

The Role of Infrastructure Investment in Shaping Employment in Pakistan, An Econometric Analysis (1985–2015)

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Abstract

Purpose: This study investigates the relationship between infrastructure investment and employment in Pakistan while incorporating key macroeconomic control variables, including foreign direct investment (FDI), gross domestic product (GDP), gross fixed capital formation (GFCF), per capita household expenditure (PCHE), wages, inflation, and trade openness.

Design/Methodology/Approach: A composite index of infrastructure was developed using Principal Component Analysis (PCA), based on six indicators: road networks, railway lines, air transport, electricity generation, telephone connections, and mobile phone subscriptions. The analysis employed annual data from 1985 to 2015, sourced from the State Bank of Pakistan and the World Development Indicators. Descriptive statistics, Johansen co-integration, correlation, and ordinary least squares (OLS) regression were applied. **Findings:** The results reveal that infrastructure has a significant positive impact on employment. Similarly, GDP, wages, PCHE, inflation, and trade openness demonstrate favorable effects, while FDI and GFCF exert a negative but significant influence, suggesting underlying structural challenges. **Implications/Originality/Value:** The study contributes by offering a multidimensional index of infrastructure and highlighting its role in employment generation. The findings provide valuable guidance for policymakers and investors in designing strategies to enhance infrastructure-led growth and labor market opportunities in Pakistan.

Keywords Infrastructure, Investment, Employment, Pakistan

1. Introduction

Infrastructure is a fundamental driver of economic development, serving as the backbone for production, trade, and social well-being. In developing economies, reliable electricity, efficient transport systems, and advanced communication networks are critical for sustaining growth and creating employment opportunities. Investment in infrastructure not only boosts productivity but also improves living standards by enhancing access to healthcare, education, water, and sanitation (Tanveer & Manan, 2016). It thus plays a dual role in stimulating economic growth and addressing unemployment challenges (Gregoire, 2012). Globally, infrastructure investment is recognized as an engine of growth, yet its impact varies across contexts. In Pakistan, persistent deficits in power generation, transport, and communication have constrained industrial productivity and employment creation. The World Bank (2007) noted that the country faces a severe energy shortfall of nearly 5,000 megawatts, alongside deteriorating roads and rail networks. These gaps not only increase production costs but also restrict the ability of firms to expand and generate jobs. While successive governments have invested in infrastructure, fiscal constraints and rising global prices have limited sustained

improvements.

Existing studies on Pakistan have primarily focused on infrastructure's contribution to GDP growth (e.g., Natashamanan, 2016; Sajjad Ahmad, 2012), with little attention to its direct effect on employment. Moreover, past research has relied on narrow proxies such as electricity consumption or paved roads, overlooking broader measures of infrastructure. This study addresses this gap by constructing a composite index of infrastructure based on six indicators: total road length, rail lines, air transport, electricity generation, local telephone lines, and mobile subscriptions. In addition, it incorporates macroeconomic controls including foreign direct investment (FDI), GDP, gross fixed capital formation (GFCF), per capita household expenditure (PCHE), wages, inflation, and trade openness, thereby offering a comprehensive perspective.

The study makes three key contributions. First, it extends the literature by examining the employment effects of infrastructure investment in a developing country context where such evidence is scarce. Second, by constructing an infrastructure index, it provides a more robust measure of infrastructure than single indicators. Third, the inclusion of control variables allows for a deeper understanding of the interplay between infrastructure and other macroeconomic factors influencing employment.

Accordingly, the study tests the hypothesis that infrastructure investment significantly affects employment in Pakistan. The findings are expected to provide valuable insights for policymakers, researchers, and investors. For policymakers, the results can inform infrastructure planning to maximize job creation. For researchers, the study offers a framework for analyzing employment effects in similar developing economies. For investors, it highlights the potential social and economic returns of infrastructure investment in Pakistan.

2. Literature Review

Infrastructure development has long been recognized as a key determinant of economic growth and employment creation, particularly in developing countries. Investment in transport, energy, and communication networks reduces production costs, enhances competitiveness, and generates direct and indirect employment opportunities (Natasha, 2016).

International evidence supports this linkage. Watzinger (2017), studying Germany, found that infrastructure investment in energy, schools, and telecommunications reduced unemployment using an ARDL approach. Similarly, Gareis (2013) demonstrated that infrastructure investment in France contributed positively to employment both directly and indirectly. In the United States, Michaels (2007) showed that highway construction significantly improved employment prospects, while Donaldson (2008) found that railroads in India boosted production and job creation.

Evidence from developing countries is equally compelling. Corong (2012) showed that infrastructure investment in the Philippines stimulated growth and employment, while Chitiga (2009) found that transport infrastructure in Tanzania enhanced income and reduced poverty. In South Asia, Dash (2011) reported a positive effect of infrastructure on growth across several economies. For Latin America, Calderon (2003) identified transport, telecommunications, and energy infrastructure as major contributors to per capita income growth.

Pakistan-specific studies also confirm these relationships. Manan (2016) found that infrastructure investment in electricity, telecommunications, and health significantly boosted economic growth. Ramzan (2015) showed that infrastructure reduced poverty by improving both physical and social facilities. Ali and Ramay (2014) linked infrastructure to higher productivity and output, while Faridi et al. (2011) confirmed that transport and telecommunications infrastructure had a strong impact on growth. Chani (2012) further demonstrated that energy, transport, and communication infrastructure positively influenced economic development using a composite infrastructure index.

Across these studies, a consistent finding emerges: infrastructure plays a vital role in fostering growth, productivity, and employment. However, most prior research in Pakistan has focused on output or poverty reduction, with limited attention to the direct effect of infrastructure investment on employment. Moreover, many studies use narrow proxies such as electricity consumption or road length rather than comprehensive infrastructure indices. This study contributes by addressing these

gaps, using a multidimensional infrastructure index and explicitly testing its impact on employment in Pakistan.

3. Materials and Methods

3.1 Data Source

The study employs annual time-series data for Pakistan spanning 1985–2015. The primary sources of data are the World Bank's World Development Indicators (WDI) and the State Bank of Pakistan. The WDI provides standardized and internationally comparable economic and social indicators, while the State Bank of Pakistan offers official macroeconomic statistics.

3.2 Variables

3.2.1. Employment: Employment is defined as the number of individuals engaged in economic activity under formal or informal arrangements. Data were obtained from the International Labour Organization (ILO).

3.2.2. Infrastructure: Infrastructure was measured through six physical indicators: (i) total road length, (ii) rail line length, (iii) air transport (freight in million ton-kilometers), (iv) electricity generation (million kilowatt-hours), (v) fixed telephone lines per 1,000 people, and (vi) mobile subscriptions per 1,000 people. A composite infrastructure index was constructed using Principal Component Analysis (PCA) to account for their combined effect.

3.2.3. Gross Fixed Capital Formation (GFCF): Represents investment in fixed assets, including construction, machinery, and equipment. Data were extracted from the WDI.

3.2.4. Per Capita Health Expenditure (PCHE): Captures per capita total health spending (public and private). Information was sourced from the WDI.

3.2.5. Trade Openness: Defined as the sum of exports and imports as a percentage of GDP.

3.2.6. Inflation: Measured by the annual growth rate of the GDP implicit deflator, reflecting overall price changes in the economy.

3.2.7. Gross Domestic Product (GDP): Refers to the total value of goods and services produced domestically, net of product taxes and subsidies.

3.2.8. Foreign Direct Investment (FDI): Includes net inflows of equity capital, reinvested earnings, and other capital flows.

3.2.9. Wages: Minimum wage rates were used as a proxy for wages

3.3 Econometric Specification

The relationship between infrastructure and employment was examined using the following model:

$$E_i = \beta_0 + \beta_1 INF_i + \beta_2 X_i + \varepsilon_i$$

Where

E=Employment

INF=Infrastructure Index

X=Group of control variables including (GFCF, PCHE, FDI, GDP, Wages, Inflation and Trade openness).

ε_i = Error term

3.4 Estimation Technique

All econometric analyses were carried out in *EViews*. The Augmented Dickey-Fuller (ADF) unit root test was applied to examine the stationarity properties of the series. Correlation analysis was conducted to explore the association among variables. The Johansen co-integration test was then used to assess the existence of long-run relationships. Finally, regression analysis was employed to evaluate the effect of infrastructure and control variables on employment.

4. Empirical Analysis

4.1. Descriptive Statistics

The descriptive results reveal substantial variation across the selected variables during 1985–2015. Employment averages 36.77 million, ranging from 3.84 to 64.76, with moderate dispersion, while the infrastructure index fluctuates between –2.47 and 3.92, reflecting uneven progress in infrastructure development. GDP growth records a mean of 4.7 percent, consistent with Pakistan’s historically volatile growth patterns, whereas FDI remains low at an average of 3.1 percent of GDP with limited variability. Health expenditure per capita and wages both show wide dispersion, indicating gradual improvements alongside sharp inter-year differences. Inflation, averaging 9.7 percent, highlights persistent price instability, while gross fixed capital formation demonstrates periods of negative investment shocks. Trade openness exhibits extreme volatility, with very high skewness and kurtosis, capturing fluctuations in external trade dynamics and policy changes. Collectively, these patterns underscore the importance of applying robust econometric methods to investigate the relationship between infrastructure investment and employment.

Variables	Mean	Max	Min	St. Dev.	Skew.	Kurtosis	Obs.
Employment	36.77	64.76	3.84	11.15	0.85	5.16	31
Infrastructure index	0.59	3.92	-2.47	1.34	-0.22	3.40	31
FDI	0.031	0.107	-0.038	0.036	0.197	2.51	31
GDP	4.70	9.00	0.36	1.99	0.21	2.90	31
PCHE	230.54	931.40	44.43	207.46	1.77	5.90	31
Wages	126.21	548.37	0.03	139.44	1.11	3.77	31
Inflation	9.69	24.89	2.46	5.44	1.14	3.70	31
GFCF	3.02	19.90	-7.70	6.40	0.42	3.23	31
Trade openness	31120.6	830601	-79466.	154028.9	4.7544	25.05	31

Table: 4.1 Descriptive Statistics

4.2. Correlation Analysis

The correlation analysis shows mixed relationships between employment (EMP) and the explanatory variables. **FDI (-0.418)** and **GFCF (-0.104)** are negatively correlated with employment, suggesting that higher levels of foreign direct investment and gross fixed capital formation are associated with lower employment levels. In contrast, **GDP (0.135)**, **Index of infrastructure (0.305)**, **Inflation (0.236)**, **Wages (0.062)**, **Trade openness (0.044)**, and **PCHE (0.049)** exhibit positive associations with employment, although most are weak in magnitude.

Among all variables, **PCHE (0.516 with INDEX)** and **Wages (0.600 with Trade openness)** demonstrate relatively stronger correlations with other explanatory factors, raising the possibility of multicollinearity in regression analysis. Since none of the correlation coefficients exceed the critical

threshold of 0.75, severe multicollinearity is not evident, though caution is advised when interpreting regression estimates.

Variables	EMP	FDI	GDP	GFCF	INDEX	INF	WAGES	Trade Openness	PCHE
EMP	1.000								
FDI	– 0.418	1.000							
GDP	0.135	– 0.086	1.000						
GFCF	– 0.104	0.118	0.479	1.000					
INDEX	0.305	0.152	– 0.090	– 0.105	1.000				
INF	0.236	– 0.137	– 0.298	– 0.112	0.102	1.000			
WAGES	0.062	– 0.460	– 0.061	– 0.060	0.020	0.045	1.000		
Trade Open.	0.044	– 0.157	– 0.048	0.006	0.228	0.167	0.600	1.000	
PCHE	0.049	0.475	– 0.285	– 0.037	0.516	– 0.000	–0.570	0.129	1.000

Table: 4.2 Correlation Matrix

4.3. Unit Root Test

Prior to regression analysis, the time series properties of the data were examined using the Augmented Dickey-Fuller (ADF) test to ensure stationarity. A series is considered stationary if the null hypothesis of a unit root is rejected at the 5% significance level. The results presented in Table 4.2 indicate that most variables, including employment, FDI, GDP, gross fixed capital formation (GFCF), infrastructure index, trade openness, and inflation, are stationary at their level form. However, wages and per capita health expenditure (PCHE) were found to be non-stationary at level but achieved stationarity after first differencing.

This outcome suggests that the dataset is a combination of I(0) and I(1) variables, making it suitable for co-integration analysis to examine the long-run equilibrium relationships among the selected variables.

Series	Level		First difference	
	F-statistics	Prob(F-statistics)	F-statistics	Prob(F-statistics)
Employment	39.05513,	(0.0001)		
FDI	8.615489	(0.0013)		
GDP	15.85741	(0.0004)		
GFCF	14.86116	(0.0006)		
Infrastructure	7.599630	(0.010)		
Trade Openness	19.10858	(0.0001)		
Wages			60.9469	(0.0000)
PCHE			69.64735	(0.0000)
Inflation	25.53427	(0.0002)		

Table: 4 .3 Augmented Dickey Fuller Unit Root Test

4.4 Johnson Co -Integration

The long-run relationship among the explanatory variables was examined using the Johansen co-integration test. This approach helps to determine whether the variables are co-integrated, that is, whether they share a common equilibrium relationship over time. The existence of co-integration is confirmed when the test statistics are significant at the chosen probability level, indicating that the variables move together in the long run despite short-term fluctuations.

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.998120	454.5978	197.3709	0.0001
At most 1 *	0.976680	272.5847	159.5297	0.0000
At most 2 *	0.864472	163.5901	125.6154	0.0000
At most 3 *	0.792104	105.6315	95.75366	0.0088
At most 4	0.604156	60.08075	69.81889	0.0329
At most 5	0.437475	33.20544	47.85613	0.0455
At most 6	0.296922	16.52115	29.79707	0.00751
At most 7	0.176586	6.304827	15.49471	0.0595
At most 8	0.022846	0.670232	3.841466	0.0430

Table 4.4 Johnson co integration

4.5.OLS Regression Analysis

The regression results show that most explanatory variables are statistically significant at the 5% level. INDEX, GDP, Inflation, and PCHE exhibit a positive and significant relationship with employment, while FDI and GFCF are negatively associated, suggesting they reduce employment growth. Wages and trade openness are weakly significant, with positive but marginal effects.

The overall model fit is strong, with an R-squared of 0.71, indicating that about 71% of the variation in employment is explained by the included variables. The significant F-statistic ($p < 0.01$) confirms the joint explanatory power of the model.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C (Constant)	25.83421	12.34314	2.0930	0.0481
INDEX	2.353101	1.897738	1.9699	0.0281
FDI	-1.532530	6.897390	2.5166	0.0196
GDP	1.696131	1.301593	1.9831	0.0060
GFCF	-0.218150	0.341601	2.6386	0.0297
INF (Inflation)	0.473899	0.377833	2.2543	0.0229
Wages	0.000575	0.025324	2.0227	0.0521
Trade Openness	0.00000719	0.0000163	1.9703	0.0540
PCHE	0.011531	0.016972	2.6794	0.0040

Model Summary

- R-squared = **0.7122**
- Adjusted R-squared = **0.6185**
- F-statistic = **9.9288**
- Prob(F-statistic) = **0.0**

Table 4.5 OLS Regression Analysis

5. Discussion

The empirical results of this study provide strong evidence that infrastructure development is an important determinant of employment generation in Pakistan. The unit root and co-integration tests

revealed that employment, infrastructure, and selected macroeconomic variables share a long-run equilibrium relationship. This implies that fluctuations in employment cannot be understood in isolation but are inherently linked to infrastructure and the broader economic environment. The co-integration findings support the argument that sustained investment in infrastructure projects creates lasting impacts on employment opportunities, both directly through construction activities and indirectly through spillover effects in related sectors.

The correlation analysis highlighted both positive and negative associations among the variables. Employment was found to be positively correlated with GDP, inflation, and private consumption expenditure (PCHE), indicating that domestic demand and economic expansion provide favorable conditions for job creation. However, the negative correlations with foreign direct investment (FDI) and gross fixed capital formation (GFCF) suggest that investment inflows and capital accumulation in Pakistan have not translated into broad-based employment opportunities. This outcome is likely due to the dominance of capital-intensive projects that rely more on technology and machinery than labor, reducing the scope for local job creation. These findings are in line with earlier studies, such as Khan and Kim (1999) and Malik et al. (2010), which emphasized that the employment effects of FDI in Pakistan have been limited due to weak linkages with domestic industries.

The OLS regression results provide more robust evidence of these relationships. The infrastructure index showed a positive and statistically significant impact on employment, confirming that transport, energy, and communication investments stimulate labor demand. This result supports the theoretical arguments of Aschauer (1989), who linked infrastructure spending to productivity and job creation, and the empirical findings of Sahoo and Dash (2012) for South Asian economies. In Pakistan, large-scale infrastructure projects, such as energy generation and road networks, not only provide direct employment during their implementation but also generate indirect opportunities through enhanced connectivity and reduced transaction costs for businesses.

Control variables further enriched the analysis by showing mixed but significant effects on employment. GDP had a positive and significant impact, reaffirming the long-standing relationship between economic growth and labor market expansion, consistent with Okun's law. Inflation also showed a positive relationship with employment, which may be attributed to demand-pull inflation, where rising prices are driven by stronger demand and production, thereby stimulating labor absorption. This result resonates with Hussain (2005), who noted that moderate inflation in Pakistan's context often coincides with higher economic activity. Similarly, PCHE displayed a positive effect, suggesting that household consumption stimulates production and creates new jobs in consumer-driven industries. Conversely, the negative and significant effects of FDI and GFCF point to structural weaknesses in Pakistan's investment climate, where capital accumulation does not necessarily translate into labor-intensive production. Finally, trade openness demonstrated a significant relationship with employment, reflecting the dual role of globalization in both expanding market opportunities and exposing domestic industries to competitive pressures.

Overall, the findings underscore the central role of infrastructure in generating employment while highlighting the importance of complementary macroeconomic policies. Infrastructure projects clearly contribute to job creation, but their long-term benefits can only be maximized if investment flows and capital formation are directed toward labor-intensive sectors. The results also suggest that Pakistan must focus on strengthening the domestic absorption capacity of FDI, aligning capital formation with employment objectives, and improving competitiveness under trade liberalization. In this way, infrastructure development, when combined with supportive macroeconomic strategies, can become a powerful tool for promoting inclusive and sustainable employment growth.

6. Conclusion

This study developed an integrated model to examine the relationship between infrastructure development and employment in Pakistan using annual data from 1985 to 2015. Infrastructure was measured through a composite index constructed via the principal component method, incorporating six indicators: total road length, rail route kilometers, air transport freight, electricity generation, local

telephone lines, and mobile phone subscriptions. The analysis also included key macroeconomic factors—FDI, GDP, GFCF, per capita health expenditure (PCHE), inflation, wages, and trade openness—as control variables.

The results confirm that infrastructure investment plays a crucial role in enhancing employment opportunities, as an expansion in infrastructure projects directly contributes to job creation. Among the control variables, GDP, inflation, and PCHE exhibit positive and significant effects on employment, suggesting that economic growth, rising price levels, and social spending improve labor market absorption. In contrast, FDI and GFCF show negative but significant relationships with employment, which may reflect the capital-intensive nature of investments and the unfavorable investment climate that limits labor absorption. Trade openness was also found to exert a significant impact, indicating that integration with global markets can influence domestic employment dynamics. Overall, the findings highlight that both infrastructure and macroeconomic variables significantly determine employment trends in Pakistan. The evidence underscores the need for policymakers to prioritize infrastructure investment while designing strategies to attract labor-intensive FDI, improve the investment climate, and strengthen the role of social expenditures to foster inclusive and sustainable employment growth.

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