RAIL FREIGHT GROWTH IN EMERGING ECONOMIES: EVIDENCE FROM INDIA AND CHINA

Boby Thomas [1]

KEY WORDS

Rail freight transport, Economic growth, GDP,

India, China, Emerging economies.

ABSTRACT

This study analyzes the relationship between rail freight transport and economic growth in India and China from 1995 to 2021 using World Bank data, employing descriptive statistics, trend analysis, Spearman's rank correlation, and regression to evaluate their performance. Results demonstrate a strong positive correlation between rail freight and GDP in both nations—more pronounced in India (ρ=0.979) than in China (ρ=0.880)—reflecting India's continued reliance on freight-intensive growth versus China's structural transition toward less freight-intensive sectors. While both countries experienced long-term expansion, regression analysis reveals an absence of a sustained secular trend, indicating that growth has instead been driven by cyclical fluctuations; notably, India exhibited higher average growth and lower volatility, whereas China displayed greater variability and a prolonged contraction between 2012 and 2015. Ultimately, the findings suggest that rail freight trajectories in these emerging economies are shaped primarily by periodic macroeconomic and structural disturbances rather than consistent acceleration, providing critical insights for

[1] Dr. Boby Thomas, Assistant Professor of Commerce, Pavanatma College, Kerala

future infrastructure planning and transport policy.

1. Introduction

Rail freight transport plays a crucial role in supporting economic activity by facilitating the movement of raw materials, intermediate goods, and finished products across regions. As one of the most cost-effective modes of land transportation for bulk commodities, railways contribute significantly to industrial development, trade expansion, and regional integration. Consequently, the growth of rail freight transport is often closely associated with economic growth, particularly in large emerging economies.

India and China have experienced remarkable economic expansion during the last three decades and possess two of the world's largest railway systems. However, the growth trajectories of their rail freight sectors have differed considerably. China has emerged as a global manufacturing hub supported by extensive investments in transport infrastructure, while India has witnessed more gradual freight growth despite sustained economic expansion. These contrasting experiences offer an opportunity to examine how rail freight transport has evolved alongside economic growth in both economies.

Previous studies have highlighted the importance of railway infrastructure, operational efficiency, logistics integration, and market competitiveness in improving freight transport performance (Lu and Li, 2022; Love et al., 2018; Jaržemskis and Jaržemskienė, 2017). However, limited research has directly compared the long-term relationship between rail freight transport and economic growth in India and China. Such a comparison is important for understanding whether freight demand continues to grow in proportion to economic output and whether the nature of economic growth influences freight transport patterns.

Against this background, the present study compares the growth of rail freight transport in India and China during 1995–2021 using data from the World Bank. The analysis examines trends in rail freight transport and Gross Domestic Product (GDP), evaluates their growth patterns through descriptive statistics, and investigates the extent to which freight transport has evolved alongside GDP in the two economies.

2. Data and Methodology

2.1 Data Source

The study is based on secondary data obtained from the World Bank database. Data on railways, goods transported (ton-kilometres), and Gross Domestic Product (GDP) for India and China covering the period 1995–2021 were collected from the World Development Indicators database. GDP is measured at constant 2015 prices and expressed in United States dollars, thereby eliminating the effects of inflation and facilitating inter-temporal comparisons (World Bank, 2026).

2.2 Methodology

The study employs descriptive and comparative analytical techniques to examine rail freight growth in India and China. Line graphs are used to analyse long-term trends in rail freight transport and GDP. Descriptive statistics, including mean, median, standard deviation, and coefficient of variation, are used to assess the characteristics and variability of the data. Growth patterns are further examined through growth-rate analysis. In addition, Spearman's rank correlation is used to assess the relationship between rail freight transport and economic growth in the two countries.

3. Literature Review

3.1 Rail Freight Growth and Competitiveness

Utilising spare network capacity for parcel transportation, High-Speed

Rail Express Delivery offers a highly effective freight solution. A case study of China's HSR network found that the existing capacity was sufficient to meet current demand; however, projected growth in freight volumes may create future bottlenecks. Therefore, the authors emphasized the importance of proactive strategic planning and robust capacity management to ensure the long-term sustainability of high-speed rail freight services (Bi, He, & Xu, 2019). An analysis of Poland's rail cargo sector (2010–2021) aligns national strategy with the EU's White Paper on Transport, which mandates shifting road freight over 300 kilometres to rail or water to cut emissions by 60%. Market liberalisation doubled the number of active freight carriers over a decade; while state-owned PKP Cargo leads, private operators successfully capture niche markets with competitive pricing and superior service. However, despite modernising operational shifts and a massive fourfold increase in intermodal and containerised transport, the sector remains structurally dependent, as traditional bulk commodities such as hard coal and lignite still dominate total tonnage (Macioszek, 2023). A decade-long analysis (2009–2019) of Polish transport highlights road transport's dominance, commanding over 64% of passenger journeys and 84% of freight. Paradoxically, despite a 10.2% expansion of the road network, road passenger volumes plummeted by 47.3%, while road freight volumes surged by 52.1% due to mining and fossil fuel transit. Rail remained the secondary pillar, handling 34% of passenger traffic and 15% of freight, with over half of that freight being fossil fuels. However, the rail sector contracted systemically, losing 4.5% of total track length and 20.3% of available rolling stock. Ultimately, rail's competitive disadvantage stems from uneven infrastructure distribution, historically neglected track conditions, and prohibitive pricing for smaller cargo loads (Macioszek 2021).

An assessment of the North Caucasian Railway highlights its competitive vulnerability: despite rising traffic volumes, highly profitable cargo is frequently diverted to rival modes of transport. To recapture market share, the authors propose a targeted modernisation strategy prioritising customer-centric service improvements, scheduled freight traffic, and integrated logistics. Crucially, digitising client interactions through the "Freight transportation" electronic trading platform, streamlined electronic document management, and the "Complex of Transport Services for Business" portal is essential for enhancing accessibility and operational efficiency. Ultimately, integrating comprehensive quality management with a robust digital ecosystem is the most effective pathway to retaining cargo owners and securing the railway's competitive edge (Zubkov et al., 2022). Intermodal rail freight transport faces significant challenges in global and European markets that necessitate a strategic evolution in infrastructure, rolling stock, and operational mobility. Research by Licciardello and Ricci (2022) highlights that while current modal shares remain constrained, the integration of automation, digitalization, advanced environmental noise management, and operational optimization is critical for improving competitiveness and sustainability. By addressing these technical and structural requirements, the sector can better align with the evolving demands of global logistics, ultimately establishing a more efficient and resilient framework for future transportation (Licciardello and Ricci, 2022).

The rail freight markets of Lithuania and Poland are combined to examine structural differences and intermodal competition in the context of Rail Baltica integration. Using descriptive statistical and comparative analyses, it evaluates freight distribution, commodity-specific modal shares, traffic flows, and market concentration. The findings reveal that Lithuania relies

heavily on rail for transporting oil and chemical fertilisers through a centralised, transit-oriented railway system, whereas Poland has a decentralised, competitive market in which road transport dominates similar freight segments. The study concludes that understanding differences in market structure, infrastructure pricing, and traffic patterns is essential for successful cross-border rail integration and improved freight transport efficiency (Jaržemskis and Jaržemskienė, 2017).

3.2 Railway Infrastructure and Economic Growth

A multi-period difference-in-differences (DID) model examines the impact of high-speed rail (HSR) development on enterprise capacity utilisation (CU) among China's listed companies, from both production and consumption perspectives. Empirical findings demonstrate that HSR opening significantly improves overall capacity utilisation, with a more pronounced positive effect on the supply side (labour quality, financing scale, and innovation) than the demand side (consumption, investment, and exports). Furthermore, these benefits are stronger for labour-intensive, non-state-owned firms in eastern regions located closer to high-grade HSR stations, highlighting transportation infrastructure's critical role in mitigating regional market segmentation and reducing overcapacity (Lu and Li, 2022). China’s "Great Western Development" initiative strategically constructs an extensive railway and highway network to connect its historically isolated, landlocked western provinces with oceanic ports. This infrastructure overcomes rugged terrain and massive distances from maritime trade, narrowing the economic gap with the prosperous eastern seaboard. Beyond domestic growth, these overland routes serve a profound geopolitical purpose. By transforming into physical conduits for trade and forging deep economic interdependencies, this modern network enables China to systematically project its strategic

presence, expand its influence, and cement its regional dominance across Central, South, and Southwest Asia (Garver, 2006).

The study investigates the importance of effective asset information management for improving the long-term performance of rail infrastructure. Using a case study of the electrical systems at Bayswater railway station in Western Australia, it identifies inaccuracies, omissions, and redundancies in conventional paper- and CAD-based documentation. To overcome these limitations, the study proposes Digital Asset Management (DAM) supported by a Systems Information Model (SIM). The findings show that the object-oriented SIM approach enhances data accuracy, simplifies the transfer of engineering information to asset management systems, and improves infrastructure maintenance, operational efficiency, and lifecycle cost management (Love et al., 2018).

The reviewed literature demonstrates that rail freight performance is influenced not merely by the size of the railway network but by factors such as infrastructure modernisation, capacity utilisation, operational efficiency, digital integration, market competitiveness, and the ability to align transport systems with economic growth. Studies on China highlight the role of sustained infrastructure investment, network expansion, capacity optimisation, and strategic integration of freight services in supporting rapid freight growth and economic development. In contrast, evidence from other railway systems suggests that inefficiencies can persist despite extensive network coverage when capacity utilisation, service quality, and operational competitiveness are inadequate. However, relatively little research has directly compared the freight transport performance of major emerging economies with large railway networks. This creates a need to examine why India, despite possessing one of the world's largest railway networks, exhibits substantially lower freight

transport efficiency than China and the Russian Federation, and to identify the infrastructural, operational, and economic factors responsible for these differences.

4. Data Analysis

4.1 Overview of the Dataset

The research questions are addressed using data from the World Bank on Railroads*, goods transported (million ton-km),* and *GDP* for India and China during the period 1995–2021 (World Bank, 2026).

4.2 Descriptive Statistics

The descriptive statistics reveal that China maintained substantially higher levels of both rail freight transport and economic output than India throughout the study period. While freight transport remained relatively stable in both countries, GDP exhibited considerably greater variability, particularly in China. The coefficient of variation indicates that freight transport expanded more steadily than economic output, suggesting that economic growth increasingly relied on factors beyond the physical movement of goods. These findings provide preliminary evidence that the relationship between freight transport and economic growth may have weakened over time, especially in China. Table 1 shows the summary statistics.

Table 1

Summary Statistics, using the observations 1995 - 2021

Variable	Mean	Median	SD	CV
India Freight	49.904	52.137	17.233	0.34534
India GDP	148.70	131.24	71.068	0.47794

China Freight	215.56	237.54	64.036	0.29708
China GDP	733.90	637.35	457.67	0.62361

NB: missing values were skipped

The median value of freight carried by Indian Railway (52.1 billion ton-km) is slightly higher than the mean, suggesting a mild concentration of lower freight values in the earlier years and higher values in later years. The standard deviation of 17.23 indicates moderate variation in freight transport over time. The coefficient of variation (CV) of 34.5% indicates that freight transport remained relatively stable relative to GDP. India experienced a gradual and consistent increase in rail freight movements, reflecting steady growth in industrial production, trade, and freight demand.

The mean of India's GDP exceeds the median only slightly, indicating a generally upward trend in economic growth. The standard deviation **(**71.07**)** is considerably larger than that of freight transport. The CV of 47.8% indicates that GDP exhibited greater variability than freight movement. Economic growth in India accelerated significantly during the period, but freight transport expanded at a slower and more stable pace. This suggests that GDP growth was driven not only by freight-intensive sectors but also increasingly by services and knowledge-based industries.

In China, the median (237.5) exceeds the mean, indicating that lower Railway freight volumes in the early years reduce the overall average. The standard deviation of 64.0 reflects substantial fluctuations in freight transport. However, the CV of 29.7% is the lowest among all variables. Although China's freight volumes were very large, they were relatively stable compared with its scale. This indicates a highly developed and

efficient freight transport system supporting industrial and export activities.

The difference between China's mean and median GDP reflects rapid economic expansion over the study period. The standard deviation (457.67) is very high, indicating strong growth dynamics. The CV of 62.4% is the highest among all variables. China experienced the most rapid economic transformation among the variables studied. GDP expanded dramatically, particularly after 2000, leading to substantial year-to-year variability.

Table 2 presents the descriptive statistics of rail freight transport and GDP for India and China during the study period.

Table. 2

Comparative Variability of Rail Freight Transport and GDP

Country	Freight CV	GDP CV
India	34.5%	47.8%
China	29.7%	62.4%

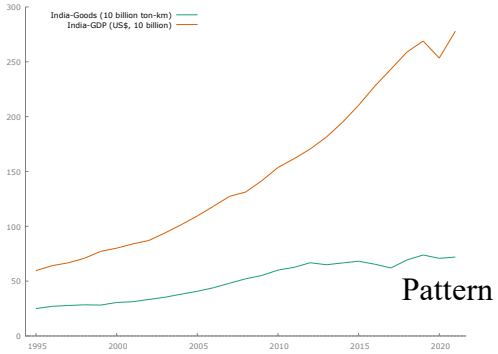
A notable observation is that GDP fluctuated more than freight transport in both countries. This suggests that economic growth occurred faster than rail freight transport expanded. The finding points to improvements in freight efficiency, structural changes in the economy, and increased contributions of the service and technology sectors to GDP.

4.3 Comparative Growth Patterns of Rail Freight and GDP

While China maintained a substantial lead in absolute economic output and exhibited a steeper growth trajectory than India over the analysed period, the relationship between Gross Domestic Product (GDP) and rail

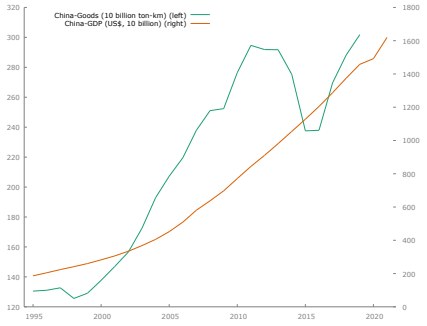
freight transport reveals distinct decoupling patterns between the two economies. Figure 1 and 2 shows the pattern.

Figure 1



Pattern of Growth- India

Figure 2



Pattern of Growth- China

In India, rail freight demand demonstrated a highly synchronised, positive elasticity relative to macroeconomic expansion. Except for a transitory, pandemic-induced contraction in 2020, India's rail freight volume grew by approximately 188% overall, evolving through three distinct macro-phases:

- **Moderate Growth Phase (1995–2003):** Characterised by steady, incremental expansion in line with baseline industrial output.
- **Rapid Expansion Phase (2004–2012):** Marked by intensive infrastructural and industrial scaling, wherein freight volumes nearly doubled, surging from 38.12 to 66.76 billion ton-kilometres.
- **Volatility and Resilience (2013–2021):** This period saw minor cyclical contractions in 2013, 2016, and 2017, followed by a robust structural recovery post-2018. The exogenous shock of the COVID-19 pandemic caused a sharp decline in 2020, which was swiftly mitigated by a V-shaped recovery in 2021.

China's rail freight trajectory yielded a lower net increase (~131%) relative to its explosive GDP growth, signalling a profound structural shift and a distinct decoupling of transport demand from aggregate economic output after 2012.

- **Stable Growth (1995–2002):** Freight volumes grew moderately from 130 to 157 billion ton-kilometres, reflecting the initial phases of market liberalisation.
- **Rapid Industrial Expansion (2003–2011):** Driven by heavy manufacturing, urbanisation, and infrastructure investment, freight volumes surged from 172 to 295 billion ton-kilometres.
- **The 2012 Inflexion Point and Structural Plateau (2012–2013):** Freight volumes stagnated around 292 billion ton-kilometres, marking the end of investment-led growth.
- **The Divergence Phase (2014–2016):** Despite uninterrupted and rapid GDP growth, rail freight experienced absolute declines. This divergence underscores a fundamental macroeconomic transition: China's growth engine pivoted away from freight-intensive heavy industries toward services, high-tech sectors, and domestic consumption.
- **Cyclical Recovery (2017–2019):** Freight volumes rebounded to 302 billion ton-kilometres, driven by logistical optimisations and targeted industrial corrections prior to global supply chain disruptions.

The comparative data demonstrate that while India remains in a growth phase in which physical freight infrastructure is closely tied to macroeconomic velocity, China has successfully transitioned to a post-industrial growth paradigm. In China, GDP expansion is increasingly driven by high-value-added, low-weight economic activities, effectively

severing the historical dependency between aggregate economic growth and raw freight volume.

4.4 Correlation Analysis of Rail Freight Transport and GDP

The results of the Spearman's rank correlation analysis indicate a strong, statistically significant positive relationship between rail freight transport and GDP in both economies. India records a correlation coefficient of $\rho = 0.979$, suggesting that freight transport growth closely mirrors economic growth. China also demonstrates a strong positive association ($\rho = 0.880$), although the relationship is comparatively weaker. The table showing the correlation analysis between Goods transported (10 billion ton-km) and GDP (constant 2015 US$, 10 billion) is given in Table 3.

Table 3

Spearman Correlation between Rail Freight Transport and GDP

Variables	Spearman's rho	t	p-value
India	0.979	24.16	0.00001
China	0.883	9.025	0.00001

Overall, the findings support the view that rail freight transport remains an important facilitator of economic activity in emerging economies. Rail freight transport is more closely associated with economic growth in India than in China. This finding supports the argument that India remains relatively more dependent on freight-intensive sectors (NITI Aayog, RMI, & RMI India, 2021), whereas China has undergone greater structural transformation toward less freight-dependent economic activities (Brühl, 2024).

4.4 Growth Rate Analysis

To evaluate the growth dynamics of rail freight in two major emerging economies, the annual logarithmic growth rates of rail freight volumes in India and China were analysed over the period 1996–2021. The logarithmic annual growth rate, referred to hereafter as the freight growth rate, measures the yearly percentage change in freight traffic and provides insights into the stability and sustainability of freight expansion.

India recorded an average annual freight growth rate of 4.07% during the study period, indicating moderate long-term expansion in rail freight transport. The median growth rate (5.71%) exceeded the mean, suggesting that a limited number of years with exceptionally weak or negative growth reduced the overall average. Freight growth varied between −5.38% and 11.09%, with a standard deviation of 4.52 percentage points and a coefficient of variation of 1.11, indicating considerable year-to-year fluctuations. Negative freight growth was observed in 1999, 2013, 2016, 2017, and 2020, corresponding to periods of economic slowdown, sectoral adjustments, and the disruption caused by the COVID-19 pandemic. The negative skewness (−0.68) further suggests that occasional sharp contractions exerted a greater influence than unusually high growth years. Although the estimated time trend from the OLS regression was negative (−0.183 percentage points per year), it was not statistically significant ($p = 0.146$). This indicates that India's freight growth did not follow a consistent long-term upward or downward trajectory but fluctuated around its long-run average, reflecting the influence of changing economic conditions, industrial demand, and other macroeconomic factors.

China exhibited a comparable pattern of moderate long-term freight growth, with an average annual growth rate of 3.49% and a median of 5.56%. Similar to India, the higher median relative to the mean indicates

that a few years of exceptionally poor performance lowered the average growth rate. However, China's freight growth was considerably more volatile, as reflected by a higher standard deviation of 6.14 percentage points and a coefficient of variation of 1.76. Annual growth ranged from a contraction of 14.75% to an expansion of 12.51%, demonstrating greater sensitivity to economic cycles, structural adjustments, and external shocks. Negative freight growth occurred in 1998 and consecutively from 2012 to 2015, highlighting a prolonged period of contraction compared with India's more intermittent declines. The stronger negative skewness (−1.14) indicates that severe contractionary episodes were more pronounced than unusually strong expansionary years. The estimated OLS trend coefficient was −0.077 percentage points per year, but this decline was statistically insignificant ($p = 0.695$), suggesting that China's freight growth also lacked a systematic long-term trend despite substantial annual fluctuations.

A comparison of the two countries reveals several common features. Both India and China experienced positive average freight growth over the study period, with median growth rates exceeding their respective means, indicating that negative shocks rather than persistent weak performance lowered average growth. In both cases, the regression analysis found no statistically significant long-term trend, implying that rail freight growth has been characterised by cyclical fluctuations rather than a sustained acceleration or deceleration. Nevertheless, important differences are evident. India achieved a slightly higher average growth rate and experienced relatively lower volatility, whereas China displayed greater variability and more pronounced negative growth episodes. However, the pattern of contractions differed. India's negative growth years (1999, 2013, 2016, 2017, and 2020) were intermittent, whereas China experienced an isolated contraction in 1998 followed by a prolonged sequence of negative

growth during 2012–2015. These findings suggest that while rail freight in both emerging economies has expanded over the long run, its growth trajectory has been shaped primarily by periodic macroeconomic and structural disturbances rather than by a stable secular trend.

5. Conclusion

This study examined the growth patterns of rail freight transport and their relationship with economic growth in India and China during the period 1995–2021, using data from the World Bank. The findings reveal substantial differences in the scale, dynamics, and structural trajectories of rail freight transport between the two countries.

Descriptive statistics indicate that China maintained significantly higher levels of both rail freight transport and GDP throughout the study period, reflecting its extensive industrial base and sustained investment in transport infrastructure. However, the coefficient of variation suggests that rail freight transport exhibited lower variability than GDP in both countries. This indicates that, while both nations experienced robust long-term growth, economic output expanded faster than freight movement.

This divergence between GDP and freight volume was particularly pronounced in China, where freight growth decelerated after 2012 despite continued economic expansion. In contrast, India displayed a more consistent, parallel pattern in which freight transport growth closely tracked the expansion of economic output.

The correlation analysis confirms a strong and statistically significant positive relationship between rail freight transport and GDP in both countries. However, the relationship is stronger in India (rho = 0.979) than in China (rho = 0.880). This suggests that economic growth in India remains closely tied to the physical movement of goods. Conversely, the

comparatively weaker relationship in China indicates that its economic growth has become less dependent on sheer freight transport volume over time. This shift aligns with China's gradual structural transition toward service-oriented, technology-intensive, and less freight-dependent economic activities, highlighting how changing macroeconomic structures alter traditional logistics linkages.

From a policy perspective, these results underscore that rail freight transport remains foundational to supporting economic development in emerging economies, though the nature of this support varies by country context:

- **For India:** Expanding physical freight capacity, improving logistics efficiency, and accelerating investments in dedicated freight corridors are essential structural imperatives to sustain future economic growth.
- **For China:** Policy focus should pivot toward optimising freight efficiency, network quality, and logistics integration rather than simply expanding raw volumetric capacities.

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