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**Abstract**

The significance of public physical infrastructure (PPI) is hard to brush aside. Whereas, misallocation of PPI tends to overshadow the growth as well as creates disruption and unrest among the territories. The theory of public choice proposes that embracing the equity effect in distribution of PPI can improve overall economic growth as well as concord the economic well-being. The current study has empirically tested the equity approach in distribution of PPI among the provinces of Pakistan. We have adopted an innovative approach by analyzing the equity principle. Panel data for provinces of Pakistan has been employed for the period of 1988-2018. The stationarity of the variables has been checked through Levin, Lin & Chu test. As we get mixed order of integration, panel ARDL is used to estimate the results. The study concludes that the distribution of PPI in provinces of Pakistan is based on the equity principle. Whereas the other economic indicator efficiency is traded off against equity. The short run negative and significant ECT term also confirms the existence of long run relationship between variables. These results ensure that despite the heterogenous characteristics of each province, the distribution of PPI is done to equalize the living standards across the country.

**Key words:** Public choice, Public physical infrastructure, Equity approach and ARDL

## 1. Introduction

The advancements in economic literature has driven the economists and policy makers in such a way that they are more implicated towards the inputs for achieving the sustainable development rather than the outputs. Besides, the traditional inputs (like labor and capital), the narrative of public capital stock has gained much attention in last two decades. In this regard, the significance of public physical infrastructure (PPI) is hard to brush aside. A wide range of empirical economic literature has established the relationship between economic prosperity with the provision of public physical infrastructure. However, the strategic management for the distribution of PPI is fundamental for an even and harmonious growth process across the country. On the other hand, misallocation of PPI tends to overshadow the growth as well as creates disruption and unrest among the territories. The theory of public choice proposes that the principle of distributional equity should not be ignored while designing the distribution scheme for regional economies. Embracing the equity effect in distribution of PPI can improve overall economic growth as well as concord the economic well-being.

The conventional approach of public finance pertains the concept of economic welfare maximization which is achieved by an optimum allocation of resources. The optimum allocation of resources can rely on two basic principles of budgetary allocations; equity and efficiency (Hyman, 2014 and Yamano and Ohkawara, 2000). Equity approach propagates the just and equitable distribution whereas efficiency approach postulates the rationale of marginal product should be the basis of distribution. Besides these principles, there lies a confusion between equity and equality. Although, these terms are phonetically same, but they are distinct in their philosophical meanings. The distributional equality is objective in nature and calls for an equal treatment of equals. On the contrary, equitable distribution of resources is subjective in nature and requires an unequal treatment based on

the variant characteristics of each; it requires justice in distribution on the basis of individual differences (Bronfenbrenner, 1973 and Espinoza, 2007). Besides, just distribution of resources is also necessary because it pours in the fairness along with the maximum welfare across the regions of the economy.

The PPI is the most commonly supplied pure public good with the impulse of equity; fairness in infrastructure provision. PPI, by its existence should not be distributed equally across the regions in an economy. It is because provision of infrastructure services is determined by number of factors (like population geographical location, revenue generation capacity and political favoritism) as well as its requirement could be different in different localities. For instance, roads and highways are to be supplied more in highly populated areas than the less populated regions. Therefore, equal infrastructure investments for all regions is not preferable nor desirable.

The resource sharing mechanism among the governments in Pakistan has faced many questions since its evolution. Under National Finance Commission (NFC) award, resources are transferred from national to sub-national governments in Pakistan. There are voices that the rationale of self-interest or the deliberate precedence of specific provinces has been entertained in resource sharing scheme for in Pakistan (Ahmed and Kamal, 2014 and Ahmed and Baloch, 2015). Also, there is empirical economic literature supporting the view that resource sharing schemes are often polarized in nature and politicized in some cases (Rao and Singh, 2000; Tsekeris, 2011; Reino and Alcalde, 2011; Simon-Cosano et al., 2013 and Monastiriotis and Psycharis, 2014).

The economy of Pakistan is comprised of five provinces along with the capital city Islamabad. Other regions include FATA, Gilgit Baltistan and AJK. All provinces of Pakistan (Punjab, Sindh, Baluchistan, Khyber Pakhtunkhwa and Gilgit Baltistan) and the regional territories are distinct in terms of economic conditions with diversified geographical

locations. Therefore, the need and requirement of each is different from the other. For a coherent economic growth, each region must be supplied with the ample PPI as per their requirement.

## 1.1. Resource Distribution Criterion in Pakistan and Distribution of PPI

The Federally administrated economies tend to be the administrator of resource sharing mechanism. In addition, the process of distribution of resources is well accomplished by national government. Whereas, provincial government can effectively supply the public goods. This is because the local governments can identify the requirements of specific region and then can supply public goods and services accordingly (Tiebout, 1956). Further, the formula-based distribution schemes restrain the political influence over resource distribution process. In case of Pakistan, NFC award is formulated which delivers the resources from national to sub-national governments (i.e. provincial governments). The structure of current NFC is based on four key indicators which are population, poverty, revenue collection and inverse population density. These indicators have assigned different weights. Among all, population has been assigned the highest weight that is 82 percent. The rest of the indicators have been assigned 10.3 %, 5.0 % and 2.7 % respectively. Before 7$^{th}$ NFC award, 100 % weight was assigned to population but after 18$^{th}$ amendment in constitution in 2010, the provincial economies are not only decentralized but the resource sharing scheme has also been revised. NFC is to be delivered every five years but unfortunately, the delivery of NFC has faced unnecessary delay and dissonance. Since the mechanism is developed, we have been able to deliver only five conclusive NFC awards. The following Table-1.1. presents the province wise resource sharing in Pakistan for 7$^{th}$ NFC award.

| Indicators | Share of Provinces in Terms of Indicators | | | | |
|---|---|---|---|---|---|
| | **Weight** | **Punjab** | **Sindh** | **KPK** | **Baluchistan** |
| **Population Share** | 82.0 | 57.36 | 23.71 | 13.82 | 5.11 |
| **Poverty** | 10.3 | 23.16 | 23.41 | 27.82 | 25.61 |
| **Revenue Generation** | 5.0 | 44.0 | 50.0 | 5.0 | 1.0 |
| **Inverse Population Density** | 2.7 | 4.34 | 7.21 | 6.54 | 81.92 |
| **Total Share** | 100 | 51.74 | 24.55 | 14.62 | 9.09 |

Source: First Quarterly Report for FY10, State Bank of Pakistan.

Table-1.1. Revenue Sharing Scheme for 7th NFC

On the other hand, PPI is a comprehensive term which includes the delivery of number of public goods and services like roads, water and sanitation, power and energy, ports and harbors, bridges, public health facilities, public educational institutes, telecommunication and many more. An adequate supply of PPI not only contributes towards economic growth but also maximizes the social welfare. However, the unjust distribution of PPI may cause social unrest, regional disparities and loss of national harmony.

Each province of Pakistan has diverse set of needs regarding PPI. Punjab province is the most populated province with the area 205,345 square kms. Punjab province has always been criticized as it gets the lion's share of resources as well as infrastructure disparities among the districts have also been knocked (Paras et al., 2018). The other prominent province is Sindh with the population of 47.89 million covering the geographical area of 140,914 square kms. Provincial capital, Karachi is said to be the commercial hub because of Muhammad Bin Qasim port and Karachi port. Based on the economic contribution from the Sindh, there is insufficient supplies of PPI. Table-1.2. represents the growth rates of important provincial indicators.

Table-1.2. Growth Rate of Key Indicators in Provinces of Pakistan (in percent)

| **Time period/ Indicators** | 1988-1998 | 1999-2008 | 2009-2018 |
|---|---|---|---|
| **Punjab** | | | |
| **Provincial GDP** | 2.06 | 5.59 | 6.55 |
| **Revenues** | 12.9 | 15.7 | 17.2 |
| **Population** | 2.6 | 2.1 | 2.1 |
| **Dev. expenditures** | 5.2 | 27.6 | 16.1 |
| **Sindh** | | | |
| **Provincial GDP** | 3.22 | 3.40 | 1.88 |
| **Revenues** | 15.8 | 18.2 | 16.6 |
| **Population** | 2.8 | 2.3 | 2.3 |
| **Dev. expenditures** | 1.03 | 34.1 | 21.4 |
| **Khyber Pakhtunkhwa** | | | |
| **Provincial GDP** | 4.3 | 3.1 | 20.2 |
| **Revenues** | 14.1 | 10.58 | 19.40 |
| **Population** | 2.81 | 2.86 | 2.86 |
| **Dev. expenditures** | 8.06 | 17.2 | 20.21 |
| **Baluchistan** | | | |
| **Provincial GDP** | 4.77 | 1.45 | 2.05 |
| **Revenues** | 15.5 | 12.2 | 18.0 |
| **Population** | 2.4 | 3.3 | 3.3 |
| **Dev. expenditures** | 7.1 | 22.7 | 13.8 |

Source: Auther's own calculations

KPK is at third position with the population of mor than 35 million yet it is smallest in terms of area which is only 101,741 square kms. The province has highest poverty rates with 39 % (Govt. of KPK, 2018). The largest province in terms of area is Baluchistan. The geographical area of Baluchistan is 347,190 square kms enclosing huge reserves of natural resources. The population of Baluchistan is only 12.34 million. Although, the province is important due to its geographical location and vast reservoirs of natural resources yet provided with the insufficient PPI.

The current study intends to explore the case of four provinces of Pakistan in terms of infrastructure distribution. Due to unavailability of enough data, FATA, Gilgit Baltistan and AJK are not empirically tested for equitable distribution of PPI. Our study has devised the mechanism to check the equity principle in distribution of PPI in provinces of Pakistan for the period 1988-2018. We have employed panel data followed by panel ARDL methodology to check whether the distribution of PPI in provinces of Pakistan is based on equity or not. The rest of the study is organized as follows; section 2 presents the literature review, section 3 discusses the econometric methodology; section 4 discusses the empirical results and section 5 presents the conclusion with policy implications.

## 2. Literature review

The Austrian economy have been tested for the distribution of grants by Worthington and Dollery (1998). The data of six states of Austria have been empirically tested for the allocation of grants. The study has examined education, social welfare and security and health sectors for 1982-1992 in states of Austria. The empirical analysis has proved that the allocation of grants has disregarded the economic indicators altogether. Whereas the motive of political capital formation has been served instead of equitable distribution.

Porto and Sanguinetti (2001) examined the case of Argentina for transfer of funds from National to sub- national governments. The study has empirically tested the provincial

economies in terms of resource sharing mechanism. The results of the study suggest that resource transfer was not need based in nature. Therefore, the absence of fairness and just distribution cause social unrest among provinces.

The supply of infrastructure services contributes towards social welfare as well as to the productivity of private sector. The supply of infrastructure services in cities of Germany has been analyzed by Kemmerling and Stephan (2002). The study employed the data of 1980, 1986 and 1988 for German cities. Simultaneous equation model has been employed for the empirical analysis. The study concludes that although the economic indicators for distribution of infrastructure were not given primary importance yet the positive economic outcomes in private sector productivity cannot be denied.

Spatial approach for to determine the factors affecting the distribution of infrastructure expenditures have been analyzed by Gosh and Meaghar (2004). The analysis has been supported by employing market-based variables like structure of market, barriers to market entry and exit and market orientation. The study suggests that the economic principles of public choice theory have been replaced with the motive to reelect. In addition, the absence of economic indicators in infrastructure distribution leads to an ineffective distribution and thus causes regional agitation.

Lambrinidis et al., (2005) have empirically tested the determinants of infrastructure services in Greece for the period 1982-1994. The study employed panel data methodology to test for the determinants of infrastructure services in regional economies. The study employed the indicators for infrastructure distribution like population, regional per capita income and population density. The empirical findings of the study show that regional per capita income and provision of infrastructure services are positively related. Whereas, other variables are significantly and negatively affecting infrastructure services. In addition, the study suggests that self-serving factors are more dominant in distribution of infrastructure

services in regions of Greece rather than ideological distribution mechanism (equity and efficiency).

Golden and Picci (2008) have empirically tested the distributive effects of infrastructure expenditures for 92 provinces of Italy. The employed period of the study was 1995 to 1994. The study has employed various indicators for infrastructure distribution like the role of influential legislature, role of political factors and the area of each region. The empirical results support the claims that no economic criterion has been followed in distribution of infrastructure services. Instead, the distribution criterion for infrastructure services follows a tactic approach.

González et al., (2011) have empirically tested the distribution of infrastructure in 24 districts of Argentina for 2000 to 2009 period. Panel data estimation has been employed for empirical verification. The empirical findings of the study show that the economic principles of equity and efficiency have been ignored in distribution of infrastructure across Argentina. The study suggests that infrastructure investment can be used as a tool for redistribution of income. Also, the study proposes that infrastructure expenditures can also be used to promote just distribution of income and to curb political unrest. Coehlho et al. (2014) has empirically tested the infrastructure allocation in UK. The study incorporated wide range of indicators for empirical analysis. The findings of the study suggest that social welfare and economic criterion have been sacrificed against the conflict and political risk.

Guo et al. (2019) empirically tested the energy distribution in provinces of China. The study has quantified the individual preferences of each province and examined for equity efficiency trade off. The study suggested that historically, the distribution of energy resources among provinces were based on energy consumption patterns of each province. The empirical analysis shows that as a result of defying economic criterion in distribution, income disparities and development gaps have been created among the provinces. Besides, equity

efficiency trade off exists among provincial economies of China in terms of distribution of energy infrastructure.

A critical overview of literature review suggests that distribution criteria often ignore the economic indicators of distribution (i.e. equity and efficiency) in infrastructure. As a result, distribution is not only unjust but give rise to social unrest and loss of political harmony. To the best of our knowledge, the case of provincial economies of Pakistan has not been empirically tested for distribution of infrastructure so far. The current study intends to fill this gap. The current study would empirically test whether the distribution of PPI in provinces of Pakistan has been equitable or not.

## 3. Selection of Variables and Econometric Methodology

The economic rationale for the distribution of infrastructure services has already been discussed in empirical economic literature. However, the factors determining the distribution infrastructure expenditures are not fully explored. Based on previous empirical studies (Macky, 2001; Kemmerling and Stephan, 2008 and Golden and Picci, 2008), the important economic determinants of infrastructure distribution among regions are population, equity, efficiency and output growth. For current study, we have augmented the model of Lambrinidis et al., (2005) in order to test the status of distribution of infrastructure in Pakistan. we have employed the following function:

$$INFRA_{it} = f\left(EQUI_{it}, EFFI_{it}, EXP_{it}, \mathrm{GDP}_{it}\right)$$

Where, INFRA is expenditures on infrastructures; EQUI is a measure of equitable distribution; EFFI is the measure of efficient distribution; EXP represents expenditures and GDP is the measure of economic activity in each province. The study has employed panel data with the historical period of the study 1988-2018 for provinces of Pakistan. Comprising the PPI for provincial economies was challenging. It is because the enough comparable data for provinces is not available in Pakistan. Also, PPI is a compound measure of number of

goods and services. To address this problem, the study has employed development expenditures of each province as a proxy measure of PPI. Equity is formulated as dividing development expenditures by the geographical area of each province. Efficiency is developed as dividing provincial output by infrastructure expenditures. Current expenditures in provincial economies has been taken as a proxy of expenditures and provincial GDP has taken as a measure of economic activity in each province. Panel data methodology has been adopted in current study. The expected signs of equity and expenditures are negative whereas all other variables are expected to have positive signs.

## 4. Empirical Analysis and Results Discussion

### 4.1. Test for Unit Root

Panel unit root results are more effective as compare to the results of time series. We have employed Levin, Lin & Chu test in order to check for the existence of unit root. The results are reported in Table-4.1.

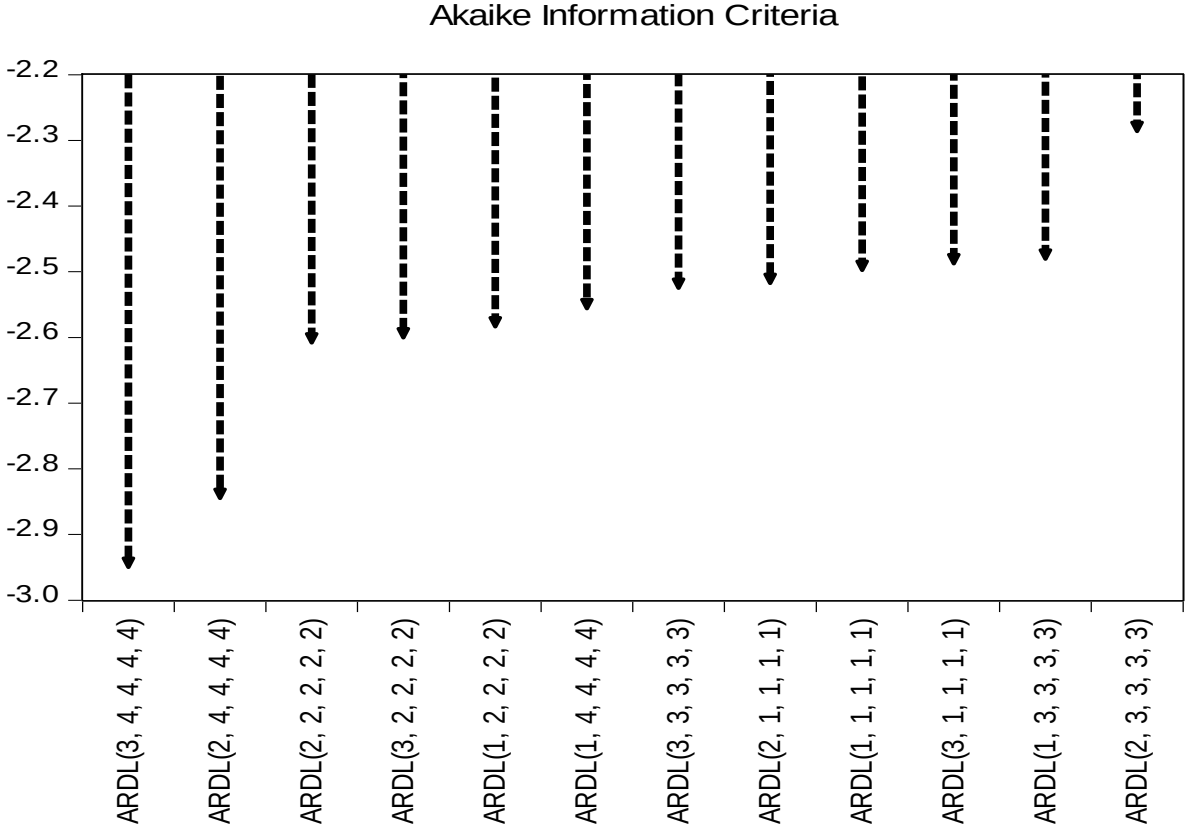
Table-4.1. Results Panel Unit Root Test

| Variable | At Level | | At First Difference | |
|---|---|---|---|---|
| | Individual Intercept | Individual Intercept and Trend | Individual Intercept | Individual Intercept and Trend |
| $LINFRA_{it}$ | 2.03385<br>(0.9790) | -0.0278<br>(0.4889) | -11.0591<br>(0.0000) | -9.3363*<br>(0.0000) |
| $EQUITY_{it}$ | -4.3588**<br>(0.0000) | -2.0740*<br>(0.0190) | -5.6576*<br>(0.0000) | -7.97354*<br>(0.0000) |
| $EFFI_{it}$ | -1.8248**<br>(0.0340) | -1.4494<br>(0.0736) | -3.6116*<br>(0.0000) | -1.72320**<br>(0.0424) |

| | | | | |
|---|---|---|---|---|
| LCEXPit | 1.6616<br>(0.9517) | 0.1639<br>(0.5651) | -8.7640*<br>(0.0000) | -7.3488*<br>(0.0000) |
| LGDPit | -0.5096<br>(0.3052) | -1.74782<br>(0.0402) | -10.3831*<br>(0.0000) | -10.0383*<br>(0.0000) |

The results reported in Table-4.1. shows that we have mixed order of integration. Some of our variables are stationary at level others are stationary at first difference. In this situation, panel ARDL is appropriate technique to be used for short run and long run results. Also, when we have small number of cross sections then PMG technique is considered as desirable. Further, it minimizes the problem of endogeneity in the model. Before long run results, we need to select appropriate number of lags of both explanatory and explained variables. For this purpose, we have adopted Akaike Information Criterion.

Figure-4.1. Akaike Information Criteria



| **Dependent Variable = $LINFRA_{it}$** | | | |
|---|---|---|---|
| **Variable Name** | **Coefficient** | **T-Statistic** | **Probability** |
| **$EQUITY_{it}$** | -0.2229 | -3.3775 | 0.0016 |
| **$EFFI_{it}$** | -0.0638 | -5.4493 | 0.0000 |
| **$LCEXP_{it}$** | -0.7969 | -1.8811 | 0.0672 |
| **$LGDP_{it}$** | 0.8328 | 2.2570 | 0.0029 |

According to the Figure-4.1, four lags of each variable (both dependent and independent variables) must be considered while estimating the model for long run and short run estimates.

### 4.2. The Long Run and Short Run Results

After determining appropriate lag length, we have employed panel ARDL technique for empirical estimation of our model. Through panel ARDL, we have estimated the results and represented in the Table-4.2 for the long run.

Table-4.2. The Long-Run Results

The results reported in Table-4.2. show that all variables are statistically significant at 5 percent level except CEXP significant at 10 percent level with expected signs. The coefficient of equity is negative as well as significant; the provinces with the equitable and fair distribution of PPI are supplied with less infrastructure expenditures. Rather, the PPI is diverted towards deprived provinces. The efficiency coefficient is also negative which confirms the equity efficiency trade off in terms of infrastructure distribution among provinces of Pakistan. The negative coefficient of current expenditures is negative as if

current expenditure increase, infrastructure expenditures would decrease. Whereas, increased output growth would lead to increased infrastructure expenditures.

The empirical results for the short run have been presented in Table-4.3. the short run results show that most of the variables are statistically insignificant. According to the results reported in Table-4.3, we have a negative as well as significant error correction term. A negative as well as significant error term confirms the existence of long run relationship between infrastructure expenditures and relevant variables in the model. Whereas the co-efficient of error correction term represents the speed of convergence towards equilibrium.

Table-4.3. The Short-Run Results

| **Dependent Variable = D($LINFRA_{it}$)** | | | |
|---|---|---|---|
| **Variable Name** | **Coefficient** | **t-Statistic** | **Probability** |
| **D($LINFRA_{it}$ (-1))** | -0.4393 | -1.6977 | 0.0973 |
| **D(LINFRA(-2))** | -0.5108 | -1.8394 | 0.0733 |
| **D($EQUITY_{it}$)** | 0.0409 | 1.7196 | 0.0932 |
| **D($EQUITY_{it}$ (-1))** | 0.0335 | 1.3164 | 0.1955 |
| **D($EQUITY_{it}$ (-2))** | 0.0229 | 1.5802 | 0.1219 |
| **D($EQUITY_{it}$ (-3))** | -0.0043 | -1.4844 | 0.1455 |
| **D($EFFI_{it}$)** | -0.0057 | -2.2711 | 0.0286 |
| **D($EFFI_{it}$ (-1))** | -0.0050 | -1.2870 | 0.2055 |
| **D($EFFI_{it}$ (-2))** | -0.0031 | -2.0827 | 0.0437 |
| **D($EFFI_{it}$ (-3))** | 0.0003 | 0.6589 | 0.5138 |
| **D(LCEXPit)** | 0.1981 | 1.5129 | 0.1382 |
| **D($LCEXP_{it}$ (-1))** | -0.0602 | -0.1732 | 0.8634 |
| **D(LCEXP $_{it}$ (-2))** | 0.0604 | 0.6376 | 0.5274 |

| | | | |
|---|---|---|---|
| **D(LCEXP$_{it}$ (-3))** | 0.0600 | 0.2047 | 0.8388 |
| **D(LGDP$_{it}$)** | 0.1384 | 3.4763 | 0.0012 |
| **D(LGDP$_{it}$ (-1))** | 0.0600 | 3.0089 | 0.0045 |
| **D(LGDP$_{it}$ (-2))** | 0.0324 | 0.3893 | 0.6991 |
| **D(LGDP$_{it}$ (-3))** | 0.0899 | 1.9136 | 0.0628 |
| **Constant** | -5.4803 | -2.1405 | 0.0385 |
| **ECT(-1)** | -0.0636 | -2.0962 | 0.0424 |

## 5. Conclusion and Policy Implications

Attaining sustainable development through provision of adequate PPI has gained popularity in economic literature. Also, PPI can be used as a tool for redistribution of income. However, there are number of factors affecting the distribution of PPI. A just supply of PPI across the provincial economies promotes harmony and just living standards whereas, absence of fairness in distribution results as sub-optimal allocation as well as creates income disparities across the provinces. The current study tried to empirically test whether the distribution of PPI is equity based or not in provinces of Pakistan. Our study has empirically tested the equity approach in distribution of PPI among provinces of Pakistan. Panel data analysis has been conducted by taking the data from 19888-2018 for provinces of Pakistan. The stationarity of the variables has been checked through Levin, Lin & Chu test. As we get mixed order of integration, panel ARDL is used to estimate the results. After selecting appropriate lag length, the study concludes that the distribution of PPI in provinces of Pakistan is based on the equity principle; PPI is distributed among the provinces on need basis and is fair in nature. Whereas the other economic indicator, efficiency is traded off against equity in case of Pakistan. The short run negative and significant error correction term

also confirms the existence of long run relationship between dependent and independent variables.

The empirical findings of the study suggest that PPI is distributed on the equity principle among provinces of Pakistan. These results ensure that despite of heterogenous characteristics of each province, the distribution of PPI is done to equalize the equitable living standards across the country. But promoting equitable distribution is costing us to sacrifice efficiency principle which states that the region with the higher marginal product should be supplied with more PPI. In this regard, the resource distribution criterion, NFC can also be revised. Usually, the formula-based approach like NFC is followed to curb the political influence yet it is proposed and developed by the political actors. Effective monitoring of distribution of PPI can be done to avoid the political influence. Moreover, both equity as well as efficiency criterion can be incorporated simultaneously. In this regard the structure of NFC should be amended, and it must include the efficiency element as determinant of PPI. For this purpose, performance efficiency of each province should be added in NFC with due weight. Moreover, avoiding the unnecessary delays over NFC delivery as well as unanimity over national interests can also improve the economic status of the country.

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