Pakistan Economic Review
5:1 (Summer 2022), PP. 128-156

Growth in Steel Industry and Exchange Rate Pass-Through into Pakistan's Import Steel Price: An Empirical Analysis Based on ARDL Model

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Abstract

Pakistan's steel industry is crucial for providing raw materials to different sectors, but it heavily relies on imported steel raw materials. However, the industry faces challenges, such as gas and power shortages, financial constraints, inadequate raw materials, and vulnerability to local currency devaluation and rising raw material prices. Therefore, it is required to examine the degree of exchange rate pass through to the prices of imported steel after appropriately controlling for exporters production cost and demand condition. For this analysis, first we find the sources of growth for Pakistan's steel industry in which we are interested in estimating the percentage contribution resulting from input (labor, capital, energy, raw material) utilization, technological progress, and economies of scale. If raw material is one of the significant contributors then how the exchange rate passes through the prices of imported raw material. Using a Cobb-Douglas production function, the results indicate that over the period 1990 to 2020, the technical change parameter indicates that Pakistan's steel industry is characterized by small plants and majority of them are employing outdated technology. Growth in the steel sector of Pakistan is significantly contributed by the energy, capital and raw material inputs. In the exchange rate pass through model we found that domestic demand and exporters production costs drive the import price of steel rather than the depreciation of rupee.

Keywords: Source of Growth, CDPF, Exchange Rate Pass-Through, Import Steel Price, ARDL Model

JEL code: L1, F1

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1-Introduction

The steel industry plays a crucial role in driving industrial and economic growth in a country. Its importance in various industries such as construction, transportation, machinery, metal products, energy and electrical apparatus, and domestic appliances cannot be overstated. Steel production is made up of two main components: iron ore and recyclable steel. It is a capital-intensive industry, as the production process requires large factories, iron ore, energy and labor. The high costs associated with producing steel, coupled with low returns, can make it difficult for new investors to enter the market.

The steel industry contributes in economic development of Pakistan through its role in construction projects, infrastructure building and industrial development. Its significance and implications in manufacturing sector cannot be overlooked. The growth and development of this sector contributes to economic growth, employment generation, infrastructure development, and export earnings, while reducing reliance on imported steel products.

Pakistan relies profoundly on imported steel raw materials, particularly steel scrap, while some of iron ore is produced locally. China is the primary source of raw materials for steel production in Pakistan. In FY21, Pakistan imported approximately USD 1.9 billion worth of iron and steel scrap, which accounted for about 3.4% of the country's total imports. The quantity of imported iron and steel scrap also increased by about 21% YoY, reaching approximately 4.7 million tons, compared to approximately 3.9 million tons in FY20. This high dependency on imported raw materials makes steel sector vulnerable to changes in international raw material prices and exchange rate variations. Additionally, Pakistan produced only around 725k tons of iron ore during FY21, which is a relatively insignificant contribution to the sector's overall requirement. (PACRA, 2022[2]).

The motivation of this study is to realize the steel industry in Pakistan often encounters obstacles that impede its ability to function at maximum capacity. These obstacles include shortages of gas, power outages, financial constraints, and insufficient raw materials. Likewise, the depreciation of the local currency and the increase in raw

[2]PACRA, an Executive Agency under the Ministry of Commerce, Trade and Industry (MCTI), was created in accordance with the Patents and Companies Registration Agency Act, No. 15 of 2010. Its main function is to facilitate the registration of businesses and maintain a registry for both business entities and intellectual property. The citation done is taken from PACRA presentation, present on its website.

material costs can also have an impact on the steel industry's profit margins. Therefore, it is necessary to identify the reasons for underutilization of the steel industry and to investigate the extent to which exchange rate fluctuations affect imported steel prices, while taking into account the exporters' production costs and demand conditions.

What sets this study apart from other studies is that it began by engaging with stakeholders to uncover the genuine challenges facing Pakistan's steel industry. The industry's profitability is also affected by the weakening of the local currency and the rise in raw material prices. Pakistan is mainly importing steel raw material. Hence, it is crucial to determine the reasons for the industry's underutilization and examine how exchange rate fluctuations impact the prices of imported steel.

The organization of the study is as follows: in Section 2, the development of the steel industry in Pakistan is discussed; Section 3 covers the review of literature, while Section 4 provides an explanation of the theoretical background. Section 5 presents the empirical results, and finally, the conclusion and recommendations are elaborated in Section 6.

2-Development of Steel Industry in Pakistan

Proposal of Steel Mill	establish a steel industry was first introduced in the first Plan (1955-1960).
Establishment of Karachi Steel Mill	Steel mill was established in 1968 and supported by the privately held steel factory in Karachi. According to the 1913 statute, it was a separate cooperation..
Pakistan Steel Industry	In 1973, Mr. Zulfiqar Ali Bhutto laid the foundation of Pakistan steel industry.
Role of Soviet Union	In January 1971, Soviet Union signs a letter and ensured to deliver technology and financial assessment toform steel mill. The work was started under the direction of Soviet experts.
	Ministry of Industries set up two key entities: The Price

	Control and Prevention of Profiteering and Hoarding Act, 1977[3] and The Office of the Controller General of Prices (CGP). The steel mill included over twenty components, each of which was made up of a huge unit &commissionedrights.
Entry in the Club of Steel and Iron	The commission of the Blast and Furnace (1981) represented Pakistan's into the mace of steel/iron producing economies. This project had a capital cost of 24700 million dollars.
Steel Mill	In 1985, steel mill was formally initiated by General Zia-ul-Haq.
Production Capacity	New steel production facilities are eventually installed as a result of many investments made by the private sector. Now Steel industry is big complex production unit having 600 smaller and bigger mills and production capacity of 3.3 Million tons in 2019[4], which is 0.18% of the world production [World steel association report 2020].
Major Players	Pakistan steel has 20 major players in organized sector; Amreli, Agha, Mughal, Frontier Foundry Steel, Razaque, Bilal and Aitamad Steels are quite well known with sizable market share. They account for 80% of the total market. A combined revenue of PKR 150/- billion was generated by these entities in FY 2020 (Steel Sector an Overview 2020, PACRA).

[3] According to the Act, the government was allowed to fix maximum prices of essential products. This mechanism served as a barrier to investment, however that office has since been closed.

[4]Raw materials (such as iron ore and scrap) as well as flat (such as sheets & plates used in the automobile industry) and long products are included (steel bars, wire rods etc.).

Companies listed on PSX

The industry has 11 entities listed on the PSX having major contribution to local steel production capacity.

S.No.	Company Name	Market Capitalization (Million Rs.)
1	Quality Steel Works Limited	17.72
2	Aisha Steel Mills Ltd	28.70
3	Metropolitan Steel Corporation Limited	309.78
4	Aisha Steel Mills Limited (Preference Shares)	443.57
5	Crescent Steel & Allied Products Limited	776.32
6	Mughal Iron and Steel Industries Limited	2918.56
7	Amreli Steels Ltd.	2970.11
8	Dost Steels Limited	3157.34
9	International Steels Limited	4350.00
10	Agha Steel Industries Limited	5760.75
11	Aisha Steel Mills Limited	7655.29

Source: Pakistan Stock Exchange

2.1Current Worldwide Standing

The world steel production has experienced a significant increase, rising from 1,149 million tons in 2005 to 1,625 million tons in 2015, and presently reaching 1,875 million tons. The World Steel Association has identified China, India, Japan, the United States, Russia, South Korea, Germany, Turkey, Brazil, and Iran as the top 10 steel-producing countries in 2019. Whereas, Pakistan's steel production accounts for only 0.18% of the world's total output, ranking 39th out of 50 countries.

Figure 1: Share of Global Crude Steel Production (2019)

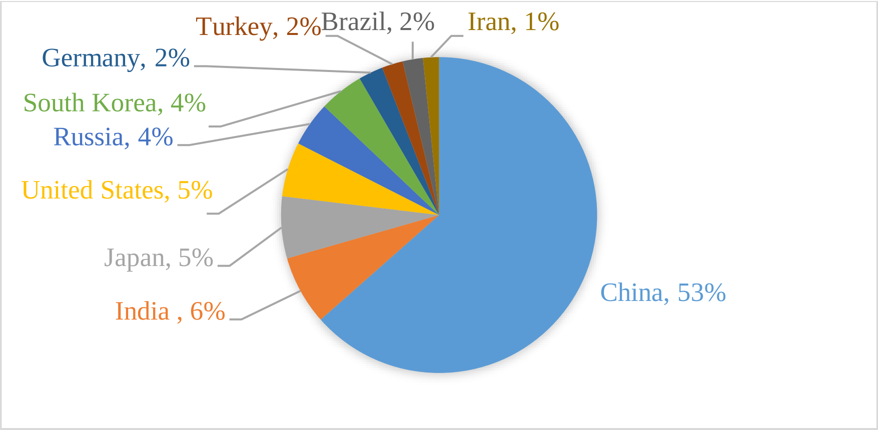
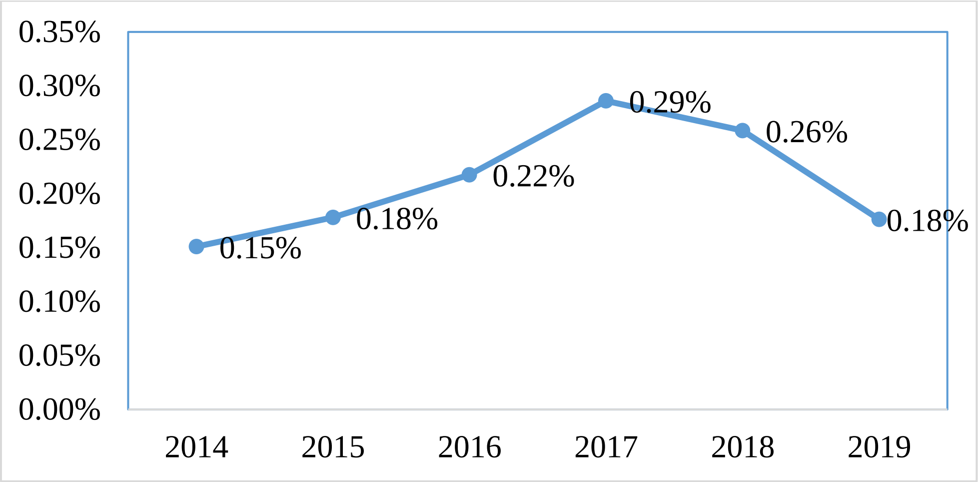


Figure 2: Pakistan Contribution in World Production



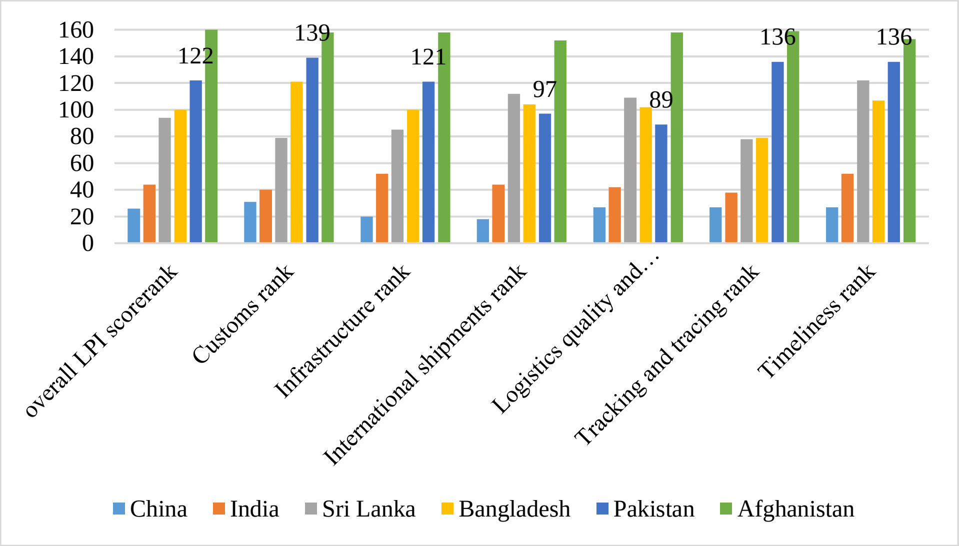
Source: World Steel Association

The Logistics Performance Index (LPI)[5], an interactive benchmarking tool, was developed by the World Bank to assist countries in recognizing their trade logistics opportunities and challenges and determining ways to improve their performance. Due to a lack of funding for infrastructure developments like airports and motorways, Pakistan is placed 122 out of

[5]The Logistics Performance Index is a benchmarking tool that aids nations in identifying their trade logistics performance issues and potential solutions. The weighted average of a country's rankings on six significant criteria determines it, including customs performance, infrastructure quality, ease of shipment setup, quality of logistics services, consignment tracking and tracing, and timeliness of shipments.As we are focusing on steel industry in Pakistan, steel is heavily used in construction, transport, machinery, metal equipment etc. Import and Export of steel is also a concern so analyzing LPI is relevant.

160 countries in the aggregate Logistic Performance Index (LPI) for the year 2018. This places Pakistan behind other Asian nations. The top performance in the region is India, which is ranked 44th, while Bangladesh and Sri Lanka are ranked 100th and 94th, respectively.

Figure 3: Logistic Performance Index Rankings



Source: World Bank

2.2Steel Production, Imports and Exports

The import and export of finished and semi-finished steel products, as well as the key trends in Pakistan's crude steel production between 2008 and 2019 are illustrated in figure 4 and 5. The domestic production and import of steel has expended significantly due to increase in domestic demand. The main factors that led to the increase in steel production between 2008 and 2018 were industrialization and expansions, increase in housing projects, and increase in demand for steel in the transportation, defense, automotive, appliance and infrastructure projects under CPEC(SBP, 2018).

However, the production and imports of steel decline from 2017 to onward, the vehicle business is contracting as a result of a decrease in home demand. The production of long steel items, which are mostly used in construction industry activities, also fell precipitously. Additionally, because demand was consistently low due to the decline in the automotive industry, flat steel producers suffered throughout the year (SBP, 2018; SBP, 2020).

Figure 4: Steel Import and Export

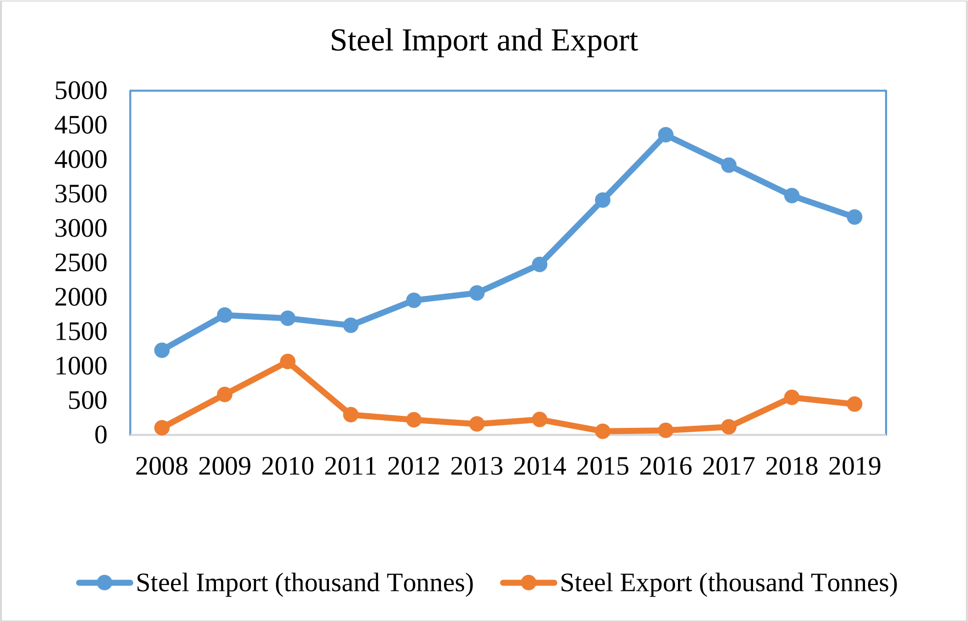
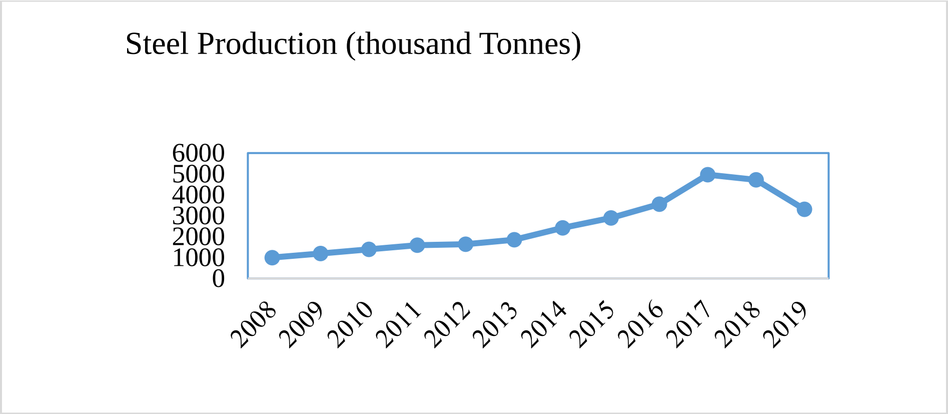


Figure 5: Steel Production



Source: Steel Statistical Yearbook, 2020 and World Steel Association

Over the last five years the average domestic demand of steel and iron is 7.3 million tons per year, and domestic production only covers 3.8 million tons. In order to meet this demand-supply gap, Pakistan has been importing from different countries and incurring too much cost on steel importing. Higher imports also indicate that the industry lagged behind the desired progress and unable to fulfill the market need. Therefore, it is necessary to figure out the causes for understanding the under-utilization of steel industry.

The goal of this research is twofold. First to find the sources of growth for Pakistan's steel industry in which we are interested in estimating the percentage contribution resulting from input (labor, capital, energy, raw material) utilization, technological progress, and second is to assess the economies of scale over the period 1990 to 2020.Research question is if raw material is a significant contributor then how the exchange rate pass through the prices of imported raw material. Steel mills personnel, members of regulatory bodies,believe that the global trend of rising raw material prices, combined with the depreciation of rupee, has placed pressure on profit margins (Zia & Hina, 2021).

3-Review of Literature

The literature in this section highlights Pakistan's positive production , factors responsible for this positivity, factors responsible for decline in production, contributions in steel industryresulting from input (labor, capital, energy, raw material) utilization, technological progress, and economies of scale over the period 1990 to 2020. Raw material is thought to be a significant contributor in steel industry and dependence on imports include reliance on an overvalued exchange rate. Subsequently, steel producers are investing heavily to increase operating capacity and improve product quality. This is mostly caused by an ongoing increase in domestic steel demand.

A noteworthy fact is reported by Protopopov&Feyler (2016) in steel production, Pakistan is present in the list of the countries with encouraging production dynamics while Ahmad et al. (2020) discussed Pakistan's crude steel production between 2008 and 2018, as well as information on the country's import and export patterns of finished and semi-finished steel products.They observed a substantial increase in the domestic production of steel during the mentioned period. In the meantime, the import of steel has also augmented because of massive domestic demand.

The literature also identifiesincreasing trend of steel production and factors responsible for increase in steel production.The production of steel increased by more than 140,000 tonnes over the previous year in 2017, more than doubling from 2015 to 2016. They also noticed that the rise in steel production from 2016 to 2017 is similar to the rise during a period of six years, from 2008 to 2014. Steel imports fell by 450 thousand tonnes between 2016 and

2017, and steel exports rose by almost 50 thousand tonnes as a result of this dramatic rise in production.According to them, the primary drivers of the rise in steel production are rising consumer demand from a diverse range of industries, including those in the transportation, defence, automotive, and appliance sectors; rapid industrialization and expansions; population growth leading to an increase in housing projects that require steel; and CPEC infrastructure projects (SBP, 2018).

On the other hand there are some factors responsible of decrease in steel production. There was a decrease of 250,000 tonnes in steel production and a decrease of 450,000 tonnes in steel imports between 2017 and 2018. Steel exports increase by 3.5 times from 2017 to 2018, despite a waning in steel production and imports. The holding-up of key projects by the Pakistani government and private developers, including work on the CPEC, and the Supreme Court of Pakistan's restriction on the construction of tall structures are the most likely causes. Additionally, the illegal smuggling of steel bars from the Iran border to Pakistan and the USA-led sanctions on Iran significantly lowered the demand for steel on the domestic market. Ahmad et al (2020) also discussed that the quality of steel is not meeting standards as Pakistan’s steel mills are made up of small factories that rely on outdated, inefficient technologies.

As mentioned by Siddique et al. (2016) the long-term connection between steel production and economic expansion in Pakistan. Although the profitability of the Pakistani steel sector is unquestionably low due to some faulty government policies and poor industry management, output capacity is dropping. Lack of energy, bad weather, flooding, a lack of law and order, among other issues and natural calamities have hampered investment and economic progress in Pakistan. The Pakistani government has taken certain initiatives to support the country's steel industry, including privatisation at a discount price that disregards profitability. The industry started paying a high labour cost for idle workers as a result of this regulatory intervention, which also had a negative

impact on industrial production.According to causality findings, there are no direct networks between the economy and the steel industry. The steel sector really needs to increase its performance.

Alongside,the steel industry in Pakistan is investing heavily to increase production capacity and improve product quality. This is mostly caused by the ongoing increase in domestic demand. The sector reported an impressive rise of nearly 20 percent during

FY17 and FY18, signaling that it has emerged from a contractionary phase that began with the suspension of operations at Pakistan Steel Mills in FY15 (SBP, 2018). High imports show the high demand for steel products even after record domestic production. Four elements stand out in terms of demand.First, the automobile, defence, transportation, and appliance industries now have a diverse consumer base for steel commodities. Second, more space has been made due to an increase in industrial activity generally because most of the related businesses to construction are substantially investing in expansions. Third, the housing scarcity brought on by the population boom is being addressed through private housing projects. Fourth, increased government spending and CPEC-related infrastructure projects are driving up steel demand. The demand for steel would continue to rise as a result of these four changes in the future. On the supply side, imported finished goods, notably those from China, present the domestic producers with fierce competition.The sales of domestic small players are particularly being impacted by imported products, which are both competitive in price and quality. These businesses are unable to compete due to high operating expenses and multiple taxation[6] throughout the industry. After the government added anti-dumping charges (ADD) to already existing regulatory duties on finished steel goods, the industry has recently experienced some relief (SBP, 2018).

Additionally, stepping up its efforts to lessen its reliance on imported raw materials is the required move. Given that domestic scrap sources don't produce high-quality products, scrap imports will likely continue to rise; nonetheless, industry participants have started growing their billet production, which manufacturers then further process into long bar products. (SBP, 2018).

As according to(PACRA[7]) some raw materials are important for steel production like Iron Ore[8], Coal[9] and Steel Scrap[10]. Steel scrap is a key raw material in Pakistan's local

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[6] Double taxation

[7]https://www.pacra.com/sector_research/PACRA%20Research%20-%20Steel%20-%20Sep'21_1630576235.pdf

steel industry. Even though it produces iron ore, Pakistan imports raw steel and iron scrap (less than a million tonne in a year). In contrast, Pakistan also imports completed steel products to meet domestic demand (as mentioned above). Due to the industry's heavy reliance on imported raw materials to supply demand, it is susceptible to changes in global raw material costs and exchange rate variations.It is anticipated that global prices for scrap steel will stay range-bound, which will boost the sector's profitability.

Major strengths of this sector are: the capital-intensive nature, favorable margins during demand booms, substantial prospective demand, robust dealership and distribution network, non-availability of substitutes. While the sector's acknowledged weaknesses include: a dependance on imported raw materials, sensitivity to exchange rate instability, seasonality and demand unpredictability, and a difficulty to pass on the effects of rising costs during periods of weak demand.

Another concern is if the raw material is a significant contributor then how the exchange rate pass through the prices of imported raw material. In this connection,Capma and Goldberg (2005) conducted a study that analyzed the association between exchange rates and import prices in 23 OECD countries using both cross-country and time series data.They have discovered strong evidence of short-term partial pass-through, particularly in the manufacturing sector. Producer-currency pricing is communal over time for several different sorts of imported commodities. Although macroeconomic factors have only had a minimal impact on how pass-through elasticities have changed over time, countries having higher exchange rate volatility show higher pass-through elasticities. It is significant to notice that these countries have seen pass-through changes, including significantly different country import bundle compositions.

Another argument as reported by Marazzi& Sheets (2007)shows a strong and continuous deterioration in exchange rate pass-through to U.S. import prices (more than 0.5 during the 1970s and 1980s to around 0.2 over the last decade).They place the blame for this reduction on the escalating Chinese rivalry, a change in import pricebehaviordue to the Asian financial crisis, and the decline in the proportion of material-intensive imports into

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[8]A mineral heated to yield metallic iron
[9] To produce Carbon
[10] Recyclable nature

the United States. Another indication is the growing trend of international exporters fixing their pricing in response to American prices. The findings in turn point to a new, more comprehensive explanation that connects the drop in pass-through to the changing global dynamics of market competition and structural alterations in production.

The industry is vulnerable to variations in global raw material costs and exchange rate volatility due to its high reliance on imported raw materials. There are no indications that construction activity in China will significantly expand during CY21, so prices for steel bars and iron ore are projected to stay low globally. Given their heavy reliance on imported raw materials, Pakistan's steel firms would benefit from the decline in iron ore prices.

As per our focus group discussion with the Steel mills owners, members of regulatory bodies they highlighted that the global trend of rising raw material prices, combined with the depreciation of rupee, has put pressure on profit margins (Zia & Hina, 2021)

4-Theoretical Framework

4.1 Economic Model for Source of Growth

The simplest production function utilized in economics was formed by Charles Cobb and Paul Douglas in 1928; also recognized as the Cobb-Douglas production function (CDPF). The CDPF provides a suitable foundation for identifying growth sources.

The Cobb-Douglas Production function can be written as:

$$Q_t = Ae^{\lambda t} K_t^{\alpha} L_t^{\beta} E_t^{\gamma} RM_t^{\delta} \qquad (1)$$

Equation (1) in estimable form after adding the error term gives:

$$lnQ_t = LnA + \lambda t + \alpha lnK_t + \beta lnL_t + \gamma lnE_t + \delta lnRM_t + \varepsilon_t \qquad (2)$$

Where, Q_t is the output of the steel industry, λ is the technical change parameter, t is the time trend, K_t capital stock in the steel industry, L_t employment in numbers, E_t is electricity, fuel and lighting, RM_t is the raw material.

$\alpha, \beta, \gamma, \delta$ are elasticity of production with respect to capital, labor, energy and raw material respectively. $\alpha + \beta + \gamma + \delta \gtreqless 1$, represents increasing, constant or decreasing returns to scale. ε_t is the error term.

4.2 Economic Model of Exchange Rate Pass Through

The economic model to study the exchange rate impact on the importing steel price of Pakistan is based on the exporter's pricing behavior. According to Olofsdotter, K., &Thede (2014) from the perspective of exporters' profit maximization under imperfect competition the import goods prices in terms of national coinage are determined by marginal costs , exchange rate, and markups prices.

The profit maximizing behavior of foreigner steel exporter with the domestic steel importer under imperfect competition is defined as

$$Max \prod = eP^x Q - C(Q, W) \qquad (3)$$

Where *e* represents exchange rate that is exporting country's currency as per unit of importing country currency

P^x is the foreign exporter's price of exporting steel (local currency units)

Q is the quantity demand of steel

C is the exporter's production cost and

W is input price

The optimal pricing strategy of foreign producer is define by taking first differences of equ (2) with respect to output as:

$$P^x = \frac{MC}{e} \times \frac{\eta}{\eta - 1} = \frac{MC}{e} \times \mu \qquad (3)$$

Where MC represents the marginal costs of the foreign producer, μ is the markup over MC and its value is determined by the price elasticity of demand for steel (η) in the importing country. Equation (3) explains that importing steel price (local currency) is determined by exchange rate, marginal costs and markups pricing. Marginal costs is the rate of change in producer cost which is mainly depends on producer's input prices (w_t), raw material prices, capital cost and wages and markup prices depends on demand (y_t) of the importer country. The exchange rate pass through equation is obtained by taking the logarithm of Equation (3) as

$$lnP_t = \beta_0 + \beta_1 lne_t + \beta_2 lnw_t + \beta_3 lny_t \qquad (4)$$

Where $p_t$represents import price of steel, $e_t$signifies Nominal Effective Exchange Rate (NEER), w_t is the producer cost and with reference to the availability of data Producer Price Index (PPI) and Commodity Price Index (CPI) are normally used as a substitute of producer costs [Hong and Zhang (2016)]. The domestic demand is usually measured by GDP.

4.3 Econometric Model

This study uses the Autoregressive Distributed Lag (ARDL) co-integration method and bounds tests by Pesaran, et al. (2001) to estimate equation (2) and equation (4). The ARDL approach favors examining variables with small samples of time series data. Additionally, ARDL[11]is applied irrespective of integration order (either the variables are I (0), I (1), or both).

ARDL model for CDPF can be specifies as

$$\Delta \boldsymbol{lnQ_t} = \boldsymbol{\alpha_{1o}} + \boldsymbol{\lambda t} + \sum_{k=1}^{l} \boldsymbol{\alpha_{11k}} \Delta \boldsymbol{lnQ_{t-k}} + \sum_{k=0}^{l} \boldsymbol{\alpha_{12k}}\, \Delta \boldsymbol{lnK_{t-k}} + \sum_{k=0}^{l} \boldsymbol{\alpha_{13k}} \Delta \boldsymbol{lnL_{t-k}} + \sum_{k=0}^{l} \boldsymbol{\alpha_{14k}} \Delta \boldsymbol{lnE_{t-k}} + \sum_{k=0}^{l} \boldsymbol{\alpha_{15k}} \Delta \boldsymbol{lnRM_{t-k}} + \delta_{11} \boldsymbol{lnQ_{t-1}} + \delta_{12} \boldsymbol{lnK_{t-1}} + \delta_{13} \boldsymbol{lnL_{t-1}} + \delta_{14} \boldsymbol{lnE_{t-1}} + \delta_{15} \boldsymbol{lnRM_{t-1}} + \boldsymbol{\varepsilon_t}$$

In literature it is common to explore the symmetric effect of exchange rate pass through on the import price of commodities by linear ARDL co-integration method and bounds tests by Pesaran, *et al.* (2001) [Hong and Zhang (2016), Marazzi et al., (2005)]. Therefore, to review the long-term relationship, the ARDL bound testing approach developed by Pesaran et al. (2001) will be used to estimate the regression model (4). The mathematical representation of the error correction mechanisms are as follows.

$$\Delta lnP_t = \alpha_{2o} + \sum_{k=1}^{l} \alpha_{21k} \Delta lnP_{t-k} + \sum_{k=0}^{l} \alpha_{22k}\, \Delta lnNEER_{t-k} + \sum_{k=0}^{l} \alpha_{23k} \Delta lnw_{t-k} + \sum_{k=0}^{l} \alpha_{24k} \Delta lny_{t-k} + \delta_{21} lnP_{t-1} + \delta_{22} lnNEER_{t-1} + \delta_{23} lnw_{t-1} + \delta_{24} lny_{t-1} + \varepsilon_t \quad (6)$$

The bound test examines the existence a long-term association between variables by testing the hypothesis which assures the lagged variables coefficients are zero i.e.,H_0: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ it means there exists no long-run relationship among the variables. Whereas the alternative hypothesis for cointegrating relationship is H_A: $\delta_1 \neq$

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[11]ARDL bound test is applicable if all variables are either I(1) or mixture of I(1) and I0). But crashes in the presence of I(2) variable (Pesaran, et al., 2001, Menegaki, 2019).

$\delta_2 \neq \delta_3 \neq \delta_4 \neq 0$. Pesaran et al. (2001) states that if the F-test statistic is greater than the critical value for I(1), it suggests a long-term relationship and the null hypothesis is rejected. However, if the statistic is less than the critical value for I(0), the null hypothesis cannot be rejected. However, if the statistics falls in between the bounds, the conclusion is inconclusive.

4.4 Data and Variable Construction

This study uses annual data from 1990 through 2020 obtained from Census of Manufacturing Industries (CMI) various issues, State Bank of Pakistan (SBP), Pakistan Bureau of Statistics (PBS), World Integrated Trade Statistics (WITS) and International Financial Statistics (IFS). A detailed description of the data and data sources is provided in Table 1.

Table 1: Description of Variables

Symbol	**Variables**	**Description/ Measure**	**Source**
		Cobb- Douglas Production Function	
Dependent Variable			
Q_t	Output of the steel industry	Data on output is obtained from the various issues of the CMI and deflated by the manufacturing price index.	CMI, SBP
Independent Variables			
K_t	Capital stock	Capital stock denote the value of fixed assets deflated by the price index of machinery.	CMI, SBP
L_t	employment in steel industry	Employment (in numbers)	CMI
E_t	Electricity, fuel and lighting	Cost of electricity, fuel and lighting deflated by the prices of fuel, lighting and lubricants	CMI, SBP
RM_t	Raw Material	Cost of raw material deflated by	CMI, SBP

		the raw material prices	
Exchange Rate Pass through Model			
Dependent Variable			
P_t	Import price of steel	It is obtained by dividing the value of imports of steel in rupees in thousands by quantity of imports of steel in metric ton.	Imports by commodities and country PBS
Independent Variables			
e_t	Nominal Effective Exchange rate (NEER)	The trade weighted bilateral exchange rates between Pakistan and its trading partner countries for imported steel are used as a measure. The calculation is as follows: $NEER_t = \prod \left[\frac{e_{it}}{e_{io}}\right]^{wit} \times 100$ Where e_{it} is the number of foreign currency units for trading partner i per Pakistani rupee at time t e_{io} is the number of foreign currency units for trading partner i per Pakistani rupee in the base year 2000 wit is the trade weight for the currency of trading partner i at time t The major trading partner of steel with Pakistan are China (28%), UK (10%), USA (8.2%), Japan (7.9%) and UAE (7.8%)	IMF, SBP, WITS
w_t	Exporters' Production Costs	PPI is utilized as a proxy for the production costs of exporters. To	IFS

		determine the total PPI of trading partners, the PPI of trading partners is first converted into a fixed base index using 2000 as the base period. Then, the trade-weighted PPI is calculated using the same method as the trade-weighted NEER.	
Y_t	Domestic Demand	Real GDP is taken as a proxy for domestic demand. By dividing the nominal GDP by the GDP deflator, we obtain the real GDP.	SBP

Since we aim to calculate the responsiveness of steel production to changes in capital, labor, energy and raw materials, and the impact of exchange rate on import prices (exchange rate elasticity of import prices), we transformed data in logarithms.

5- Results

5.1 Unit Root Test

Before estimating ARDL, we check for stationarity of the variables. We have used ADF test in order to be sure that none of the variable is integrated of order two that is second difference stationary. Otherwise, If the data is I(2), the variable F statistics provided by Pesaran et al. (2001) is not useful. Augmented Dickey-Fuller(ADF) is implemented on all series, however, Zivot-Andrews unit root test is applied on lnw_t, lnL_t due to check structural break in the series. The results of the unit root test are given in Table 2. According to the unit root tests, all variables are integrated of order one.

Table 2: Unit Root Test

Variables	**At level**				**At first Difference**				**Conclusion**
	t_{cal}	t_{tab}	**c, t**	**lag**	t_{cal}	t_{tab}	**c, t**	**Lag**	
Variables of Cobb- Douglas Production Function									
lnQ_t	-2.63 (0.27)	-3.55	c, t	1	-4.28	-2.95	c	0	I(1)
lnL_t	-2.08 (0.25)	-2.95	c	3	-13.16	-4.90	c	2	I(1)
lnK_t	-0.67 (0.97)	-3.55	c, t	1	-3.24 (0.09)	-3.55	c, t	0	I(1)
lnE_t	-1.92 (0.62)	-3.55	c, t	1	-4.83 (0.00)	-2.95	c	0	I(1)
$lnRM_t$	-0.50 (0.88)	-2.95	c	1	-3.20 (0.02)	-2.95	c	0	I(1)

Variables of Exchange Rate Pass through Model									
lnP_t	-0.64 (0.85)	-2.94	c	0	-5.78 (0.00)	-1.95	-	0	I(1)
lne_t	-0.21 (0.93)	-2.94	c	0	-3.09 (0.00)	-1.95	-	0	I(1)
lnw_t	-1.18 (0.66)	-2.96	c	0	-4.42 (0.01)	-1.96	-	0	I(1)
lny_t	-2.11 (0.52)	-3.57	c, t	1	-4.40 (0.00)	-2.97	c	0	I(1)

5.2 Bounds testing for cointegration

The existence of long run cointegration relationship among the variables of CDPF Eq. (2) and exchange rate pass through Eq. (4) is examined by ARDL. We also investigate the exchange rate pass through to "import price of steel" by ignoring the exporters' production costs and the domestic demand.The Akaike Information Criteria (AIC) is used to choose the maximum lag2 for first difference variables. Hendry's general-to-specific strategy (1992) is applied to drop irrelevant lags of first difference variables.The final model is chosen if it passes all diagnostic tests, mainly the Jarque-Bera statistic to check for normal distribution of residuals, the Breusch-Godfrey (1978) Lagrange Multiplier test to ensure there is no serial correlation, and Engle's (1982) autocorrelation conditional heteroskedasticity test to confirm that the residuals have constant variance. The results of the cointegration test are shown in Table 3.

Table 3 Results of Cointegration Test

	F-statistics	I(0)	I(1)	outcome
<u>CDPF</u>				
$F_{\ln Q}(\ln Q/\ln K, \ln L, \ln E, \ln RM)$	7.45	4.4	5.72***	CI
<u>ERPT Model with exchange rate only</u>				
$F_{\ln P}(\ln p/\ln e)$	4.67	3.02	3.51**	CI
<u>ERPT Model Eq. (4)</u>				
$F_{\ln P}(\ln p/\ln e, \ln w, \ln y)$	3.42	2.37	3.2*	CI

Note: No-CI and CI symbolizes no-cointegration and cointegration respectively. Asymptotic critical value bounds are obtained from Table CI(iv) Case IV: Unrestricted intercept and restricted trend (Pesaran, *et al.*, 2001,p.301) at ***1%, **5% and * at 10% significance level.

The outcomes of the bounds cointegration test are presented in Table 3. The F-statistic does not reject the null hypothesis of no long-term relationship and there is strong evidence of a long-term relationship in the CDPF and ERPT models. Table 4 presents the long-run estimates found by scaling the cointegrating vector on the dependent variable of each model, after identifying the long-term relationship.

Table 4: Long Run Estimates

4a: CDPF			***4b: ERPT Model***		
Dependent variable	Ln Q		Dependent variable	$\ln p$	$\ln p$
Independent Variable			Independent Variable	**(1)**	**(2)**
c	-3.29***		c	-6.90**	-69.80***
lnK_t	-0.02***		$\ln e$	3.49***	-0.94
lnL_t	0.16***		$\ln w$		0.37*
lnE_t	0.09**		$\ln y$		5.69***
$lnRM_t$	0.95***				
lnK_t	0.14***				
Diagnostic Test					
Serial Correlation LM Test	3.67 [0.06]		Serial Correlation LM Test	0.01 [0.91]	0.02 [0.88]
JB Normality Test	1.39 [0.50]		JB Normality Test	0.62 [0.73]	2.41 [0.30]
ARCH Test	0.46 [0.50]		ARCH Test	0.81 [0.36]	0.50 [0.49]

Significance is shown by *, **, ***, at the 10%, 5% and 1% levels respectively and p-values are stated in [ ].

Table 4, provides long-run equilibrium coefficients of CDPF. All the estimated coefficients are significant at the conventional levels. We find the elasticity of output with respect to energy is 0.95 which is higher than the elasticity of output with respect to capital, labor and raw material. This result is supported by some previous research. For example, a study by Jorgenson and Wilcoxen (1993) found that the elasticity of output with respect to energy was higher than the elasticity of output with respect to labor and capital in the United States. Another study by Dargay and Gately (1995) found similar results for several OECD countries. The technical change parameter is -0.02 which is negative and indicating the fact that Pakistan's steel industry is characterized by small plants and majority of them employing outdated technology and it is confirmed by study of Ahmad (2020). Most melting, re-rolling, and fabricating firms, in particular, have small factories as compared to other market players in steel-exporting countries. Correspondingly, the usage of obsolete technology increases the production cost for these businesses, resulting in low-quality output with varied standards (Zia & Hina, 2021). Furthermore, some steel plants are shutting down or operating at lesser capacity due to current economic policies.In fact, domestic output is low while imported coal[12] prices are high which increases the cost of production.The finding is consistent with Metthews& Raj (2020).

The estimates intable 4 are used to compute the contribution of different sources to growth in the steel sector over the period 1990 to 2020, see Table 5. The steel output grew at the average annual rate of 12.30 percent during the analysis period and positive growth is also reported byProtopopov&Feyler (2016) for year 2014, 2015. From this the contribution of capital, labor, energy and raw material are obtained as follows: the partial elasticity of output with respect to capital of 0.16 is multiplied by the average annual rate of growth of capital of 9.2 percent. This yielded the contribution of capital of 1.5 percentage points which works out to be 10.32 percent. Similarly, the partial elasticity of output with respect to labor of 0.9is multiplied by its rate of growth which was7 percent per annum. This yielded the contribution of labor at 6.5 percentage points per annum which is 4.52 percent. Partial elasticity of output with respect to energy of 0.95 is multiplied by the average annual rate of growth of energy of 11.4 percent. This yielded the contribution of energy of 10.81 percentage points which works out to be 75.76 percent. Partial elasticity of output with respect to raw material of 0.14 is multiplied by the average annual rate of growth of raw material of 9.6 percent. This yielded the contribution of raw material of 1.34 percentage points which works out to be 9.4 percent. The estimatedsum 1.34 is indicating that the steel sector in Pakistan experiences increasing

[12]Metallurgical coal (coking coal) is the primary source of carbon used in steelmaking.

returns to scale. This reveals that a 100% increase in factors of production will result in a 134% increase in production.

Table 5: Sources of Steel Output Growth: 1990 to 2020

Sources of Growth	Percentage Contribution
Capital	10.32
Labor	4.52
Energy	75.76
Raw material	9.4
Total	100.00

Note: Computed from the estimates contained in Table 4a

As we observed that raw material is the third largest source of growth in the steel sector. Therefore, it is essential to investigate the pass through of exchange rate in the imported prices of steel. The Table 5, provides long-run equilibrium coefficients of ERPT models. As can be seen, NEER (e) has positive estimated value and significant, when we ignore the exporters' production costs (w) and the domestic demand (y) meaning depreciation of domestic currency (PKR)against the trading partners' currency increase the import prices of steel by 3.5%. The result that NEER has a positive impact on import prices of steel is supported by previous research. For example, a study by Bahmani-Oskooee and Rhee (1996) found that exchange rate depreciation increases import prices in developing countries. Another study by Gruber and Kamin (2007) found that exchange rate movements can have a significant impact on import prices in the United States. However, the result that ignores the exporters' production costs and domestic demand is biased. This is because these factors can influence the price of imported steel in different ways. For example, if exporters face higher production costs, they may not be able to lower their prices in response to a depreciation of the domestic currency. Additionally, if there is weak domestic demand for steel, importers may be able to negotiate lower prices, regardless of the exchange rate.

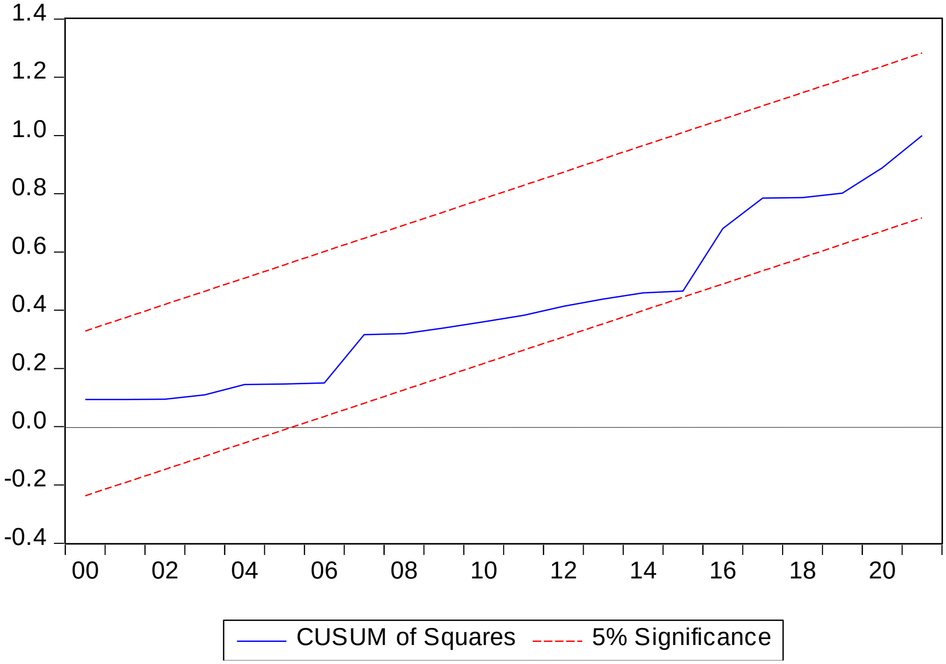
When we complete the model by incorporating exporters' production costs and the domestic demand we found that actual cause of higher import prices of steel is the exporters productions cost and has positive effect on the steel import prices. Similarly, there is an evidence of positive association between steel import prices and domestic demand, meaning that an increase in domestic demand would lead to an increase in import prices. These findings are consistent with previous research (e.g. Hong and Zhang, 2016, Jalil 2021). This result is also supported by Oskooee&Goswami (2003). Their findings show that the impact of exchange rate changes on the trade balance varies significantly depending on the type of goods being traded. In particular, they find that the impact of exchange rate changes on the import price of goods is smaller for goods with high exporters' production costs and low domestic demand. This suggests that ignoring the exporters' production costs and the domestic demand can lead to biased and inaccurate results when analyzing the impact of exchange rate changes on import prices.

Short-run dynamic parameters of the ERPT model Eq. (4) are estimated through the error correction model (ECM) which is related to the long-run estimates. The ECM regression is presented in Table 6. It can be seen from the results again domestic demand and exporters production costs matter a lot as they derive the import price of steel rather than depreciation of rupee.

Table 6: Error Correction Model of ERPT

Variable	Coefficient	t-Statistic	Prob.
Δw_t	0.55***	3.82	0.01
Δy_t	8.11***	7.30	0.01
ECM_{t-1}	-0.58***	-4.50	0.01
Ramsey RESER Test	1.50 (0.23)		

Figure 6. A plot of CUSUM Squares Test



6-Conclusion and Recommendations

This study highlights the importance of Steel industry which delivers essential inputs for the Pakistan's industrial economic growth and development. The overall objective is twofold. First to find the sources of growth for steel industry in which we are interested in estimating the percentage contribution resulting from input (labor, capital, energy, raw material) utilization, technological progress, and economies of scale. Time series has been selected over the period 1990 to 2020. The study tries to find , if raw material is a significant contributor then how the exchange rate pass through the prices of imported raw material.

Employing the Autoregressive Distributed Lag (ARDL) co-integration method and bounds test confirmed the existence of the long run relationship.The technical change parameter is smaller in magnitude and shows negative sign. It is indicating the fact that the steel industry in Pakistan is dominated by small factories that use outdated technology. This results in a higher cost of production and lower quality output compared to steel-exporting countries. Many melting, re-rolling, and fabricating firms in particular have small factories with less capacity to produce and use outdated technology, which makes it more difficult for them to compete with other countries in terms of quality and efficiency.

In the ERPT model, the short-term dynamic parameters are estimated using the error correction model (ECM) which is linked to the long-term estimates. The findings indicate that the import price of steel is primarily influenced by domestic demand and exporters' production costs rather than the depreciation of the rupee.

Therefore, it is recommended that Pakistan should have timely comprehensive economic policy to support steel sector. Efforts should be done for technology enhancement as still there is use of old techniques & obsolete methods. Encouragement of competitive environment is required. The country should try to bring cost of business to minimum possible level in order to compete in the world.

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