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Empirical investigation of the S-curve phenomenon in Pakistan-China commodity trade

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Abstract

This study investigates the short-term effects of currency depreciation on the trade balance between Pakistan and China, with a specific emphasis on analyzing the industry-level S-curve phenomenon. Employing a quantitative research design and utilizing time-series data, the research employs correlation analysis to explore the presence of the S-curve phenomenon across 26 industries. The findings highlight the industry-specific nature of the S-curve phenomenon, underscoring the insufficiency of currency devaluation as a standalone strategy for maintaining a stable trade balance. Consequently, policymakers are advised to consider industry-level factors when formulating trade policies. This study challenges the conventional use of the Consumer Price Index (CPI) in aggregate settings, where its inclusion of diverse goods frequently leads to misleading results. Instead, we take a novel approach by developing a commodity-based CPI tailored to bilateral trade between countries. The findings have practical relevance in guiding policy decisions regarding commodity trade, while the industry-wise analysis enriches the understanding of the short-term effects of currency depreciation on trade balance dynamics.

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1. Introduction

The connection between the trade balance and the actual exchange rate is one of several aspects of international economics that have attracted a great deal of attention. Researchers were only concerned with the long-term effects of devaluation on the trade balance through estimation and confirmation of the well-known Marshall-Lerner condition before the current floating exchange rate regime, which entered into effect in 1973. According to a 1973 theory by Junz, Rhomberg, and Magee (1973), adjustment lags may cause a devaluation or depreciation to have short-term consequences on the trade balance that is different from its long-term effects. They argued that maintaining a devaluation policy will not prevent a nation's trade balance from getting worse in the short run. The "J-Curve" phenomenon results from the fact that the trade balance will continue to deteriorate before it improves. Bahmani-Oskooee (1985) provided a candid trade balance model that was used to show how one can evaluate the J curve Phenomenon through regression analysis. The short-run relationship between the trade balance and the real exchange rate was examined differently by Backus et al. (1994).

Backus et al. (1994) alternatively examined the short-run relationship between the trade balance and the real exchange rate. Using the general equilibrium approach, they demonstrated that the current exchange rate and the anticipated future values of the trade balance have a positive cross-correlation. However, there is a negative link between the present exchange rate and previous trade balance values. They call their discovery the "S-Curve" because it resembles the letter S on a plot of the cross-correlation coefficients against the number of leads and lag values needed to calculate them. On further investigation, Bahmani-Oskooee and Ratha (2007a) disaggregated the US data by trade partners and found that the disaggregated data at the bilateral level provides greater support for the S-curve. Bahmani-Oskooee and Ratha (2007b) examined bilateral data between Japan and its trading partners that provide similar support for the S-curve. Caporale et al., (2017) studied the existence of the behavior of the S-curve in Colombia using quarterly data from 1991 to 2014 at the bilateral and aggregate levels. The study found support for the existence of the S-curve in 30% of all industries. Bahmani-Oskooee and Xu (2010) studied the trade pattern between the United States and Hong Kong to test the existence of an S-curve. The existence of the S-curve was reported in 34 out of 104 industries that traded between the US and Hong Kong.

Some studies in the literature have also examined the S-curve phenomena using aggregate data. By combining trade data from 59 developing countries, Parikh and Shibatha (2004) provide more support in favor of the S-curve. Looking for nations that are not included in the list above. In their research, Bahmani-Oskooee et al. (2008b) identify the S-curve pattern for eight of the 20 African countries. Finally, Bahmani-Oskooee et al. (2008c) look at the S-curve for 10 emerging markets in Central and Eastern Europe using monthly data from roughly 1990 to 2005. Strong evidence of an S-curve is found in the case of Bulgaria, Croatia, Poland, and Slovakia; weak evidence is found in the cases of the Czech Republic, Hungary, and Turkey; and there is no support in the cases of Cyprus, Romania, and Russia. Bahmani-Oskooee and Ratha (2007b) estimate the S-curves between the United States and its 24 trading partners while utilizing the disaggregate level trade data to address the issue of aggregation bias. The study indicates S-curves have substantially stronger support in favor of the S-curve. Likewise, Bahmani-Oskooee and Ratha (2007c) used quarterly bilateral-level trade data from 1980 to 2005 and found greater support for the S curve for Japan against her 12 trading partners.

The third category consists of research work that has broken down bilateral data between the two countries by commodity to account for the second aggregation bias that was supposed to exist in bilateral-level trade data. For example, Bahmani-Oskooee and Ratha (2008)

disaggregated the bilateral trade at industry-level data between the US and the UK to look for evidence of the S curve in a total of 52 industries. The study shows evidence of the S curve in a total of 36 industries. Similarly, Bahmani-Oskooee and Ratha (2009a) find that 41 of 60 industries exhibit the S-curve pattern when applying the same approach to commodities trade between the USA and Canada. The S-curve at the commodity level between the USA and China was further investigated by Bahmani-Oskooee and Ratha (2009b); 104 industries were taken into account in their investigation. Approximately 50% of industries supported the S-curve. Similar to this, Bahmani-Oskooee and Ratha (2009a) extend the same study to commodity trade between the USA and Canada and find that 41 of 60 industries exhibit the S-curve pattern. The analysis was extended to the US and China by Bahmani-Oskooee and Ratha (2009b) to look for evidence of the S curve between the two countries while considering 104 industries between the two countries. In almost 50% of industries, the S-curve was accepted.

Bahmani-Oskooee and Ratha (2010) discovered evidence of the S curve pattern for trade between the USA and India in 15 of 27 industries from 1973 to 2004. In the case of Pakistan, a series of studies have systematically contributed to the comprehension of trade dynamics pertaining to Pakistan, with a particular emphasis on the J-Curve phenomenon. A study conducted by Iqbal, Khan, and Nosheen (2019) investigates aggregated and commodity-level trade flows between Pakistan and the SAARC region in order to provide empirical support for the J-Curve. Expanding upon this, Iqbal et al. (2021) conduct an exhaustive bilateral analysis by employing a variety of frameworks to extract nuanced insights. Bahmani-Oskooee, Iqbal, and Nosheen (2016) and Iqbal et al. (2015) make further contributions to the field by examining commodity trade with the United States and the Marshall-Lerner Condition in bilateral trade, respectively. Kousar et al. (2017) studied the behavior of the S-curve for a total of sixteen industries. Only Six industries supported the S-curve, which means that these industries have a positive correlation with the devaluation of the currency. Similar to the J-curve study, disaggregated data appear to provide the most compelling arguments in favor of the S-curve. Ahmad, S., et al. (2023) also studied the dynamics of the asymmetric behavior of the S-curve between Pakistan and Japan commodity trade. The findings show that eleven out of fifteen industries support asymmetry. It means that the exchange rate appreciation or depreciation has a different response to the trade balance of a country.

We focus on trade relations between Pakistan and China. Pakistan is an important South Asian economy with a total GDP of $312.57 billion in 2018. Given that Pakistan shares a border with two economic giants, China and India. Pakistan's geostrategic location is of key significance. China holds an 8.5 percent trade share, making it Pakistan's second-largest trade partner. The volume of trade between Pakistan and China has grown over time. The official statistics provided by Pakistan's Ministry of Commerce show that trade between the two countries increased from $4.8 billion in 2007 to $16.4 billion in 2018. China is Pakistan's second-largest export market, and the government has been actively working to boost exports to that country by providing special subsidies to the business community, promoting industrialization throughout the country, and collaborating closely with the businesses and Chinese government to better understand Chinese market demands. Pakistan's second-largest export market at the moment is China. Recently, a multibillion-dollar agreement known as CPEC was announced between Pakistan and China (China-Pakistan Economic Corridor). However, the amount has already surpassed $60 billion. China had planned to invest $46 billion in infrastructure, energy, transportation, and industry. In addition to CPEC, bilateral commerce between Pakistan and China has reached over 16 billion US dollars and has room to expand (Ullah et al., 2018). TB, however, is heavily biased in China's favor. Pakistan must therefore look into potential factors that could help balance China and Pakistan better and increase commerce between the two countries. The monetary authorities in Pakistan have most

frequently used the exchange rate policy tool, although there has not been any good development in this area. The current study presents a detailed analysis of the trajectory taken by the trade balance in the aftermath of excessive depreciation (devaluation). The current study seeks to analyze the pattern of the S-curve phenomena between Pakistan and China at the industry level, across 26 industries that trade between the two countries.

It is important to note that we have considered a wide variety of industries including small and large industries in the manufacturing sectors. The same is also true for durables and non-durable commodities. Some industries are excluded from the list due to unavailability of data. We have taken a great interest and targeted China which is the growing economy in the world and the largest trading partner of Pakistan in terms of imports. The trade deficit of Pakistan with China is $43 billion because the economy of Pakistan relies on imports from China. Thus, when the Government depreciates the currency, it affects the trade balance negatively. In the existing study, we are testing the economic theory that depreciation affects the trade balance of the economy positively. Therefore, we have taken a great interest in China-Pakistan commodity trade and this study has some implications for other economies where their trade is in deficit. Thus, our findings show that depreciation fails to bring a favorable impact on the trade balance of Pakistan when it is involved in trade with China.

The remaining portions of the study are structured in a way that part II presents data and methodology. The results and their analysis are presented in section III, and the study's conclusion and suggestions are presented in section IV.

2. Data and Methodology

Following the methodology used by Bahmani-Oskooee and Ratha (2010), who examined the behavior of the S-curve at the industries level for China, we aim to investigate the pattern of the S-curve between Pakistan and China at the industry level in order to avoid "aggregate bias" associate with the aggregate level trade data. To carry out the empirical analysis, the present study utilizes time series data from 1980 to 2020 for twenty-six (26) industries/commodities at 3-digit levels. The 3-digit levels based on the standard International trade classification, also known as SITC, is a product categorization used by the United Nations (UN) for external trade data (goods volumes and values at export and import), enabling cross-border comparisons of manufactured goods and raw materials. A hierarchical system of codes used by SITC to express various levels of detail is as follows: The broadest categories include things like food and live animals, equipment, chemicals, etc. The categories get more specific as you go down the hierarchy, allowing for a more thorough classification of the products. All industry-level trade data have been taken from World Integrated Trade Solution (WITS) which in turn receives the data from the United Nations COMTRADE database. The data regarding other variables such as GDP and exchange rate have been taken from the World Development Indicators and International Financial Statistics while the CPI data has been constructed commodity-based and used the commodity-specific CPI.

As Pakistan is the reported country, we defined the variables from Pakistan's perspective. Thus, the trade balance is our dependent variable which is defined as the difference between Exports and Imports and divided by the GDP of Pakistan $\frac{Xi-Mi}{\mathrm{GDP_{Pak}}}$, as the same procedure was also used by Bahmani-Oskooee and Xu (2010, 2013, 2014). Where Xi indicates Pakistani Exports of the industry i to China, Mi denotes Pakistani Imports of the same industry from China and the Gross Domestic Product of Pakistan is represented by GDP_{pak}, the entire data has been taken in nominal values. The other variable in the construction of the cross-correlation coefficient is the RER. The real Exchange Rate is indirectly defined in this study where RER

equals $((Commodity\ Prices_{PAK} \div Commodity\ Prices_{CHN}) \times NER)$. Here, NER refers to the nominal exchange rate defined as the number of rupees per Renminbi using the bilateral CPI of that commodity. We have criticized the existing literature which has used a country-specific index for CPI containing baskets of hundreds of commodities which is misleading. However, in this study, we contribute by constructing industry/commodity-specific CPI for each commodity that is not used in the existing literature on J and S-curves. Therefore, an increase on the right-hand side (nominal exchange rate) will transform to the other side and increase the real exchange rate. This increase reflects foreign currency (Renminbi) appreciation or depreciation of the domestic currency (rupee). In this context, the domestic currency means Pakistani currency and foreign currency means Chinese currency. To have favorable effects of the rupee's depreciation on net exports of industry i, the contemporaneous correlation coefficient where K= 0 should appear with positive values. If the Pakistani rupee depreciates and the Chinese Renminbi appreciates, it will have a positive effect on net exports. According to economic theory, initially, the trade balance becomes worse due to the depreciation of the currency in the short run, and in the long run, the trade balance will improve, how is this possible? Its economic logic is that due to the depreciation of the rupee, Pakistani products will be cheaper for foreign investors and they will increase the demand for Pakistani currency, and the trade balance will improve. But over time, the currency appreciates and so the local products will be expensive for the foreign investors, and there will be a decline in the demand for that currency. Due to this, the trade balance starts worsening again which makes the S-curve shape. By studying the past literature, we defined the cross-correlation function through the following formula:

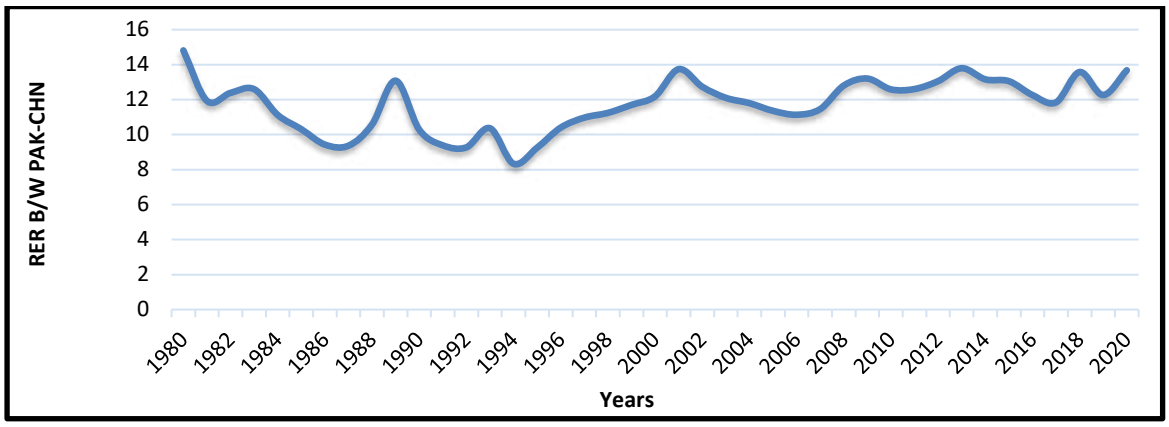
$$COR = \frac{\sum(RER_t - \overline{RER})(TB_{t+k} - \overline{TB})}{\sqrt{\sum(RER_t - \overline{RER})^2 \quad (TB_{t+k} - \overline{TB})^2}}$$

Where $\overline{RER}$ and $\overline{TB}$ depict the mean values of all data points of the real exchange rate and net exports respectively. We establish the cross-correlation between the exchange rate and TB and use these coefficients to get to the S-curve, whereas the lags (past) values must be negative and lead (future) values must be positive. If k is allowed to take positive values (1, 2, 3, 4, 5….), it is a representation of the COR between the present exchange rate and future trade values while if k takes negative values (-1, -2, -3, -4, -5…..), it represents the correlation between the values of present exchange rate and past trade balance. If we plot the constructed COR coefficient of leads and lags, then we get the pattern of the S-curve.

3. Results and Discussion

The behavior of the S-curves can now be reported in this part of the article. Time series data has been taken from 1980 to 2020 are used to carry out the study. The first step using Bilateral trade data between Pakistan and China commodity trade to confirm past studies. Figure 1 explains the behavior of the real exchange rate between Pakistan and China. The figure depicts that the Pakistani exchange rate is volatile e-i., appreciates and depreciates. The downward trend in the real exchange rate shows that Pakistani currency appreciates while the upward trend shows the depreciation of the Pakistani rupee. There is no secular trend rather it is showing a mean-reverting behavior.

Figure 1: The exchange rate between PAK-China



Source: Authors' compilation

We present the data in Table 1 in a simplified way and for a comprehensive explanation, we made Table 2 based on estimated results. To save space in the journal, we first present a summary of our findings for all industries in Table 1 by listing the name, SITC code, and average trade share of each industry for the most recent year, 2020. The Standard international trade classification, also known as SITC, is a product categorization used by the United Nations (UN) for external trade data (goods volumes and values at export and import), enabling cross-border comparisons of manufactured goods and raw materials.

Table 1: S-curves in Pak-China industries

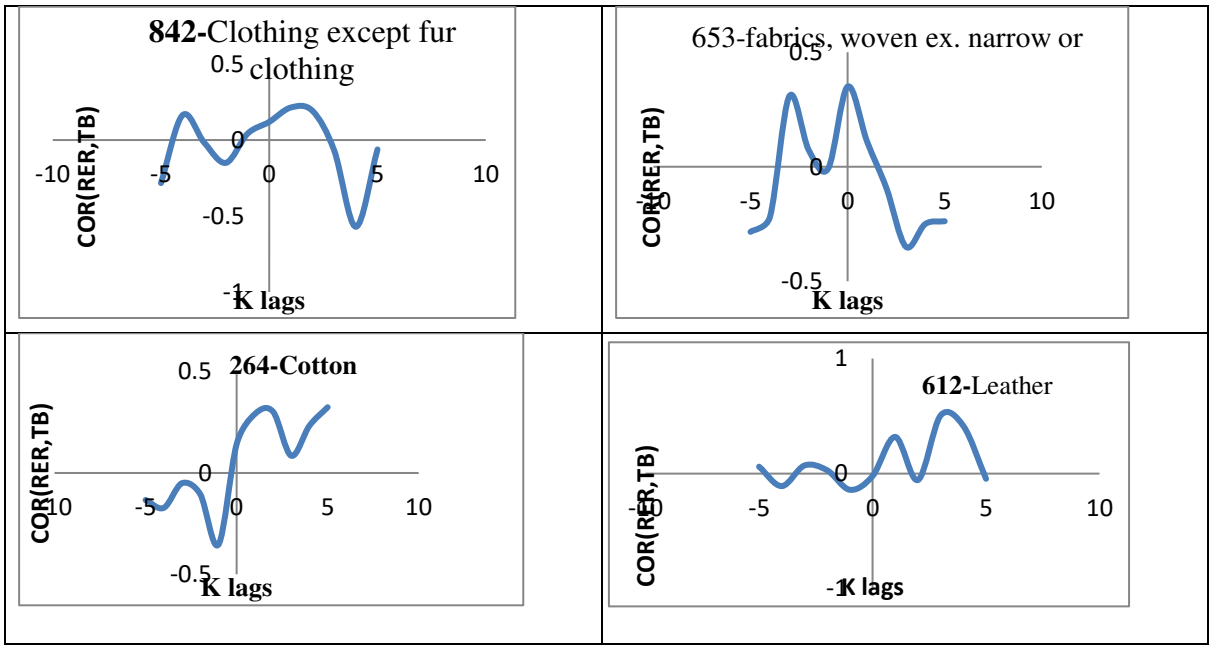
SL	Industries	Code	Trade Shares %	S-curve
1	Clothing except fur clothing industry	842	0.06	No
2	Cotton Fabrics, woven ex. narrow or	653	2.06	No
3	cotton industry	264	1.18	**Yes**
4	Crude vegetable materials n.e.s.	321	0.022	No
5	Crude animal vegetable n.e.s	292	0.64	No
6	Dried fruit including artificially	052	0.338	**Yes**
7	Floor coverings, tapestries, etc	661	0.067	No
8	Footwear industry	661	0.05	No
9	leather industry	612	0.004	No
10	Household equipment of base metals	698	0.004	No
11	Machinery & appliances nonelectric	722	0.83	No
12	Made up articles, wholly or chiefly	657	0.202	No
13	Manuf. of leather or of artif. Or r	613	0.0009	No
14	Manufactured articles, n.e.s	931	0.01	No
15	Mineral manufactures, n.e.s.	664	0.01	**Yes**
16	Ores & concentrates of non-ferrous	284	2.207	No
17	Perambulators, toys, games & sports	895	0.08	No
18	Printed matter	893	0.007	No
19	Road motor vehicles	733	0.76	No
20	Scientific, medical, optical, means	862	0.034	No
21	Special transactions not classified Acc	941	0.134	No
22	Text fabrics woven ex narrow, spec	654	0.045	No
23	Textile yarn & thread	652	11.18	No

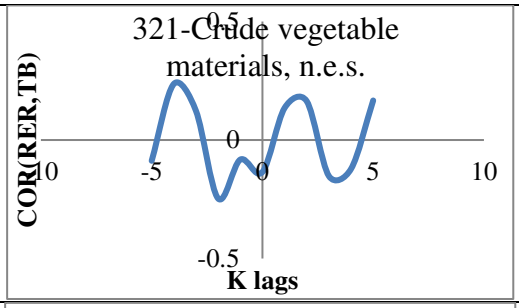
24	Wool & other animal hair	263	11.18	**Yes**
25	Medicinal & pharmaceutical products	551	0.76	**Yes**
26	Pearls in precious & semi-precious.	671	0.036	No

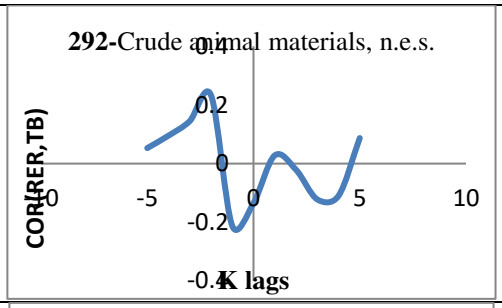
Source: Self Constructed

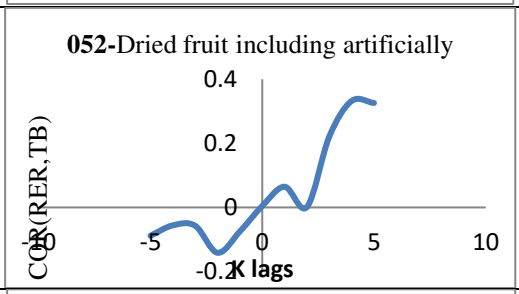
Table 2 clearly shows that the S-curve is validated in only five industries out of twenty-six. This inference is based on the plot of cross-correlation coefficients of all five lags and leads values. It appears that rupee (Pakistani currency) depreciation will benefit the trade balance of these five industries (Cotton, Dried fruit including artificial, Mineral manufacturing, n.e.s., Wool & Other animal hair, and Medicinal & Pharmaceutical products) in the future, and thus the correlation between current exchange rate and future trade balances are positive. Pakistan's industries exhibit a varied profile in terms of size, product durability, and overall attributes, as demonstrated by their respective codes and bolstered by S-curve evidence. The cotton industry (Code: 264) is a cornerstone of the textile sector, with a diverse range of enterprises ranging from large-scale mills to small-scale operations, and its products, particularly textiles, are classified as durable goods. The dried fruit industry, including artificially dried variants (Code: 052), on the other hand, has a diverse landscape with both large processors and smaller, local producers, primarily dealing with non-durable goods due to the perishable nature of their products. The mineral manufacturers (Code: 664) category reflects diversity in both product range and enterprise size, with durability varying depending on specific mineral products. The wool and other animal hair industry (Code: 263) is similar to the cotton sector in that it contributes to textiles with a mix of large and small players, whereas pharmaceutical products (Code: 551) highlight a diverse pharmaceutical sector with both large and specialized firms, primarily dealing with non-durable goods due to the consumable nature of pharmaceuticals. This nuanced understanding serves as a foundation for informed decision-making, policy formulation, and strategic planning in Pakistan's dynamic industrial landscape.

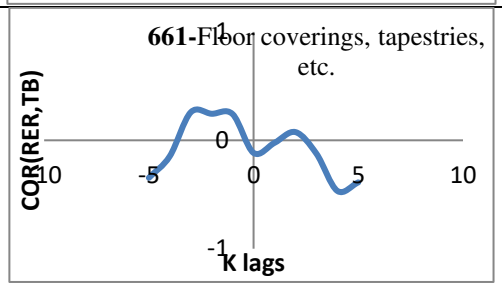
Table 2: S-curve in industries of Pak-China

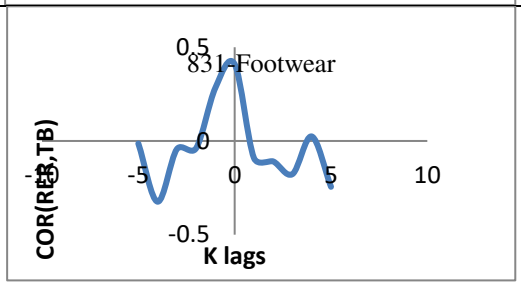


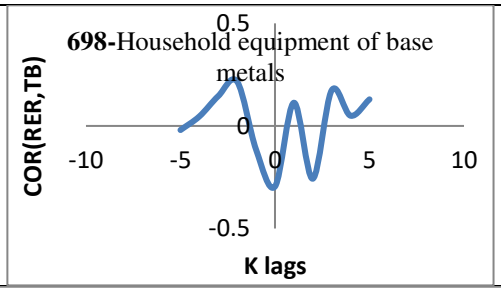

321-Crude vegetable materials, n.e.s.
COR(RER,TB)
K lags

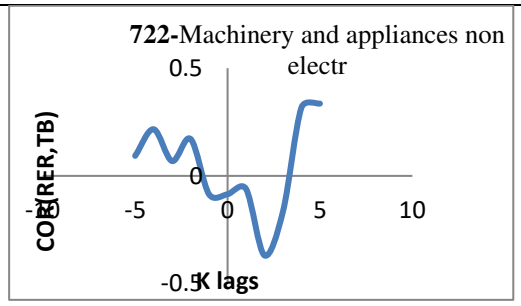

292-Crude animal materials, n.e.s.
COR(RER,TB)
K lags

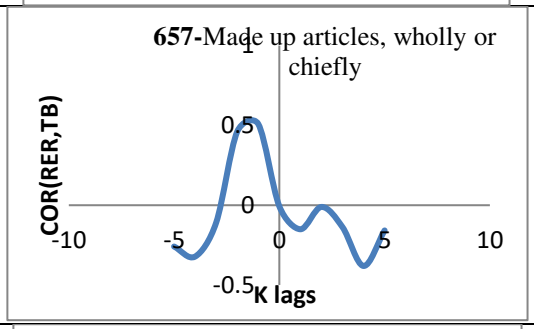

052-Dried fruit including artificially
COR(RER,TB)
K lags

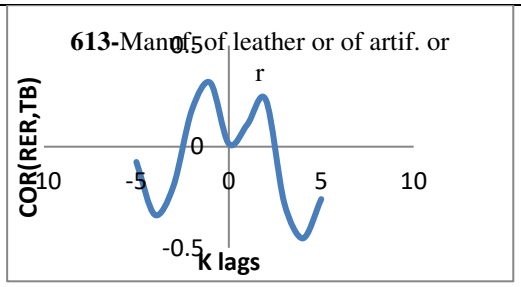

661-Floor coverings, tapestries, etc.
COR(RER,TB)
K lags

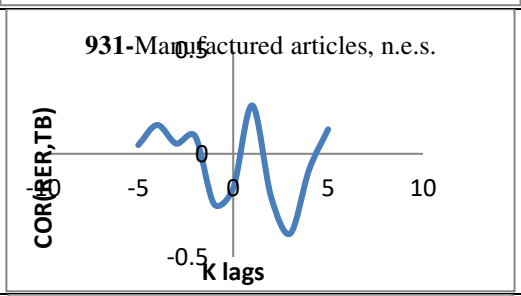

831-Footwear
COR(RER,TB)
K lags

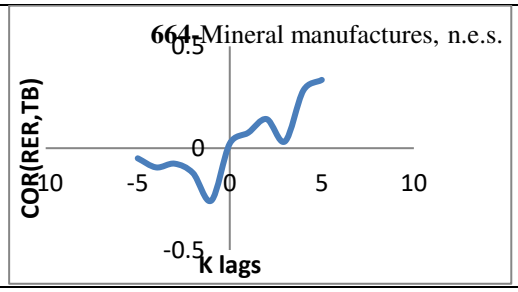

698-Household equipment of base metals
COR(RER,TB)
K lags

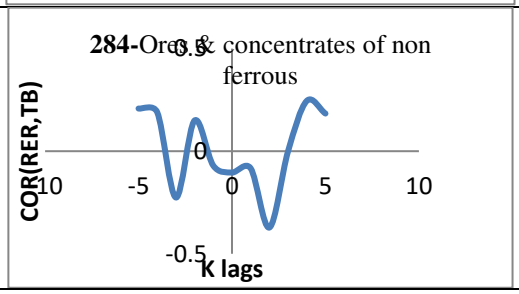

722-Machinery and appliances non electr
COR(RER,TB)
K lags

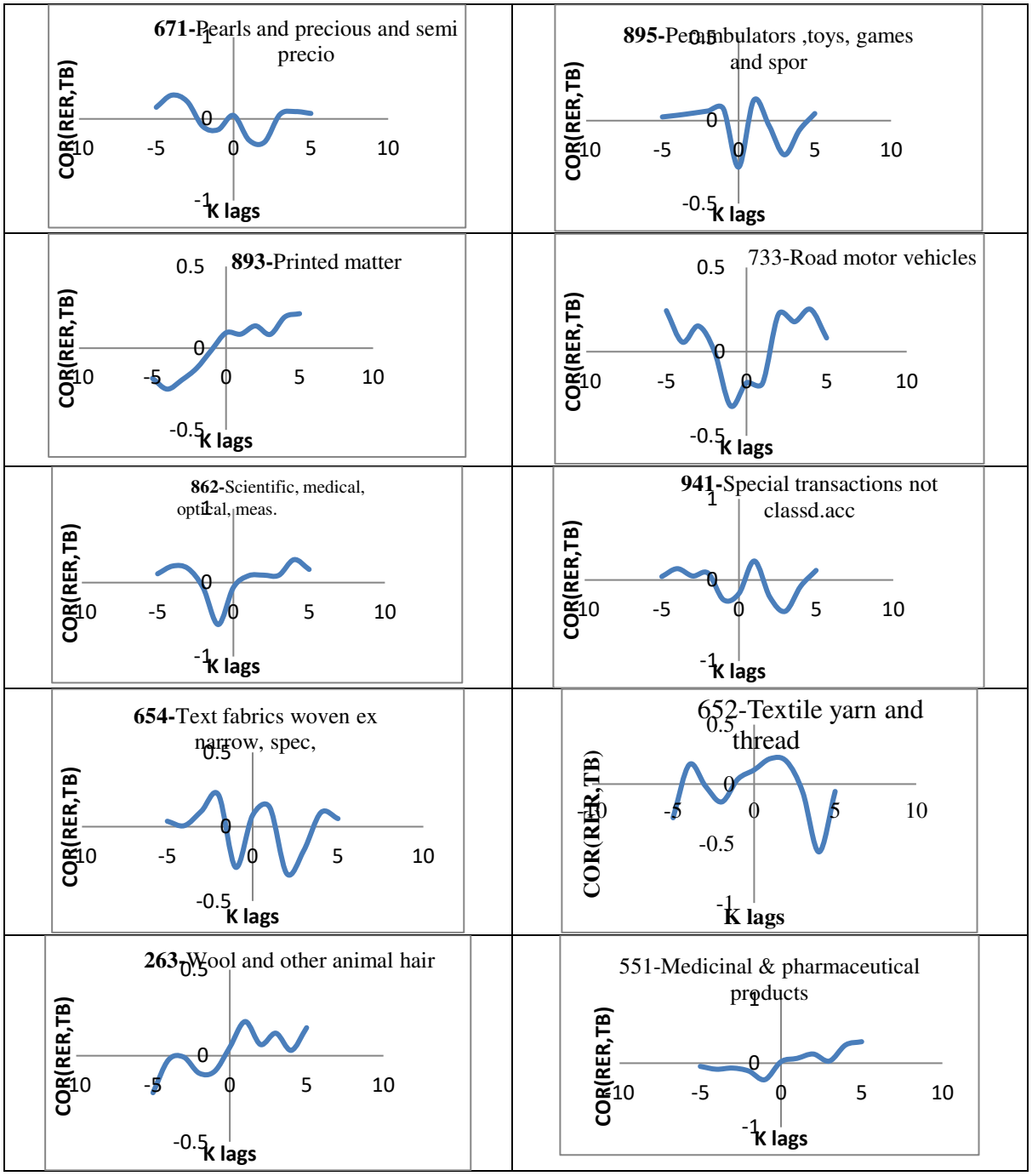

657-Made up articles, wholly or chiefly
COR(RER,TB)
K lags


613-Manuf of leather or of artif. or r
COR(RER,TB)
K lags


931-Manufactured articles, n.e.s.
COR(RER,TB)
K lags


664-Mineral manufactures, n.e.s.
COR(RER,TB)
K lags


284-Ores & concentrates of non ferrous
COR(RER,TB)
K lags



S-curve patterns in these industries correspond to well-established economic theories, particularly the Product Life Cycle Theory. Industries go through phases of introduction, growth, maturity, and decline, as evidenced by the rapid expansion of the pharmaceutical sector following innovation. Technological advancements, which are critical for innovation-driven industries like pharmaceuticals, contribute to slow initial growth followed by rapid expansion. Market saturation or maturity, as seen in wool, also explains S-curves. Global economic trends, such as those affecting cotton, influence demand through trade policies and consumer preferences. Changes in consumer preferences and processing techniques in dried fruit drive industry growth. Through global partnerships and legislative changes, trade dynamics, as reflected in trade shares, have an impact on industries such as pharmaceuticals. The observed S-curve patterns might also be the result of a combination of factors such as product life cycle

dynamics, technological breakthroughs, market maturity, global economic trends, innovation, and trade dynamics, allowing for a comprehensive understanding of each industry's unique trajectory.

The absence of the S-curve in Table 2 is attributed to aggregation bias. This absence is widespread across the majority of industries, and the underlying economic rationale lies in the context of bilateral trade between Pakistan and China. Given China's status as the world's leading economy and its position as Pakistan's primary import partner, the trade dynamics reveal a substantial trade deficit of $43 billion due to currency depreciation. Despite the depreciation theoretically favoring exports, the actual impact on improving the trade balance is minimal. Commodity attributes, as analyzed in this study, do not emerge as significant contributors. The remaining twenty-one industries that do not exhibit a correlation with rupee depreciation may be characterized by low demand elasticities. This observation aligns with the findings of Bahmani-Oskooee and Hegerty (2011). Notably, in the industries where the S-curve is observed, the presence of a J-curve precedes it.This suggests that, in these particular industries, both the J-curve and S-curve phenomena coexist. Therefore, the study concludes that the J-curve also manifests in these five industries. Key items in Pakistan's export portfolio to China include cotton, textiles, agricultural products, leather goods, minerals, and sports products. In return, Pakistan imports machinery, electronics, chemical products, textiles, apparel, consumer goods, and footwear from China. Notably, Pakistan holds a prominent position as a major exporter of cotton and rice products to China, ranking as the sixth-largest rice exporter globally. However, a significant challenge arises as Pakistan tends to export these goods in their raw or primary form, lacking conformity with international standards. Consequently, the quality gap results in lower export earnings. Adding to the trade imbalance, China enhances the quality of the imported products and subsequently re-exports them to Pakistan at elevated prices, contributing to Pakistan's trade deficit with China.

4. Conclusion and Recommendations

A persistent trade imbalance characterizes Pakistan's economy. Policymakers have assessed the effectiveness of the exchange rate policy in addressing the issue of trade imbalance. In this study, we look for evidence of the S-curve phenomenon to ascertain how different industries respond to changes in the exchange rate. To test this, we examine 26 industries in our data set. The absence of an S-curve for industries is indicative of the fact that devaluation has no discernible impact on the trade balance, whereas the existence of the S-curve suggests the opposite. It is evident from empirical studies that S-curves are absent in the majority of industries. Five industries are the only ones to exhibit an S-curve. If we observe it closely, first the J-curve exists in these industries initially which is followed by the S-curve. Majority of the industries don't support J and S-curve, because Pakistan has a huge trade deficit with China to the tune of $43 billion. If the Pakistani currency experiences depreciation, the trade deficit is supposed to increase. Thus, depreciation is not a fruitful option for Pakistan to enhance the trade balance. The empirical results indicate that devaluation benefits just a limited selection of industries rather than having a favorable impact on most of them.

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