IMPACT OF THE EXCHANGE RATE ON THE INTERNATIONAL TRADE IN CEARÁ FOOTWEAR - 1997-2019

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Como citar: SILVA FILHO, L. A.; MORAIS JUNIOR, A. C.; SANTOS, P. L.; SIQUEIRA, R. M. Impact of the exchange rate on the international trade in Ceará footwear (1997-2019). *Revista Análise Econômica e Políticas Públicas - RAEPP*, v. 6, n. 2, p. 2-19, 2023.

Abstract: This article analyzes the relationship between the exchange rate and footwear exports from Ceará from 1997 to 2019. To this end, an empirical exercise was used, based on the use of econometric techniques in time series applied to data from the Secretariat of Foreign Trade (SECEX) of the Ministry of Development, Industry and Foreign Trade (MDIC) and the *Bank for International Settlements* (BIS). The results show that Ceará has a substantial share in Brazilian footwear exports and maintains a significant share of its export revenues in the footwear sector despite the reduction recorded in recent years. The econometric tests do not confirm a statistically significant relationship between the exchange rate and footwear exports from Ceará. Therefore, it is inferred that other variables not observed in this study contribute to the state's trade, with the exchange rate not being relevant for exports from the Ceará footwear sector in the period analyzed.

Keywords: Time series econometrics. Footwear exports. Exchange rate. Ceará.

Resumo: Este artigo tem como objetivo analisar a relação entre a taxa de câmbio e as exportações de calçados do Ceará no período de 1997 a 2019. Para isso, recorreu-se a um exercício empírico, a partir do uso de técnicas de econometria em séries temporais aplicadas aos dados da Secretaria de Comércio Exterior (SECEX) do Ministério do Desenvolvimento, Indústria e Comércio Exterior (MDIC) e do *Bank for International Settlements* (BIS). Os resultados mostram que o Ceará tem participação substancial nas exportações brasileiras de calçados, bem como mantém no setor calçadista parcela expressiva de suas receitas com exportações, apesar da redução registrada nos últimos anos. Os testes econométricos utilizados não confirmam uma relação estatisticamente

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significante entre a taxa de câmbio e as exportações de calçados do estado do Ceará. Portanto, infere-se que outras variáveis não observadas neste estudo contribuem para o comércio do estado, não sendo a taxa de câmbio relevante para as exportações do setor calçadista cearense no período analisado.

Palavras-chave: Econometria em séries temporais. Exportações de calçados. Taxa de câmbio. Ceará.

1 Initial Considerations

Relevant discussions have been held regarding the main determinants of trade relations between countries worldwide. The exchange rate, the distance between countries, and preferential agreements have been highlighted. In this sense, specialized scientific production suggests that macroeconomic transformations observed over the years can affect these economic relations. Therefore, in addition to presenting new evidence, revisiting the results found in the literature in recent decades is opportune.

Understanding the determinants of international trade can be associated with a microeconomic approach, such as that cited in the studies by Machado Neto (2006), which suggests that what initially determines the entry of underdeveloped countries into international trade are comparative advantages in production. Therefore, only after developing more efficient production techniques do companies in this group of countries begin to add value to their products, achieving a competitive advantage in production. This approach is based on the microeconomic assumptions that economies of scale produced by firms are relevant for their entry into and permanence in foreign trade relations. However, more recent studies show that the organization of production encompasses a diversity of possibilities that extend to the advancement of economic restructuring dynamics and permeate the firm's perspective as an inducer of the very process of entry into and permanence in foreign trade.

Using another analytical approach, Guidolin *et al.* (2010), analyzing the footwear sector, demonstrated in their study that low production costs alone do not determine the success of a footwear industry, in which the manufacturing production system ceases to be the primary determinant of competitiveness. As a result, the value of the sound produced determines how it is marketed. In other words, countries with competitive advantages revealed in their stages of development of footwear production, that have a distribution of the production chain and investments in marketing and design, can stand out, gaining space previously occupied only by industries that operated through low-cost production mechanisms.

Marconi and Rocha (2012) suggest that, from the perspective addressed by macroeconomic issues of foreign trade, the exchange rate directly influences the level of external competitiveness of a country when there is a definition in the relationship between prices of non-tradable and tradable goods, with an exchange rate depreciation favoring the country's trade balance by reducing imports and increasing export levels, and an exchange rate appreciation unfavoring the trade balance, as it increases imports and reduces export levels.

Similarly, Veríssimo and Xavier (2013) emphasize that the exchange rate plays a vital role in a country's economic growth, where a more competitive – depreciated – exchange rate stimulates investments and exports, providing higher economic growth.

However, it is worth emphasizing that the productive structure and integration into the international market must have preceded the exchange rate dynamics for the country to, in fact, be able to maintain its participation in foreign trade relations.

Carmo *et al.* (2014) add that a volatile exchange rate can directly influence the quantity of products a country trades with its trading partners. As a result, an appreciated exchange rate increases the cost of a company entering the international market, making it difficult to achieve the level of competitiveness required for this trade to occur and for the company to enter the international market. After analyzing the data in a gravity trade model, the authors, as mentioned earlier, found, as the main result, that high volatility of the exchange rate causes a significant reduction in the number of products traded by the country to trading partner countries, causing them to have a reduced share of their export agenda.

Meanwhile, other issues can be reported on the influence of foreign trade and the exchange rate. Braga and Oliveira (2018) were concerned with demonstrating how significant impacts on the exchange rate and variations in world income influence a country's exports. After implementing the chosen methodology, through the application of econometrics in time series, they verified that only one of the variables, world income, was relevant to explain long-term fluctuations in exports and demonstrate that an excellent international situation directly influences the quantity of *commodities a country exports*. On the other hand, the exchange rate showed a relationship contrary to that commonly indicated by economic theory; however, it had a significant coefficient in the study, in which its greatest influence was in the short term. Still, this imbalance is corrected in the long term.

Concerning footwear, the central focus of this analysis, Anderson's (2001) study on footwear exports from MERCOSUR countries, showed that even with trade agreements and the elimination of tariff barriers between members of the bloc, other measures act as obstacles to trade between these countries, such as non-tariff barriers, which the author identifies. The author concluded that Brazilian footwear exports face three main non-tariff barriers: i) changes in the consumer protection code of the importing country, creating obstacles to the entry of Brazilian products; ii) requirement of a prior license to export the footwear granted to importers; iii) limitation on the number of imported pairs of shoes. It is worth noting that only Argentina imposed these barriers on Brazil. Trade with the other bloc countries does not have any non-tariff barrier.

Morais and Barbosa (2006) proposed to conduct a study that addressed footwear exports, estimating the supply and demand equations of the footwear sector between 1985 and 2003, based on the methodology of Johansen (1988) to perform cointegration tests since the Brazilian economy underwent several structural transformations in its intermediate goods and capital goods industry, which gradually changed the export agenda, and that changes in the exchange rate directly influenced the footwear sector's exports. Applying the methodology proposed in their work, in the supply equation, it was observed that the quantity exported in the long term and price levels are directly impacted by an exchange rate shock, where the occurrence of the "J" effect is verified. As for demand, it was observed that price elasticity is harmful and that its effects are more fantastic in the short term, showing that for the US consumer, the Brazilian product is a normal good. The income elasticity verified was positive, with its adjustment occurring in the short term.

Freire Júnior, Paiva, and Trompieri Neto (2010) analyzed the impacts of world

income and exchange rates on international footwear trade in Ceará between 1996 and 2009. The authors used time-series econometrics for their analyses. They concluded that income and exchange rates affect footwear exports from Ceará and that these results converge with a foreign trade model and the theoretical postulates of economics. In other words, exports are affected by income from the rest of the world and the exchange rate. Thus, it is possible to interpret, based on the authors' findings, that both the exchange rate and income were effectively related to Footwear exports from Ceará over the period analyzed.

Braga, Vilhena, and Lima (2017) analyzed the international insertion of the footwear trade in Rio Grande do Sul and Ceará between 2005 and 2015. The authors took a comparative approach and concluded that the footwear sectors in the Rio Grande do Sul and Ceará participate significantly in Brazilian footwear exports and have proven competitiveness in trade with this product. However, they point to gains in trade for Ceará to the detriment of the loss of participation of the footwear industry in Rio Grande do Sul in the years under analysis. Furthermore, the authors suggest that the loss of involvement in the footwear sector in Rio Grande do Sul may be due to the geoeconomic restructuring of the footwear industry, which is expanding to the states of the Northeast, especially to the state of Ceará.

In this sense, this article aims to analyze the effects of the exchange rate on footwear exports from Ceará between 1997 and 2019 since, according to the literature, as mentioned earlier, the exchange rate can affect international trade and the footwear sector. To achieve the proposed objective, this study is structured into five sections. In addition to these initial considerations, there is also: i) in the second section, a discussion based on the evidence about footwear exports from Ceará; ii) in the third section, the methodological procedures adopted are outlined; iii) in the fourth section, the results and discussions are presented; iv) finally, in the fifth section, the final considerations and perspectives for new approaches are made.

2 Footwear industry and footwear exports from Ceará: a literature review.

The export agenda of Ceará is Predominantly made up of products from sectors with low technological levels, where most products have low added value, which prevents real progress in the state's economic growth by producing goods with significant technological intensity and greater use of capital. However, despite this lack of technological intensity, the footwear sector gained space within Ceará, using other production advantages to stand out from competing markets. Thus, over the years, the state of Ceará became a reference in the footwear production sector destined for export, ranking among Brazil's three main footwear production hubs at the end of 2010 (Mindêllo, 2014).

2.1 Conditions for the production and international trade of footwear in Ceará.

From the perspective of footwear production in Ceará destined for international trade, a series of approaches list some conditions that deal with everything from the production restructuring process to macroeconomic mechanisms related to tax

exchange rates and growth in world income as determining factors of these production and trade relations, as suggested by the literature below.

Santos *et al.* (2001) show the main determinants for forming the footwear industry in Ceará, highlighting the migration of part of the southern footwear sector to Ceará to optimize its production. For the authors, factors such as low-cost labor, the granting of tax and financial incentives provided by the state, the granting of infrastructure for the installation of manufacturing plants, logistics for the arrival of raw materials, and the flow of production were decisive for the growth of the sector in Ceará. This migration brought positive impacts, both in the increase in the level of employment and the development of the number of industries in the state, increasing the income level of the population of Ceará.

Regarding the entry and productive performance of the footwear sector in Ceará, the study by Santos *et al.* (2002) notes that among the main advantages found by footwear companies, one of the incentives given by the state for the migration of companies from the South of the country, such as tax benefits, such as the deferral of ICMS; exemption from income tax; exemption from municipal taxes for the long term; granting of loans; infrastructure, in the form of donation of the industrial area where the factory would be installed; and facilitation of access to energy, water, road access and communication at the gates of these factories. This set of benefits instituted in the policy of attracting industries to the state of Ceará, concerning the footwear sector, may have significantly contributed to their installation and permanence over the years.

Regarding the flow of production, Oliveira and Dias (2005) proposed studying which factors determined the competitiveness and growth of footwear exports from Ceará, verifying competitiveness strategies and, more precisely, reducing production costs. For the authors, the reduction of costs contributed fervently to the constant growth of the levels of participation in exports of the footwear sector of the state. The authors concluded that, despite the protectionism imposed by competing economies, footwear from Ceará was conquering spaces in international markets since the producing companies took advantage of the fiscal and tax incentives granted by the Government, strategies for managing the costs of production inputs, and investments in technology and innovation of models combined with adequate distribution logistics. These measures adopted allowed the footwear sector of Ceará to significantly increase its participation in the state's export agenda in the years studied.

According to Machado Neto (2006), the footwear sector is susceptible to variations in wage levels, as this production factor directly affects the final cost of the product. With this, the author suggests that from the 1970s onwards, countries such as Taiwan, Brazil, and Korea, the South began to offer lovely conditions for the sector, as footwear production is labor-intensive. These countries had abundant and low-cost labor, bringing the industry greater competitiveness compared to countries such as Spain and Italy, which had higher costs. This perspective led states that sought to attract productive activities that generated jobs to strive to attract industries in the footwear sector since this activity was labor-intensive. This increased employment and the income of state residents receiving these productive activities.

The tax incentive policies implemented by the state of Ceará may have boosted its footwear sector over the years, making it stand out in job creation and industrial dynamics. From this perspective, the study by Costa (2012) shows that the state of Ceará was of great importance for the development of the Brazilian footwear sector, especially when considering the relocation of companies from the Southeast and South

regions in search of more significant competitive advantages in international trade, resulting from the restructuring of national production.

From this perspective of the restructuring of production in the national footwear sector, the approach given by Silva (2013) emphasizes that footwear companies, faced with the attempt to reduce their production costs concerning products imported from Asia, began to migrate to the Northeast, more specifically to the state of Ceará, in search of production advantages that the state began to grant for the entry of the sector into its economy. Furthermore, the tradition of the industry in the state with smaller production units also corroborated the adaptation of the workforce to the large establishments entering through the incentive measures granted.

Additionally, Silva (2013) considers that in addition to the incentives given by the Government for the installation of the footwear sector in the state of Ceará, other factors were also decisive for the success of this migration, highlighting the cheap and abundant labor, which effectively reduced the cost per unit produced when compared to southern footwear. Furthermore, an additional particularity results in a lower export cost concerning other regions of the country: Ceará is privileged by being a shorter distance between the state's port and Europe (a major partner of the sector) concerning the other ports in the country, making it easier to ship production and lowering transportation costs.

Braga *et al.* (2017) analyzed how Brazil's northern and southern regions entered the foreign trade in the footwear sector. In this study, the authors sought to verify international trade indicators, such as the relative coverage rate of imports, relative specialization coefficient, trade balance, revealed competitiveness index, contribution to the trade balance, and *market share*. When analyzing the results of the indicators in the period from 2005 to 2015, they found that the southern region of the country lost space over the analyzed period to the Northeast region, even though both areas maintained a significant share of Brazilian trade, demonstrating revealed export capacity within the analyzed period, contributing to the trade balance of their regions. They also found that the migration of the footwear industrial park to the Northeast due to political and production advantages was decisive for the growing performance of this region and the decreasing performance of the South.

The study by Trevisan et al. (2017) analyzes the pattern of trade specialization in Ceará from 1999 to 2016, focusing on identifying the most dynamic and competitive sectors. The authors used indicators such as the Symmetric Revealed Comparative Advantage Index (IVCRS), Intra-Industry Trade, and Coverage Rate. The results reveal that the state has competitive sectors like footwear, textiles, and food but faces limited productive diversification. Despite policies encouraging industrialization, the state has been unable to promote significant changes in its economic structure, remaining dependent on traditional sectors. The analysis suggests that to increase its international competitiveness, Ceará needs to invest in greater diversification of its export portfolio and policies aimed at innovation and technological development. Such measures are essential for the state to integrate more effectively into global value chains and achieve greater economic resilience.

Braga, Vilhena, and Lima (2017) examine the international insertion of the footwear sector in Brazil's Northeast and South regions between 2005 and 2015, emphasizing the states of Ceará and Rio Grande do Sul. The research uses indicators of revealed competitiveness, such as the trade balance and the coefficient of relative specialization, to assess the performance of these sectors in the foreign market. The

results point to a continuous growth in the competitiveness of the Northeast sector, while the South region, traditionally strong in the segment, showed a decline after 2010. Factors such as the relocation of the footwear industry and state incentive policies were crucial to strengthening the Northeast. The study concludes that initiatives to attract investment and reduce production costs played a central role in the rise of Ceará on the national and international scene. In addition, it highlights the importance of long-term strategies to sustain the growth and competitiveness of the footwear industries in both regions.

Mendes Junior and Ximenes (2021) explore the impacts of the COVID-19 pandemic on Brazil's leather and footwear industries, with a specific focus on the Northeast, Ceará, and Bahia. Based on sectoral economic data, the research shows significant drops in production and exports during the height of the pandemic, especially between March and September 2020. However, a gradual recovery was observed from September of the same year, driven by adaptations in the domestic market and local stimulus initiatives. The temporal focus focuses on the 2020-2021 biennium, while the spatial focus encompasses Brazilian regions that play relevant roles in the industry. The authors emphasize that the sector needs public policies encouraging innovation and market diversification to increase resilience. The observed recovery shows that rapid and coordinated actions can mitigate negative impacts and prepare the industry for new global challenges.

Mascarenhas and Silva (2022) analyze the international trade pattern and the competitiveness of Ceará's exports between 2010 and 2017. The research used indicators such as Balassa 's comparative advantage and coverage rate, focusing on low-tech products like leather and footwear. Despite the average annual growth of 11.42% in the state's exports, the trade balance remained in deficit. The leading export destination was the United States, while countries such as Turkey and Paraguay showed greater intensity in trade relations throughout the analyzed period. The study points out that the export agenda concentrated on a few products limits the state's potential for expansion in the international market. As a political implication, it is suggested that productive diversification be strengthened and strategies to expand Ceará's economic complexity be adopted, promoting more incredible insertion of the state in global value chains and more excellent financial stability.

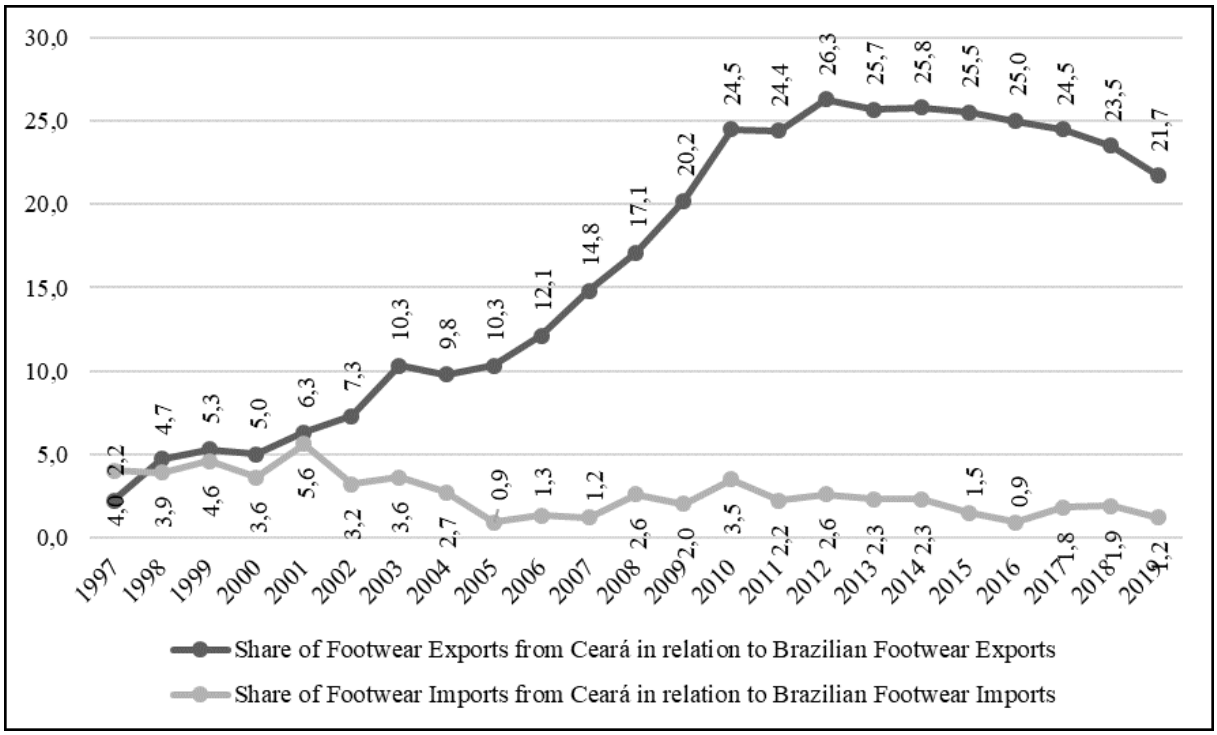
The study by Mendes Junior (2024) analyzes the economic outlook for Brazil's leather and footwear sector, considering the challenges imposed by the COVID-19 pandemic and other external factors, such as the war in Russia and lockdowns in China. Using a quantitative approach, the author highlights that, although there was a moderate recovery between 2021 and 2023, the sector still faces structural difficulties. For 2024, growth of 2.2% in footwear production and 1% in exports is estimated, although with uneven performance across states. Bahia stands out for showing growth, while Ceará and Brazil face modest growth rates. It is concluded that policies encouraging innovation, reducing costs, and expanding foreign markets are essential to strengthen the sector and ensure its competitiveness in an increasingly challenging global scenario.

2.2 Statistics on international footwear trade in Ceará: 1997 to 2019

Based on the discussions presented in the previous subsection, it is possible to identify evidence in the statistics that the state of Ceará has been relevant in the

international footwear trade over the years, and this remains the case despite the fluctuations recorded. According to the data in Graph 1, the share of Ceará's footwear exports concerning Brazilian exports of this product between 1997 and 2019 remains significant. The state went from a relative share of 4% in 1997 to 26.3% in 2012, when it entered a trajectory of relative reduction and records in the last year of the study (2019), a share of 21.7%.

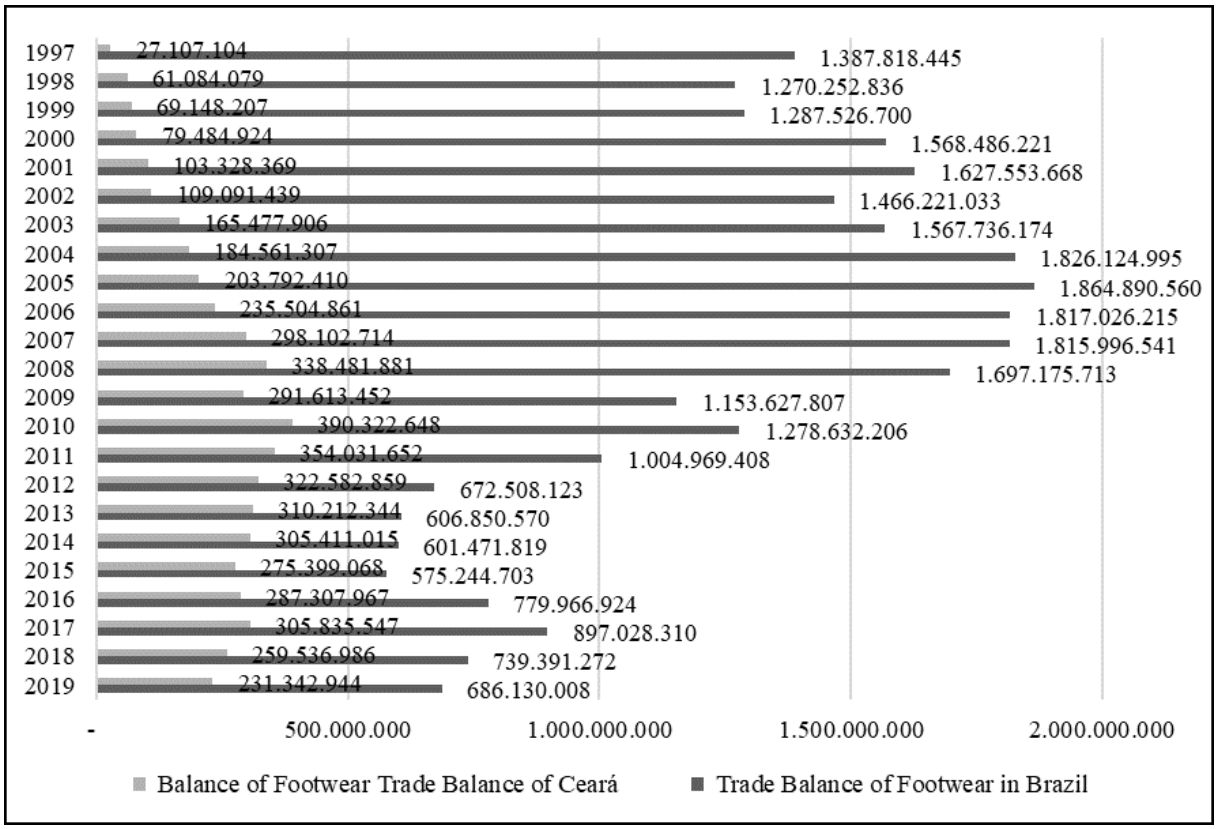
These statistics show that the state of Ceará is a national leader in the Brazilian footwear trade. These results may reflect the actions taken by the state concerning industries that had a high capacity to generate jobs in the state. The attraction of industries from other Brazilian regions to the state of Ceará was aimed at lower-cost production, thus increasing competitiveness in the international market. This movement is reflected in the indicators of Ceará's relative participation in the global trade of the product, as shown in Graph 1.



Graph 1: Ceará's participation in footwear exports and imports to Brazil – 1997-2019.
Source: The authors, based on Comex State (2020).

Regarding participation, the total import of footwear from Brazil, the data shows that this state has a low share; furthermore, this share has been decreasing over the years. This may indicate that production is geared towards meeting the state's domestic demand since it is a large-scale producer to meet international and domestic markets. The results suggest that the state is responsible for a large share of Brazilian footwear exports but relatively little for the consumption of such imported products in the country's total consumption in this sector.

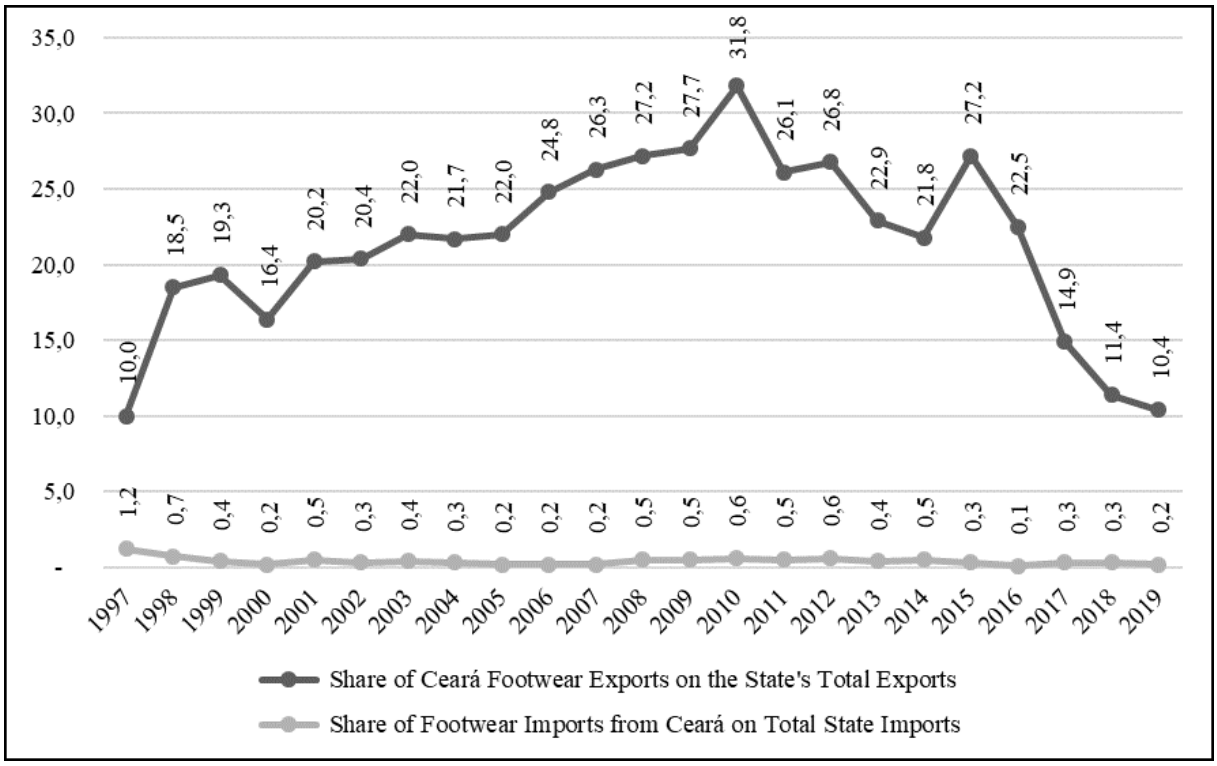
The data in Graph 2 show the footwear trade balance in Ceará. Based on the results, it is possible to state that the state has shown significant results over the years analyzed. In the first year of the series, Ceará recorded a surplus of US$27,107,104.00, the lowest value in the entire series. It reached its maximum in 2010 when it recorded a surplus of US$390,322,648.00 in footwear trade with the rest of the world.



Graph 2: trade balance of Ceará footwear exports – 1997-2019.
Source: The authors prepared data based on Comex State, 2020.

From 2010 onwards, the state recorded a reduction in the trade balance of its footwear exports, even though it remained with surpluses throughout the series analyzed, and this reduction was also relatively lower than that recorded for Brazil, as seen in the graph. In the last year under analysis, a surplus footwear trade balance of Ceará was recorded at US$ 231,342,944,00, accounting for more than 1/3 of that observed for the entire country.

Regarding the participation of Ceará's footwear exports in the state's total exports, the data in Graph 3 show that fluctuations can be observed over the years analyzed, especially since 2010. In the first year of the series (1997), ,Ceará's footwear exports accounted for approximately 10% of the value of Ceará's total exports. In 2010, its largest share was recorded, approximately 32%. From that year onwards, there were fluctuations with significant reductions. By the end of 2019, Ceará's footwear exports again accounted for approximately 10% of the state's total exports.



Graph 3: share of Ceará's footwear exports and imports, including Ceará's total exports and imports from 1997 to 2019.
Source: The authors prepared data based on Comex State, 2020.

Regarding importation, the share of footwear from Ceará in total imports shows that these reached less than 1% in 1998 and remained that way throughout all the years covered by this series. In other words, it can be stated that the share of imported footwear in total imports from the state of Ceará is meager, not even reaching 1% of the total value of its imports. In this sense, the expenditure by residents on imported products from this sector is not very significant, and this may reflect on domestic production as an essential driver of demand in the state.

3 Methodological Procedures

This article analyzes the relationship between the exchange rate and footwear exports from Ceará between 1997 and 2019. To this end, an empirical exercise using econometrics in time series was used. The estimation method underwent a series of tests defined below to analyze the series' behavior and infer the existence of a cause-and-effect relationship.

3.1 Databases and Time Frame

The data used are monthly and cover the period from January 1997 to December 2019. These were extracted from the database of the Foreign Trade Secretariat (SECEX) of the Ministry of Development, Industry and Foreign Trade (MDIC) and the Bank for International Settlements (BIS). The chosen estimation methods consist of a series of three tests, namely: i) the unit root test, ii) the Johansen Cointegration test

(1988), and iii) the Granger Causality test (1969). These aim to analyze the behavior of the series and infer the existence of a cause-and-effect relationship between the variables analyzed.

3.2 Unit Root Test (ADF)

By applying the tests presented, we intend to infer, using robust techniques, the effects of the exchange rate on Ceará's game exports. To continue this technique, tests must be performed to prove the stationarity of the series. This was done using the Augmented Dickey-Fuller (ADF) and the Elliot, Rothenberg & Stock (ERS) tests. In the Unit Root test, the difference between the three equations below is given by considering only the absence of the linear trend in the second equation βt; and linear trend βt and the constant term a in the third equation. The test aims to verify whether there is a unit root in the series. If there is a unit root, including a difference in the lagged variable is appropriate to preserve the white noise condition. Furthermore, the series must have a meaning of zero and a constant variance. Thus, the condition of stable behavior over time must be preserved.

The unit root tests have the formulas below and were performed using the R Software.

$$\Delta Y = \alpha + \beta t + yY_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta Y_{t-1} + \varepsilon_{t'} \tag{1}$$

$$\Delta Y = \alpha + yY_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta Y_{t-1} + \varepsilon_{t'} \tag{2}$$

$$\Delta Y = yY_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta Y_{t-1} + \varepsilon_{t'} \tag{3}$$

This test verifies whether the series has a unit root, where the models in which autoregressive processes of order generate the variables ρ. Thus, the tests were performed with the trend and constant terms (equation 1), only with continuous (equation 2) and without trend and without constant (equation 3). Furthermore, the null hypothesis of the test is: $H_0 : \gamma$ there is at least one unit root. Furthermore, rejecting H_0 means that the series is stationary, and its distribution is a white Gaussian noise.

3.3 Johansen Cointegration Test – Multivariate Model

Given the series' non-stationarity, the results of the unit root tests suggest that the next step is to apply the difference, repeat the tests, and check for stationarity. If there is, the path to follow is to check for long-term equilibrium based on the analysis of the cointegration test.

Johansen's cointegration test allows us to determine whether there is a long-term equilibrium relationship between variables based on the application of the difference. It is, therefore, the most widely accepted procedure for this purpose. Here, we propose to analyze whether multiple co-integration vectors exist using an autoregressive vector model. The algebraic definition takes the following formula:

$$\Delta X_t = \phi X_{t-1} + \sum_{i=1}^{p-1} A_i \Delta X_{t-1} + \varepsilon_t \quad (4)$$

Therefore, we have that: X_i is called a vector of endogenous variables already applied to the first difference, in which ϕ represents a data matrix represented by $N \times N$, and its rank is defined as $r < N$, *in situations in which the existence of* cointegration between the series is confirmed; λ, Λ_i, $i = 1, 2, \ldots, p-1$ represent specific $N \times N$ matrices which contemplate the coefficients of the endogenous variables lagged in their values; and, ε_t $N \times 1$ is defined as a vector of errors or random disturbances that are not correlated with each other. This can occur contemporaneously or temporally since the mean is zero and the covariance matrix presents non-singular variance and covariance values.

3.4 Granger Causality Test

Following the sequence proposed by the specialized literature, the next step is to perform the Granger causality test. This test is universally accepted as an efficient time series econometric estimations technique, making it widely used in literature. Its main issue is that correlation may not necessarily imply a causal relationship.

For Granger, it is only possible to state that there is a causal relationship if past values of X_{t-1} allow the prediction of values of Y_t. The Granger causality test is widely used in studies, given its acceptance. From this test, it is possible to verify much more than a simple correlation between variables, where, for Granger, this correlation may not only imply causality. The mathematical equation can assume the following formula:

$$X_t = \sum a_i Y_{t-i} + \sum b_i X_{t-i} + \mu_{1t} \quad (5)$$

$$Y_t = \sum c_i Y_{t-i} + \sum d_i X_{t-i} + \mu_{2t} \quad (6)$$

According to the literature, there are two expected hypotheses: i) The first is that the relationship between exports and the real effective exchange rate is positive; ii) the second is that changes in the real effective exchange rate cause changes in exports.

Given that all the abovementioned procedures have been carried out, the following section presents the results.

4 Results and Discussion

4.1 Results of Econometric Tests for Exchange Rate and International Footwear Trade in Ceará between 1997 and 2019

One of the main factors in the footwear sector's entry into international trade is its low production cost, which reflects a more competitive footwear value in the global market. Meanwhile, another factor that may be relevant to this trade is a favorable exchange rate, which can significantly increase the competitiveness of exported footwear (Santos et al., 2001).

Silva (2013) shows in his study that the state of Ceará has expanded its footwear production and labor hiring in recent years and significantly increased its exports in the early 2000s. Growing low-cost production combined with an exchange rate favorable to the export of Ceará footwear led the state to leverage its foreign trade significantly.

4.2 ADF Unit Root Test for Series at the Level

Initially, by performing the significance test for the constant and trend, it was found that the most appropriate model for the exchange rate and exports is the one without constant and trend. This test will help define the best method to be used, as shown in the results in Table 1.

Table 1:ADF Unit Root Test for Level Series with Full, No-Trend, Trend, and Constancy Models

Model	Exchange Rate	Exports	Critical Value*
Full	-1.549249	0.225248	-3.42
No Trend	-0.936660	-1.634325	-2.87
No Trend and No Constant	1.020489	0.173361	-1.94

(*)Dickey-Fuller critical value at 5%.
Source: Prepared by the author based on data and use of R.

When analyzing Table 1, it is verified that the null hypothesis of the existence of a unit root in the exchange rate variable for the level series from 1997 to 2019 is not rejected. In other words, the series is non-stationary. As for the footwear exports variable, once again, it is verified that the best model observed by the significance of the variables was the one without constant and without trend, where the null hypothesis of the existence of a unit root for the level series is not rejected. Therefore, this series is also non-stationary. As is known, a unit root in the level series prevents predictions from being made using the usual techniques.

Therefore, all models and variables reject the null hypothesis that the series is stationary at the 5% level. This reflects the existence of a unit root for the series at the level, and the procedure of applying the difference in the series is adopted to use additional tests.

4.3 ADF Unit Root Test for First-Differenced Series

When applying the ADF test in the first difference, as per Table 2, it is confirmed that the two series are stationary in the first difference. Therefore, both are integrated into order 1. This assures the series' property for applying tests in time series, such that the mean, variance, and autocorrelation structure will remain constant over time.

Therefore, the null hypothesis is rejected at the 5% level for all models and for both variables in the first difference. This means that the series is stationary in the first difference and, therefore, is integrated into order 1. This achieves the property of constant mean, variance, and autocorrelation structure throughout the series, allowing predictions to be made from the time series.

Table 2: ADF Unit Root Test for Series in First Difference with Complete Models, Without Trend, and With Trend and Constancy

Model	Exchange Rate	Exports	Critical Value*
Full	-11.98523	-6.604900	-3.42
No Trend	-11.99488	-6.199060	-2.87
No Trend and No Constant	-11.89438	-6.151470	-1.94

(*) Dickey-Fuller critical value at 5%.
Source: Prepared by the author based on data and use of R.

4.4 Identify the Ideal Amount of Time Lags

Hannan-Quinn selection criterion, as shown in Table 3.

Table 3:Identifying the Ideal Lag Amount Based on the Criteria of the Schwartz and Hannan-Quinn Section

Lags	Schwartz	Hannan-Quinn
0	37.37368	37.35773
1	32.29646	32.24860
2	32.20953*	32.12978*
3	32.26160	32.14994
4	32.32529	32.18173
5	32.37237	32.19691
6	32.41056	32.20319
7	32.48421	32.24494
8	32.52885	32.25768

(*) Indicates the ideal number of lags.
Source: Prepared by the author based on data and use of R.

Johansen Cointegration Test

Before performing the Johansen test, the ideal number of lags had to be identified. To this end, Schwartz's selection criterion was used, which indicated the use of two lags. According to the results presented in Table 4, the Johansen cointegration test can be performed, knowing that the level series are non-stationary and identifying the ideal number of lags.

Table 4: Johansen Cointegration Test

H0: rank=p	Stroke Test	Critical Value (5%)	Maximum Eigenvalue Test	Critical (5%)	Value
P = 0	11.97168	15.49471	11.37531	14.26460	
P $\leq$ 1	0.596377	3.841466	0.596377	3.841466	

(*) Level of rejection of the null hypothesis at 5%.
Source: Prepared by the author based on data and use of R.

Looking at Table 4, the trace and maximum eigenvalue test results suggest no cointegration between the real effective exchange rate and footwear exports from 1997 to 2019. It is concluded that the results show us that there is no cointegration at the

5% level of statistical significance. This means that there is no long-term relationship between the variables. In other words, there is no long-term relationship between the exchange rate and footwear exports from Ceará, which differs from the results of Freire Júnior, Paiva, and Trompieri Neto (2010) for 1999 and 2009. This divergence may have been because they used only 53 quarterly observations, which is considered short for applying econometrics in time series.

4.5 Granger Causality Test

To confirm the results, the Granger causality test is estimated for the same period due to the variables' non-stationarity at the level presented in Table 1. Unlike Johansen cointegration, it is performed with the variables in the first difference.

Table 5:Granger Causality Test

H0 – Null Hypothesis	F-Test	Prob.	Result
DCAMBIO does not cause DEXP	0.22653	0.7974	Not Rejected
DEXP does not cause DCHANGE	1.08586	0.3391	Not Rejected

(*) Level of rejection of the null hypothesis at 5%.
Source: Prepared by the author based on data and use of R.

The results suggest no causality (in the Granger sense) between the exchange rate variables and footwear exports in Ceará from 1997 to 2019 in the first difference. According to probability, this indicates that the exchange rate does not precede footwear exports from Ceará.

Given these results, it is possible to suggest that footwear exports from the state of Ceará occur due to macroeconomic determinants other than the exchange rate. Furthermore, given the low value of footwear exported by the state, which is a producer and exporter of products made primarily from synthetic materials, variations in the exchange rate may not significantly alter the product's price for external consumers. They may not promote substantial changes in its consumption.

5 Final Considerations

This study aimed to analyze the influence of the exchange rate on footwear exports from Ceará from 1997 to 2019, considering the relevance of this state in the international trade of the Brazilian footwear sector. The methodology applied included econometric techniques in time series, such as unit root tests, Johansen cointegration, and Granger causality, using data from the Secretariat of Foreign Trade (SECEX) and the Bank for International Settlements (BIS). These tools were chosen to investigate both the long-term relationship and potential causalities between the real effective exchange rate and export volumes. Based on preliminary graphical analyses, a growing share of Ceará in national footwear exports was identified until 2010, followed by a relative decline until 2019, when the sector represented approximately 10% of state exports, highlighting the importance of exploring the determinants of these fluctuations.

Initial results show that, although Ceará's share in national footwear exports has fluctuated over the years, the state has remained one of the main hubs of the sector in Brazil. In 2010, it reached its highest representation, with 32% of Ceará's

exports from the footwear sector. However, after this peak, the relative share declined, returning to levels close to 10% in 2019. The footwear trade balance remained positive throughout the period, with the largest surplus recorded in 2010, worth US$ 390 million. Even so, the surplus declined in subsequent years, although Ceará contributed significantly to Brazil's trade balance in this sector. This data reflects the state industry's resilience and challenges, which motivated the investigation into the relationship with the exchange rate.

Regarding the econometric results, the unit root tests revealed that the exchange rate and footwear exports are non-stationary in level but become stationary in the first difference, indicating integration of order 1. This finding allowed the application of cointegration tests to identify potential long-term equilibrium relationships between the variables. However, the Johansen cointegration test results did not indicate cointegration at the 5% level of statistical significance, suggesting that there is no stable and long-term relationship between the exchange rate and footwear exports from Ceará in the period analyzed. This result differs from part of the literature, which often associates exchange rate variations with export competitiveness, especially in labor-intensive and low-value-added sectors, such as footwear.

The Granger causality test was applied to complement the analysis, which, unlike the cointegration test, assesses short-term causal relationships. This test also did not confirm the existence of causality between the variables, indicating that variations in the exchange rate do not precede changes in footwear exports from Ceará. These findings reinforce the hypothesis that other macroeconomic or structural factors may be more relevant in determining the sector's exports. Possible explanations include the predominance of comparative advantages related to reduced production costs, tax and logistics incentives, and the relative stability of international demand for the sector's products during the period analyzed.

The analysis suggests that the competitiveness of Ceará's footwear exports is less dependent on exchange rate fluctuations than expected, probably due to the state sector's production and marketing structure. The low-added value of exported products can reduce the sensitivity of foreign sales to exchange rate fluctuations, while tax incentives and reduced production costs ensure a competitive position. In addition, the logistical proximity to international consumer markets, such as Europe, helps maintain exports, even in the face of exchange rate fluctuations. These characteristics place Ceará in a unique position in the national export market but also point to challenges related to diversification and increasing added value.

The results have significant implications for public policies in the sector. First, they reinforce the need for policies to diversify the export agenda, emphasizing the production of higher value-added goods. This change could reduce the sector's vulnerability to global economic fluctuations and increase its resilience in an increasingly competitive international market. In addition, strategies that encourage innovation and technological development can contribute to the modernization of the footwear sector and its integration into global value chains, promoting sustainable growth and the generation of higher-quality jobs in the state.

Finally, the study suggests the importance of expanding the variables analyzed in future research, including factors such as global income, levels of economic activity of Ceará's main trading partners, and variables related to the quality and innovation of exported products. Including longer time series can also provide a more robust understanding of the sector's trade dynamics. Advances in research can support the

formulation of more effective public policies, strengthening Ceará's footwear sector and its positioning in the international market.

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