ANALYZING THE INTERNATIONAL STEEL MARKET AND GLOBAL INDUSTRIAL DEMAND

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ABSTRACT: *This study examines the relationship between global macroeconomic factors and international steel demand over the period 1995–2024. In the context of increasing globalization and structural transformation, understanding the drivers of steel demand is critical for both industrial planning and policy design.Using a time-series econometric approach based on data from international sources, the study analyzes how industrial production, economic growth, investment, and urbanization are associated with steel consumption. The findings indicate that steel demand is primarily linked to industrial activity and long-term structural changes, with industrial production and urbanization emerging as the most influential factors. Economic growth and investment also play important supporting roles.The results highlight that emerging regions such as Central Asia, particularly Uzbekistan, are likely to experience continued growth in steel demand driven by infrastructure expansion and urbanization. However, limited domestic production capacity and reliance on imports increase vulnerability to external shocks.The study underscores the importance of strengthening domestic production, improving efficiency, and advancing toward sustainable and low-carbon steel technologies. Overall, the findings provide policy-relevant insights for managing steel demand in the context of economic development, globalization, and environmental transition.*

1. Introduction

The international steel market represents one of the most strategically significant sectors in the global economy, as steel remains a fundamental input for key industries such as construction, automotive manufacturing, energy, and infrastructure development. Steel accounts for nearly 95% of total metal

consumption worldwide, making it a crucial indicator of industrial activity and economic performance (World Steel Association, 2024). Global crude steel production has exceeded 1.8 billion tons in recent years, with Asia contributing more than 70% of total output and China alone accounting for over half of global production (World Steel Association, 2024; OECD, 2025). Previous studies have consistently highlighted the close relationship between steel demand and macroeconomic performance, particularly GDP growth and industrial output (Tilton, 1990; Labson, 1997). However, the global steel market continues to face structural challenges, including excess capacity, price volatility, trade distortions, and increasing environmental pressures linked to carbon emissions (OECD, 2025; Humphreys, 2010). These factors have significantly reshaped global supply-demand dynamics and intensified competition in international markets.

In developing economies, steel demand is primarily driven by rapid urbanization, industrialization, and large-scale infrastructure development. Empirical studies suggest that steel consumption tends to grow at a faster rate than GDP during early stages of economic development, reflecting the expansion of construction and manufacturing sectors (Cheng et al., 2019; Crompton, 2000). Countries such as India, Vietnam, and several African economies have demonstrated strong growth in steel demand due to increased investment in infrastructure and industrial capacity (Atradius, 2025). The construction sector alone accounts for approximately 50% of global steel consumption, highlighting its dominant role in shaping demand patterns (World Steel Association, 2024). Additionally, foreign direct investment (FDI) and government-led development programs further stimulate steel demand (EUROFER, 2025). Nevertheless, developing countries face structural challenges, including limited technological capabilities, reliance on imported raw materials, and vulnerability to global price fluctuations, which can constrain sustainable growth (Humphreys, 2010; OECD, 2025).

In the context of Central Asia, particularly Uzbekistan, the steel market remains relatively underdeveloped but exhibits significant growth potential. The region has experienced increasing demand for steel due to economic reforms,

industrial diversification, and infrastructure expansion. Uzbekistan, in particular, has implemented policies aimed at accelerating industrial growth and modernizing infrastructure, which has led to a rise in domestic steel consumption. However, local production capacity remains insufficient to fully meet demand, resulting in continued dependence on imports. Existing literature on transition economies suggests that integration into global value chains and improvements in industrial productivity are critical for enhancing competitiveness in resource-based industries (Radetzki, 2006; OECD, 2025). Despite these developments, empirical studies focusing specifically on Central Asia's steel market remain limited, indicating the need for further research in this area.

Despite the extensive body of literature on the global steel market, a significant research gap persists in understanding the interaction between global industrial demand and regional steel market development, particularly in emerging regions such as Central Asia. While previous studies have examined global demand patterns and macroeconomic determinants of steel consumption (Tilton, 1990; Labson, 1997; Cheng et al., 2019), relatively few have applied econometric models to analyze these relationships at the regional level. Furthermore, most research focuses on developed economies or major producers such as China, leaving smaller and transition economies underexplored. Therefore, the main objective of this study is to analyze the dynamics of the international steel market and examine its relationship with global industrial demand using an econometric framework. Specifically, the study aims to identify key demand drivers, assess regional disparities, and evaluate the impact of macroeconomic variables such as GDP, industrial production, and investment on steel demand. In addition, the study considers emerging challenges such as excess capacity, trade barriers, and environmental regulations, as well as new trends including green steel and decarbonization (OECD, 2025; World Steel Association, 2024).

The remainder of this paper is structured as follows. The next section presents a comprehensive literature review, synthesizing key findings from previous studies on the international steel market and industrial demand. This is followed by

the methodology section, which outlines the data sources, variable selection, and econometric model employed in the analysis. The subsequent section presents the empirical results and discusses the findings in relation to existing literature. Finally, the paper concludes with policy implications and recommendations aimed at improving the efficiency and sustainability of the steel sector at both global and regional levels.

2. Literature Review

The relationship between the international steel market and global industrial demand has been widely examined in academic literature, particularly within the context of economic growth and industrialization. Early studies by John E. Tilton (1990) established that demand for metals, including steel, follows long-term economic growth patterns, with consumption closely linked to GDP and industrial output. Similarly, Brian Labson (1997) emphasized the cyclical nature of metal demand, arguing that steel consumption is highly sensitive to business cycles and fluctuations in industrial production. These foundational studies suggest that steel demand is not only a function of economic growth but also reflects structural changes in industrial activity.

Subsequent research has expanded this perspective by incorporating the role of urbanization and infrastructure development as key drivers of steel demand. Peter Crompton (2000) demonstrated that developing economies experience disproportionately higher growth in steel consumption during early stages of industrialization, largely due to rapid expansion in construction and infrastructure sectors. More recent empirical studies, such as those by Cheng Ke et al. (2019), confirm that steel demand exhibits a strong positive relationship with GDP growth, industrial production, and investment levels, particularly in emerging markets. However, while these studies highlight the importance of demand-side factors, they often overlook supply-side constraints and market distortions.

In contrast, other scholars have focused on structural issues within the global steel market, particularly excess capacity and price dynamics. David Humphreys (2010) argued that global metal markets, including steel, are increasingly

influenced by supply-side imbalances, where overproduction leads to declining prices and reduced profitability. This perspective contrasts with earlier demand-driven models, suggesting that market dynamics cannot be fully understood without considering production capacity and trade distortions. Furthermore, recent studies on environmental sustainability emphasize the growing importance of decarbonization and technological innovation in shaping the future of the steel industry, indicating a shift from purely economic determinants toward environmental and policy-driven factors.

From a methodological perspective, previous studies employ a range of quantitative approaches to analyze steel demand. Early research primarily relied on descriptive and trend-based analysis (Tilton, 1990; Labson, 1997), while more recent studies utilize advanced econometric techniques, including time-series models, panel data analysis, and regression-based approaches (Cheng et al., 2019). These methods allow researchers to quantify the relationship between steel demand and key macroeconomic variables such as GDP, industrial production, and investment. However, despite the increasing use of econometric models, many studies focus on global aggregates or major economies, limiting their applicability to smaller or emerging regions.

Despite these contributions, several important gaps remain in the literature. First, the majority of studies concentrate on global markets or large steel-producing economies, with limited attention given to smaller and transition economies such as those in Central Asia. Second, while existing research identifies key determinants of steel demand, there is a lack of integrated analysis that simultaneously considers both global industrial demand and regional market development. Third, although econometric approaches have been widely used, few studies apply these methods to analyze steel demand in emerging regions where data availability and market structures differ significantly. Therefore, this study aims to address these gaps by providing an econometric analysis of the relationship between global industrial demand and steel consumption, with a particular focus on Central Asia. By doing so, it contributes to the literature by extending existing models to a less-studied regional

context and offering new insights into the dynamics of steel demand in emerging markets.

3. Methodology

3.1 Theoretical and Conceptual Framework

This study is grounded in the theory of derived demand, which suggests that the demand for intermediate goods such as steel is determined by the level of economic and industrial activity. According to classical and Keynesian economic frameworks, industrial output, infrastructure development, and capital formation are the primary drivers of demand for raw materials. Previous studies have consistently confirmed that steel demand is strongly correlated with macroeconomic indicators such as GDP growth and industrial production (Tilton, 1990; Labson, 1997).

Furthermore, modern empirical research emphasizes the role of investment and urbanization in shaping steel consumption patterns, particularly in developing economies (Cheng et al., 2019). Therefore, this study conceptualizes steel demand as a function of economic growth, industrial activity, and structural transformation, both at global and regional levels.

The study utilizes annual time-series data covering a 30-year period (1995–2024), which allows for robust long-term analysis of the relationship between steel demand and macroeconomic variables. The dataset is compiled from internationally recognized databases, including the World Steel Association, World Bank, IMF, and other statistical sources.

Dependent Variable:

- Steel Demand (SD) – measured as apparent steel consumption (million tons), widely used in previous empirical studies as a proxy for real market demand (Cheng et al., 2019).

Independent Variables:

- Gross Domestic Product (GDP) – indicator of economic growth

- Industrial Production Index (IPI) – proxy for industrial activity (Labson, 1997)

- Foreign Direct Investment (FDI) – reflects capital inflows and industrial expansion

- Gross Fixed Capital Formation (GFCF) – proxy for infrastructure and investment activity (Tilton, 1990)

- Urbanization Rate (URB) – captures structural transformation and construction demand (Crompton, 2000)

These variables are selected based on previous empirical studies, which identify them as key determinants of steel demand across different economies.

Econometric Model Specification

To estimate the relationship between steel demand and its determinants, this study employs a log-linear multiple regression model, which allows for interpretation of coefficients as elasticities and reduces heteroskedasticity.

The model is specified as follows:

$$lnSD_t=\beta_0+\beta_1 lnGDP_t+\beta_2 lnIPI_t+\beta_3 lnFDI_t+\beta_4 lnGFCF_t+\beta_5 lnURB_t+\varepsilon_t$$

Where:

- $lnSD_t$ – Log of steel demand
- $lnGDP_t$ – Log of GDP
- $lnIPI_t$ – Log of industrial production
- $lnFDI_t$ – Log of foreign direct investment
- $lnGFCF_t$– Log of capital formation
- $lnURB_t$– Log of urbanization rate
- β_0– Intercept
- $\beta_1 \ldots \beta_5$ – Elasticity coefficients
- ε_t – Error term

The use of a log-linear specification follows previous empirical studies (Cheng et al., 2019), which demonstrate that elasticities provide more meaningful interpretation in demand analysis.

Econometric Techniques and Estimation Procedure

To ensure robustness and reliability of results, the study follows a structured econometric procedure:

Step 1: Descriptive Analysis

Basic statistical measures are used to understand trends and distributions of variables.

Step 2: Stationarity Test

- Augmented Dickey-Fuller (ADF) test is applied to check unit roots
- Ensures variables are stationary before regression

Step 3: Cointegration Analysis

- Johansen cointegration test is used to examine long-run relationships between variables
- Determines whether a stable equilibrium relationship exists

Step 4: Model Estimation

- Ordinary Least Squares (OLS) is applied to estimate the regression model
- If cointegration exists, long-run relationships are interpreted

Step 5: Diagnostic Tests

To validate model assumptions:

- Multicollinearity: Variance Inflation Factor (VIF)
- Autocorrelation: Durbin-Watson test
- Heteroskedasticity: Breusch-Pagan / White test

This step-by-step approach ensures both statistical validity and economic reliability of the model.

Model Justification and Limitations

The log-linear regression model is appropriate as it allows for estimation of elasticities and reduces issues such as heteroskedasticity, which are common in macroeconomic data. Moreover, the inclusion of multiple explanatory variables enables a comprehensive analysis of the determinants of steel demand.

However, several limitations should be acknowledged. First, potential endogeneity issues may arise due to reverse causality between economic growth and

steel demand. Second, data limitations for specific regions such as Central Asia may affect the accuracy of results. Third, the model may suffer from omitted variable bias, as factors such as energy prices, technological change, and policy interventions are not explicitly included. Finally, external shocks such as global financial crises or pandemics may influence results but are difficult to fully capture within the model.

Despite these limitations, the methodology provides a robust framework for analyzing the relationship between the international steel market and global industrial demand.

4. RESULTS

4.1 Introduction to Results Analysis

This section presents the empirical findings on the relationship between international steel demand and global industrial activity over the period 1995–2024. The extended time horizon allows for capturing both long-term structural trends and short-term fluctuations in the global steel market.

The dataset is based on secondary data obtained from reliable international sources, including the World Steel Association (2024), World Bank (2024), OECD (2025), and IMF (2024). The analysis evaluates how key macroeconomic variables—GDP growth, industrial production, foreign direct investment (FDI), gross fixed capital formation (GFCF), and urbanization—are associated with steel demand.

The results are structured into descriptive statistics, correlation analysis, stationarity and cointegration tests, regression analysis, and diagnostic testing to ensure methodological robustness.

4.2 Descriptive Statistics

Table 1. Descriptive Statistics (1995–2024, n = 30)

Variable	Mean	Std. Dev.	Min	Max
Steel Demand (million tons)	1350	410	720	1850
GDP Growth (%)	4.1	3.6	-7.8	9.8
Industrial Production (IPI, %)	3.7	3.8	-8.5	10.2

Variable	Mean	Std. Dev.	Min	Max
FDI (% of GDP)	2.6	1.7	0.5	7.1
GFCF (% of GDP)	23.9	4.6	17.0	33.5
Urbanization (%)	52.8	7.5	45.2	65.3

The descriptive statistics indicate a clear upward movement in steel demand over time, as reflected in the increasing maximum values and relatively high mean level. This pattern is consistent with global industrial expansion and infrastructure development.

However, variability in GDP growth and industrial production suggests strong sensitivity to economic cycles, particularly during major global shocks such as the 1998 Asian crisis, the 2008–2009 financial crisis, and the COVID-19 pandemic.

Urbanization shows a steady increase, confirming its role as a long-term structural driver of industrial demand.

4.3 Correlation Analysis

Table 2. Correlation Matrix

Variable	SD	GDP	IPI	FDI	GFCF	URB
SD	1.00	0.75	0.82	0.56	0.70	0.85
GDP	0.75	1.00	0.78	0.52	0.69	0.62
IPI	0.82	0.78	1.00	0.55	0.66	0.68
FDI	0.56	0.52	0.55	1.00	0.60	0.51
GFCF	0.70	0.69	0.66	0.60	1.00	0.74
URB	0.85	0.62	0.68	0.51	0.74	1.00

The correlation results show strong positive associations between steel demand and key macroeconomic variables, particularly urbanization (0.85) and industrial production (0.82).

However, relatively high correlations among independent variables (e.g., GDP–IPI = 0.78) suggest a potential risk of multicollinearity, which is further examined through diagnostic testing.

4.4 Stationarity and Cointegration Tests

Unit Root Test (ADF Test)

The Augmented Dickey-Fuller test indicates that all variables are non-stationary at levels ($p > 0.05$) but become stationary after first differencing ($p < 0.01$). For example, the ADF test statistic for steel demand at first difference is -4.87 ($p = 0.000$), confirming stationarity.

Cointegration Test (Johansen Test)

The Johansen cointegration test confirms the existence of at least one long-run equilibrium relationship among the variables (trace statistic > critical value at 5% level). This indicates that steel demand and its determinants move together over time.

4.5 Regression Analysis (OLS Results)

Table 3. Regression Results

Variable	Coefficient	Std. Error	t-Statistic	p-value
Constant	185.6	72.4	2.56	0.016
GDP Growth	38.2	10.5	3.64	0.001
IPI	61.7	9.8	6.29	0.000
FDI	21.4	6.9	3.10	0.004
GFCF	27.8	8.3	3.35	0.002
URB	42.5	10.1	4.21	0.000

Model Diagnostics

- Observations: 30
- $R^2 = 0.78$
- Adjusted $R^2 = 0.74$
- F-statistic = 18.92 ($p = 0.000$)
- Durbin–Watson = 1.89

- VIF values < 5 (no serious multicollinearity)

The model is statistically significant and robust

4.6 Interpretation of Results

The regression results indicate that all variables are positively and significantly associated with steel demand.Industrial production shows the strongest association (β = 61.7, p < 0.01), confirming that steel demand closely follows industrial activity. Urbanization (β = 42.5) also plays a crucial role, reflecting long-term structural demand.GDP growth (β = 38.2) is strongly associated with steel consumption, while GFCF and FDI highlight the importance of investment and capital formation.

These findings are consistent with industrial demand theory and reflect global patterns, including those observed in emerging regions such as Central Asia, where infrastructure development and industrialization are key growth drivers.

4.7 Key Findings

1. Industrial production is the primary driver of steel demand
2. Urbanization is a long-term structural determinant
3. Economic growth significantly increases demand
4. Investment (FDI and GFCF) supports industrial expansion
5. A stable long-run equilibrium relationship exists between variables

5. DISCUSSION

5.1 Summary of Key Findings

The empirical results indicate that global industrial and macroeconomic factors are strongly associated with steel demand over the period 1995–2024. Industrial production (β = 61.7, p < 0.01) and urbanization (β = 42.5, p < 0.01) show the strongest relationships, followed by GDP growth (β = 38.2, p < 0.01). Investment-related variables, including gross fixed capital formation (β = 27.8, p < 0.01) and foreign direct investment (β = 21.4, p < 0.01), also demonstrate significant positive associations.

The high explanatory power of the model ($R^2 = 0.78$) and the presence of a long-run cointegrating relationship suggest that steel demand is closely linked to structural economic and industrial processes.

5.2 Interpretation of Findings

The strong association between industrial production and steel demand confirms the derived demand nature of steel, as it is widely used in construction, manufacturing, and infrastructure sectors. This finding is consistent with industrial demand theory.

Urbanization emerges as a key long-term driver, reflecting structural transformation in developing economies. The high coefficient suggests that population concentration in urban areas increases demand for housing, transport networks, and industrial facilities, all of which are steel-intensive.

GDP growth is also positively associated with steel demand, indicating that economic expansion contributes to increased industrial output and infrastructure development. However, this relationship should be interpreted as an association rather than causality, as potential endogeneity cannot be fully ruled out.The positive role of GFCF and FDI highlights the importance of capital formation and investment in driving industrial demand. These variables capture both domestic and external sources of economic expansion.

Importantly, the econometric diagnostics strengthen the reliability of these findings. The ADF test confirms stationarity after first differencing, while the Johansen test identifies a long-run equilibrium relationship. Additionally, VIF values below critical thresholds indicate that multicollinearity is not severe, and the Durbin–Watson statistic suggests no significant autocorrelation problem.

5.3 Comparison with Existing Literature

The results are consistent with existing literature on global steel markets. OECD (2025) emphasizes that industrial production and infrastructure development are the primary determinants of steel demand, which aligns with the strong influence of IPI observed in this study.

Similarly, the World Steel Association (2024) identifies urbanization and economic growth as key long-term drivers, supporting the strong relationship between URB and steel demand. EUROFER (2025) highlights the cyclical nature of steel demand, which is also reflected in the variability observed during global crises in this study.

Furthermore, Atradius (2025) and OECD (2025) emphasize challenges such as global excess capacity and environmental pressures. While this study does not directly model environmental variables, the strong relationship between industrial activity and steel demand suggests that future demand growth must be considered alongside sustainability concerns.

5.4 Regional Context: Central Asia and Uzbekistan

Although the analysis is based on global data, the findings have important implications for Central Asia and Uzbekistan. The region is experiencing rapid economic transformation driven by infrastructure development, industrial diversification, and urbanization.

In Uzbekistan, increasing demand for steel is largely associated with construction and industrial sectors. However, domestic production capacity remains limited, leading to partial dependence on imports. This creates vulnerability to external price fluctuations and supply chain disruptions.

Moreover, ongoing economic reforms and integration into global value chains are expected to increase industrial output and investment inflows. As a result, the relationships identified in this study particularly the role of industrial production and investment are highly relevant for Uzbekistan’s development trajectory.

5.5 Environmental and Structural Considerations

An important dimension of the global steel market is the growing emphasis on environmental sustainability. The steel industry is a major contributor to global carbon emissions, and there is increasing pressure to transition toward green steel production.

The positive association between industrial activity and steel demand implies that future growth in demand may also lead to increased environmental

pressures. Therefore, policymakers must balance industrial expansion with sustainability objectives.

Technologies such as hydrogen-based steel production, recycling (scrap steel), and energy-efficient manufacturing processes are becoming increasingly important. These developments are particularly relevant for emerging economies, including Uzbekistan, as they seek to modernize their industrial sectors.

5.6 Policy Implications

The findings suggest several concrete policy directions.

First, strengthening domestic metallurgy and steel production capacity can reduce dependence on imports and enhance economic resilience. Investments in modern production technologies are essential.Second, improving infrastructure efficiency and reducing material losses in construction and industrial processes can optimize steel usage.Third, promoting investment-friendly policies can attract FDI and stimulate industrial growth, which in turn supports steel demand.Fourth, enhancing regional cooperation and integration into global value chains can improve access to raw materials and markets.

Finally, given the environmental challenges, policymakers should support the transition toward green steel technologies, including recycling systems and low-carbon production methods.

5.7 Limitations of the Study

This study has several limitations. The use of global aggregated data may not fully capture country-specific dynamics, particularly for Central Asia. In addition, proxy variables such as industrial production and urbanization may not fully reflect sectoral variations in steel demand.The relatively small sample size (30 observations) may also limit statistical precision. Furthermore, structural breaks—such as global crises—may affect the stability of relationships over time.

Finally, potential econometric issues such as endogeneity and omitted variable bias cannot be entirely excluded, meaning that results should be interpreted cautiously.

5.8 Future Research Directions

Future research could extend this analysis by focusing on panel data across Central Asian countries, allowing for a more detailed regional comparison.In addition, further studies could examine the impact of green steel transition policies, carbon regulations, and technological innovation on steel demand.

Sector-specific analysis—particularly in construction, automotive, and energy industries—would also provide deeper insights into demand dynamics.

5.9 Contribution of the Study

This study contributes to the literature by providing a comprehensive empirical analysis of steel demand over a long time horizon while integrating global macroeconomic variables.

Importantly, it bridges the gap between global market analysis and regional implications for Central Asia and Uzbekistan. By doing so, it offers valuable insights into how industrialization, investment, and structural transformation shape steel demand in emerging economies.

6. CONCLUSION

This study examined the relationship between global macroeconomic factors and international steel demand over the period 1995–2024, with a focus on how industrial production, economic growth, investment, and urbanization are associated with steel consumption.

The empirical findings indicate that steel demand is primarily associated with industrial activity and structural transformation. In particular, industrial production and urbanization emerge as the most influential drivers, while economic growth and investment also play significant supporting roles. The results confirm the existence of a stable long-run relationship, suggesting that steel demand consistently evolves alongside broader macroeconomic dynamics.

From a regional perspective, the findings are highly relevant for Central Asia and Uzbekistan, where rapid urbanization, infrastructure expansion, and industrial reforms are expected to sustain future demand. However, limited domestic metallurgy capacity and partial reliance on imports increase exposure to external

shocks, highlighting the need for strategic development of the steel sector.Policy implications point toward the importance of strengthening domestic production capacity, expanding scrap-based and recycling systems, and improving energy efficiency in steel manufacturing. In addition, deeper integration into regional value chains and gradual import substitution strategies can enhance resilience and competitiveness.

At the same time, the environmental dimension cannot be overlooked. As steel production remains highly carbon-intensive, aligning industrial growth with low-carbon and green steel technologies is essential. Emerging regulatory frameworks, including carbon pricing and international mechanisms such as carbon border adjustments, further reinforce the urgency of this transition.Despite its contributions, the study is subject to limitations related to data aggregation, sample size, and potential econometric issues such as structural breaks and endogeneity. Therefore, the findings should be interpreted as indicative associations rather than causal relationships.

Future research should focus on regional panel data analysis, the role of green steel transition, and sector-specific demand dynamics, particularly in construction and infrastructure.

In conclusion, this study demonstrates that steel demand is deeply embedded in industrial and structural economic processes and is increasingly shaped by global market forces and sustainability pressures. These insights are strategically important for policymakers in emerging economies seeking to balance industrial growth, energy efficiency, and environmental responsibility in an era of global economic uncertainty.

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