynastic×Competition	-0.016	-0.015	-0.009	-0.024	-0.038
	(0.035)	(0.035)	(0.034)	(0.035)	(0.032)
	[0.656]	[0.661]	[0.801]	[0.496]	[0.238]
Observations	2,112	2,112	2,022	2,022	2,022
R-squared	0.198	0.199	0.209	0.213	0.372
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls Individual				✓	✓
Controls					✓

Notes: Outcome variable in the analysis is *doctor assigned*. The focused explanatory variable is Dynastic×Competition. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.

In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table 18: Competitive Dynastic MP and Doctor's Tenure

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Tenure (log)				
Dynastic×Competition	0.281*	0.280*	0.287*	0.157	0.137
	(0.161)	(0.161)	(0.167)	(0.166)	(0.155)
	[0.082]	[0.082]	[0.087]	[0.345]	[0.377]
Observations	2,126	2,126	2,035	2,035	2,033
R-squared	0.179	0.189	0.191	0.200	0.341
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls Individual				✓	✓
Controls					✓

Notes: Outcome variable in the analysis is *doctor assigned*. The focused explanatory variable is Dynastic×Competition. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

5.7. Results from Pakistan Social and Living Measurement Survey

In this section, we present additional results from the Pakistan Social and Living Measurement (PSLM) survey on the usage and satisfaction with basic health units (BHUs). Since the PSLM only records respondents' district of residence, we cannot apply the same empirical strategy as in our main analysis. Instead, we construct a measure of dynastic presence at the district level, defined as the share of constituencies in a district represented by dynastic candidates.[26] We estimate the following regression to estimate the effects of dynastic presence on usage and satisfaction with BHUs:

$$Y_{id} = \beta \left[\text{Dynastic Share}\right]_d + \gamma' X_{id} + \delta_t + \varepsilon_{id} \quad (3)$$

where Y_{id} is the outcome for individual i in district d (BHU usage or satisfaction), $\left[\text{Dynastic Share}\right]_d$ is the fraction of constituencies in district d held by dynastic candidates, $\boldsymbol{X_{id}}$ is a vector of individual controls (e.g.,

[26] Depending on the population, each of the 36 districts is divided into multiple provincial constituencies. Our measure is the number of dynastic constituencies divided by the total number of constituencies in the district.

age, gender, education, occupation, and urban/rural status), and δ_t is survey-year fixed effects, and ε_{id} is the error term.

Table 19 presents the results from estimating Equation 3. Since our election data are from the 2008 general elections, we use the 2009 and 2011 waves of the PSLM Survey for this analysis.[27] The results in Table 19 indicate that greater dynastic presence is associated with a lower change in BHU service (i.e. fewer improvements in clinic infrastructure) and less satisfaction with BHU services, while the coefficients for frequency of use are positive. The negative effect on satisfaction is statistically significant at the 5% level, whereas the other outcomes are not.

Table 19: Dynastic MP and Satisfaction with BHU service

	(1)	(2)	(3)
	Change in BHU service	Frequency of BHU usage	Satisfaction with BHU service
Dynastic MP (district average)	-0.159	0.180	-0.085**
	(0.113)	(0.170)	(0.036)
	[0.165]	[0.291]	[0.019]
Observations	28298	51950	28721
R-squared	0.008	0.027	0.047
Controls	✓	✓	✓

Notes: Outcome variables in the analysis come from the Pakistan Social and Living Measurement (PSLM) Surveys 2009 and 2011. The focused explanatory variable is the ratio of dynamic MPs in a given district. The unit of analysis for this analysis is the individual level. In all columns, individuals' age, gender, education, occupation, and urban/rural status are used as controls.
In all the regressions, standard errors (given in parentheses) are clustered at the district level. where, *** < 0.01; ** < 0.05; and * < 0.10.

6. Conclusion

The existing literature on the political economy of development provides several explanations of why some areas receive more public services than others. This study examined one of these explanations in the case of public health in Punjab, Pakistan. We argued in the paper that there are two plausible explanations of why dynastic MPs can perform differently from their non-dynastic MPs. First, dynastic MPs have greater political capital accumulated through their political family. Second, dynastic MPs enjoy a disproportionate electoral advantage over non-

[27] We exclude the 2013 wave because its dates overlap with the subsequent election.

dynastic MPs. The former explanation predicts that dynastic MPs will outperform non-dynastic MPs; the latter explanation indicates that dynastic MPs will underperform their counterparts.

By combining the primary data on rural health clinics collected by Callen et al. (2018) with novel data on familial links of members of the provincial assembly, this study analyzed the effects of having a dynastic MP on public service delivery in Punjab. Our empirical results found that having a dynastic MP has no impact on doctors' assignments and doctors' attendance in rural clinics. However, our study found a positive impact of having a dynastic MP on the tenure length of the doctors in clinics. Furthermore, ancillary analysis using data from the Pakistan Household and Living Measurement Survey indicates that, on average, individuals residing in districts with a greater proportion of dynastic MPs report statistically lower perceived improvements in clinic infrastructure and reduced satisfaction with the services provided. The findings of this paper suggest that alternative explanations for differences in the behavior of dynastic MPs counteract one another, nullifying their overall effects on public service delivery.

The study also probed several additional considerations to support our baseline evidence. First, it finds that dynastic MPs who served for more than one term in parliament are also unable to mobilize public services in their respective constituencies. Second, although MPs from the ruling party often have greater access to public funds, dynastic MPs from the governing party also fail to provide a greater quantity of services to their subjects. Finally, we showed that dynastic MPs who face higher political competition perform slightly better in providing public health services in the clinics in their constituencies.

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Appendix Probit and Logit Results

Table A1: Probit regressions: Impact of Dynastic MP on Doctor's Assignment

	(1)	(2)	(3)	(4)	(5)
		Outcome: Doctor Assigned=1			
Dynastic	-0.015	-0.015	-0.019	-0.032	-0.047
	(0.033)	(0.033)	(0.032)	(0.032)	(0.030)
	[0.642]	[0.644]	[0.556]	[0.309]	[0.108]
Observations	1914	1914	1871	1871	1738
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor assigned*. The focused explanatory variable is Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table A2: Probit regressions: Impact of Dynastic MP on Doctor's Attendance

	(1)	(2)	(3)	(4)	(5)
		Outcome: Doctor Present=1			
Dynastic	-0.024	-0.024	-0.016	-0.018	-0.036
	(0.030)	(0.030)	(0.030)	(0.029)	(0.025)
	[0.435]	[0.432]	[0.595]	[0.532]	[0.157]
Observations	1967	1967	1877	1877	1877
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor present*. The focused explanatory variable is Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table A3: Logit regressions: Impact of Dynastic MP on Doctor's Assignment

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Assigned=1				
Dynastic	-0.017	-0.016	-0.021	-0.036	-0.049
	(0.035)	(0.035)	(0.034)	(0.034)	(0.031)
	[0.627]	[0.641]	[0.544]	[0.283]	[0.121]
Observations	1914	1914	1871	1871	1738
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

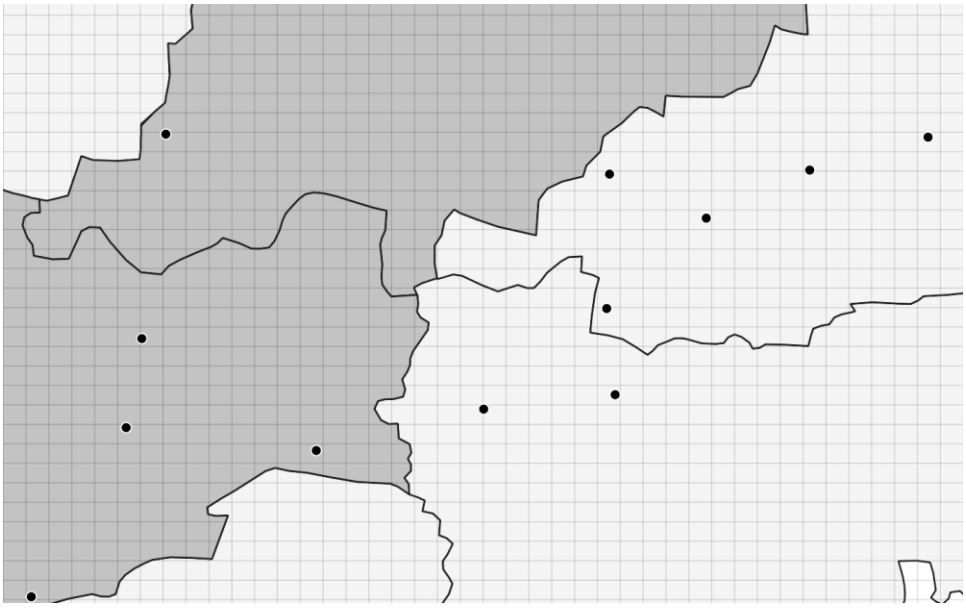
Notes: Outcome variable in the analysis is *doctor assigned*. The focused explanatory variable is Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Table A4: Logit regressions: Impact of Dynastic MP on Doctor's Attendance

	(1)	(2)	(3)	(4)	(5)
	Outcome: Doctor Present=1				
Dynastic	-0.022	-0.022	-0.013	-0.014	-0.035
	(0.030)	(0.030)	(0.030)	(0.029)	(0.026)
	[0.459]	[0.464]	[0.657]	[0.629]	[0.172]
Observations	1967	1967	1877	1877	1877
Tehsil Fixed Effects	✓	✓	✓	✓	✓
Wave Fixed Effects		✓	✓	✓	✓
Geographic Controls			✓	✓	✓
Election Controls				✓	✓
Individual Controls					✓

Notes: Outcome variable in the analysis is *doctor present*. The focused explanatory variable is Dynastic MP. The unit of analysis for the study is a clinic. In all columns, the specification of included controls is the same as Table 4.
In all the regressions, standard errors (given in parentheses) are clustered at the tehsil level. where, *** < 0.01; ** < 0.05; and * < 0.10.

Figure A1: Geographic Description of GRDD



Note: This map illustrates the spatial setup of the Geographic Regression Discontinuity Design (GRDD). Gray lines indicate 1km × 1km grid cells. Each black dot represents a Basic Health Unit (BHU).
Data Source: Author's own calculations.

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Evaluating the Impact of Withdrawal of Telegraphic Transfer (TT) Charges Reimbursement on the Remittances from the Kingdom of Saudi Arabia (KSA)*

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Abstract: The Government of Pakistan reimburses SAR 30 in Telegraphic Transfer Charges (TTC) for every USD 100 or more transferred by a foreign MTO into the country, as compensation for their transaction costs. In May 2020, the government removed this facility for KSA, citing zero transaction costs announced by the KSA authorities for digital money transfers from the kingdom. The inflow of workers' remittances from KSA began to decrease once KSA eased the travel ban. This paper aims to estimate the impact of the withdrawal of TTC reimbursement on remittances flowing from KSA to Pakistan. The difference-in-difference (DID) method is applied to data from July 2018 to September 2022. The estimates indicate that this policy caused an average monthly decline in remittances from KSA between US$ 31 million and US$ 76 million. The findings appear to be robust to various estimation adjustments.

Keywords: Pakistan, remittance inflow, policy impact, Covid-19, panel data.

JEL Classification: F24, F31.

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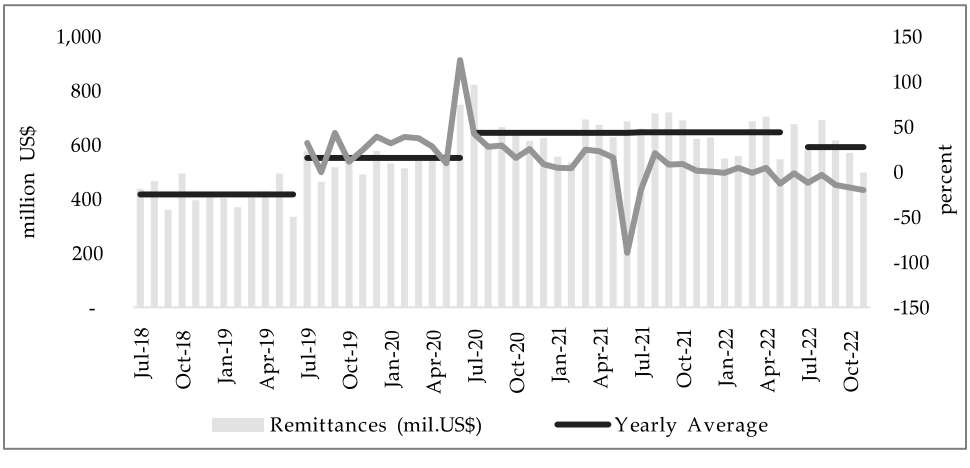
Evaluating the Impact of Withdrawal of Telegraphic Transfer (TT) Charges Reimbursement on the Remittances from the Kingdom of Saudi Arabia (KSA)*

1. Introduction

Remittances are one of the key sources of external financing, and their sustained inflow plays a very important role in stabilizing domestic prices and household consumption, and supporting domestic economic activity. Importantly, the Kingdom of Saudi Arabia (KSA) contributes around 25 percent of total workers' remittances inflows in Pakistan. Between 2019 and 2023, Pakistan received, on average, around US$7.5 billion annually from KSA in workers' remittances, compared to the total average receipt of US$28 billion. Interestingly, in the post-pandemic era, growth in remittances inflow from KSA witnessed a persistent decline, particularly since the relaxation of the Covid measures in KSA and the restarting of issuance of Umrah visa by the Kingdom in August 2021 (**Figure 1**). This phenomenon was more intriguing due to the fact that the number of workers emigrated KSA during this period increased steeply.

Figure 1: Monthly Trend of Remittance Inflows from KSA



Source: SBP

* We are thankful to anonymous referees for their valuable comments. The author is responsible for any errors or omissions and views expressed in this research.

With the outbreak of Covid-19, KSA eliminated fees on digital money transfers both within and outside the Kingdom[1]. Pakistan, however, removed the Telegraphic Transfer Charges (TTCs) on remittances coming from KSA, claiming that the cost of remitting has dropped to zero due to KSA's free digital transfer policy. This paper aims to assess the impact of the withdrawal of TTC reimbursement on remittances flowing from KSA.

Inflowing remittances are crucial for managing Pakistan's current account balance, and the country has implemented several initiatives to efficiently attract remittances through formal channels such as banks and designated MTOs. However, an impact analysis of these policies has never been conducted before, as it requires controlling for various domestic and foreign factors. Unsurprisingly, the literature on remittance flows mainly focuses on economic growth and development in recipient countries [for example, Giuliano and Ruiz-Arranz (2009), Cooray (2012), and Barajas et al. (2009)], the financing of the current account deficit [for instance, □akajac et al. (2023), Lartey (2019), and Hassan and Holmes (2015)], or the impact of these inflows on the real exchange rate in the recipient country [see, for instance, Montiel and Hakura (2010), Amuedo-Dorantes and Pozo (2004), and Acosta et al. (2009)], as well as on labor market dynamics [notable examples include Cox-Edwards and Rodríguez-Oreggia (2009), Amuedo-Dorantes and Pozo (2006), and Rodriguez and Tiongson (2001)]. Therefore, our study differs from the existing literature on remittances. Our work aligns more closely with Kpodar et al. (2022), Withers et al. (2021), and Kessegn (2021); however, these authors have focused on the impact of the COVID-19 pandemic on overall remittance inflows in specific areas, while we assess the impact of a specific policy—namely, the withdrawal of TTC reimbursement—on remittances inflow.

For estimation purposes, we used the Difference-in-Difference (DID) technique. DID is commonly employed for impact assessment, such as evaluating the effect of sudden changes in the economic environment, policies, or medical trial treatments on a group or individual. Essentially, we compare changes in a variable over time for those enrolled in or subjected to a policy intervention (the intervention group) with those who are not (the control group). Our findings suggest that the withdrawal of TTC reimbursement has led to an average decline in remittance inflows from KSA, ranging from US$ 31 million to US$ 76 million each month. Our

[1] For details, see Section 2.

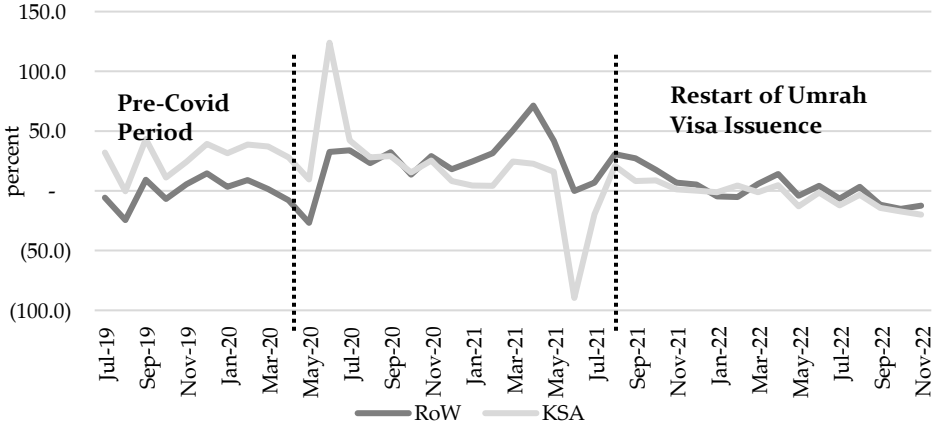
results are consistent when comparing inflows from KSA to other Gulf Cooperation Council (GCC) countries. Additionally, we employed a synthetic Difference-in-Difference test, which effectively includes a placebo test. Furthermore, as an alternative to PKR-denominated exchange rates, we also used country-specific exchange rates against the US dollar. The results remain similar, demonstrating the robustness of our estimates.

The rest of the paper is structured as follows. Section 2 explains the background development of remittance inflows from KSA, Section 3 describes the methodology adopted and explains the data used in this research, while Section 4 presents an analysis of the results. Finally, Section 5 concludes this paper.

2. Background: Remittances inflows from KSA and the recent developments

Export of crude oil and its products is the key source of revenue for GCC countries. As Brent crude prices plunged by 72.5 percent year-over-year, from US$ 111.87 per barrel in June 2014 to US$ 30.80 per barrel in January 2016, Saudi Arabia along with other GCC countries experienced growing fiscal and external sector imbalances. To restructure the economy away from oil dependency, KSA introduced several fiscal and external sector reforms aimed at diversifying the country's revenue base (**Figure A1** in **Annexure 1**).

Figure 2: YoY Growth in Monthly Remittances from KSA and Rest of World



Source: SBP

a. Remittances trend in the Pre-Covid

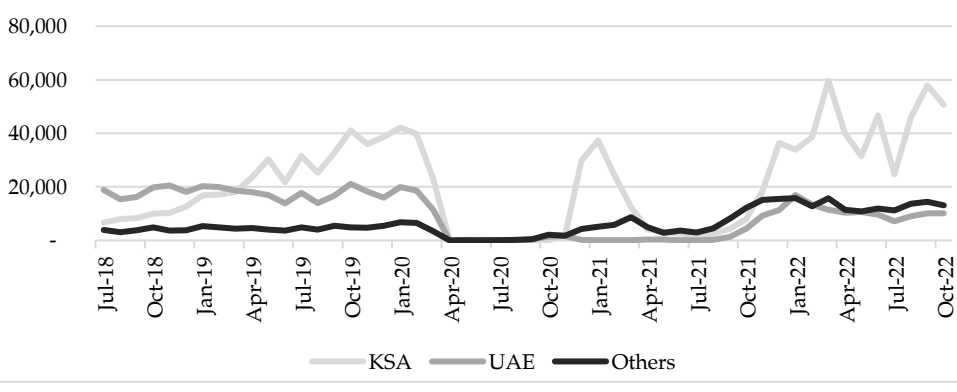
Explicitly, the Saudi government imposed new taxes, some of which were designed specifically to target expatriates. In addition to imposing taxes, KSA adopted various measures to increase the presence of the local population in the Saudi labor market (**Annexure 2- Section 2.1**). Besides their fiscal impact, these measures were expected to reduce the outflow of foreign exchange and improve the country's current account balance. However, some policies ended up increasing remittance outflows contrary to their intended objectives, as shown in the pre-Covid period in **Figure 2**. For example, the 'expatriate levy' imposed on the family members of employees forced many expatriates to send their dependents back home. This decreased their expenditure in the Kingdom and increased remittance outflows from KSA.

The government of Pakistan, at the same time, was promoting several policies to attract remittances through formal channels using a three-pronged strategy; 1) strengthening the remittance distribution network, 2) removing structural bottlenecks, and 3) introducing incentives for intermediaries and beneficiaries (**Annexure 2- Section 2.2**). As a result, Pakistan experienced a sustained increase in workers' remittance inflows, not only from KSA but also from the rest of the world during the pre-Covid period.

b. During the pandemic

The outbreak of the Covid pandemic, along with the strict implementation of lockdowns and social distancing measures, and the announcement of economic stimulus packages, significantly altered the dynamics of remittance flows worldwide. KSA, in particular, adopted more stringent social distancing measures and actively promoted digitalization to reduce human contact (**Annexure 2- Section 2.3**). In doing so, they waived fees on most fund transfers, including outbound remittances, conducted through digital means.

Figure 3: Number of Pakistani Workers Emigrating to GCC Countries per Month



Source: BE&OE

Like some other developing economies, Pakistan also witnessed a broad-based surge in the workers' remittances following the imposition of the lockdown (**Figure 2**-middle panel). While travel restrictions played an important role, the government of Pakistan also announced measures, including the introduction of the Roshan Digital Account (RDA) to strengthen the inflows through formal channels (**Annexure 2- Section 2.4**). As a result, inflows from KSA grew steeply in the months following the outbreak of the pandemic and then began declining (**Figure 2**). Between August 2021 and December 2022, inflows from KSA grew more slowly than those from the rest of the world. This occurred in spite of the fact that the number of workers emigrating to KSA rose sharply during this period (**Figure 3**).

c. Post-Covid Time Period

The government implemented a series of policy measures as the pandemic's spread threatened to trigger an economic collapse. Pakistan stopped reimbursing TT charges on remittances from KSA starting in May 2020. This policy move initially went largely unnoticed because KSA had waived fees on digital fund transfers[2]. At the same time, economic officials might have assumed that Pakistani workers in KSA would immediately switch to digital channels to send money home. However, it's important to recognize that most Pakistani laborers in the GCC are semi-skilled or unskilled workers employed in blue-collar jobs. They tend to avoid digital

[2] This was communicated to the banks and other stake holders through letters, instead of following formal process of circular/SRO.

methods and usually rely on Money Transfer Operators or a network of family and friends to send money back home.

The imposition of a travel ban not only disrupted the network but also forced these blue-collar remitters to send their money back home through money transferring operators (MTOs), which then began charging fees on remittances to Pakistan. As the lockdown eased and air travel restrictions were lifted by August 2021, Pakistani remitters reverted to using their personal networks, and remittance inflows from KSA started to decline immediately (**Figure 2**, right panel). These developments are illustrated in **Figure A2** in **Annexure 1**.

3. Methodology and Data

6.1 Methodology

We used the Difference-in-Differences (DiD) method for estimation. DiD is commonly applied to measure the effect of sudden changes in the economic environment, policies, or medical treatments on a group or individuals. It involves comparing changes in outcomes over time between a group that receives the treatment or intervention (the intervention group) and a group that does not (the control group). DiD is a quasi-experimental design widely utilized in health sciences to evaluate the impact of specific experimental interventions [Bendavid et al. (2012), King et al. (2013)] and also in economics. For example, Card and Krueger (1994) used this method to analyze the labor market, while DiTella and Ernesto (2004) applied it in criminology, and Galiani et al. (2005) studied the externalities of water privatization.

We designated all countries for which Pakistan continued to reimburse TTC upon receipt of workers' remittances as the control group (g=0) and KSA as the treatment group (g=1).[3] Furthermore, the period before May 2020 when no treatment or measure was applied, during which TTC reimbursement continued (t=0), and the period after May 2020 when treatment or measures were applied, with TTC reimbursement discontinued based on remittances from KSA (t=1). The framework of this procedure is illustrated in Figure 4. As Pakistan stopped reimbursing TT

[3] For the list of countries in the control group, see SBP for country wise workers' remittances inflows (available at: https://www.sbp.org.pk/ecodata/ORA_Arch.xlsx)

charges only for remittances from KSA starting May 2020, we defined the treatment solely for KSA and for the period from May 2020 to October 2022.

Figure 4: Schematic Diagram of Average Treatment and Control Effect

		Period		
		Not treated (0)	Treated (1)	
Group	Control (0)	(0,0)	(0,1)	(0,1)-(0,0)
	Treatment (1)	(1,0)	(1,1)	(1,1)-(1,0)

Difference in Difference (DiD) =[(1,1)-(1,0)]-[(0,1)-(0,0)]

$=\boldsymbol{\beta_3}$

Moreover, since the withdrawal of TTC reimbursement and the imposition of travel restrictions were enforced almost simultaneously, it is not possible to separate the impact of the two from the coefficient estimated. At the same time, the travel ban was the only period when remitters were forced to send remittances, through whatever means available to them, as the income stream of most low-income people back home dried up due to the imposition of strict lockdowns. This forced, abnormal remittance flow during the lockdown is likely to introduce an upward bias in the estimated coefficient, which may lead to a misleading conclusion.

To fix this problem, we first estimated DID using the full sample and then excluded the travel ban period (May 2020–August 2021) from the sample. In this setup, the full sample estimate (including the travel ban period) shows how remittance inflows from KSA behave after the withdrawal of TTC reimbursement, including the impact of the travel ban. Also included are the effects of KSA Saudization policies and Pakistan's efforts to attract remittances. The shorter sample estimate (excluding the travel ban period) illustrates the typical behavior of remittance inflows after the withdrawal of TTC reimbursement, essentially excluding the travel ban period. This estimate also accounts for the impact of KSA and Pakistan's remittances-related policies. The difference between the two coefficients demonstrates how inflows from KSA have changed after the withdrawal of the TTC reimbursement, while holding all other factors constant.

Moreover, we have constructed a panel of heterogeneous countries that differ significantly in time-invariant economic characteristics. The Difference-in-Differences (DiD) technique adequately handles this

problem. Let us assume y_{igt} that the monthly workers' remittances inflowing from any specific country *i* belonging to group *g* in the period, *t*. A general specification for the remittances inflows for this purpose could be given by (1),

$$y_{igt} = \alpha_g + \gamma_t + \beta_1 g + \beta_2 t + \beta_3 (G * t) + \epsilon_{igt} \quad (1)$$

where α_g represents the group-level fixed effect, γ_t and is the period-specific fixed effect. These account for the country-specific, time-invariant unobserved characteristics and heterogeneity over time. G is a group-specific indicator variable, t is a period-specific indicator variable, and the $\beta's$ are the regression coefficients to be estimated; ϵ_{igt} is the random error. A step-by-step formulation of this procedure is provided in Annexure 3. For estimation, we used the random effects model. The estimated coefficients are similar to those obtained with the fixed effects model.

6.2 Data

We used country-specific worker remittance inflow data from July 2018 to October 2022 to construct the panel. Moreover, to capture the remittance originating country's macroeconomic environment, first, we used the exchange rate of that country against the US dollar. We have then converted these exchange rates into Pakistani rupees using the PKR/USD exchange rate. Second, we have used OECD Trakker to capture growth in economic activity across OECD countries.[4] However, this indicator is not available for Malaysia and the GCC countries. Therefore, for Malaysia, we used YoY growth in monthly sales of manufactured products. For GCC countries, we have used year-on-year growth in the monthly Brent crude index.

To control the impact of labor migration to KSA, we included the number of workers emigrating from Pakistan every month to the destination country. We have acquired remittance data from the State Bank of Pakistan(SBP). For the exchange rate data, OECD tracker of economic activity, and Brent crude price index, we used Haver Analytics. Moreover, monthly data on workers emigrating from Pakistan have been acquired from the Bureau of Emigration and Overseas Employment (BEOE).

[4] For example, Boone (2021) has used OECD tracker as proxy of growth in OECD countries.

Descriptive statistics of these variables are provided in Table A1 (in Annexure 4).

4. Results

For estimation purposes, we have used the lag of economic activity in our models, as rising economic activity in the home country may take some time to translate into workers' wages and then into remittances outflows from that country. For similar reasons, we have used the lag of the exchange rate in our model. For the number of workers emigrating for jobs from Pakistan, we employed a second lag of this variable, as some gestation period is needed for their settlement in a new environment and sending remittances back home.

Table 1 presents the estimates from the Difference-in-Differences (DiD) analysis evaluating the impact of the withdrawal of TT charges in Pakistan on remittances from KSA. In this context, we have adopted specifications, 1) assessing the impact of TTC withdrawal solely, 2) assessing the effect of TTC withdrawal by controlling the impact of the domestic economic activity, exchange rate fluctuations, and country-specific number of workers emigrating from Pakistan.

Table 1: Impact of TTC charges Withdrawal on Remittances Inflows (mil US$)

	Coefficients	p-value
Control Group: All Countries		
No Covariates	168.2889*	(0.000)
with Covariates	197.5991*	(0.000)
Excluding the period of Umrah ban during Covid		
No Covariates	137.7537*	(0.000)
with Covariates	121.6335*	(0.000)
Impact of TTC withdrawal		
No Covariates	-30.5352	
with Covariates	-75.9656	
Control Group: Gulf Cooperation Council (GCC) Countries		
No Covariates	142.1919*	0.000
with Covariates	160.7122*	0.000
Excluding the period of Umrah ban during Covid		
No Covariates	113.6816*	0.000
with Covariates	79.0059*	0.009
Impact of TTC withdrawal		
No Covariates	-28.5103	
with Covariates	-81.7063	

Notes: Coefficients ($\boldsymbol{\beta_3}$) estimated using DID. * indicates at 1% level of significance. Covariates include Exchange rate of that country against US Dollar (Converted in Pak Rupee) and economic activity in that remittance originating country.

The results in **Table 1** suggest that workers' remittances inflow has increased by US$168.0 million since Pakistan withdrew TTC on remittances inflow from KSA. However, when covariates are included in the model, the result suggests a US$198 million per month increase in inflows. As economic activity in KSA plunged with the outbreak of COVID-19, the inclusion of the covariate further pushes this impact upward (**Figure A1 in Annexure 1**).

It is important to note that the above estimated coefficients include impacts of Saudization measure adopted by KSA, as well as Covid-induced travel restrictions, the latter had forced almost all informal inflows to the formal channel during the travel ban period (**Annexure 2**). Both of these factors have pushed the average monthly inflows upward. As a result, even after Pakistan withdrew TTC reimbursement, which imposed a cost on remitters, remittances from KSA continued to increase.[5]

KSA began easing restrictions in late 2020, allowing a significant number of immigrants to return to work (**Figure 3**). A large number of workers from Pakistan have emigrated to KSA since then. Later on, KSA further eased travel restrictions and began issuing Umrah visas in August 2021, thereby reviving informal means of sending remittances to Pakistan. As a result, remittance inflows from KSA have been slowing since then, despite a rapid increase in worker emigration to KSA (**Figure 1**). Since the withdrawal of TTC reimbursement and imposition of travel restrictions were enforced almost simultaneously, we removed the travel ban period (May 2020- August 2021) from the data to capture the actual impact of the withdrawal of TTC reimbursement.

Table 1 also shows the estimates from reduced data ('*Excluding the period of Umrah Ban during Covid*'). The estimates suggest that excluding the 'Umrah ban period' had a substantial impact on the coefficients. More precisely, the average impact of withdrawal of the TTC reimbursement resulted in an increase in the remittances inflow from KSA by US$138 million per month when no covariates were included in the model, thanks

[5] It is important to understand that Pakistani labor in GCC are mostly semi-skilled and unskilled employed in blue collar jobs. They tend to avoid digital means and rely on either Money Transfer Operators or the networking of family and friends for sending money back home. For details see Section 2.

to the 'Saudization' measures. The impact reduces to US$ 122 million when covariates are included in the model.

These results suggest that the withdrawal of TTC reimbursement reverted some remittances flowing from KSA toward informal channels. Our impact analysis suggests that, on average, US$30.5 million has shifted to the informal channel when no covariates are included. However, when covariates are included, the estimates suggest that, on average, US$76 million per month has shifted to the informal channel.

As robustness checks, we first re-estimated our model using the Synthetic Difference in Difference procedure proposed by Arkhangelsky et al. (2021) and Clarke et al. (2021) for small treatment and large control groups.[6] Moreover, the design of this test also incorporates the placebo inference procedure. To conduct this procedure, placebo treatments are randomly assigned based on the actual treatment structure; however, only to the control units. Building on these placebo assignments, placebo values for the coefficient are generated and used to calculate the variance. The coefficient of this test is reported in **Table A2** in **Annexure 4**. These estimates are very close to those reported in **Table 1**. Importantly, the impact of including the lag variable on the asymptotic normality of the estimator is unknown. This makes the Synthetic Difference-in-Differences procedure less suitable for our purpose, as we have used several covariates in their lags.

Second, we have assessed this impact in the GCC environment, using GCC countries other than KSA as a control and KSA as a treatment country. Results are reported in the lower panel of **Table 1**. In this case, the impact appears very similar, albeit in a lower magnitude, compared to the one reported in the upper panel of the table when all countries are considered.

Third, we have also estimated this impact using non-PKR exchange rates, that is, the actual exchange rate of the remittance originating country, instead of converting them into Pakistani rupees. The results are reported in **Table A3** (in **Annexure 4**). These estimates are consistent with those of

[6] Abadie et. al. (2010) faced very similar data structure like ours while investigating the impact of tobacco control program implemented in California in 1988. The impact of this reform was estimated by comparing the evolution of sales of cigarettes in packs per capita in California (the treated state) with those in 38 other (control) states, which did not significantly increase cigarette taxes during the study period.

Table 1. The results with covariates suggest that the impact is marginally lower compared to when exchange rates are in PKR. This is solely due to depreciation of the Pakistani rupee against the US Dollar, and therefore against other currencies as well.

Since DID provides an impact assessment of any specific event, the behavior or the true model explaining the determinant of workers' remittances inflow in Pakistan remained hidden. To provide the gist of the underlying model, we reported both random-effect and fixed-effect model estimates in **Table A4** (**Annexure 4**). The random effects model assumes that the country-specific characteristic has no significant impact on the covariates included in the model. However, these estimates are not very different from those of the fixed-effect model.

For the model incorporating the exchange rate in terms of the US Dollar, the results suggest that economic activity in the home country and the number of emigrants departing from Pakistan for that country are significant determinants of worker remittances inflowing from that country. The exchange rate (in US dollars) appears to be insignificant, suggesting that the exchange rate of the remittance origin country does not affect remittances coming into Pakistan. Nonetheless, beneficiaries in Pakistan receive the Pakistani rupee, and therefore, these results would be more meaningful when the exchange rate (covariate) is expressed in Pakistani rupees. This would help in capturing the impact of global exchange rate dynamics on remittances inflows in Pakistan.

Table A4 (**Annexure 4:** fourth and fifth columns) shows the estimates when exchange rates are converted to the Pakistani rupee. The results suggest that exchange rates are a significant determinant of remittances inflowing into Pakistan, together with economic activity in the remittances-originating country and the number of workers immigrating to that country. The estimate suggests that a 1% depreciation of the Pakistani rupee against the US dollar increases aggregate workers' remittances inflow in Pakistan by 0.22%. The positive and significant impact of exchange rates (asset prices) provides some evidence that remittances inflows in Pakistan also support investment activity, in addition to supporting the consumption of beneficiaries. However, conclusive evidence requires further research in this direction.

5. Conclusion

This paper attempted to estimate the impact of the withdrawal of TTC reimbursement on remittances inflowing from KSA in Pakistan. Our estimates suggest that this policy led to a decline in remittances from KSA of between US$31 million and US$76 million per month. Based on our assessment, the government of Pakistan has revised this policy since October 2023.

The following caveats are in order. Monthly information is available only on the gross stock of workers who emigrated from Pakistan. Theoretically, the net stock of workers emigrating from Pakistan, excluding those returning, should have been used. This number is not readily available. Moreover, BOE&E data on the number of workers going abroad is more meaningful for GCC countries as the laborers going to these countries had to register themselves with the Directorate of Emigration. The number of workers going to advanced economies is sparsely registered with the Directorate of Emigration. Furthermore, limited information on informal remittance inflow is acknowledged. Future work can better capture this channel-switching behavior.

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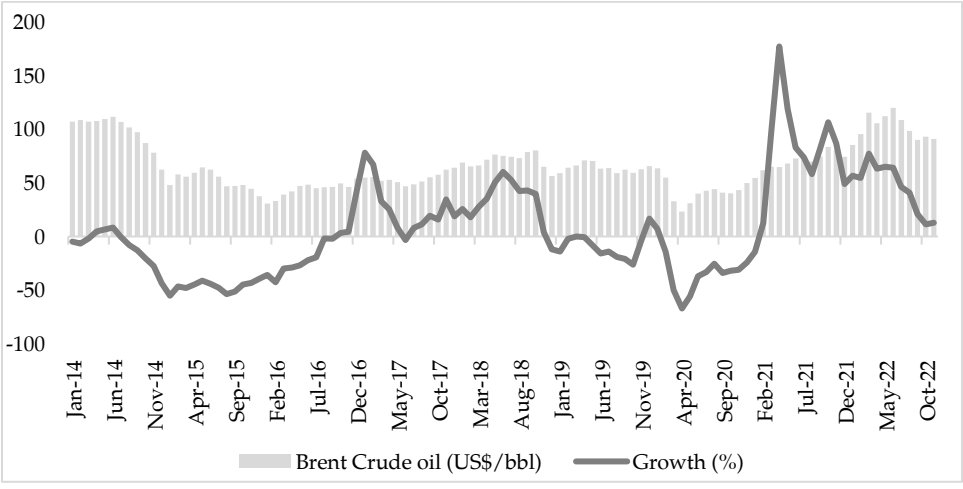
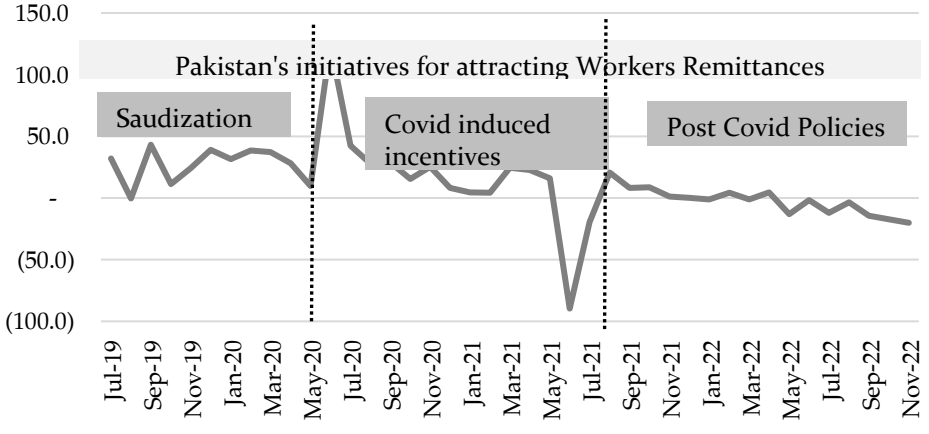
Annexure 1

Figure A1: Trend in Brent Crude Oil Prices



Source: World Bank

Figure A2: Remittances growth from KSA with Related Policy Development



Annexure 2

6. Pre-COVID Measures

6.3 KSA's Policy of Saudization

A) **Expatriate levy**: From July 2017, the KSA government imposed SAR 100 per dependent per month on expatriates and their dependents. This tax gradually rose every year until 2020. The tax amount doubled to SAR 200 in July 2018, increased to SAR 300 in July 2019, and to SAR 400 in July 2020.

Most expatriates responded by sending their dependents back home. As a result, this measure increased the outflow of workers' remittances from KSA.

B) **Taxing firms employing foreign workers:** From January 2018, the tax rate on private companies hiring an equal number of expatriates and Saudi workers increased to SAR 300 per foreign employee per month, from SAR 200. This rate was expected to increase to SAR 500 per foreign employee per month in 2019 and to SAR 700 per foreign employee per month in 2020. Moreover, in 2018, companies employing foreign workers, rather than Saudi nationals, were required to pay SAR 400 per employee per month. The tax rate was expected to increase to SAR 600 in 2019 and SAR 800 in 2020.

C) **Nitaqat Program**: Later on, the tax imposed on firms employing foreign workers was replaced by a performance-based nationalization of the job market, under the 'Nitaqat' program. The KSA government evaluates the performance of private entities on hiring Saudi nationals by calculating the percentage of Saudi nationals employed by the firms. The nationalization effort of the companies is calculated using a 13-week moving average over successive periods. The entities are classified into Excellent (Grey), Green, Yellow, and Red bands based on their performances relative to their economic activity and size. Firms are provided with various incentives based on their performance.

D) **Value Added Tax (VAT)**: Saudi Arabia has imposed a Value Added Tax (VAT) at the rate of 5.0 percent since January 2018. VAT has been imposed on wholesale and retail sales, including those of restaurants. This tax increased the cost of living for low-income expats in KSA and UAE.

6.4 Measures Adopted by Pakistan to Attract Remittances from the Formal Channel

From the start of the last decade, Pakistan adopted a three-pronged strategy to attract workers' remittances through the formal channel. These include a) strengthening of the remittances distribution network, b) removing structural bottlenecks in the inflow of remittances, and c) incentivizing the intermediaries and beneficiaries.

6.2.1 Strengthening of Remittances Distribution Network

a) Pakistan Remittances Initiative (PRI), in consultation with SBP and the Government of Pakistan (GoP), undertook more than 1,000 non-exclusive bilateral arrangements between domestic financial institutions and foreign entities, including foreign banks and money transferring organizations (MTOs). This substantially enhanced the reach of the domestic remittance-distribution network.

b) PRI launched two major schemes in December 2017: Asaan Remittance Account and digital *m-wallet*. The key feature of the 'Asaan Remittance Account' is that it can be opened in any scheduled bank through a simplified procedure.[7] Meanwhile, the government also launched a scheme to promote remittances through *m-wallets*, to accelerate remittance delivery and reduce remittance costs. The key feature of the *m-wallet* scheme is that the beneficiaries could withdraw cash from ATMs, bank branches or from hundreds of thousands of branchless banking agents. Moreover, they could make digital payments, for example to pay utility bills, using m-wallets.

c) These schemes utilized 12 Branchless Banking Operators (BBOs) with a network of 400,000 branchless banking agents spanning every nook and corner of the country. These BBOs supplement the domestic remittances distribution network, which consists of 24 banks, 5 microfinance banks, and 17 exchange companies.

[7] Similar to the 'Asaan Account' launched by SBP in 2015, the one-page account opening form for the 'Asaan Remittance Account' asks for basic customer information only. The customer's due diligence and other controls specified for 'Asaan Account' are applicable on the opening of the Asaan Remittance Account as well. This initiative aimed to encourage beneficiaries to receive remittances in a secured banking environment instead of over-the-counter cash they receive through traditional sources.

6.2.2 Removing structural impediments

a) SBP allowed authorized dealers (banks) to implement Business to Customer (B2C) and Customer to Business (C2B) transactions through foreign correspondent entities under either existing or new home remittance agency arrangements.

b) An individual, in B2C transactions, is allowed to receive up to US$ 1,500 per month for providing freelance and information systems services. Service providers other than of computer and information services are also allowed to receive up to US$ 1,500 per individual per month. Individual pensioners are also allowed to receive up to Rs 250,000 per month in remittances.

c) Meanwhile, in C2B transactions, overseas Pakistanis were allowed to pay directly utility bills, fees of Higher Education Commission-accredited institutions, insurance premiums, and make superstore purchases and on credit card payments. Overseas Pakistanis are also allowed to remit funds to purchase residential and commercial houses, plots, flats and buildings from reputed real estate builders/developers and housing societies.

6.2.3: Incentivizing beneficiaries and intermediaries

a) The government announced PKR 2.0 airtime incentive for mobile wallet users receiving up to for every US$ 1.0.

b) Exchange companies and banks were incentivized with PKR 1.0 for each US$ 1.0 incremental remittance that bring over 15.0 percent growth from previous financial year receipt.

7. Policies Adopted During COVID, and Subsequent Period

7.1 KSA measures that had implications for remittances inflow in Pakistan[8]

a) After the registration of the first COVID-19 case, Saudi Arabia suspended all schools, social events, sports activities, domestic travel, and international flights.

[8] Initiatives and services introduced by Saudi Arabian government authorities to support businesses during the emerging COVID-19 pandemic | Ministry of Investment (misa.gov.sa)

b) Restrictions were imposed on public movements, social and religious gatherings, travel, and businesses ahead of the first 100 confirmed COVID-19 cases.

c) The 2020 Hajj pilgrimage was scaled down to a limited number of participants. No cases of COVID-19 were detected among pilgrims.

d) Exempting expatriates, whose residency ended between March 2020 to June 2020, from the necessary financial requirements needed for visa renewal. In these cases, the residency period is extended by three months without reapplication.

e) Employers were allowed to extend unused exit and return visas during the entry and exit ban for three months at no charge.

f) Taking into account that the commercial activities were most affected, business owners were allowed to delay, by extending the postponement period as needed, for the following,

   a. Supplying value-added tax, selective goods tax, and income tax
   b. Submission of zakat returns and payment of zakat owed
   c. Implementing procedures to stop services and seizure of funds by the General Authority of Zakat and Income.

g) All customers were exempted from the fees for transactions made via electronic channels.

7.2 Measures taken by Pakistan to keep remittance inflows unaffected

The State Bank of Pakistan announced new measures on April 15, 2020, to encourage banks and exchange companies to attract higher remittance volumes.[9]

a) The rate of reimbursement for telegraphic transfer (TT) charges doubled. Specifically, the reimbursement rate for inflow between US$100-200 increased from SAR 10 to SAR 20 for each transaction.

b) A tier-based system was introduced to reimburse marketing transactions, where higher growth in remittances would lead to higher reimbursement of marketing charges. Authorized Dealer (ADs)

[9] Via EPD Circular Letters 11 and 12 of 2020.

generating remittances above the defined threshold growth became eligible to receive PKR 0.5, PKR 0.75, and PKR 1 for every additional US dollar generated.

c) The banks were also encouraged to promote digital channels for sending and receiving remittances and to introduce incentive schemes for their own customers.

d) From July 1, 2020, withholding tax on cash withdrawals, issuance of banking instruments, and on transfers in domestic bank accounts was withdrawn to the extent of the amount of remittances received into the accounts in a year.

Annexure 3

Step by step details of the DID procedure

For the period (t=0) when the TTC reimbursement policy was not withdrawn, both groups should have a similar trend driven by the intrinsic domestic and international factors; remittances inflows in the two groups could be described as:

Treatment group (g=1)

$$y_{i10} = \alpha_1 + \gamma_0 + \beta_1(1) + \beta_2(0) + \beta_3(1 * 0) + \epsilon_{i10} \quad (2)$$

Control group (g=0)

$$y_{i00} = \alpha_0 + \gamma_0 + \beta_1(0) + \beta_2(0) + \beta_3(0 * 0) + \epsilon_{i00} \quad (3)$$

After the withdrawal of reimbursement of TTC, the remittances inflows in the two groups could be described as:

Treatment group (g=1)

$$y_{i11} = \alpha_1 + \gamma_1 + \beta_1.1 + \beta_2.1 + \beta_3(1 * 1) + \epsilon_{ig11} \quad (4)$$

Control group (g=0)

$$y_{i01} = \alpha_0 + \gamma_1 + \beta_1.0 + \beta_2.1 + \beta_3(0 * 1) + \epsilon_{i01} \quad (5)$$

Change in remittances inflows in the treatment group [over the period (‘t’)] = (4) – (2)

$$y_{i11} - y_{i10} = (\alpha_1 + \gamma_1 + \beta_1.1 + \beta_2.1 + \beta_3(1 * 1) + \epsilon_{ig11}) - (\alpha_1 + \gamma_0 + \beta_1(1) + \beta_2(0) + \beta_3(1 * 0) + \epsilon_{i10}).$$

Or,

$$y_{i11} - y_{i10} = (\gamma_1 - \gamma_0) + \beta_2 + \beta_3 + (\epsilon_{ig11} - \epsilon_{i10}) \quad (6)$$

Change in remittances inflows in control group [over the period (‘t’)] = (5) – (3)

$$y_{i01} - y_{i00} = (\alpha_0 + \gamma_0 + \beta_1.0 + \beta_2.1 + \beta_3(0 * 1) + \epsilon_{i01}) - (\alpha_0 + \gamma_0 + \beta_1(0) + \beta_2(0) + \beta_3(0 * 0) + \epsilon_{00}$$

$$y_{i01} - y_{i00} = \beta_2 + (\gamma_1 - \gamma_0) + (\epsilon_{01} - \epsilon_{00}) \quad (7)$$

Average treatment effect or (Difference in Difference effect) = (6)-(7)

$$= (y_{i11} - y_{i10}) - (y_{i01} - y_{i00})$$

$$= \big((\gamma_1 - \gamma_0) + \beta_2 + \beta_3\big) - (\beta_2 + (\gamma_1 - \gamma_0)) + ((\epsilon_{ig11} - \epsilon_{i10}) - (\epsilon_{01} - \epsilon_{00}))$$

$$= \beta_3 + [(\epsilon_{ig11} - \epsilon_{i10}) - (\epsilon_{01} - \epsilon_{00})]$$

$$= \beta_3 + [Random\ error]$$

Annexure 4

Table A1: Descriptive Statistics

Variables	Observation	Mean	Standard deviation	Minimum	Maximum
Remittances	1,352	83.3	146.7	0.2	821.6
Econ. Activity	1,352	6.7	26.5	-67.2	177.5
Exchange Rate (in USD)	1,352	51.9	227.5	0.3	1426.1
No of Workers Emigrating	1,352	1464.9	5802.3	0.0	59615.0
Exchange Rate (in PKR)	1,352	163.3	134.9	0.1	780.2
No of cluster				1	12
No of Countries				1	26

Table A2: Robustness Test Using Synthetic Difference in Difference with Placebo Selection (million US$)

	Coefficients	p-value
No Covariates	181.9141*	0.000
with Covariates	164.6826*	0.000
Excluding the period of Umrah ban during Covid		
No Covariates	158.8868*	0.000
with Covariates	99.3212*	0.002
Impact of TTC withdrawal		
No Covariates	-23.0723	
with Covariates	-65.3614	

Notes: Coefficients ($\boldsymbol{\beta_3}$) estimated using DID. * indicates at 1% level of significance.

Table A3: Impact of TTC charges Withdrawal on Remittances Inflows (mil US$)

	Coefficients	p-value
All Countries		
No Covariates	168.2889*	0.000
with Covariates	195.4906*	0.000
Excluding the period of Umrah ban during Covid		
No Covariates	137.7537*	0.000
with Covariates	120.8412*	0.000
Impact of TTC withdrawal		
No Covariates	-30.5352	
with Covariates	-74.6494	
Gulf Cooperation Council (GCC) Countries		
No Covariates	142.1919*	0.000
with Covariates	172.1448*	0.000
Excluding the period of Umrah ban during Covid		
No Covariates	113.6816*	0.000
with Covariates	102.7883*	0.001
Impact of TTC withdrawal		
No Covariates	-28.5103	
with Covariates	-69.3565	

Notes: Coefficients ($\boldsymbol{\beta_3}$) estimated using DID. * indicates at 1% level of significance.

Table A4: Impact of Key Factors on Remittances Inflows in Pakistan

	All Countries			
	Exchange rate in USD		Exchange rate in PKR	
	Fixed Effect	Random Effect	Fixed Effect	Random Effect
Economic Activity (-1)	0.2414*	0.2443*	0.2113*	0.2181*
	(0.000)	(0.000)	(0.000)	(0.000)
Exchange rate (-1)	0.0121	-0.0324	0.2038*	0.1750*
	(0.863)	(0.520)	(0.000)	(0.000)
No. of Workers	-0.0015*	-0.0013*	-0.0015*	-0.0013836
Emigrating (-2)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	84.9930*	85.9061*	52.1894*	55.6214
	(0.000)	(0.000)	(0.000)	(0.001)

Notes: Estimates obtained using fixed effect and random effect models.

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Financial Development and CO_2 Emissions: A Global Analysis and Continent-level Comparisons of Institutional Quality's Mediating Role

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Abstract: This study examines the relationships among financial development, renewable energy, institutional quality, and carbon dioxide (CO2) emissions using dynamic panel data techniques from 1990 to 2020. The empirical results of the econometric analysis suggest that financial development does not necessarily reduce CO2 emissions unless institutional quality improves. Financial development exacerbates environmental deterioration by increasing CO2 emissions in all regions except Europe, whereas renewable energy consumption and institutional quality improve environmental quality. Thus, good institutional quality emerged as a mediating variable between financial development and environmental quality in curbing CO2 emissions and promoting sustainable development worldwide.

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Financial Development and CO_2 Emissions: A Global Analysis and Continent-level Comparisons of Institutional Quality's Mediating Role

1. Introduction

The environmental deterioration marked by increased greenhouse gas (GHG) emissions has become an unavoidable global challenge. Among GHGs, carbon dioxide (CO2) is one of the primary contributors to pollution, accounting for at least 75.01% of worldwide emissions (Ritchie et al., 2024) and contributing to adverse climatic conditions. This increase in CO2 emissions and climate change can be attributed to rapid industrialization, deforestation, and the unchecked use of fossil fuels to accelerate economic growth (Chirwa, 2023). To design and implement effective climate strategies, it is essential to understand the interactions among the financial sector, regulatory authorities, and other socio-economic factors, such as economic growth, renewable energy use, population, and industrialization.

Despite a growing body of literature, conflicting results mean that the impact of financial development (FD) on CO_2 emissions remains unclear (Azam *et al*., 2019). With several studies supporting positive spillover effects of FD in boosting the economic and ecological prosperity of a nation by research and development, increasing energy efficiency through investment in eco-friendly projects and cleaner technologies (Habiba & Xinbang, 2022; Li *et al*., 2022; Ruan *et al.,* 2023; Cheng *et al.,* 2025), while others highlight the detrimental environmental effects of increased industrial activities and energy intensive devices increasing CO_2 emissions in the atmosphere (Jensen, 1996; Zhang, 2011; Shoaib *et al.,* 2020; Sakilu & Chen, 2024). In addition to FD, institutional quality (IQ) plays a pivotal role in addressing environmental challenges through enforcing stringent regulations. Governments with robust institutional frameworks can effectively direct finances towards sustainable energy initiatives such as renewable energy (RE) adoption, technological innovations, and green energy promotion (Trevisan *et al.,* 2023). However, the extent to which IQ moderates the environmental impact of FD remains underexplored. This study aims to bridge this gap by investigating the combined impact of FD and IQ globally and regionally.

The analytical foundation of the study relies on the STIRPAT framework, which extends the IPAT model to quantify the impact of socio-economic and demographic indicators, including population, affluence, and technology, on environmental quality proxied by CO_2 emissions. This model rests upon well-grounded theories that provide insight into the real drivers of environmental change. A complementary approach, the Porter Hypothesis, proposed by Porter (1991), holds that strict environmental regulations incentivize firms to adopt cleaner processes and technologies that enhance productivity, reduce costs, and spur innovation. This highlights the critical role of FD in promoting eco-friendly innovations. It mobilizes financial resources to drive innovations such as Fintech (the fusion of finance and technology), which reduces carbon emission intensity by increasing energy efficiency and supporting green finance (Xu *et al.*, 2023; Wang *et al.*, 2024). However, the lack of transparent governance can compromise the benefits of financial flows, leading to increased CO_2 emissions.

These theoretical foundations facilitate the selection of potential determinants of environmental quality, such as economic growth (GDP), renewable energy (RE), industrialization, urban population, and trade (Le *et al.*, 2016; Pata, 2018; Azam *et al*., 2022). Most studies focused on the relationship between FD and CO_2 emissions, while ignoring the role of IQ (Jiang & Ma, 2019; Habiba & Xinbang, 2022; Udeagha & Breitenbach, 2023). However, a few studies examine the role of IQ alongside FD, but either use a single proxy for FD and IQ or are confined to a specific region (Tamazian & Rao, 2010; Sheraz *et al.*, 2022), thereby ignoring a wider perspective.

This study will contribute to the literature by addressing the following gaps. First, this study uses indices of FD and IQ constructed by including variables that affect FD and IQ. Unlike previous studies, which used only a single proxy for FD and IQ to capture their impact on environmental quality. Second, this study provides evidence for an analysis by continent, as previous research has been clustered around specific regions (Sheraz *et al.*, 2022; Adedoyin *et al.*, 2022; Vatamanu & Zugravo, 2023). Continent-level analysis provides insights into the regional disparities in resource availability, technological capabilities, and institutional structures, guiding policymakers in implementing targeted interventions in the transition towards a low-carbon economy. Third, the inconclusive effects of FD on CO_2 emissions necessitate an interaction term (FD*IQ) to determine whether institutions mitigate the harmful impact of FD on CO_2 emissions. Fourth, this study used GMM to address

endogeneity, followed by a robustness check using Panel Quantile and Driscoll and Kraay standard error analyses. Driscoll and Kraay's standard error also considers cross-sectional dependence.

This study investigates the following research questions: 1) What is the effect of FD on CO_2 emissions? 2) What is the effect of IQ on CO_2 emissions? 3) To what extent does IQ moderate the relationship of FD with CO_2 emissions, and 4) How does RE contribute to CO_2 emissions? and 5) How do these relationships change at the global and continent levels?

The study is structured as follows: Section 2 provides the literature. Section 3 consists of data description and methodology. Section 4 provides results and discussion. Sections 5 and 6 provide robustness analysis and a conclusion.

2. Literature Review

2.1 Theoretical Underpinnings

Over the past few decades, the process of industrialization, powered by the utilization of fossil fuels, has fostered breakthrough economic growth. However, these developments have brought radical changes in people's living standards. It adversely affects the quality of life by polluting the atmosphere (Darcin, 2014). To address worsening climate change, global economies are working to curb CO_2 emissions.

The association between economic growth and environmental quality has been explored extensively in the literature since the 1970s, following the publication of "The Limits to Growth" by the Club of Rome (Meadows *et al.,* 1972), which advocates a zero-growth or steady-state economy to mitigate environmental risks. Findings across studies yield contrasting results (Bansal, 2014; Sineviciene *et al.,* 2018; Chong *et al.,* 2022). Environmental quality depends on several factors, including scale effects, composition effects, and technique effects. The scale effect describes how the level of economic activity impacts the environment. An increase in industrial activities results in greater use of natural resources, higher energy consumption, and increased GHG emissions, which worsen environmental degradation (Liobikiene & Butkus, 2019). The composition effect indicates a structural change in the economy that is a shift to less carbon-intensive sectors, while technique effects foster technological innovation, leading to a cleaner environment.

FD and environmental degradation are closely linked, as was first noted by Aufderheide & Rich (1988) and Schmidheiny & Zorraquin (1998). They reported that FD leads to environmental decline. They emphasized the role of the World Bank and other multilateral banks, which often overlook environmental factors when disbursing loan funds. They cited evidence from India, where financial aid without environmental safeguards resulted in soil erosion and forest land degradation, particularly due to rubber projects.

The financial sector plays a critical role in the smooth functioning of an economy by disseminating information on funding, monitoring investments, enhancing profits, minimizing risks, accelerating trade, and creating employment opportunities, all of which contribute to a nation's economic growth (Pagano, 1993; Calderon & Liu, 2003). The history of each developed nation shows the presence of strong financial institutions that helped mobilize capital and allocate resources. In this way, FD helps balance growth across all sectors of the economy. FD can both support and deteriorate environmental quality. On one hand, FD stimulates the economy by increasing access to funds that could be invested in clean energy projects (Khan *et al.* 2020, Sun *et al.*, 2023), supporting environmental improvement, while on the other hand, increased energy consumption and production based on fossil fuels can lead to increased CO_2 emissions. Possible reasons for these conflicting results include the nature of the data, the measurement method, and regional differences.

The theory of IQ explains the influential role of a nation's institutions in shaping people's economic and social behavior. It consists of a wide set of rules, norms, and values, and guides developing countries to learn from developed nations and to develop appropriate policies that could pave the way to prosperity. Strong government institutions ensure the enforcement of environmental standards, thereby improving environmental quality (Danish & Ulucak, 2020). The role of governance in enhancing the quality of institutions by imposing strict regulatory measures and ensuring transparency helps abate CO_2 emissions by redirecting funds to clean energy projects, thereby achieving the SDGs.

Sustainable development theory is defined as "the development that meets the needs of the present without compromising the ability of future generations to meet their needs." It describes the interconnected crises of environment, energy, and development, as well as the insufficiency of current resources. The 2030 Agenda for Sustainable

Development emphasizes reaching goals that support inclusive growth and balanced economic, social, and environmental progress (United Nations, 2015).

Ecological modernization theory states that advanced economies develop institutionalized environmental governance systems that gradually decouple economic activity from ecological effects. Similarly, EKC also states that as the economy grows, environmental conditions deteriorate, but after reaching a certain point, environmental quality begins to improve. Thus, EKC suggests a non-linear relationship between economic development and environmental quality, whereas IPAT assumes a linear increase in environmental impact with increasing population (Majeed & Tauqir, 2020).

2.2 FD and CO_2 Emissions

The empirical literature also provides conflicting results regarding the impact of FD and CO_2 emissions. The studies of Jiang & Ma (2019), Wang *et al.* (2020), and Qayyum *et al.* (2021) reported an increase in CO_2 emissions from FD, while Charfeddine (2017), Kirikkaleli & Adebayo (2020), and Udeagha & Breitenbach (2023) reported a decrease in CO_2 emissions from FD. Jiang & Ma (2019) conducted a panel data study of 155 countries, and the results showed that financial growth exacerbates CO2 emissions in developing and emerging economies, while being insignificant for developed nations. It can be attributed to differences in priorities: developing and emerging economies are more inclined to scale up rather than invest in energy-efficient technologies, whereas developed economies prioritize environmental safety. The studies by Wang *et al.* (2020) for N-11 countries and Islam (2022) for South Asia concluded an increase in CO_2 emissions from FD. Qayyum *et al.* (2021) also reported a surge in CO_2 emissions in India due to the inefficiency of financial institutions that invest in small-scale businesses to generate profits.

Another group of researchers found conflicting results, where FD negatively impacts CO2 emissions on a global and regional scale level. Kirikkaleli & Adebayo (2020) conducted a study on the global economy and found FD to be effective in decreasing CO_2 emissions by providing access to loans for investment in environmental protection programs. Udeagha & Breitenbach (2023) explored the direct and indirect impacts of FD on climate change mitigation in South Africa using the Environment Kuznets Curve (EKC) analytical framework. Their results revealed that FD

both temporarily and permanently helps reduce CO_2 emissions and suggested national interventions to achieve sustainability targets for net-zero CO_2 emissions. Similarly, the study of Solaymani & Montes (2024) also reported a decrease in CO_2 emissions from FD in New Zealand. FD encourages research and development, provides green loans, and finances energy-efficient projects.

Khan *et al.* (2020) also found similar results for Pakistan, where FD helped in decreasing CO_2 emissions. The author suggested adopting efficient national environmental, fiscal, and monetary policies to safeguard the environment. These results are similar to those of Charfeddine (2017) for Qatar, who also advocated designing and implementing efficient environmental policies to combat rising CO_2 emissions.

The transition to a low-carbon economy has been supported by the transformative role of Fintech and the Internet of Things (IoT), reshaping the FD paradigm. The digital innovations like e-banking, big data, and blockchain technology ensure financial inclusion, transparency in the stock market, support green economic growth, increase renewable energy adoption, and reduce corporate carbon emissions, paving the path to sustainability (Brem *et al.*, 2016; Croutzet & Dabbous, 2021; Awais *et al.*, 2023; Wang *et al.*, 2024). Similarly, IoT-driven technologies help curb carbon emissions by increasing transparency through real-time data tracking and monitoring (Tsokov & Antonova, 2017; Alpan *et al.*, 2022; Li *et al.*, 2025).

2.3 IQ and CO_2 emissions

Strong institutional frameworks can lead to the sustainable use of financial resources, helping to mitigate CO_2 emissions. Tamazian & Rao (2010) establish the significance of IQ in reducing CO_2 emissions across 24 transitional economies. Their results suggested that efficient financial institutions can lead to environmentally sustainable pathways in the presence of strong regulatory bodies and support the development of clean technologies, thereby reducing environmental degradation. Ibrahim & Law (2016) examined the roles of IQ and trade in a sample of 40 Sub-Saharan African countries and found that institutional reforms were extremely helpful in realizing the benefits of trade and reducing CO_2 emissions. Halder & Sethi (2021) investigated the moderating impact of IQ on energy consumption and CO_2 emissions across 39 developing countries and found that IQ was helpful in abating emissions, particularly in the

residential and transportation sectors. This effective role of IQ can be attributed to strict environmental rules that promote investment in clean energy sources and energy efficiency.

Khan & Rana (2021) conducted a panel data study across 41 Asian countries to measure the direct and indirect effects of IQ on CO_2 emissions and found that strong political institutions significantly help reduce CO_2 emissions in Asia. A moderating effect of IQ on the negative impacts of income was also detected. This highlights the important role of governance in improving environmental quality. Since economic growth is a key indicator of a country's overall performance, a growth-emissions relationship study for Indonesia, Thailand, and South Korea by Salman *et al.* (2019) also supports the existence of effective domestic institutions that both promote economic growth and encourage green investment to curb CO_2 emissions.

A recent study conducted by Vatamanu & Zugravo (2023) shed light on the dynamic relationship between FD and consumption of RE in the presence of institutional variables. The results of this study for 27 European Union (EU) member states confirmed a robust positive relationship between all the variables. The literature also provides contradictory results regarding the relationship between IQ and CO_2 emissions. Godil *et al.* (2020) conducted a study for Pakistan, and the results show that IQ increases CO_2 emissions. The study suggested restructuring the financial institutions and energy consumption patterns to combat the evils of bad governance and corruption, and improving IQ could help in achieving a sustainable environment.

A comparative study of the European Union (EU) and G-20 members conducted by Dinca *et al.* (2022) revealed a direct positive impact of IQ on increased CO_2 emissions in these regions. The authors suggested implementing strict rules and regulations to build public confidence in the government's decisions and using renewable energy resources to enhance environmental performance.

A comprehensive review of the literature also shows RE to be one of the most important contributors to change in CO_2 emissions. RE consumption boosts economic growth by protecting the environment from hazardous, poisonous chemicals released during the burning of fossil fuels, thereby encouraging the adoption of clean technology (Magazzino *et al.*, 2022). Thus, the energy transition from 'vulnerable' to 'sustainable'

resources is being followed everywhere in the world (Khan *et al*., 2022). The idea of RE-driven sustainable development, emphasizing green growth, has garnered significant attention recently (Usman *et al.*, 2020; Khan *et al.*, 2023; Zheng *et al*., 2023). RE sources are inexhaustible, cheaper, and environment-friendly, ensure energy security, reduce fossil fuel import dependence, and provide a reliable solution to combating the problems associated with non-RE sources (Chen *et al*., 2022).

Taken together, the divergent findings from the empirical review of FD and IQ on CO_2 emissions stem from a variety of reasons, including data coverage, variable inclusion, and methodological differences, but most importantly from regional heterogeneity in economic and institutional structures.

This indicates the need for a thorough analysis of the fundamental causes of carbon emissions. The review of the literature reveals some weaknesses. First, most studies are based on the theoretical framework of EKC, which primarily focuses on economic growth rather than sustainable development. The term 'sustainable development' is a broader concept that involves redirecting investments toward alternative energy sources like renewables, along with institutional reforms that can support green growth and ultimately a sustainable future. Second, many studies assess the impact of FD and IQ on CO_2 emissions using proxy variables instead of developing a comprehensive index that encompasses all relevant factors affecting CO_2 emissions. Third, only a few studies offer global evidence (Kirikkaleli & Adebayo, 2020; Sun *et al.*, 2023). Lastly, a comparative analysis at both the global and continent level is lacking, which could reveal differences masked in the overall global perspective. These variations are influenced by geographical location, natural resource endowments, population size, and cultural or institutional factors.

The current study fills the gap by providing a comprehensive analysis of the impact of FD and IQ on CO_2 emissions at the global level and for the continents of Asia, Africa, and Europe by employing panel data techniques from 1990 to 2020. It also measures the combined impact of FD and IQ on CO_2 emissions and explains its significance in the context of differences in results across continents. The study also provides evidence about the impact of FD, IQ, and FD*IQ on CO_2 emissions across quantiles.

3. Data Description and Methodology

3.1. Data and Variables Description

Panel data for 111 countries from 1990 to 2020 are taken from the World Bank (2023), as per the availability of CO_2 emissions data. This 31-year span also allows us to consider the major financial, institutional, and environmental reforms across the globe. The disaggregated analysis included 41 Asian, 47 African, and 21 European countries. The selection of variables is based on well-established theoretical and empirical research available in this field. CO_2 is widely used as a proxy for environmental degradation (Ehrlich & Holdren, 1971; Xaisongkham & Liu, 2024), whereas FD, IQ, GDP, RE, trade, urban population, and industrialization are used as independent variables in their relevance to the IPAT and STIRPAT model (Dietz & Rosa, 1997). The FD index is constructed following Tahir *et al*. (2021) and Muhoza (2019) using variables such as domestic credit to the private sector (DCP), domestic credit to the private sector by banks (DCPB), and broad money (BM). These indicators reflect the financial intermediation and depth of the financial market. Domestic credit to the private sector measures the support provided by financial institutions to private firms or businesses, while broad money is an indicator of the total money in circulation in the economy. Similarly, an index of IQ is constructed by using six variables, namely control of corruption (COC), political stability (PS), regulatory quality (RQ), rule of law (ROL), government effectiveness (GE), and voice and accountability (VOA) (Ha & Nguyen, 2023). These proxies are used to construct a composite index of financial development and institutional quality via Principal Component Analysis (PCA), which helps capture the true picture of these variables across countries over time and also addresses the problem of multicollinearity (Muhoza, 2019; Tahir *et al*., 2021). The details are provided in Appendix A. The internal consistency of the variables used to construct indices is further verified by calculating Cronbach's Alpha. The reliability scores (α=0.97 for FD and α=0.96 for IQ) support the use of PCA. An interaction term of FD and IQ (FD*IQ) is also added to test the moderating role of IQ. Table 1 describes all the variables and sources.

Table 1: Data Description & Source

Variable	Abs	Definition/Description	Source	Transformation
CO_2 emissions	CO_2	Metric tons per capita	World Bank, 2023	Log
Independent Focused Variables				
Financial development	FD	Index of DCP, DCPB, and BM	World Bank, 2023	Level
Institutional quality	IQ	Index of COC, PS, RQ, ROL, GE and VOA	World Bank, 2023	Level
Interaction Term	FD*IQ	Product of FD and IQ	Self-constructed	Level
Control Variables				
Economic Growth	GDP	GDP per capita constant 2015 US$	World Bank, 2023	Log
Renewable Energy	RE	Percentage of final total energy consumption	World Bank, 2023	Log
Trade	TRADE	% of GDP	World Bank, 2023	Log
Urban Population	URB	% of the total population	World Bank, 2023	Log
Industrialization	IND	Industry (including construction), % of GDP	World Bank, 2023	Log

3.2. Analytical Framework

Ehrlich & Holdren (1971) developed the IPAT model to examine how population expansion affects the environment. I represent the environmental impact quantified by taking carbon dioxide as a proxy and three other factors, including population (P), affluence (A), and technology (T), combined to form this identity;

$$I = P*A*T$$

To examine the impact of different factors on the environment and function, later researchers, Dietz & Rosa (1997), expanded the STIRPAT model from the initial IPAT version. In this way, CO_2 emissions depend on P, A, and T in the following ways;

$$CO_{2it} = aP_{it}^{b} A_{it}^{c} T_{it}^{d} e_{it} \quad (1)$$

Where a denotes the regression slope coefficient, i the cross-sectional units, and t the time period. Similarly, b, c, and d denote the

elasticity coefficients of P, A, and T. Lastly, *e* represents the residual. In logarithmic form, the model is rewritten as follows (Equation 2):

$$LCO_{2it} = \alpha_0 + \beta LP_{it} + \gamma LA_{it} + \varphi LT_{it} + \varepsilon_{it} \quad (2)$$

Where *P* is the population proxied by the urban population (Baloch *et al.*, 2019; Ahmad *et al.*, 2020), *A* is affluence proxied by GDP per capita (Sun *et al.*, 2021), and *T* is technology proxied by FD (Hafeez *et al.*, 2018; Baloch *et al.*, 2019) and renewable energy.

An increase in urban population increases energy consumption, land usage, and waste generation. This signifies its inclusion in the IPAT framework to analyze its impact on carbon emissions. Industrialization is also a major contributor to rising emissions that cause environmental harm. Increased industrial activity and free trade lead to economic growth, which is usually characterized by strong financial institutions. The role of institutions is crucial for preventing corruption and enforcing strict environmental policies (Danish & Ulucak, 2020; Haldar & Sethi, 2021). Thus, the positive contributions of the financial sector and better governance pave the way for sustainable development. To test the moderating role of institutional quality on CO_2 emissions, an interaction term, FD*IQ, has also been added. The extended version of the STRIPAT model can be written as Equation 3:

$$LCO_{2it} = \beta_0 + \beta_1 LGDP_{it} + \beta_2 FD_{it} + \beta_3 IQ_{it} + \beta_4 FD_{it} * IQ_{it} + \beta_5 LRE_{it} + \beta_6 LTRADE_{it} + \beta_7 LURB_{it} + \beta_8 LIND_{it} + \mu_{it} \quad (3)$$

where CO_2 are the CO_2 emissions, FD represents the FD index, and IQ is the IQ index. All other variables, including GDP, represent economic growth; RE represents RE consumption; TRADE represents trade openness; URB represents urban population; and IND represents industrialization, and are used as control variables in the model. L represents the log-transformed variables. β_0 and μ_{it} are, respectively, the intercept and the error term.

The model will assist us in analyzing the quantitative impact of explanatory variables on global CO_2 emissions. To gain more insight, the analysis has been split into three independent continents—Asia, Africa, and Europe—to determine which continent would benefit the most from changes to its financial institutions and more effective governance.

3.3. Econometric Technique

Panel data are a convincing option for this research, as they integrate cross-sectional and time-series data. Before investigating the causal relationship between the observed variables, Pesaran (2004) recommends tests for cross-sectional independence, followed by panel unit root tests for stationarity. The analysis proceeds by estimating fixed effects and random effects. The fixed effects estimate individual-specific effects that capture inherent differences among countries that remain stable over time. The random effects model estimates average effects and treats unobserved heterogeneity as a random variable. In addition, the VIF values are also reported in Table 4, confirming that multicollinearity is not a significant problem.

The System GMM proposed by Blundell & Bond (1998) is employed for the estimation of the dynamic panel, as it accounts for unbalanced panels and addresses the problems of endogeneity and autocorrelation in the error terms. It provides more reliable and unbiased estimates, as the number of cross-sectional units (N) is greater than the number of periods (T) in global data. However, the System GMM suffers from instrument proliferation, which undermines the statistical significance of the Hansen test. To address this issue, specifically in regional sub-samples, the number of instruments is restricted to achieve unbiased results (Roodman, 2009).

Additionally, Panel Quantile Regression and Driscoll-Kraay Standard Errors are also used as robustness checks. Driscoll-Kraay Standard errors also consider cross-sectional dependence.

3.4. Descriptive Analysis

Table 2 provides descriptive statistics.

Table 2: Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
CO_2	1922	3.440	4.383	.021	39.582
GDP	1922	9216.314	15921.25	234.709	84611.1
FD	1922	0.119	1.126	-.772	9.509
IQ	1922	-0.123	.916	-1.539	2.531
RE	1922	40.544	32.496	.01	98.27
TRADE	1922	81.067	48.300	9.955	437.326
URB POP	1922	52.080	22.442	7.412	100
IND	1922	28.440	12.335	4.428	86.669

3.5. Correlation Analysis:

Table 3 shows the correlation matrix. It shows a positive and significant correlation between all variables and carbon emissions at the global level, except RE consumption, which has a negative relationship with CO_2. The correlation between urban population and CO_2 is 0.664, which is the highest among all.

Table 3: Correlation Matrix

Variables	CO_2	GDP	FD	IQ	RE	TRADE	URBPOP	IND
CO_2	1.000							
GDP	0.659	1.000						
FD	0.282	0.517	1.000					
IQ	0.475	0.798	0.522	1.000				
RE	-0.579	-0.375	-0.359	-0.349	1.000			
TRADE	0.308	0.388	0.205	0.386	-0.360	1.000		
URBPOP	0.664	0.632	0.418	0.563	-0.669	0.397	1.000	
IND	0.373	0.007	0.027	-0.100	-0.308	0.099	0.222	1.000

3.6. Cross-Sectional Dependence Test:

After correlation analysis, Pesaran's (2004) test for cross-sectional independence is applied. A test statistic of 17.09 (p-value < 0.001) confirmed the presence of significant cross-sectional dependence across nations, implying the use of more robust techniques, such as Driscoll-Kraay standard errors, to obtain unbiased estimates.

3.7. Unit Root Tests

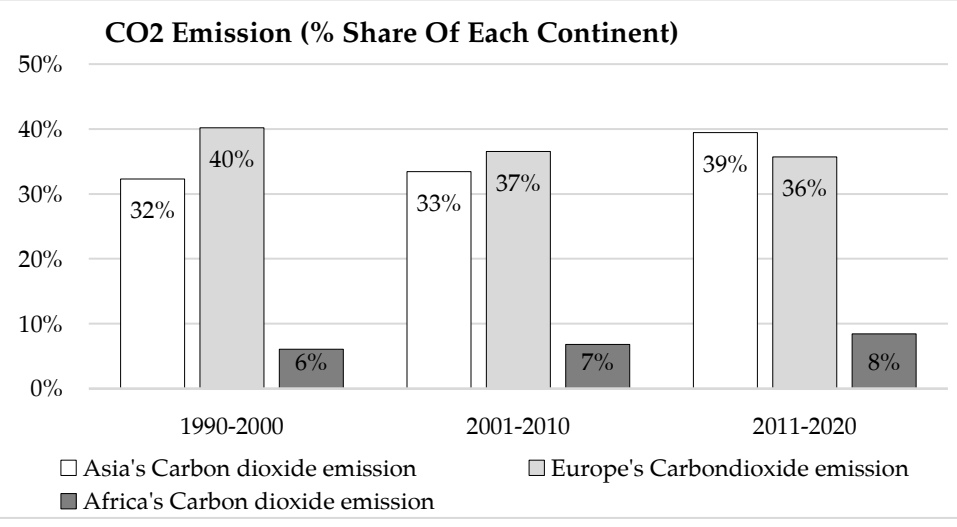
After cross-sectional dependence, we checked the stationarity of variables by employing the Im-Pesaran and Shin test (IPS-2003) and the Fisher-ADF panel unit root test (1999). These results indicate that the series are stationary in first differences, showing integration of order one, I(1). The details are provided in Appendix B. This signifies the use of suitable econometric techniques, such as system GMM, which ensure robust estimates despite non-stationarity.

4. Results and Discussion

Figure 1 illustrates the level of CO_2 emissions (percentage) during the last three decades in Asia, Africa, and Europe. CO_2 emissions in the

continent of Europe have decreased, whereas in Asia and Africa, they have surged.

Figure 1: CO2 emissions in Asia, Africa and Europe



The quantitative analysis uses both fixed and random effects models. The fixed effects model permits the use of dummy variables to account for individual-specific effects, with each entity having its own intercept. The regression results from the fixed effects are shown in Table 4, where columns A, B, C, and D display the analysis for the global panel, followed by Asia, Africa, and Europe separately. Economic growth positively influences CO_2 emissions both globally and at the continent level, indicating that an increase in GDP is associated with higher CO_2 emissions.

The results demonstrate a significant positive effect of FD on CO_2 emissions at both the global and continent levels. These findings align with the studies of Bayar *et al*. (2020), Qayyum *et al.* (2021), and Wang *et al.* (2020), which indicate that improved financial access tends to boost production and energy consumption rather than investment in cleaner technologies, resulting in higher carbon emissions in post-transition European economies, India, and N-11 nations. The effectiveness of institutional quality (IQ) in reducing CO_2 emissions is presumed, yet an insignificant effect of IQ on CO_2 emissions is observed at the global level and in Asia. Conversely, it shows a negative relationship in Africa and a positive one in Europe. This counterintuitive result of IQ in Europe could

be due to high industrial activity, accurate emission estimation, or the static nature of the FE model. The sign and magnitude of the interaction term FD*IQ reveal different patterns across regions. It is negative globally and for Asia, indicating a strong dependence between the two variables, and suggesting that effective governance combined with robust financial institutions can significantly reduce CO_2 emissions. In contrast, the interaction is insignificant in Africa and positively significant in Europe. The use of renewable energy (RE) contributes to a reduction in CO_2 emissions, as evidenced by its negative coefficients across all regions. These results are consistent with the study by Kirikkaleli & Adebayo (2020), which shows similar trends globally, but they contradict the findings of Avazkhodjaev *et al*. (2022), who found that RE generation was associated with increased CO_2 emissions in the long run. An increase in urban population also has a significant positive impact on CO_2 emissions at both the global and continent levels. Diagnostic test results are provided in Table 4. The VIF scores for multicollinearity range from 2.5 to 4.38, indicating low to moderate multicollinearity. The results for heteroscedasticity and autocorrelation are significant and should be addressed.

Table 4: Fixed Effects Results

	Dependent Variable: Carbon Dioxide Emissions			
Variables	**Global (A)**	**Asia (B)**	**Africa (C)**	**Europe (D)**
LGDP	0.389***	0.399***	0.498***	0.107**
	(0.0278)	(0.0433)	(0.0484)	(0.0507)
FD	0.0959***	0.206***	0.0468**	0.0320**
	(0.0142)	(0.0206)	(0.0236)	(0.0143)
IQ	0.0182	0.0116	-0.100**	0.110***
	(0.0297)	(0.0379)	(0.0468)	(0.0251)
FD*IQ	-0.0636***	-0.123***	0.00204	0.0305**
	(0.00924)	(0.0150)	(0.0123)	(0.0139)
LRE	-0.316***	-0.139***	-0.345***	-0.300***
	(0.0149)	(0.0219)	(0.0396)	(0.0174)
LTRADE	0.0731***	0.0228	0.162***	-0.0377
	(0.0197)	(0.0289)	(0.0293)	(0.0432)
LURB POP	0.964***	0.997***	0.615***	1.105***
	(0.0631)	(0.113)	(0.0902)	(0.274)
LIND	0.128***	0.195***	0.0216	0.484***
	(0.0233)	(0.0384)	(0.0328)	(0.0763)
Constant	-6.368***	-6.804***	-6.133***	-4.453***
	(0.245)	(0.377)	(0.445)	(1.150)

Dependent Variable: Carbon Dioxide Emissions				
Variables	**Global (A)**	**Asia (B)**	**Africa (C)**	**Europe (D)**
Observations	1,922	638	875	385
R-squared	0.598	0.799	0.517	0.629
Number of Ids	111	41	47	21
Multicollinearity (VIF)	2.58	3.64	3.34	4.38
Heteroscedasticity	0.0000	0.0000	0.0000	0.0000
Serial Correlation	0.0000	0.0000	0.0000	0.0000

Source: Authors' calculations; Standard errors in parenthesis $^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$

Another method used to account for individual-specific effects is the random effects model. It assumes that these effects are uncorrelated with the error term and treats them as random variables. Table 5 displays the results from the random effects model. The findings indicate that greater economic growth leads to increased environmental degradation. A positive and significant effect of FD on CO_2 emissions is observed globally and across specific continents. This aligns with the studies of Kirikkaleli & Adebayo (2020) and Batool *et al.* (2022), which reported higher CO_2 emissions linked to FD. The highest emissions are in Asia, where a one-unit increase in FD results in a 20.9% rise in CO_2 emissions. IQ shows differing effects across regions. It has an insignificant impact on CO_2 emissions globally and in Asia but is significantly positive in Europe and negative in Africa. Ibrahim & Law (2016) found similar results for Sub-Saharan African countries, highlighting the importance of institutional reforms. The positive coefficient of IQ in Europe, like that in the FE model, can stem from the same reasons, and the assumption that there is no link between country-specific effects and independent variables in the RE model can contribute to this paradox. The interaction term FD*IQ indicates that a one-unit change in FD*IQ causes a 6.8% decrease in CO_2 emissions globally and a 12.4% decrease in Asia, though it is insignificant for Africa and positively significant for Europe.

The negative sign of the coefficient on RE supports its role in minimizing CO_2 concentration and is more pronounced in Africa (0.331%). The results are consistent with the studies of Sharif *et al*. (2019) and contradict the findings of Adams & Nsiah (2019), who reported a positive relationship between CO_2 emissions and RE in the long run. Industrialization and urban population play a significant role in increasing CO_2 emissions. The results of the LM and Hausman tests help us choose the most appropriate model, between fixed and random effects, at the global level and for the selected continents.

Table 5: Random Effects Results

	Dependent Variable: Carbon Dioxide Emissions			
Variables	**Global (A)**	**Asia (B)**	**Africa (C)**	**Europe (D)**
LGDP	0.423***	0.392***	0.593***	0.108**
	(0.0259)	(0.0402)	(0.0458)	(0.0457)
FD	0.0968***	0.209***	0.0552**	0.0329**
	(0.0140)	(0.0199)	(0.0229)	(0.0140)
IQ	6.38e-05	-0.0147	-0.0746*	0.101***
	(0.0284)	(0.0344)	(0.0451)	(0.0247)
FD*IQ	-0.0680***	-0.124***	-0.00396	0.0280**
	(0.00916)	(0.0145)	(0.0122)	(0.0137)
LRE	-0.292***	-0.130***	-0.331***	-0.294***
	(0.0132)	(0.0181)	(0.0346)	(0.0166)
LTRADE	0.0653***	0.0160	0.152***	-0.0339
	(0.0197)	(0.0280)	(0.0294)	(0.0405)
LURB POP	0.924***	0.990***	0.576***	0.963***
	(0.0599)	(0.102)	(0.0828)	(0.238)
LIND	0.130***	0.201***	0.0275	0.497***
	(0.0235)	(0.0374)	(0.0329)	(0.0740)
Constant	-6.559***	-6.714***	-6.737***	-3.966***
	(0.236)	(0.361)	(0.416)	(0.964)
Observations	1,922	638	875	385
Number of Ids	111	41	47	21
LM Test	Random effects model is preferred	Random effects model is preferred	Random effects model is preferred	Random effects model is preferred
Hausman Test	Random effects model is preferred	Random effects model is preferred	Fixed effects model is preferred	Random effects model is preferred

Standard errors in parenthesis ***p<0.01, **p<0.05, *p<0.1

To address the issues of endogeneity and unobserved heterogeneity, a more advanced econometric technique, System GMM, is applied, yielding more accurate, consistent, and efficient parameter estimates. The dependent variable, CO_2 emissions, is treated as endogenous, while the lagged values of all regressors are used as exogenous instrumental variables. The estimated coefficients are presented in Table 6. The significant coefficients support the existence of a nonlinear relationship among the variables. The significant coefficient on the lagged variable $CO_{2(t-1)}$ indicates that current CO_2 emissions depend on emissions from the previous year, implying that a one-unit increase in CO_2 emissions globally results in a 79.6% increase in emissions this year. The increases in

CO_2 emissions for Asia, Africa, and Europe are 57.9%, 59.6%, and 68.5%, respectively.

A significant positive relationship between GDP and CO_2 emissions indicates environmental deterioration caused by increased economic growth, suggesting the need for green growth policies. FD has a significant positive relationship with CO_2 emissions globally and in Asia and Africa, but a one-unit increase in FD decreases CO_2 emissions by 0.0503 percent in Europe. This result is contrary to the studies of Gok (2020) and Bayar *et al.* (2020), who found a positive relationship between CO_2 emissions and FD in Europe. Gok (2020) attributed this difference in results to the design and characteristics of the studies, such as the region, time period, estimation technique, and indicators used for FD.

The direct effect of IQ on CO_2 emissions is negative across the globe and in specific continents, indicating that effective governance can abate CO_2 emissions. The significant coefficients of the interaction term FD*IQ also confirm the nonlinearity of the relationship. The parameters of the estimated variables show a significant negative relationship with CO_2 emissions globally and by continent. A one-unit increase in FD, moderated by IQ, is estimated to decrease CO_2 emissions by 5.9%, 4.7%, 2.02%, and 3.61% at the global and regional levels in Asia, Africa, and Europe. The results support the existence of the Porter Hypothesis, which relates to the application of environmental standards and advocates the use of high-quality institutions to facilitate green investments. Our results also align with the findings of Hunjra *et al.* (2020).

Consumption of RE helps mitigate CO_2 emissions and is highest in Europe (9.34%), necessitating the integration of more renewable resources into existing energy systems. The possible reasons are the technological innovations that increase fuel efficiency, reliance on electric vehicles for transportation, green financing, and heavy reliance on RE sources for power generation. This negative relationship between RE and CO_2 supports the findings of Shaari *et al*. (2020) and Mukhtarov *et al.* (2023), and contradicts the findings of Apergis & Payne (2010), who found a positive relationship between CO_2 emissions and RE. Trade has a positive effect on global CO_2 emissions, whereas it is insignificant in Asia, Africa, and Europe.

Industrialization and urban population degrade environmental quality globally, including across continents, except in Europe, where a

higher urban population share is negatively related to CO_2 emissions. This highlights the importance of sustainable urban planning, effective management, and strict environmental regulation enforcement. This finding is also supported by the study conducted by Khoshnevis Yazdi & Shakouri (2018), which found a negative impact of increased urbanization on CO_2 emissions in Europe, while studies by Ponce de Leon Barido & Marshall (2014) show an elastic relationship between rising urbanization and CO_2 emissions.

The results of Arellano Bond AR(1) and AR(2) indicate the absence of both first and second order autocorrelation. Also, the Hansen J-test values lie within the acceptable range, ensuring the validity of instruments.

Table 6: System GMM Results

	Dependent Variable: Carbon Dioxide Emissions			
Variables	**Global (A)**	**Asia (B)**	**Africa (C)**	**Europe (D)**
$CO_{2i,t-1}$	0.796***	0.579***	0.596***	0.685***
	(0.00645)	(0.0912)	(0.0650)	(0.0985)
LGDP	0.161***	0.148***	0.364***	0.143***
	(0.00669)	(0.0343)	(0.0645)	(0.0362)
FD	0.0255***	0.110***	0.0849***	-0.0503***
	(0.00441)	(0.0221)	(0.0159)	(0.0140)
IQ	-0.0719***	-0.0527***	-0.0445**	-0.0851***
	(0.00532)	(0.0153)	(0.0213)	(0.0220)
FD*IQ	-0.0595***	-0.0479***	-0.0202***	-0.0361***
	(0.00295)	(0.0109)	(0.00704)	(0.0127)
LRE	-0.0288***	-0.0484***	-0.0672***	-0.0934***
	(0.00318)	(0.0130)	(0.00842)	(0.0302)
LTRADE	0.0303***	0.0114	0.0281	-0.0573
	(0.00658)	(0.00878)	(0.0242)	(0.0353)
LURB POP	0.0552***	0.353***	0.137***	-0.354*
	(0.00589)	(0.124)	(0.0320)	(0.202)
LIND	0.0511***	0.187***	0.0953***	0.0132
	(0.00769)	(0.0298)	(0.0271)	(0.108)
Constant	-1.608***	-2.778***	-3.586***	-0.874
	(0.0790)	(0.713)	(0.629)	(0.991)
Observations	1,920	635	875	385
Number of Ids	111	41	47	21
AR (1) Pr>z	0.373	0.410	0.057	0.160
AR (2) Pr>z	0.592	0.558	0.146	0.530
Hansen Test	0.734	0.942	0.807	0.877

Standard errors in parenthesis ***p<0.01, **p<0.05, *p<0.1

5. Robustness check

5.1. Panel Quantile Regression Results

To assess the robustness of the findings, panel quantile regression analysis is conducted, and the results are presented in Table 7.

Table 7: Panel Quantile Regression Results

Variables	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
LGDP	1.032***	0.980***	0.948***	0.920***	0.898***	0.866***	0.819***	0.756***	0.669***
	(0.025)	(0.021)	(0.020)	(0.020)	(0.021)	(0.023)	(0.027)	(0.033)	(0.043)
FD	0.101***	0.111***	0.117***	0.122***	0.126***	0.132***	0.140***	0.152***	0.168***
	(0.017)	(0.015)	(0.015)	(0.014)	(0.015)	(0.016)	(0.018)	(0.023)	(0.030)
IQ	-0.130***	-0.135***	-0.138***	-0.140***	-0.142***	-0.145***	-0.149***	-0.155***	-0.163***
	(0.024)	(0.021)	(0.020)	(0.020)	(0.021)	(0.022)	(0.026)	(0.032)	(0.042)
FD*IQ	-0.400***	-0.367***	-0.348***	-0.331***	-0.318***	-0.298***	-0.269***	-0.231***	-0.177***
	(0.019)	(0.016)	(0.016)	(0.016)	(0.016)	(0.018)	(0.021)	(0.026)	(0.033)
LRE	-0.060***	-0.079***	-0.091***	-0.101***	-0.108***	-0.120***	-0.137***	-0.160***	-0.191***
	(0.011)	(0.010)	(0.009)	(0.009)	(0.010)	(0.011)	(0.013)	(0.015)	(0.020)
LTRADE	.0432	0.065**	0.079***	0.090***	0.099***	0.113***	0.132***	0.158***	0.195***
	(0.030)	(0.026)	(0.025)	(0.025)	(0.026)	(0.028)	(0.032)	(0.040)	(0.052)
LURB POP	0.412***	0.466***	0.499***	0.528***	0.550***	0.583***	0.631***	0.696***	0.786***
	(0.045)	(0.039)	(0.038)	(0.038)	(0.039)	(0.042)	(0.048)	(0.060)	(0.079)
LIND	0.238***	0.255***	0.265***	0.274***	0.281***	0.290***	0.305***	0.325***	0.353***
	(0.037)	(0.032)	(0.031)	(0.032)	(0.032)	(0.034)	(0.040)	(0.049)	(0.065)

Standard errors in parentheses: $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

The results support a decline in CO_2 emissions across all quantiles. The negative impact of the interaction term (FD*IQ), IQ, and RE remains the same across all quantiles and is consistent with the previous findings. These results suggest that at higher levels of CO_2 emissions, IQ and RE contribute to improved environmental quality, whereas the impact of FD*IQ decreases because of a change in the coefficient's magnitude. The coefficient of GDP shows the magnitude of the relationship between GDP (FD, trade, urban population, and industrialization) and CO_2 across the distribution of CO_2 emissions, which is positive and statistically significant across all quantiles suggesting that increase in GDP (FD, trade, urban population and industrialization) will increase CO_2 emissions across all quantiles, consistent with our previous findings.

5.2 Driscoll-Kray Standard Errors

The study used Driscoll and Kray's standard errors to account for cross-sectional dependence and to examine the robustness of the results. The impact of RE remains the same across all panels, while the effect of

FD*IQ becomes insignificant in Europe. This result indeed suggests regional heterogeneity in the mediating role of institutional quality. The possible reasons are as follows: First, European economies generally exhibit higher institutional quality (IQ) and financial development (FD) than other regions. The marginal benefit of further improvements in FD*IQ on CO_2 reduction may diminish at higher levels of economic development. At a higher level of development, the public prioritizes environmental quality as suggested by the EKC. Second, Europe's stringent climate policies may dominate the FD-IQ mediation pathway, making their interaction effect statistically insignificant in our model. Third, Europe's highly complex and saturated financial systems may require more nuanced measures of FD and IQ than our model captures, potentially obscuring their interaction effects. Thus, in the case of Europe, it suggests that environmental regulation becomes embedded in state apparatus and corporate norms, reducing dependency on financial-institutional mediation. Moreover, green innovation becomes systemic rather than market-dependent.

Table 8: Driscoll-Kray Standard Errors

	Dependent Variable: Carbon Dioxide Emissions			
Variables	**Global (A)**	**Asia (B)**	**Africa (C)**	**Europe (D)**
LGDP	0.8731***	0.3445***	0.9913***	0.2697***
	(0.0369)	(0.0823)	(0.0207)	(0.0867)
FD	0.1305***	0.2249***	0.2585***	0.0078
	(0.0080)	(0.0301)	(0.0207)	(0.0445)
IQ	-0.1445***	-0.0562	0.0218	-0.1672***
	(0.0248)	(0.0387)	(0.0148)	(0.0391)
FD*IQ	-0.3022***	-0.1208***	-0.0955***	0.0073
	(0.0300)	(0.0101)	(0.0137)	(0.0375)
LRE	-0.1178***	-0.1114***	-0.1167***	-0.2357***
	(0.0085)	(0.0076)	(0.0169)	(0.0234)
LTRADE	0.1098***	-0.0062	-0.001	0.1455*
	(0.0225)	(0.0203)	(0.0366)	(0.0708)
LURB POP	0.5762***	1.0645***	0.4261***	0.5259*
	(0.0712)	(0.1359)	(0.0718)	(0.2777)
LIND	0.2887***	0.4722***	0.2686***	0.7098***
	(0.0526)	(0.0440)	(0.0471)	(0.1053)
Constant	-9.9513***	-7.4846***	-9.9569***	-5.353***
	(0.1879)	(0.1864)	(0.2914)	(0.4345)
Observations	1,922	638	875	385
Number of Ids	111	41	47	21
R-Squared	0.896	0.918	0.918	0.597

Standard errors in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6. Conclusion and Policy Recommendations

The exploration of the relationship between FD and IQ has become a key focus for researchers worldwide. Efforts to combat climate change and promote green growth help achieve several Sustainable Development Goals (SDGs), particularly SDG 13 related to climate action. Growing environmental concerns and the need for a cleaner, safer environment have led to investigations into how FD and IQ relate to environmental degradation (CO_2 emissions) at both the global and continent levels (Asia, Africa, and Europe).

The study takes an interesting turn when the mediating role of IQ comes into play. The interaction term FD*IQ is important in resolving whether financial institutions, along with effective governance, help curb or increase CO_2 emissions. This key role of FD aligns with SDG 9, which focuses on promoting technological innovation and sustainable industrialization. Additionally, the analysis is not limited to a specific region; it covers the global level and extends to the continents of Asia, Africa, and Europe to show how differences in institutional structures can impact CO_2 emissions across the world. The study conducts an empirical analysis of the global panel and the continents of Asia, Africa, and Europe, covering the years from 1990 to 2020.

The association between the variables is examined using traditional econometric techniques, including fixed- and random-effect models. A two-step system GMM is then used to obtain efficient and consistent estimates in the presence of endogeneity. The results show that economic growth increases CO_2 emissions worldwide. This goes against SDG 8, which emphasizes promoting sustainable economic growth. FD increases CO_2 emissions globally and across Asia and Africa, while well-developed financial institutions in Europe lead to a decline in CO_2 emissions. The quality of institutions and its moderating effect, FD*IQ, yield a significant negative relationship across the globe and in the specific continents, rejecting the null hypothesis of no significant moderating effect of FD*IQ. This demonstrates that strong institutions, along with well-developed and well-managed financial institutions, help reduce carbon emissions by transitioning from non-renewable to renewable energy sources and stimulating green growth. The robustness check using Panel quantile and Driscoll and Kraay standard error approaches also supports our findings.

Institutions that manage risk, enforce agreements, and ensure fair distribution of gains build investor confidence in long-term, environmentally friendly projects. This supports SDG 16: Peace, Justice, and Strong Institutions, which promotes resilient and sustainable development. The use and deployment of renewable energy (RE) across various sectors reduces atmospheric CO_2 levels worldwide, aiding SDG 7: Affordable and Clean Energy. Although trade significantly affects CO_2 emissions globally, its effects is statistically insignificant in Asia, Africa, and Europe. Urban growth and industrialization increase CO_2 emissions, except in Europe, where industrialization has little effect, and a higher population correlates with a decrease in emissions.

Based on the findings of this study and the diverse economic, institutional, and ecological settings across Asia, Africa, and Europe, a region-specific policy is essential. In Asia, policymakers should strengthen institutional quality by ensuring transparency, equity, and accountability while incentivizing financial institutions to spur investment in RE, smart grids, and green hydrogen. The African nations should prioritize the adoption and expansion of decentralized RE systems, such as solar microgrids, battery storage systems, and biomass generators, to meet increasing energy demand, and establish strong, capable regulatory authorities to monitor these systems and attract climate finance for the region. The European nations should expand the use of innovative financial instruments such as green bonds and securities, with strict monitoring policies to affirm their commitment to a low-carbon economy. This context-specific approach will ensure that each region can successfully make a move towards a sustainable economy.

The study has certain limitations: missing data reduced the sample size, potential omitted variable bias exists despite using system GMM, and the data quality varies, especially across countries with weak institutional structures. The panel data at the global and regional levels may have overlooked country-specific dynamics that could significantly influence results. The primary focus of this research was on panel data rather than time series analysis, leaving room for future exploration of stationarity within sub-samples. Additionally, for the continent-level analysis, only three continents—Asia, Africa, and Europe—were included; therefore, future studies could include Australia, North America, and South America to account for geographical and institutional differences for a more comprehensive understanding.

Future studies can extend this research in many ways: employing advanced causal inference methods to investigate the causal relationships between FD, RE, and IQ, incorporating technological innovations like smart grids, carbon capture and storage (CCS), hydrogen economy, and blockchain technology into the analysis can provide an in-depth understanding of the efficacy of these innovations and their consequent effect on CO_2 emissions. To get a comprehensive view of the impact of these variables on CO_2 emissions, including the externalities associated with RE adoption, such as employment levels, can also be considered. Advanced econometric techniques, such as polynomial regression and machine learning algorithms, can be used to explore the non-linear relationship between the variables. A comparative analysis comprising the countries having differences in economic development, institutional structures, and cultural factors can shed light on how significant these factors are in improving environmental quality and combating climate change.

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Appendix A

Table A1: Results of PCA for FD

Initial Eigenvalues			
Component	**Eigenvalue**	**Proportion**	**Cumulative**
Comp 1	2.811	0.937	0.937
Comp 2	0.175	0.058	0.995
Comp 3	0.012	0.004	1.000
PCA Rotation			
Component	**Variance**	**Proportion**	**Cumulative**
Comp 1	1.000	0.333	0.333
Comp 2	0.999	0.333	0.666
Comp 3	0.999	0.333	1.000
PC (Eigenvectors)			
Variable	**Comp 1**	**Comp 2**	**Comp 3**
bm	0.559	0.829	0.008
dcp	0.586	-0.388	-0.710
dcpb	0.585	-0.402	0.703

Table A2: Results of PCA for IQ

Initial Eigenvalues			
Component	**Eigenvalue**	**Proportion**	**Cumulative**
Comp 1	5.189	0.864	0.864
Comp 2	0.379	0.063	0.928
Comp 3	0.250	0.041	0.969
Comp 4	0.107	0.017	0.987
Comp 5	0.041	0.006	0.994
Comp 6	0.031	0.005	1.000
PCA Rotation			
Component	**Variance**	**Proportion**	**Cumulative**
Comp 1	1	0.1667	0.1667
Comp 2	1	0.1667	0.333
Comp 3	1	0.1667	0.500
Comp 4	1	0.1667	0.666
Comp 5	0.999	0.1667	0.833
Comp 6	0.999	0.1667	1.000

PC (Eigenvectors)						
Variable	**Comp 1**	**Comp 2**	**Comp 3**	**Comp 4**	**Comp 5**	**Comp 6**
ps	0.363	0.882	0.274	0.099	0.005	0.069
rol	0.4316	-0.0460	-0.1642	-0.1002	-0.0707	-0.8773
voa	0.3858	-0.4024	0.8085	-0.1221	-0.1173	0.0830
coc	0.4201	-0.0286	-0.2974	-0.7007	0.3811	0.3132
ge	0.4242	-0.0989	-0.3682	0.1581	-0.7380	0.3242
rq	0.4202	-0.2172	-0.1419	0.6703	0.5397	0.1246

Appendix B

Table B1: Unit Root Results

Variables	IPS		ADF	
	Level	1st Difference	Level	1st Difference
LCO2	1.297	-30.047***	7.0554***	136.156***
LGDP	3.215***	-20.802***	3.5414***	73.4329***
FD	4.264***	-19.613***	0.7826	63.3547***
IQ	-3.716***	-21.451***	9.7427***	96.6332***
FD*IQ	1.056	-13.459***	6.8684***	52.9785***
LRE	-2.365***	-28.169***	6.3747***	121.2347***
LTRADE	-4.525***	-29.776***	7.3843***	130.5037***
LURB POP	-9.405***	-2.511***	152.3598***	17.6438***
LIND	-1.795*	-27.929***	3.6785***	120.2092***

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The Economic Impact of Environmental Sustainability Practices in the Hospitality Sector: A Global Review with Policy Implications for Pakistan

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Abstract: This paper explores the economics of environmental sustainability practices in the hospitality industry, focusing on the operational efficiency of hotels, cost-effectiveness, and return on investment (ROI), with a specific focus on the emerging market in Pakistan. Results indicate that green retrofits, including LED lighting and HVAC optimization, deliver average energy savings of 25-40 percent, payback periods of 1-5 years, and internal rate of return (IRR) of 18. Food-waste minimization systems, such as Winnow and Leanpath, have a 7:1 ROI in two years, and water recycling systems reduce consumption by 20-30 percent in less than four years. Hotels that operate sustainably worldwide show reduced operating costs by up to 30 percent and premium rates of 5-15 percent, based on customer willingness to pay higher rates in environmentally conscious hotels. The article presents a combination of comparative ROI modeling, policy SWOT analysis, and cross-regional benchmarking to assess the feasibility and scalability of green investments. By linking economic indicators to environmental performance, this research confirms that sustainability practices are not only environmentally advantageous but also economically strategic.

Keywords: Pakistan, remittance inflow, policy impact, Covid-19, panel data.

JEL Classification: E22, F64, O13.

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The Economic Impact of Environmental Sustainability Practices in the Hospitality Sector: A Global Review with Policy Implications for Pakistan

1. Introduction and Literature

Environmental sustainability in hotels is critical because the hospitality sector is economically important but resource-intensive. Globally, tourism contributed about USD 5.8 trillion (□6.1% of GDP) in 2021 (Yusoff et al., 2020), supporting hundreds of millions of jobs. However, hotels consume large amounts of energy, water, and materials, generating substantial waste and greenhouse gas (GHG) emissions (Wood, 2013). For example, tourism's carbon footprint grew from 3.9 to 4.5 Gt CO_2 between 2009 and 2013 (Uyar, et al., 2020), with accommodation accounting for roughly 6% of tourism's emissions (□324 $MtCO_2$) (Tranfield and Smart, 2003). On a planetary scale, hotels contribute about 1% of global CO_2 emissions (Kholijah, 2024). In Pakistan, the hotel industry is a key economic sector (□7% of GDP and 3.85 million jobs (Sharma and Kumar, 2021) but also has a large environmental footprint (Sharma and Kumar, 2021). As a result, there is growing interest in "green" hotel practices that reduce energy and water use and waste.

Implementing sustainability practices often yields economic benefits (ROI and savings) that can offset upfront costs. Multiple studies across regions report that "green" measures improve profitability and efficiency. For example, a novel modeling study in UK hotels demonstrated significant cost–benefit gains from energy and water efficiency measures (Damigos et al., 2023). In Poland, Kusa et al. (2023) found that hotel "greening" (e.g., lower energy and water use, waste recycling, renewable investments) significantly improved performance (Pelikanova et al., 2021). Similarly, Shahzady (2023) showed that Pakistani eco-hotels saw higher guest satisfaction and financial performance after adopting green practices, with eco-conscious guests willing to pay premium rates and operations benefiting from lower utility bills (Paul & Criado, 2020). In general, analyses indicate that sustainable investments in hospitality have short payback periods (often 3–6 years) and strong internal rates of return (IRR). For instance, an Indonesian hotel retrofit (insulating walls, adding windows, etc.) cut energy use by 12% and yielded an IRR of ~13.6% (5.5-year payback) (Sadiq et al., 2022). In the United States, sustainable hotel projects have seen even higher returns: a Hampton

Inn case achieved an 18% ROI with a 6-year payback (Yüksek & Kalyoncu, 2021), and Hyatt Maui reported similar figures (Paciarotti et al., 2022). In Australia, mandatory energy ratings (NABERS) helped hotel owners save AUD 870 million (~USD 600 million) in energy costs and avoid 6 million tonnes of CO_2 (Uyar et al., 2020). Table 1 summarizes key literature on hospitality sustainability, showing study focus, methods, and findings.

"Consumers who are willing to pay to stay at green hotels would accept a premium of around 5%." Consumers often value green hotels, accepting room rate premiums of 5% (Perera et al., 2025). Many hotels capitalize on this: over 80% of hotels worldwide now implement energy-saving measures, ~63% have waste-reduction programs, and ~85% have food-waste prevention strategies (Yusoff et al., 2020). Demand for green practices, along with savings on utilities, translates into new revenue and cost reductions (Wood, 2013; Yigitcanlar and Cugurullo, 2020). For example, the Sustainable Hospitality Alliance reports that a hotel project achieved an 18% ROI and a 6-year payback by installing efficient HVAC, LED lighting, and solar PV, with lifetime electricity savings of USD 410,000 (Serrano et al., 2021). Similarly, simple water conservation (e.g., upgrading cooling towers and restroom fixtures) can have dramatic effects: Hyatt Regency Atlanta cut water use by 35% (36 million gallons) and saved $1 million per year in utility costs (Ogunnaike et al., 2022). In that case, adding a $12,000 condensate-recovery system paid back in six months (ROI >200%) [14]. These examples illustrate that sustainability investments can be self-financing through reduced utility bills and enhanced market appeal (Wood, 2013; Yigitcanlar et al., 2020).

This paper surveys global hospitality sustainability practices (e.g., energy efficiency, waste management, green certifications, etc.) and examines their economic impacts – including cost reductions, ROI, profitability, and customer willingness-to-pay. This article places particular emphasis on developing countries (e.g., South Asia) and both the luxury and budget hotel sectors. Finally, challenges and policy implications for Pakistan's hospitality industry were analyzed, drawing on global best practices.

2. Methodology

A systematic literature search was conducted, focusing on publications from 2018–2025 in hospitality and sustainability, using databases such as Scopus, Web of Science, and publisher platforms (e.g.,

Elsevier, Springer, MDPI). Search terms included "sustainable hospitality," "hotel energy efficiency," "green hotel economics," etc. Peer-reviewed journal articles, conference papers, and authoritative reports were included. Case studies of major hotel chains (Marriott, Hilton, Accor, etc.) and industry reports (e.g., by Deloitte, Sustainable Hospitality Alliance) were included as real-world examples. From the gathered literature, we extracted data on sustainability initiatives (technology, programs) and on economic outcomes (costs, savings, ROI, consumer behavior). The analysis synthesized quantitative results (e.g., percent savings) and qualitative findings to build a comprehensive picture of trends and impacts across regions and hotel types.

In addition to peer-reviewed literature and international industry reports, the country-specific data used in Table 2 and Figures 2–4 were sourced from published reports, industry reports, and hotel CSR reports. Adoption status of technologies and certifications in Pakistan was obtained from official hotel websites and sustainability/technology provider websites, and was supplemented with direct phone verification with hotel engineering or sustainability departments.

Fig 1: Methodology Flowchart

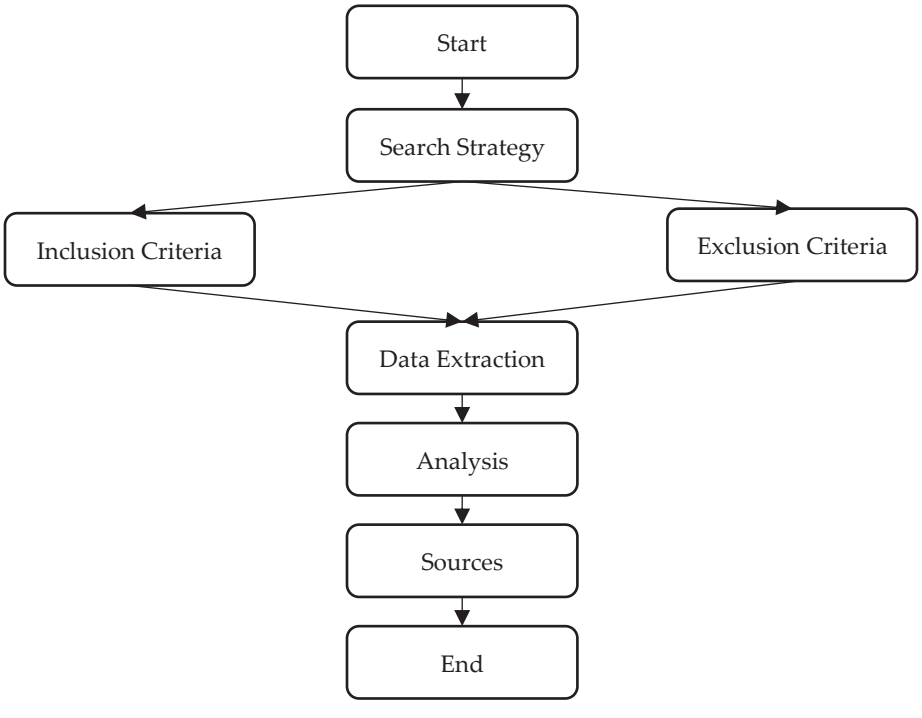


Table 1: Selected Studies on Hospitality Sustainability (cost–benefit and ROI focus)

Author(s)	Location & Sector	Focus & Method	Key Findings (economic/sustainability impact)
(Makoondlall and Bokhoree, 2024)	*Global review*	Literature review of hotel sustain. assessment tools	Hotels consume significant resources; they need better assessment tools and technologies to improve sustainability and guide policy.
(Shahzady, 2023)	Pakistan (eco-hotels)	Survey & analysis	Eco-friendly hotels saw higher guest satisfaction and higher revenues and profits; green practices also cut energy/water costs.
(Kusa *et al.*, 2023)	Poland (SME hotels)	PLS-SEM of 101 hotels	"Greening" (energy/water reduction, waste reuse, renewables) had a significant positive impact on hotel performance.
(Satriopratomo *et al.*, 2025)	Indonesia (hotel bldg)	Building simulation & CBA	Retrofitting (better insulation, windows, skylights) cut energy use ~12%; energy cost savings 9.1%; IRR 13.6%, payback 5.5 years.
(Perera *et al.*, 2025)	Sri Lanka (restaurant)	Case study, financial analysis	Vegan restaurant (eco-design) projected break-even in 10 months, 15.2% net margin by year 1; green practices (waste reduction, inventory tech) improved efficiency.
(Sharma and Kumar, 2021)	India (hotel industry)	Data Envelopment Analysis	Indian hotels could, on average, reduce energy use by ~55% with no loss in revenue, indicating large efficiency potential.
Kholijah (2024)	Indonesia (sector-wide)	Lit. review & case analysis	Green business practices (EE lighting, water conservation, waste reduction) lead to substantial cost savings and new revenue; govt incentives are crucial for adoption.

Each study in Table 1 highlights economic gains from sustainability. In practice, widely available technologies can deliver these gains. For example, adopting LED lighting, efficient HVAC systems, and solar PV/thermal heating is commonplace in green hotels (Serrano et al., 2021). Lighting retrofits often pay back in 1–3 years, HVAC upgrades in ~4–6 years, and solar installations in 5–7 years (shorter with subsidies). Similarly, water-saving fixtures (low-flow showers/toilets) and cooling tower optimizations often recover costs in 1–2 years (Ogunnaike et al.,

2022). Emerging smart technologies (IoT sensors, building management systems) can further optimize energy use in real time. Greywater recycling and rainwater harvesting—used in many resorts—can slash water bills and ease supply pressure. While exact ROI varies by project, a review found that many hotels adopting renewable energy and efficiency measures generate returns in the teens of percentage per annum (Song and Lin, 2010).

3. Global Trends in Sustainability Practices in Hospitality

Recent literature and industry analyses identify several core areas of sustainability innovation in hotels and restaurants. Key trends include energy efficiency, water conservation, waste management, sustainable procurement, green building certification, and staff and guest engagement.

Table 2. several sustainability practices and technologies, noting global adoption and the status in Pakistan's hospitality sector

Tech / Practice	Global Adoption & Benefit	Pakistan Status (Current Study)	Example ROI Impact
LED Lighting	Near-universal adoption; saves >75% on lighting; payback in 1–2 years *(Sustainable Hospitality Alliance)*.	Partial uptake; many hotels still on incandescent bulbs.	6–12 month payback; ~80–90% lighting energy saved (Shahzady, 2023).
Solar Heating / PV	Common in developed countries; covers 50–80% water/electric needs *(Sustainable Hospitality Alliance)*.	Rare; high CAPEX and subsidized grid hinder uptake.	Hyatt ROI: 18%, 6-yr payback (Rasool et al., 2022).
Efficient HVAC (VFDs, Heat Pumps)	Standard globally; VRF systems cut ~30% energy.	Limited use; outdated units still prevalent.	3–5 yr payback; ROI higher with energy cost rises (Ahmed et al., 2022).
Water Recycling (Greywater)	20–30% water savings in EU/US luxury hotels.	Almost unused; no regulations or infrastructure.	2–4 year payback depending on water tariffs (NEECA, 2020).
Composting / Biogas	Adopted at resorts and large hotels to cut landfills and generate energy.	Extremely rare; most waste is landfilled.	Small-scale energy offset, waste diversion (UNEP, 2021).
Waste-to-Energy (Anaerobic Digestion)	Pilot programs in N. America/Europe; moderate adoption.	Not yet piloted.	Methane from organics; offsets part of energy load.
BEMS (Building Energy Management)	Widely used for facility-wide energy control; savings 10–20% *(EPA)*.	Rare; low automation in older hotels.	<3 yr payback; notable utility bill reduction (U4E, 2021).
Water Audit & Leak Control	Mandated in water-stressed regions like CA/AU *(EPA, 2014)*—e.g., Hyatt Atlanta	Very limited activity.	Hyatt Atlanta: $1 M/year savings (Shamspower Ltd., 2023).

Tech / Practice	Global Adoption & Benefit	Pakistan Status (Current Study)	Example ROI Impact
	saved US $1 M/year through system upgrades.		
Green Certification (LEED, NABERS)	Common; certified hotels enjoy higher occupancy and rates; NABERS saved AUD 870 M (~USD 600 M) nationally.	No formal scheme in Pakistan.	NABERS + sustainability requires; enhances marketability (Ahmed et al., 2022).
Green Key Certification	Used in 60+ countries; holistic rating for energy, water, waste, staff training *(Green Key Global)*.	Unknown locally; no auditing agency presence.	Rated hotels consistently perform better financially and reputationally (NEECA, 2020).
Winnow (AI Food Waste)	AI-powered scales/cameras reduce food waste by 40–70%, slashing costs by 2–8% *(Business Insider, 2024)*. In one UAE pilot: 76% kitchen waste & 55% post-consumer cut.	Not deployed in Pakistani hotels yet.	Hilton UAE saw 76% pre-consumer and 55% post-consumer reductions; $1.6 M saved across 90 hotels in MENA (AED 6M/year) (Shamspower Ltd., 2023).
Leanpath (Food-Waste Analytics)	Widely used in commercial kitchens; baseline food waste is 5–15% of food budget. Solutions include camera, scales, analytics.	No public evidence of use.	Food waste commonly 5–15% of budget; tech can reduce that significantly *(Green Lodging News)*.

These examples show that many cost-effective green technologies (some with paybacks <2 years) are standard elsewhere but underutilized in Pakistan due to low awareness, weak incentives, and subsidized energy costs.

Fig 2. Estimated ROI from Environmental Sustainability Technologies in Hospitality

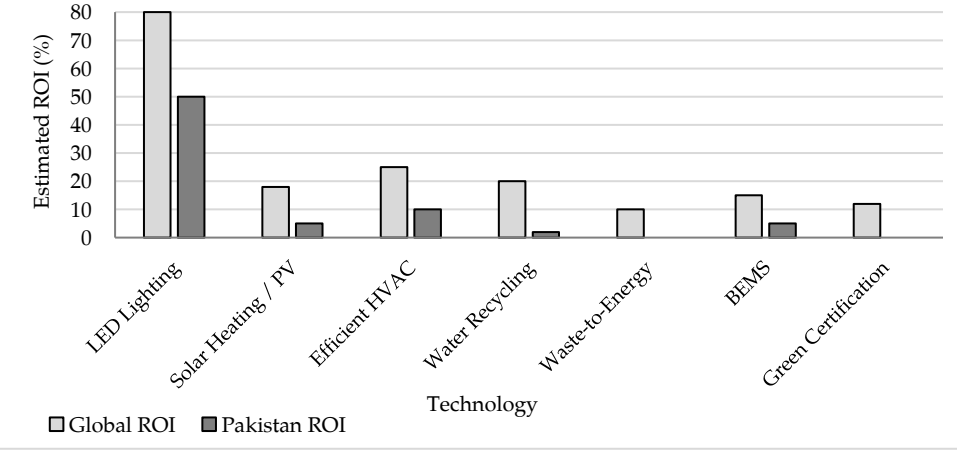


Fig 3. Payback Period for Sustainability Technologies: Global vs Pakistan

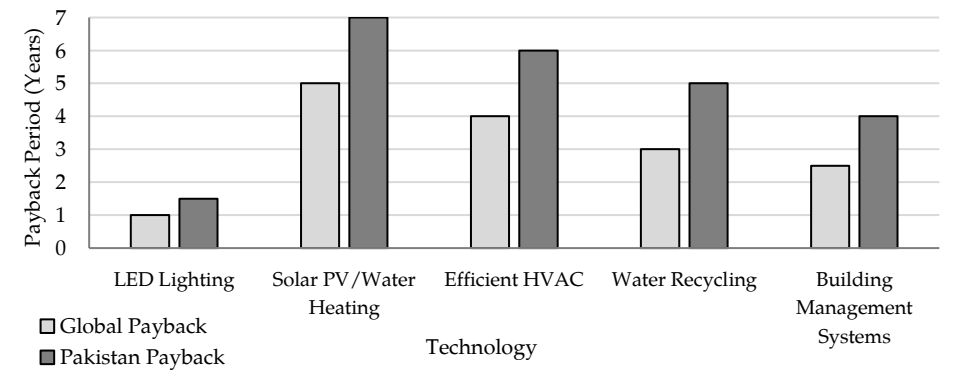
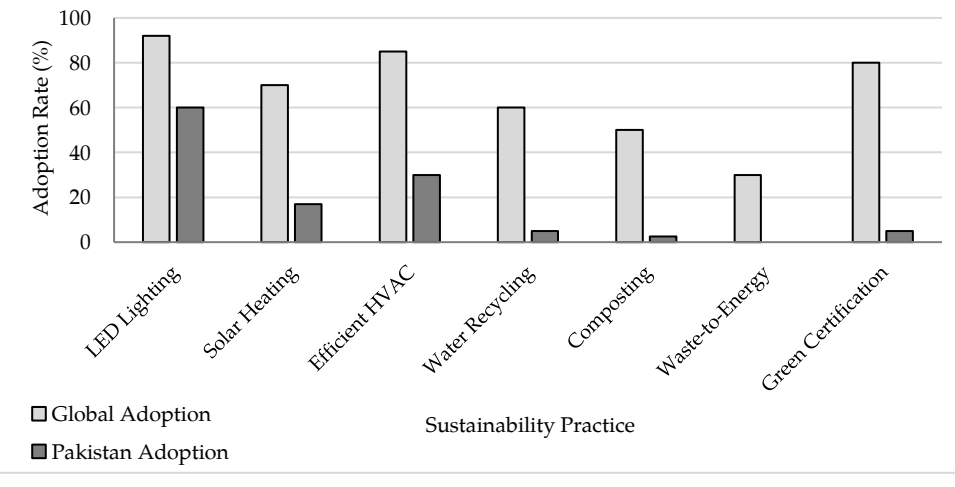


Fig 4. Adoption of Sustainability Practices in Hotels (Global vs Pakistan)



1. ROI Comparison: Highlights that the return on investment for sustainability technologies is significantly higher globally than in Pakistan, especially for solar energy and waste-to-energy systems.
2. Adoption Rates: Show that global hotel industries have widely adopted sustainable practices, while Pakistan lags in most areas, especially in water recycling and Certification.
3. Payback Periods: Green technologies pay back faster globally than in Pakistan, largely due to higher energy prices, subsidies, and better infrastructure elsewhere.

3.1. Energy Efficiency Technologies

Hotels are increasingly adopting technologies such as LED lighting, high-efficiency HVAC, and smart energy-management systems. Switching to LEDs can cut lighting energy use by ~75–80% (Reynolds & Gutman, 1988); for example, a U.S. hotel chain saved USD 60,000/year by retrofitting rooms with LEDs (Paiva Neto, et al., 2020). Smart Building Management Systems (BMS) that monitor and optimize heating, cooling, and lighting can reduce total energy use by ~30%; a Singapore hotel achieved a 30% energy reduction (□USD 100k/yr saved) with a smart BMS (Torres-Prunonosa et al., 2023). Overall, deploying these systems significantly reduces utility expenditure (Small, 1999). Renewable energy is also growing: some hotels install on-site solar PV or solar-thermal for water heating. One report notes that German subsidy programs boosted hotel solar adoption by ~40% (Penz et al., 2017). However, high upfront costs remain a barrier: energy retrofit projects can require $100–500k per property (Shalender and Sharma, 2021), which many small hotels cannot easily fund (Tanford et al., 2020).

3.2. Water Conservation

Water-saving fixtures (low-flow toilets and showers), dual-flush systems, and leak detection reduce bills. Rainwater harvesting and graywater reuse are also used: for instance, an Indian luxury resort collects ~18 million liters of rainwater annually to meet irrigation and laundry needs (Preziosi et al., 2022). Indonesian and Middle Eastern hotels often use treated wastewater or desalinated water with efficient HVAC chillers to cut potable water use. Overall, such measures can trim water costs by 20–30%, especially critical in arid or regulation-heavy regions. (For example, one analysis projects that hotels could reduce water bills by up to 30% through conservation programs (Tanford et al., 2020).

3.3 Waste Management Systems

Reducing food and other waste is both environmentally and economically important. Advanced kitchen monitoring solutions (e.g., AI-based Winnow and Leanpath) help chefs track and cut food waste by up to 50%, improving kitchen efficiency and yields (Tiwari and Sanjeev, 2021). A World Resources Institute study found that 95% of hotels implementing food-waste programs achieved a 7:1 ROI in under 2 years (Segarra-Ona et al., 2012); in other words, every $1 spent on waste-reduction tech or

training returned $7 in savings (Sustainable Hospitality Alliance, 2020). Hotels also manage recyclables and general waste: some large resorts now compost food waste (e.g., diverting 263,000 tons in one case (National Energy Efficiency and Conservation Authority, 2020)) and eliminate single-use plastics (see Section 7 on greenwashing). These practices lower disposal costs and can even create new revenue (e.g., by selling compost or recovered materials).

3.4 Sustainable Procurement and Local Sourcing

Many hotels prioritize buying local, seasonal, or certified products. This reduces transportation emissions and spoilage and often lowers purchase costs. Economically, it keeps money in the community: sourcing from local farmers and artisans creates jobs and has a multiplier effect (Tranfield and Smart, 2003). It also enhances the guest experience: travelers enjoy fresher, distinctive cuisine and crafts (Oztürk et al., 2024). For example, one report noted that local procurement strengthens community ties and brand reputation (Pirani and Arafat, 2016). Luxury chains like Banyan Tree and Four Seasons have farm-to-table programs, while some budget hotels partner with community co-ops for supplies. In all, sustainable purchasing can reduce supply-chain risk and improve public perception without sacrificing profitability (Sun et al., 2019).

3.5 Green Building Certifications

Certifications (LEED, BREEAM, Green Key, etc.) verify that hotels meet rigorous sustainability standards. The literature shows that certified hotels enjoy both cost and revenue benefits (Sharma et al., 2020). Energy- and water-efficient construction and insulation lower utility bills (e.g., one source notes that green buildings are ~20% more resource-efficient (Makoondlall and Bokhoree, 2022). On the revenue side, certification allows higher room rates: certified hotels have higher average daily rates (ADRs) and often higher occupancy from eco-minded guests (Sharma and Kumar, 2021). For instance, a study found that green-certified hotels attracted more consumers and commanded premium pricing (Shahzady, 2023). Industry surveys also note that many corporate clients require sustainability credentials, making certification a competitive necessity (Rana and Paul, 2017).

3.6 Staff Training & Guest Awareness Campaigns

Education is crucial to realizing savings from new technologies. Hotels provide staff training on efficient maintenance (e.g., optimizing laundry loads and HVAC settings) and sustainable best practices. Studies report that hotels with comprehensive employee training manage resources more effectively (reducing wasteful use) (Thams et al., 2020). Guest-facing campaigns (e.g., placards or app notifications) encourage behaviors such as towel/linen reuse and energy conservation.

Evidence suggests these campaigns work: for example, towel-reuse programs can cut hotel energy use by ~10–15% (Thommandru et al., 2023). Quality management ensures that such campaigns do not compromise guest comfort; satisfied eco-conscious guests may even spend more or provide positive reviews.

In sum, hoteliers worldwide are implementing a broad suite of sustainability measures. These range from technology investments (LEDs, solar panels, smart sensors) to softer initiatives (training, eco-labeling, community engagement). Deloitte finds that companies are now going "beyond LEDs," deploying automated energy management (saving $1+ billion in utilities for one chain) and innovative water projects such as rain harvesting (Tao et al., 2018). Table 1 highlights illustrative practice-impact examples drawn from these sources.

4. Economic Impacts of Sustainability Practices

Adopting sustainable practices has clear economic implications for hotels. We discuss the key financial metrics below: cost savings and ROI, efficiency gains, long-term profitability and brand value, and consumer willingness to pay.

4.1 Savings and ROI Metrics

Upfront investments in green technology or processes typically pay off through lower operating costs. Numerous studies quantify these returns. For energy and water retrofits, payback periods are often 1–5 years. The Business Case for Sustainable Hotels report (World Green Travel Council) notes that new-build green hotels can recoup upgrades in under one year through utility savings (1–10 years in existing retrofits) (Rasool et al., 2022). Likewise, a green-certified hotel is generally at least

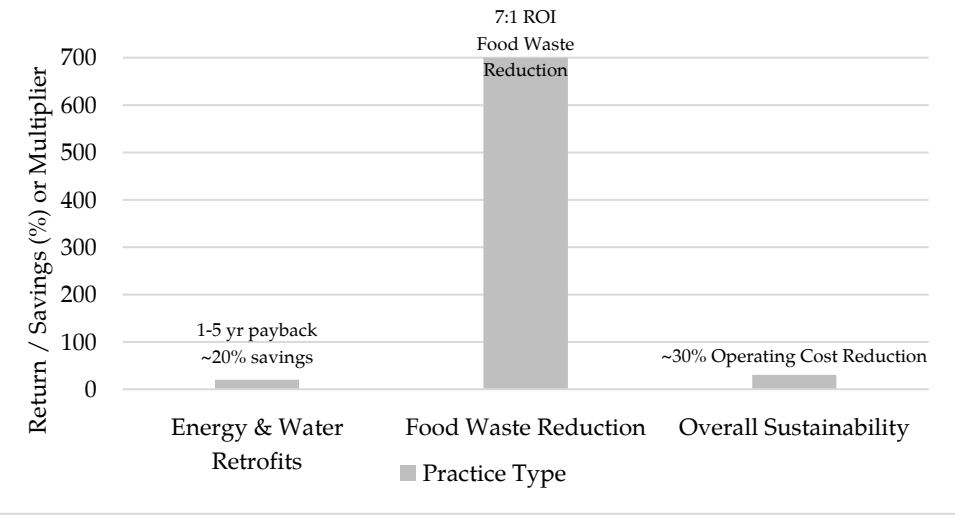
20% more resource-efficient than a conventional building (Shen et al., 2021).

For food waste and operational efficiency, ROI is even higher. As noted, a survey of hotels found that 95% achieved a 7:1 ROI on food-waste reduction initiatives within two years (Ta□çıoglu et al., 2022). In other words, every dollar spent on waste-management tools and training yielded $7 in cost savings by reducing waste disposal and food costs. Another industry report confirms that hotels typically save $7–$8 for every $1 invested in waste reduction (Sharma and Kumar, 2021). This is because kitchens can dramatically reduce overproduction, spoilage, and labor time through these systems.

Beyond such case-specific figures, general studies estimate large aggregate benefits. Industry analysts indicate that hotels prioritizing sustainability can reduce operating costs by up to ~30% (Volgger et al., 2022). These savings stem from energy savings, water reduction, and waste avoidance combined. For example, in response to post-pandemic inflation, many operators found that efficiency measures (LEDs, insulation, waste cutting) that were previously marginal became cost-effective (Kusa et al., 2023). Companies also gain by avoiding future regulatory costs: proactive green measures can shield hotels from carbon taxes or water restrictions (Rahman et al., 2015).

In sum, metrics across studies indicate favorable economics: sustainability measures deliver substantial cost savings and typically yield positive ROI. Hotels often report that project paybacks (1–3 years) align with asset-holding periods, making them sound investments (Ghimire et al., 2023). These savings can either flow directly to bottom-line profit or be reinvested in improved guest amenities.

Fig 4: ROI and Cost Savings from Sustainability Practices (Rasool et al., 2022)



4.2 Operational Efficiency

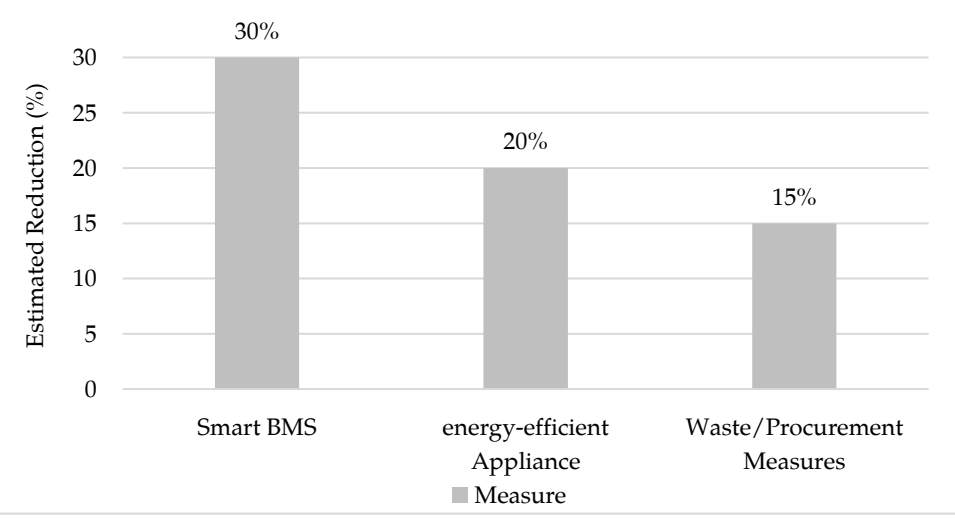
Sustainability drives operational streamlining. Energy management systems and efficiency upgrades automate controls, reducing staff labor and maintenance. For example, automated lighting and HVAC scheduling not only slash utility use (by ~20–30%) but also stabilize equipment loads and reduce maintenance issues. One case study reported a 30% reduction in energy use from a smart BMS deployment (Saydam et al., 2022). More generally, energy-efficient appliances and building retrofits yield routine savings (Wang et al., 2013).

Waste and procurement measures also improve efficiency. Food-waste monitoring identifies menu items with overproduction, enabling chefs to adjust ordering and preparation. Recycling and composting programs reduce waste-hauling costs and can even generate revenue (e.g., compost sales or carbon credits). Local sourcing shortens supply chains, reduces spoilage, and streamlines transportation logistics.

Overall, sustainability fosters leaner operations. The Principal Real Estate report on European hotels states that waste reduction and resource efficiency are now "competitive necessities," especially under high inflation (Sharma and Kumar, 2021). This indicates that once a sustainability program is in place, hotels operate more smoothly and

predictably, cutting downtime and reactive maintenance. These efficiencies compound direct cost savings, amplifying profit margins.

Fig 5: Operational Efficiency Gains from Sustainability (Shahzady, 2023; Rasool et al., 2022; Ahmed et al., 2022).



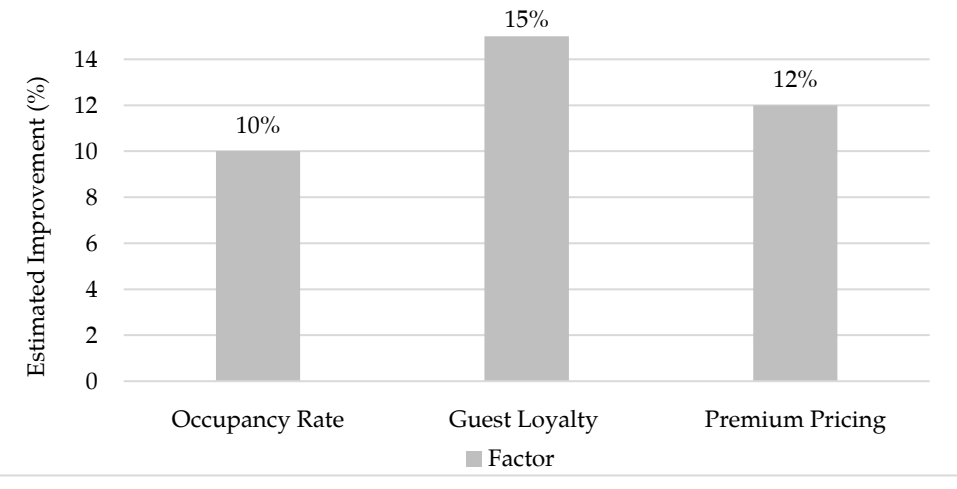
4.3 Long-Term Profitability and Brand Value

Investing in sustainability can boost a hotel's brand and goodwill, yielding long-term revenue benefits. Studies show that green credentials enhance reputation and guest loyalty. For instance, a recent study found that green-certified hotels have higher occupancy rates and stronger repeat business among eco-conscious travelers (National Energy Efficiency and Conservation Authority, 2020). Guests tend to choose hotels that match their values, so a sustainability commitment serves as a brand differentiator. One study reported that executive management increasingly views environmental strategy as vital to long-term competitiveness.

Moreover, hotels often use "savings" from green measures to enhance the guest experience. For example, reduced utility and waste costs can be channeled into facility upgrades, spa discounts, or staff bonuses, all of which improve service quality. The energy study in (National Energy Efficiency and Conservation Authority, 2020) explicitly notes that energy savings were redirected to improve services and guest amenities, bolstering loyalty.

Empirical evidence supports the claim that "green" hotels may enjoy premium returns. One journal article reports that green hotels achieved substantial cost savings (in energy and water) and simultaneously commanded premium pricing (Ogunnaike et al., 2022). Even if occupancy is similar to that of non-green peers, charging higher rates (with little drop-off in demand) increases revenue per available room (RevPAR). In sum, while sustainability paybacks may appear as cost-line improvements, they also manifest as intangible asset value through branding and market positioning.

Fig 6: Long-Term Profitability and Brand Value of Green Hotels (NEECA, 2020; UNEP, 2021; U4E, 2021; Shamspower Ltd., 2023)



4.4 Consumer Willingness to Pay for Green Services

Consumers increasingly reward sustainable hotels with their business – often at a premium price. Surveys indicate that a large majority of travelers are willing to pay more for eco-friendly accommodations (Kusa et al., 2023). For example, one study found that 85.6% of respondents "don't mind paying extra" for an environmentally conscious hotel (Rasool et al., 2022). Another source notes that guests will pay about a 10–15% rate premium for a well-advertised green hotel (though figures vary by market). In practice, many hotels successfully add surcharges or premium pricing to "green" rooms or packages, leveraging this consumer trend (Shen et al., 2021).

Guest satisfaction also tends to rise when hotels adopt visible green practices. Travelers report feeling better about a stay when they see their waste recycled or their room cleaned with eco-friendly products. This positive perception can translate into better online reviews and word-of-mouth, indirectly boosting demand and helping sustainable hotels maintain higher occupancies or rates. In short, eco-investments create consumer goodwill that hotels can convert into revenue gains over time.

4.5 Case Studies (Global Examples)

Several major hotel chains and projects exemplify the economic success of sustainability:

- Hilton – LightStay Platform: Hilton Worldwide's proprietary "LightStay" energy management platform (using advanced data analytics) has helped the chain achieve verified savings of over $1 billion globally (Shahzady, 2023). According to an industry report, Hilton's property managers share energy data via LightStay, which in turn identifies AI-driven strategies to cut consumption. This has resulted in 20% reductions in water and energy use and 30% cuts in carbon emissions and waste across the portfolio (Rasool, et al., 2022). Importantly, this centralized system earned a corporate mandate: every Hilton property must use it, ensuring ongoing ROI and continuous improvement (Pirani & Arafat, 2016).
- Accor – Planet 21 Linen Initiative: Accor's sustainability program "Planet 21" includes eco-friendly uniforms and linen. In 2018, Accor introduced natural-colored towels and linens (avoiding chemical bleaching) across its economy and midscale brands. The result was a 42% reduction in CO_2 emissions and a 48% reduction in water use per towel or bathrobe from manufacturing (Rasool, Khan, & Durrani, 2022). This led to direct resource savings (no increase in guest rates) and reduced chemical costs by 88%. Accor reports significant cost avoidance from this large-scale roll-out, which also generated PR value around "Natural is the new white!" (Perera et al., 2025).
- Marriott – Solar and Energy Goals: Marriott's "Serve 360" sustainability reports (2021–2023) outline various initiatives. For example, a JW Marriott in Cairo installed rooftop solar with UN

support, reducing its grid energy consumption. Marriott has set a target of at least 30% of electricity from renewables across its portfolio by 2025. While specific ROI figures are proprietary, Marriott cites cumulative millions in energy savings and hundreds of hotels with green certifications.

- Dubai Resorts and Others: In the Middle East, luxury resorts have invested in innovations such as solar cooling, thermal desalination, and waste-to-energy. For instance, one Dubai resort diverts virtually all food waste through biogas converters, both saving landfill fees and producing biogas for its grid. (Exact figures are often confidential, but the practice follows the "payback plus brand" model.)
- Greenbond Financing Examples: A variety of hotel investment funds now issue green bonds or ESG-linked loans. Portfolio managers report that funds focused on certified green hotels generate higher net operating income and attract more investor interest (Sabatino, et al., 2025). For example, IFC (World Bank) reports financing over $1 billion in green hotel projects, noting that investors view these assets as lower risk and with higher cash flows (Shalender and Sharma, 2021).

5. Comparative Analysis by Region

5.1. Europe and North America

These markets are generally the most mature in hotel sustainability, driven by strict building codes (e.g., EU "Nearly Zero Energy Building" mandates) and consumer demand. Studies show that many large hotel owners in the EU and North America are integrating ESG into valuations (Ta□çıoglu et al., 2022). For example, a European real estate investor report notes that hotels adopting green practices can cut operating costs by up to 30% (Volgger et al., 2022). Western hotels often pursue multiple certifications (LEED, Green Key, ENERGY STAR) and maintain sophisticated reporting. Guests from these regions also tend to have a higher willingness to pay for green credentials.

5.2. Asia-Pacific

Asia hosts both high-tech urban hotels and small, rural hotels. Leading hotel groups in Japan, Singapore, Australia, and China have

robust green programs. For instance, Singapore's Marina Bay Sands (MBS) retrofit achieved double-digit energy savings with a <2-year payback. However, across Southeast and South Asia, many hotels are still catching up. Government incentives are emerging (e.g., Singapore's Green Mark scheme and tax rebates for hotels; India's AMRUT program for water management). Rapid tourism growth in Asia (projected ~5% annual increase through 2030) creates both opportunity and urgency (Ta□çıoglu et al., 2022). Asia-Pacific guests increasingly expect sustainability, but budget hotels may need low-cost solutions. In India and Nepal, some chains use solar water heaters and rainwater tanks, yet adoption is uneven. Overall, Asia's diversity makes it hard to generalize, but the trend is upward.

5.3. Middle East and Africa

In the Middle East, resource constraints drive some innovations. Resorts in the UAE and Qatar often use thermal energy storage (solar-powered AC) and treat seawater for laundry. Dubai's hotels invest heavily in LEED and "lowest energy star" certifications; for example, the Address Hotel achieved 50% less energy use after upgrades. However, in many African countries, sustainability efforts are nascent. Some safari lodges and eco-lodges in Kenya, Tanzania, and South Africa have advanced practices (solar power, compost toilets) motivated by ecotourism branding. Financial and infrastructure constraints remain the main barriers in this region. There is also growing recognition of climate risk (droughts, etc.), driving interest in resilience (e.g., water harvesting in Mauritanian hotels).

5.4. Latin America

Latin America is a leader in community-based and eco-tourism. Costa Rica's national park lodges consistently rank highly for sustainability, combining energy efficiency with local community projects. Mexico's Riviera Maya has seen several hotels earn EarthCheck certification, focusing on renewable energy and mangrove restoration. However, much of Latin hospitality consists of small inns and hostels with limited capital. Programs like the Mexican Sustainable Tourism certification encourage resource-saving, and Brazil's hotels increasingly procure local produce. A cultural emphasis on biodiversity has led some Amazonian lodges to fund conservation. Overall, sustainability practices in Latin hospitality are growing but remain lower than in North America or Europe.

6. Challenges and Barriers to Implementation

Despite the benefits, many hotels face obstacles.

6.1 Financial and Technical Constraints

High upfront costs are the most frequently cited barrier. Small and medium hotels, in particular, struggle to finance retrofits (studies in Pakistan note that hundreds of thousands of USD are needed for even modest projects (Sustainable Hospitality Alliance, 2020). Even when ROI is strong, the initial capital outlay can be prohibitive without subsidies or loans. Technical challenges also arise: many older hotels lack the infrastructure for solar panels or efficient HVAC, and there may be a shortage of skilled technicians in emerging markets (Thams et al., 2020).

6.2 Policy Gaps

In many countries (including Pakistan), building codes and tourism policies do not explicitly require or incentivize green hotels. The absence of uniform regulations often leaves sustainability to voluntary action. A lack of tax incentives, grants, or enforcement hampers wider adoption. Unlike places like Europe (which has tough carbon and water targets), developing regions often have limited environmental oversight in hospitality. This policy vacuum slows progress. (We did not find detailed source data on Pakistan's policy gaps, but the consensus in studies is that regulatory support is weak in many developing nations.)

6.3 Cultural and Behavioral Barrier

Even within hotels, culture can impede change. Staff and management may resist altering routines or distrust new technology. A study notes that cultural resistance (habits, skepticism) delayed sustainability projects in about 30% of hotels surveyed (Ta□çıoglu et al., 2022). Without strong leadership buy-in and training, energy-saving reminders and recycling programs often fizzle out. On the guest side, some travelers worry that "green" means sacrificing luxury, requiring careful marketing.

6.4 Misinformation and Greenwashing

Some hotels may exaggerate their "green" claims to attract customers (greenwashing), which can backfire. Research shows that

perceived false green claims erode customer trust and loyalty (Volgger et al., 2022). For example, if a guest believes a hotel's sustainability messaging is insincere, they may penalize the brand. Misinformation also confuses consumers: without transparency (e.g., real data on savings), guests can't reward genuine efforts. This underscores the need for credible certification and clear communication.

7. Policy Implications for Pakistan

7.1. Current Status of Sustainable Hospitality in Pakistan

Pakistan's hospitality sector remains nascent in sustainability. There are few certified "green" hotels and limited industry-wide programs. SME hotels – which dominate the market – generally lack strategic focus on environmental issues (Tanford et al., 2020). Resource limitations (frequent energy and water shortages) and cost pressures often override green priorities. However, Pakistan's natural attractions (mountains, heritage sites) provide a strong incentive to preserve the environment. A recent policy review underscores Pakistan's infrastructure gaps: poor air connectivity, roads, and outdated facilities hinder even basic tourism growth (Shen et al., 2021). These same deficits complicate the launch of sustainability initiatives (e.g., an unreliable grid makes solar less predictable without storage).

7.2. SWOT Analysis of Pakistan's Hospitality Sector

Strengths include Pakistan's vast tourism potential, scenic landscapes (Karakorum peaks, northern valleys), rich culture, and low-cost labor, which can attract international visitors (Sadiq et al., 2022). There is also growing government interest in tourism promotion, suggesting political will for sustainable planning. Weaknesses are serious: infrastructure is weak (roads, power), and the sector is fragmented, with many informal operators (Sabatino et al., 2025). There is minimal local production of green technologies, so hotels depend on imports. Opportunities lie in a "first-mover" position: adopting sustainability now could brand Pakistan as an eco-destination. For example, establishing a network of eco-lodges and green-certified hotels (inspired by Costa Rica's model) could attract niche tourists (Sabatino et al., 2025). Adventure and community tourism are on-trend and could be leveraged sustainably. Threats include climate change (glacial melt, water scarcity), which could damage tourism sites, and unchecked mass tourism, which risks ecological

damage (Oztürk et al., 2024). Politically, frequent energy and security crises could sideline sustainability agendas.

7.3. Gaps in Policy and Practice

Currently, Pakistan lacks specific tourism sustainability standards or incentives. There is no national green hotel certification, and industry players have little guidance. Policy-wise, environmental regulations (on building or energy use) are not enforced in the hospitality sector. This policy gap means hotels have no incentive to invest in efficiency. At the same time, awareness among hoteliers is low – there are few local training programs or case studies tailored to Pakistan. The above SWOT analysis suggests a critical need for government and industry collaboration: policies to encourage renewables, support for certification schemes, and integration of tourism into climate plans.

7.4. Lessons from Global Best Practices

Pakistan can draw on several international examples. Costa Rica's eco-lodges (solar roofs, reforestation projects, limits on tourist numbers) show how sustainability can underpin a national brand. Similarly, offering tax breaks or low-interest loans, as in Germany and Australia for green hotels, could jump-start Pakistani adoption. The EU's energy-performance directive (cited above) drove ~25% energy cuts in hotels (Kusa et al., 2023); a Pakistani equivalent would combine efficiency grants with building code updates. Chain hotels in Asia (e.g., Oberoi, Taj) could be encouraged to mentor local hotels, sharing best practices. International partnerships (UNEP, UNWTO) might provide technical support for local initiatives. Importantly, carbon offset or "climate fund" schemes (as in Bhutan's tourism tax) could channel tourist revenue back into conservation and hotel greening.

7.5. Recommendations for Tourism/Hospitality Policy:

- Incentivize Green Investment: Implement subsidies or tax incentives for hotel energy and water retrofits and certifications, as in the German subsidy that raised solar adoption by 40% (Kholijah, 2024).
- Set Minimum Standards: Adopt mandatory energy- and water-efficiency standards in building codes and for new hotel designs. Encourage star-rating schemes to include sustainability criteria.

- Capacity Building: Develop training programs (possibly through tourism boards or hotel associations) to teach sustainable operations. Collaborate with vocational institutes to train staff on green practices.
- Green Certification Program: Establish a national "Green Hotel" label (or adapt international ones) to recognize compliance. Publicize certified hotels in tourism marketing.
- Public-Private Partnerships: Leverage PPPs to build infrastructure (e.g., reliable solar grids at resorts). Pilot projects (e.g., solar micro-grids for mountain lodges) could demonstrate viability.
- Data and Monitoring: Encourage hotels to use reporting tools (such as Hilton's LightStay) for energy tracking. The government could aggregate this data to benchmark industry performance.

Overall, aligning Pakistan's tourism strategy with sustainability – by learning from global models – can strengthen the sector's economic resilience. These policy measures would help Pakistan avoid the "mass tourism" pitfalls of some countries and instead build a tourism sector that enriches communities while preserving resources (Ghimire et al., 2023).

8. Future Directions and Research Gaps

Despite advances, gaps remain in knowledge and practice. Future research should evaluate emerging technologies and digital solutions in hospitality. For example, the role of AI and IoT in real-time energy and water management is promising: one study in Pakistan found that enhancing hotels' AI capability significantly strengthened the impact of eco-innovations on sustainable performance. Research could quantify how much more savings smart sensors or predictive analytics yield compared with conventional upgrades. Similarly, blockchain and traceability tools could transform sustainable procurement (tracking carbon in supply chains), but studies are scarce.

Other gaps include the social dimensions of green hotels. While many papers examine environmental measures, fewer analyze labor impacts – e.g., how green human resource management (GHRM) affects employee motivation and retention in hotels. Also, the interplay of culture

and sustainability needs work: what drives or hinders sustainable behaviors among hotel staff and guests in different regions?

On policy, comparative studies of developing-country approaches would help. For instance, examining how India or Malaysia incentivize hotel sustainability (compared with Pakistan) could guide best practices. There is also a need for localized ROI analysis: what are the payback periods for solar panels or water recycling in a Pakistani climate?

Finally, the role of digital tools is expanding. Research could examine how mobile apps (for guest eco-education) or AI chatbots (promoting green options at check-in) influence guest behavior. Moreover, the sector's response to climate change (e.g., risk management for extreme weather, insurance impacts) is an emerging research frontier. The COVID-19 era also underscored links between health crises and sustainability, suggesting that future studies should integrate resilience to shocks into the sustainability paradigm.

9. Conclusion

This review highlights that sustainability practices in hospitality yield both environmental and economic dividends. Measures such as energy efficiency, water conservation, and waste reduction not only substantially reduce operating costs but also strengthen brand value and demand. Consumers increasingly reward green hotels with higher willingness to pay. Yet implementation faces financial, technical, and cultural barriers, especially in developing economies.

For Pakistan and similar countries, the findings underscore a major opportunity: sustainable tourism is both a business strategy and a socio-environmental imperative. By leveraging global lessons – from energy-efficiency subsidies to community-based ecolodges – Pakistan's industry can build profitability while advancing conservation. Policymakers and hoteliers should view sustainability not as a cost center but as a path to resilience and competitiveness. In this sense, green investments today can yield years of savings, higher rates, and a stronger tourism brand tomorrow.

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Measuring Availability of Resources: A Case Study of Selected CPI Items in Pakistan

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Abstract: It is widely believed that resources are becoming scarcer, and measuring their availability is crucial for efficient allocation. This study measures the availability and affordability of essential items in Pakistan before and after COVID-19. Time Price, Price Elasticity of Population (PEP), and Simon Abundance Index (SAI) are calculated to analyze thirty-nine items from Pakistan's CPI basket. The findings reveal that from 2006 to 2018, the Time Price decreased for almost all items, indicating increased affordability and resource abundance relative to population growth. However, the COVID-19 pandemic significantly increased the Time Prices of essential commodities, making them less affordable and less abundant. Policymakers are advised to adjust wages to maintain purchasing power and to adopt resilient strategies to ensure Pakistan is well prepared for such crises.

Keywords: Resource abundance, time price, Simon abundance index, inflation measurement, COVID-19 impact, Pakistan.

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Measuring Availability of Resources: A Case Study of Selected CPI Items in Pakistan

1. Introduction

Natural resources have a positive impact on a country's growth and development, both socially and economically (Hodor & Clodnitchi, 2021). Resources become scarce when demand exceeds supply, leading to the depletion of available stocks. This imbalance often results in rising costs, making essential resources less accessible to lower-income groups. Consequently, such scarcity can contribute to unsustainable growth and widening economic inequality.

The relationship between population growth and resource availability has long been debated among economists, demographers, and environmentalists. Classical pessimists such as Malthus (1798) and Ehrlich (1968) argued that population growth has a negative effect on economic growth and resource availability, resulting in declining living standards. In contrast, Julian Simon (1996) presented a more optimistic view, arguing that the stock of human knowledge, innovation, and technological progress always finds solutions to human problems. He further argued that scarcity is only a short-run phenomenon, and in the long run, market mechanisms transform potential scarcity into greater abundance. According to him, population growth provides not only additional consumers but also more problem-solvers, making resources more effectively available over time.

Building on Simon (1996), Tupy and Pooley (2022) developed new analytical concepts to measure the scarcity and availability of resources. In their book Superabundance, they challenge the traditional belief that population growth inevitably leads to resource scarcity. Instead, their findings reveal that, over time, most resources are becoming more abundant despite population growth, a phenomenon they term 'superabundance'.

To operationalize Simon's idea that scarcity is only a short-run phenomenon and that, in the long run, the prices of most items eventually fall, Tupy and Pooley developed the concepts of Time Price, the Simon Abundance Index (SAI), and the Price Elasticity of Population (PEP). The Time Price is the time a worker has to spend to buy a unit of a good or

service. Because time is a universal unit, it can be used to compare the prices (in terms of time spent) of a wide range of commodities. For example, the time needed to earn enough to buy a day's supply of rice in India reportedly fell from about seven hours in 1960 to less than one hour today (Tupy & Pooley, 2022).

Building on the concept of Time Price, they further developed the Simon Abundance Index (SAI) to quantify changes in global resource abundance by combining variations in Time Prices with population growth. Their results show that between 1980 and 2024, the average Time Price of 50 basic commodities fell by about 70.4%, while the world population rose by 82%, indicating that resources became substantially more affordable over time despite the increase in global population. Similarly, the results for the Price Elasticity of Population (PEP), which measures the percentage change in Time Price per percentage change in population, show a greater decrease in Time Prices than the increase in population at the global level.

This study uses the innovative measures Time Price, SAI, and PEP to assess the availability of essential CPI items in Pakistan across two distinct periods: pre-COVID (2006–2018) and COVID/post-COVID (2019–2022). This approach offers a new perspective on inflation and scarcity in Pakistan and tests whether global patterns of falling Time Prices and rising abundance also hold in a developing country like Pakistan.

2. Literature Review

Generally, people believe there is a negative relationship between population growth and resource availability. However, this pessimistic view was challenged by Julian Simon (1996) in his book 'The Ultimate Resource 2,' in which he stated that humans, in general, are builders, not destroyers, of resources. He believed that over time, resources become less scarce in an economic sense due to innovation and improvements in technology. He laid the foundation for all later work measuring the scarcity of resources through different and innovative methods.

Based on his ideas and work, Pooley and Tupy (2021) developed the concepts of time price, price elasticity of population, and the Simon Abundance Index. Their results show that over the past 40 years, the value of SAI has reached 618 (base year 1980 = 100). This suggests that global resource abundance has doubled approximately every 14 years and has

grown at a compound annual growth rate of around 5%. They discovered that abundance is expanding faster than population growth, a phenomenon known as "Superabundance," which is what mankind is currently experiencing.

Later, Pooley (2024) calculated the time price of gasoline in the USA by collecting nominal gasoline price data from the Bureau of Labor Statistics and average hourly earnings. According to his research, the average time spent paying for a gallon of gasoline has been 6.34 minutes since 2013. During the COVID-19 lockdown, when demand was stifled in April 2020, the lowest time price was 3.75 minutes. In June 2022, when supply and demand were moving in opposing directions, the price reached its maximum at 9.43 minutes. The trend line predicts that the time price will continue to fall, indicating a rise in the supply of gasoline. In September 2023, US crude oil output reached a record high of 13.21 million barrels per day. This represented a 88.7% increase from 7 million barrels per day in January 2013. With more than half of the world's wells, the United States is the world's top producer of natural gas and crude oil.

Similarly, Pooley (2023) demonstrated that, for key consumer goods such as gasoline, airfare, and food items, nominal prices declined relative to wages, resulting in measurable improvements in personal abundance.

Many researchers also examine the impact of COVID-19 on inflation and resource availability. A study by Younis et al. (2023) conducted a systematic review of the literature to analyze the impact of COVID-19 on supply chain disruptions. They divided the literature into two groups. The first group of studies found that the pandemic has resulted in disruptions to the global supply chain, while the second group found that it has created many new business opportunities, such as in transportation, pharmaceuticals, and container shipping.

In Pakistan, a study by Shafi et al. (2020) highlighted the impact of COVID-19 on micro, small, and medium-sized enterprises (MSMEs). By collecting data from 184 MSMEs, the study found that most businesses were severely affected by reduced demand, supply chain disruptions, and lower profit rates. For example, the textile and apparel industry was badly affected by the lockdown, and the agriculture sector was affected by the unavailability of labor and transport. Similarly, small businesses such as clothing, shoes, food, and electronics were also affected by the lockdown

during Ramadan and by the additional cost of safety measures, such as buying masks, gloves, and sanitizers.

Using a demand-system approach, Hayat (2023) also analyzed household food consumption patterns and found that as the prices of staple foods increased, households tended to buy cheaper products, indicating declining affordability and nutritional quality.

Headey et al. (2024) argue that tracking only food prices doesn't fully capture how affordable diets are. They suggest a food wage index that compares the wages of unskilled workers with food prices or the cost of a healthy diet. This index helps show how inflation reduces people's real buying power.

Lee et al. (2013) further strengthen this analytical direction by presenting a comprehensive framework for assessing food prices and diet affordability, emphasizing the importance of linking diet costs to household income. Taken together, these studies provide empirical evidence and methodological guidance for the present analysis of Pakistan, offering tools to evaluate how inflation affects resource availability, affordability, and overall household welfare beyond conventional price indices.

Overall, the literature shows that traditional CPI or nominal price measures often signal high inflation and deteriorating affordability. However, when we incorporate changes in wages, hours worked, and population, the results for many essential items show a trend of increasing availability. This study aims to fill a gap in the literature in Pakistan by applying the concepts of time price, SAI, and PEP to measure the affordability of necessary items in Pakistan.

3. Materials and Methods

3.1 Data Sources

The data on average hourly wages (total skilled workers) were retrieved from the International Labor Organization (ILO). The data on commodity prices were taken from the Pakistan Bureau of Statistics (PBS) and the China Economic Information Center (CEIC). The population data were taken from the World Bank.

3.2 Selection of Commodities

The CPI basket in Pakistan comprises twelve categories. Due to data limitations, thirty-nine representative items were selected, covering essential food products (protein sources, dairy, and basic cooking ingredients), household and personal care goods (shirting fabric, soaps), energy items (kerosene, petrol, gas charges, and firewood), footwear for men and women, and basic communication expenses such as local call fees.

3.3 Methodology

This study follows the methodological framework developed under the Simon Project at the Cato Institute (Pooley & Tupy, 2018). Specifically, it applies the concepts of Time Price, Price Elasticity of Population (PEP), and the Simon Abundance Index (SAI) to assess the scarcity or abundance of selected CPI items in Pakistan.

Time Price (TP)

Time-price is the amount of time an average human must work to earn enough money to buy a commodity. Money prices can be converted to Time Prices by dividing the money price by hourly income. Time Prices in this study are expressed in minutes.

$$TP = \frac{Price\ of\ a\ commodity}{Hourly\ wage} \times 60$$

Percentage Change in Time Prices (%ΔTP)

Percentage change in Time Price (%ΔTP) provides more valuable information than individual TP. It indicates whether resources are becoming easier or harder to obtain in terms of work time, with a negative %ΔTP reflecting greater abundance and a positive %ΔTP indicating increased scarcity.

$$\%\,\Delta\ in\ TP = \left(\frac{TP_{final\ year} - TP_{Initial\ year}}{TP_{Initial\ year}}\right) \times 100$$

Price Elasticity of Population (PEP)

The concept of elasticity is used to estimate the sensitivity of changes in TP to changes in population. PEP produces a coefficient that can

be interpreted as a measure of abundance. If the PEP value is positive, the TP of commodities increases in response to population growth. If the PEP value is negative, the TP of commodities declines in response to population growth.

$$PEP = (\%\ Change\ in\ Time\ Price) \div (\%\ chagne\ in\ Population)$$

Abundance Multiplier

The Abundance Multiplier indicates the number of units of a resource that can be purchased with the same amount of working time at different points in time. The multiplier shows how much more or less abundant a resource has become from the perspective of an individual over time. It is the ratio of the start-year TP to the end-year TP.

$$Multiplier = \text{start year TP}/\text{end} - \text{year TP}$$

As long as the multiplier is greater than 1, personal resource abundance is increasing.

Simon Abundance Index

The Simon Abundance Index (SAI) measures the change in the abundance of a resource over a period. SAI compares the change in commodity resource abundance to the change in population.

$$SAI = (1 + \%\ change\ in\ Abudance\ Multiplier) \times (1 + \%\ change\ in\ Population) \times 100$$

A rising SAI indicates that resources are becoming more abundant, as fewer work hours are needed to purchase them—reflecting gains in technology, productivity, and efficiency. Conversely, a declining SAI suggests increasing scarcity, as more work time is required to afford the same resources.

4. Results and Analysis

4.1 Trends in Time Price

Nominal price data show that prices for most commodities have consistently increased over the study period. Prices for some items, especially food items such as wheat, vegetable ghee, beef, mutton, and curd, increased during and after COVID. Prices for other essential items,

such as shirting, also increased, along with petrol and gas prices. In addition to global factors, domestic factors such as rising energy prices, power shortages, government policies, and economic and political instability played a major role in rising inflation measured in nominal terms. However, if we measure resource availability using Time Prices, we find a different picture. Table 1 presents the Time Price and the percentage changes in Time Price for thirty-nine items during the years 2006-2018 and 2019-2022 for total skilled workers.

Table 1: Time Price and Percentage Change in Time Price

Items	Time Price				Percentage Change in Time Price	
	2006	2018	2019	2022	2006-18	2019-22
Wheat/Kg	31.53	24.45	22.82	26.36	-22.44	15.49
Veg. Ghee/Kg	157.89	100.56	89.94	236.72	-36.31	163.20
Sugar/Kg	75.17	37.18	39.04	37.96	-50.54	-2.76
Gur/Kg	93.50	53.28	56.51	56.49	-43.02	-0.04
Fresh Milk/Lt	61.16	53.89	49.47	56.03	-11.88	13.26
Basmati Rice/Kg	50.90	47.73	44.88	49.73	-6.24	10.82
Rice Irri 6/Kg	37.24	32.02	32.47	36.52	-14.03	12.46
Basmati Rice: Broken/Kg	46.77	44.78	43.99	50.19	-4.27	14.09
Masoor Pulse/Kg	104.43	73.59	68.07	120.52	-29.53	77.05
Moong Pulse: Washed/Kg	109.70	73.41	90.29	76.74	-33.08	-15.02
Mash Pulse/Kg	122.76	102.46	94.48	131.19	-16.54	38.86
Gram Pulse/Kg	72.20	73.79	69.92	86.76	2.19	24.09
Beef with Bone/Kg	247.89	216.61	228.03	284.74	-12.62	24.87
Mutton: Goat/Kg	468.91	472.50	471.73	591.28	0.77	25.34
Farm Chicken/Kg	153.32	98.71	91.28	109.31	-35.62	19.76
Farm Eggs Hens/Dozen	81.37	64.10	47.03	79.50	-21.22	69.05
Cooked Beef Plate/Each	60.49	63.06	67.56	83.71	4.25	23.92
Cooked Dal Plate/Each	36.31	36.55	35.42	41.37	0.66	16.79
Banana/Dozen	65.38	50.35	62.84	83.38	-22.99	32.69
Potato/Kg	42.18	21.06	17.61	21.27	-50.08	20.78
Dry Onion/Kg	27.89	30.19	29.05	34.39	8.25	18.36
Curd/Kg	65.85	61.60	58.21	63.62	-6.45	9.30
Tomato/Kg	45.20	37.04	26.27	34.38	-18.04	30.89
Mustard Oil/Kg	154.76	114.28	107.57	228.36	-26.16	112.30
Tea Prepared/Cup	13.39	13.19	13.19	15.75	-1.47	19.40
Rock Salt/Kg	9.14	6.90	6.84	5.50	-24.56	-19.64
Red Chilies /Kg	925.75	434.30	385.23	612.62	-53.09	59.03
Gents Shoes: BATA/Pair	693.74	372.17	330.12	302.51	-46.35	-8.36
Ladies Shoes: BATA/Pair	9.63	9.65	8.91	9.05	0.21	1.61
Firewood/Kg	1.44	1.40	1.36	1.67	-2.39	23.04

Items	Time Price				Percentage Change in Time Price	
	2006	2018	2019	2022	2006-18	2019-22
Matches Box/Each	17.94	16.40	17.31	38.40	-8.58	121.86
Washing Soap/Cake	32.32	25.27	22.65	27.71	-21.82	22.37
Lifebuoy Soap/Cake	144.69	108.85	104.89	121.86	-24.77	16.18
Shirting/M	33.02	26.14	24.92	74.36	-20.83	198.39
Bread Plains/Each	83.97	61.35	72.23	71.34	-26.94	-1.23
Kerosene/L	128.10	50.14	62.68	94.33	-60.86	50.48
Petrol Super/L	204.36	79.96	79.96	61.27	-60.87	-23.37
Gas Charges/MNBTU	5.36	2.45	2.56	0.77	-54.33	-69.77
Local Call Chargers/Call	31.53	24.45	22.82	26.36	-22.44	15.49

Source: *Authors' o*wn Calculations

The results show that the Time Price of various food items declined significantly between 2006 and 2018. Important products such as wheat dropped by 22.44%, sugar by 50.54%, gur by 43.02%, bananas by 22.99%, and vegetable ghee by 36.31%, suggesting improved real wage growth or productivity. These findings align with global evidence that falling time prices reflect technological advancement, economic growth, and relatively faster wage increases than commodity prices (Pooley & Tupy, 2018; Tupy & Pooley, 2022).

In contrast, the period following the pandemic saw increases in the time prices of many food items, such as vegetable ghee, edible oils, pulses, meat, and dairy products. This reversal can be attributed to government lockdown policies during COVID, which led to job losses, higher international commodity prices, domestic inflation, and a decrease in the value of the Pakistani currency. However, despite the pandemic, a few items, including sugar, moong pulse, petrol, and gas, registered stable or lower time prices due to subsidies or global price corrections.

Overall, while the pre-COVID period saw rising abundance, the period after COVID underscored the economy's vulnerability to global shocks and domestic inflationary pressures.

4.2 Trends in Price Elasticity of Population and Simon Abundance Index

The trends in PEP and SAI are analyzed using the calculations presented in Table 2. A positive PEP indicates rising TP with population growth, whereas higher SAI values indicate greater abundance that keeps pace with population expansion.

Table 2: Price Elasticity of Population and Simon Abundance Index

Items	Price Elasticity of Population		Simon Abundance Index	
	2006-2018	2019-2022	2006-2018	2019-2022
Wheat	-0.96	2.77	159.10	91.43
Veg. Ghee	-1.55	29.20	193.75	40.12
Sugar	-2.16	-0.49	249.50	108.58
Gur	-1.84	-0.01	216.56	105.63
Fresh Milk	-0.51	2.37	140.04	93.23
Basmati Rice	-0.27	1.94	131.61	95.28
Rice Irri 6	-0.60	2.23	143.53	93.89
Basmati Rice: Broken	-0.18	2.52	128.90	92.55
Masoor Pulse	-1.26	13.79	175.12	59.64
Moong Pulse	-1.41	-2.69	184.40	124.25
Mash Pulse	-0.71	6.95	147.84	76.04
Gram Pulse	0.09	4.31	120.75	85.09
Beef: Cow or Buffalo with Bone	-0.54	4.45	141.21	84.56
Mutton: Goat	0.03	4.53	122.46	84.24
Farm Chicken	-1.52	3.53	191.67	88.17
Farm Eggs Hens	-0.91	12.36	156.64	62.46
Cooked Beef Plate	0.18	4.28	118.37	85.21
Cooked Dal Plate	0.03	3.00	122.58	90.41
Banana	-0.98	5.85	160.23	79.58
Potato	-2.14	3.72	247.19	87.42
Dry Onion	0.35	3.28	113.99	89.21
Curd	-0.28	1.66	131.90	96.60
Tomato	-0.77	5.53	150.56	80.67
Mustard Oil	-1.12	20.09	167.10	49.74
Tea Prepared	-0.06	3.47	125.24	88.43
Rock Salt	-1.05	-3.51	163.56	131.39
Red Chilies	0.04	-4.09	122.37	136.90
Gents Shoes: BATA	-2.27	10.56	263.03	66.40
Ladies Shoes: BATA	-1.98	-1.50	230.02	115.23
Firewood: Kikar or Babul	0.01	0.29	123.14	103.92
Matches Box	-0.10	4.12	126.41	85.82
Washing Soap	-0.37	21.80	134.98	47.59
Lifebuoy Soap	-0.93	4.00	157.83	86.29
Shirting	-1.06	2.89	164.02	90.89
Bread Plains	-0.89	35.50	155.86	35.39
Kerosene	-1.15	-0.22	168.89	106.90
Petrol Super	-2.60	9.03	315.25	70.17
Gas Charges	-2.60	-4.18	315.37	137.80
Local Call Chargers	-2.32	-12.48	270.17	349.30

Source: Authors' own Calculations

4.2.1 Analysis of Price Elasticity of Population

The PEP measures changes in Time Price of goods relative to changes in population size. As shown in Table 2, almost all items have negative PEP values from 2006 to 2018, indicating that they are becoming more affordable over time despite population growth. This suggests possible gains in productivity, improved distribution systems, and a steady supply of essential goods. For example, the PEP values for wheat (-0.96), sugar (-2.16), and vegetable ghee (-1.55) show that the percentage decrease in time prices was greater than the percentage increase in the country's population. These findings confirm Simon's (1996) prediction that, despite population growth, the real prices of most items tend to decline in the long run.

However, results since the start of the pandemic show increases in the PEP values of many items. For instance, wheat's PEP rose from □0.96 (2006–2018) to 2.77 (2019–2022), vegetable ghee from □1.55 to 29.20, mutton from 0.03 to 4.53, and sugar from □2.16 to □0.49, showing a greater increase in the TP relative to population growth. These results are consistent with earlier findings showing a rise in TP after the pandemic, driven by a depreciated Pakistani rupee and inflationary pressures, particularly for imported items such as edible oil and petroleum. However, not all goods followed this pattern. Commodities including sugar (-0.49), gur (-0.01), and local call charges (-12.48) showed relatively stable markets, possibly due to domestic availability and substitution effects. Energy-related items like kerosene (-0.22) and gas charges (-4.18) showed even greater negative values, reflecting state price controls or subsidies.

4.2.2. Analysis of Simon Abundance Index

SAI measures the abundance of resources relative to population growth, with a base value of 100 in 2006. Any value greater than 100 indicates an improvement in resource abundance, meaning that, on average, people would be able to buy more goods and services with the same amount of work they did in the past (1980).

The results show a sharp increase in the abundance of many items from 2006 to 2018, including sugar, potatoes, petrol super, gent's shoes, and gas charges, driven by stable global prices, technological advancements, and improved agricultural yields. Some items, including wheat, vegetable ghee, and fresh milk, have moderate SAI values. A few

goods, such as mutton, gram pulse, and cooked beef plate, show relatively low SAI values due to limited production and higher input costs.

On the contrary, a general decline in abundance is evident after the pandemic. Wheat dropped from 159.10 to 91.43, vegetable ghee from 193.75 to 40.12, and washing soap from 134.98 to 47.59. Essential food and household items thus became scarcer relative to population growth. In other words, after the pandemic, people were able to obtain smaller quantities of these goods even when working the same amount as before COVID-19.

Some exceptions remain, for instance, the SAI values for sugar (108.58), gur (105.63), and rock salt (131.39) were retained or even improved post-pandemic, reflecting resilience due to domestic availability. Items related to energy and services, such as local call charges (349.30), also showed substantial improvements in SAI, reflecting expansion of digital infrastructure during COVID.

Overall, these results align with global values for abundance indicators and show a greater abundance of essential items in Pakistan, despite the increase in population.

5. Conclusion and Recommendations

This study applies the innovative concepts of Time Price, Price Elasticity of Population, and the Simon Abundance Index to assess the affordability and abundance of key CPI items in Pakistan across two distinct periods: pre-COVID (2006–2018) and COVID/post-COVID (2019–2022). Between 2006 and 2018, the time prices of staples, meat, dairy products, and energy declined significantly for total skill level workers, indicating increased accessibility and affordability for workers in Pakistan. Essential household commodities, clothing, and footwear also showed notable decreases in TP during this period, suggesting that individuals had to spend less time to afford these items. Similarly, the results of the PEP and the SAI show a greater decrease in TP than the increase in population. This means that workers in Pakistan can afford a larger quantity of goods with the same effort they used to put in in 2006.

However, results for all these indicators show a reversal, with rising TP and declining abundance after the pandemic, driven by various domestic and international factors. Overall, considering the entire study

period, the findings support Julian Simon's view that population growth does not create resource scarcity. Rather, in the long run, humans always come up with novel solutions and innovative ideas that solve the problem of scarcity, which exists only in the short run. The study also highlights the importance of measuring inflation and resource availability through new indicators that incorporate both wages and prices simultaneously.

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Data Sources

(List these separately under "Data Sources" or "Appendix" if required by your journal format.)

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