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The effects of US import tariffs on steel and aluminum imports from Mexico

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Abstract. This research aims to analyze the effect that the United States tariff policy has had on its imports of steel and aluminum from Mexico. We attempt to ascertain how the United States' protective trade policy, followed since 2017, influences trade volumes, import prices, and the possible diversion of trade to the rest of the world (ROW). It is suggested that this policy generates an adverse effect on US imports of these metals from Mexico. To this end, mathematical and statistical methods are used to model the effect of tariffs, *ex-ante* and *ex-post*, after implementing this trade policy, on exports of aluminum and steel from Mexico to the United States, versus US imports of these metals from the ROW. The results show that the protectionist tariff policy had a structural effect on US imports; likewise, the tariff shock implemented by the United States in June 2018 adversely affected its imports of these goods, both in terms of volume and value. This suggests that bilateral trade may be affected, but the effect is differentiated. The United States may be achieving its objective of protecting its domestic industry or it may impact upwards on the domestic prices of these metals, which could influence the prices paid by the final consumer. For Mexico, trade may be diverted or its export capacity reduced, adversely affecting its trade balance of these metals.

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1. INTRODUCTION

This research aims to analyze the effect that the United States tariff policy has had on its imports of steel and aluminum from Mexico. We attempt to ascertain how the United States' protective trade policy, followed since 2017, influences trade volumes, import prices, and the possible diversion of trade to the rest of the world (ROW). It is suggested that this policy generates an adverse effect on US imports of these metals from Mexico.

Aluminum is the second most used metal globally, only behind steel, with China being the most relevant actor in the world market. In 2016, the United States imported five times more aluminum than was supplied by local producers; the level of import penetration was around 90 percent, compared to 66 percent in 2012 (WTO, 2019).

It should be noted that even though Mexico exports products that contain aluminum, the production of aluminum itself is still modest in Mexico, although it is growing consistently. In 2015, the basic aluminum industry contributed 0.04 percent to the national GDP, 0.1 percent to the industrial GDP, and 0.2 percent to the manufacturing industry (US Department of Commerce, 2018).

Meanwhile, the steel industry is one of the most important industries in the world. Mexico is no exception, as in 2019 it produced around 18,400,000 tonnes of steel, becoming the world's 15th-largest producer. According to Mexico's National Chamber of the Iron and Steel Industry (CANACERO), in 2021, world steel demand is expected to increase by 3.8 percent compared to 2020 - a recovery for the steel industry (CANACERO, 2021).

The steel production process helps different industries to develop specialized products and services. According to CANACERO, its production is mainly used in construction, metal products, and the mechanical and electrical equipment sectors. Due to its multiple uses, steel is considered the most critical engineering and construction material in the world. Additionally, it can be recycled again and again without losing its properties (Benavides, 2016).

The last time the US government imposed tariffs on steel imports was in 2002, when the Bush administration imposed temporary tariffs of 8-30 percent. Imports from Canada and Mexico were exempted at that time, as per the North American Free Trade Agreement (NAFTA) terms. The tariffs were lifted twenty months later. During those 20 months, around 200,000 American jobs were lost in manufacturing sectors that depended on steel imports. The magnitude of this year's tariffs is far more significant than those imposed in 2002, in part due to the lack of exemptions to the country's trading partners.

The possible breaking apart of supply chains is another risk that would directly affect US companies. Since the signing of NAFTA, various cross-border supply chains have been created by the US and international companies to maximize production efficiency. These supply chains are already under the threat of the ongoing renegotiation of NAFTA terms. The imposition of tariffs on imports from Mexico and Canada would further complicate the renegotiation process and increase the risk of NAFTA disintegration. That would mean a severe shock on the performance of companies in industries, such as the automobile and textile and apparel industries, which are highly dependent on cross-border supply chains. Companies in those sectors will need to redraw their production structures and reconstruct their supply chains. Not only would this be a costly exercise for them, but it would also make them less competitive globally (US Department of Commerce, 2018).

With the decision made by former President Donald Trump, from May 31, 2017, Canada, Mexico, and the European Union's export of steel and aluminum were covered with an extra 25 percent and 10 percent duties, respectively.

In 2019, after negotiations between Mexico and the United States on the tariffs imposed on Mexican steel and aluminum under Section 232 of the Trade Expansion Act of 1962, a mutually beneficial agreement

was reached: the taxes would be removed, and quotas on Mexico's steel and aluminum would be avoided. These products will again be traded freely (US Department of Commerce, 2018).

In this context, this research aims to analyze the effect that the United States' tariff policy has had on its imports of steel and aluminum from Mexico, trying to ascertain how the US's protective trade policy, followed since 2017, influences trade volumes and import prices. Therefore, it is suggested that this policy generates an adverse effect on its imports of these metals from Mexico. To this end, section two reviews the theoretical foundations of the object of study; section three presents the context in which the aluminum and steel industry has developed. Section four presents the model and characteristics of the data, which make it possible to estimate the direct effect of the United States' tariff policy on its steel and aluminum imports from Mexico. The results from the estimated model are presented in section five to incorporate the conclusions derived in section six.

2. LITERATURE REVIEW

2.1. Theoretical background

Economic relations among countries might be shaped under free trade, protectionism, or a blend of both. More restrictive trade policies impose duties and other measures to reduce imports and thus improve the trade balance. When such actions are taken with retaliations, countries experience a trade war. The premises for imposing duties are diversified with their motivations and economic justification. They include the need to:

- protect infant industries (Shafaeddin, 2000; Baldwin, 1969; Krueger and Tucner, 1982; Harrison, 1994; Melitz, 2005; Sauré, 2007; Panagariya, 2011; Xu, 2006; Clemhout and Wan Jr., 1970);
- protect senile industries (Gray, 1973; Hillman, 1982; Choi, 2001; Long and Vousden, 1991; Magee, 2002; Lee and Swagel, 1997; Hillman and Cassing, 1986; Brainard and Verdier, 1997);
- undertake anti-dumping actions (Panagariya and Gupta, 1998; Brenton, 2011; Dinlersoz and Dogan, 2010**;** Cheng et al., 2001);
- shape strategic trade policy (Milner and Yoffie, 1989; Krugman, 1994; Brander, 1995; Rugman and Verbeke, 1990*;* Grossman and Maggi, 1997; Ionaşcu and žigić, 2001).

The most frequently raised reason is the need to protect national producers and suppliers, shift demand from imported towards domestic products, and reduce unemployment. The import of goods is equated with the export of capital and workplaces. Such an understanding is rooted in the idea of mercantilism, but its economic justification is insufficient (Magnusson, 2015; Allen, 1991). Nevertheless, it appeals to the public as a desire to protect the domestic market and thus is frequently employed by politicians to substantiate imposing the duties, which often leads to the symmetric reaction of the counterparty and the initiation of a trade war. Imposing duties could be either bilateral or evolve into a global (multilateral) affair. Whichever path is followed, the consequences cover both directly involved countries and rest of the world (ROW), but their direction and strength may vary.

In the case of a bilateral war, one country's protectionism may not be answered with the retaliation of the other, although it could lead to escalation and a tit-for-tat tariff war. The case of the US-Mexico trade war (so far) has followed the first prospect, where specific actions of the American administration are not met with symmetric reactions of the Mexican side. However, it does not mean that American customers and suppliers do not suffer the consequences. There are several scenarios in which covering and covered countries might be negatively affected.

The option desired by the country following such a trade policy assumes that imposing duties reduces import from the selected country and diverts demand from imported towards domestic goods (Bhagwati, 1988). Another alternative assumes that the government imposing duties would experience reduced imports from the selected country, not compensated with increased demand for domestic products, but those from ROW. In the third possibility, the imposed duties would not influence the demand, thus increasing the local prices of both imported and domestic goods via increased costs of imported raw materials and intermediates (Milner and Yoffie, 1989).

The United States and Mexico, together with Canada, were members of NAFTA. However, on July 1, 2020, it was replaced with USMCA (the United States-Mexico-Canada Agreement), although the general idea remains – to facilitate the international trade and growth of the continent. Although the new deal is an achievement of President Trump, in parallel, he imposed several duties on imports from Mexico.

According to Riezman and Kennan (1988), trade wars may, under certain circumstances, bring benefits, e.g., they provide a theoretical model, and they argue that if a country is substantially bigger, it may gain from imposing barriers in trade. Empirical studies do not confirm this conclusion, however, claiming that a trade war is a lose-lose with negative impacts on various aspects of the economy.

2.2. Industry context

Both analyzed metals, steel and aluminum, can be infinitely recycled. The aluminum industry in Mexico is already a strategic sector. Due to the exports of aluminum auto parts (engines and automotive accessories), in 2018, it represented over 32 percent of the country's total exports with a value of more than $38 bln). However, the country's shortage of bauxite, a rock made up of minerals and the main element of aluminum, pushes imports of this metal. According to figures from the Data México website regarding the aluminum and the manufacture of aluminum sectors, Mexico mainly gets its supplies from the United States, where 46.2 percent of total international purchases come from, followed by China, with 22.7 percent, and the United Arab Emirates, with 3.8 percent (Navarro, 2020).

The growing demand for this metal and the rules of regional content in specific products established by USMCA challenge Mexico to raise its production, many times through scrap recycling and the import of basic inputs. The absence of primary aluminum production plants is due to the lack of aluminum, while high production costs (intensive electrical energy consumption) make it unattractive for investment. Thus, the domestic market is fed by imported primary aluminum and the regeneration and recycling of aluminum scrap.

Although the aluminum industry's importance results from the use of this material as an input in several sectors, such as electronics, automotive, and aeronautics, in which Mexico has been seen as a good place for their development, it also involves the medical (research and surgery) and construction sectors. Years later, it became one of the pillars of the economy of the state of Nuevo León, and Mexico as a whole, until its closure in 1986. Today, it is an ecological park and was declared a World Heritage Site due to its economic importance and transformation.

Steel is a combination of iron and coal, minerals extracted through mining, or the recycling of raw materials. Also, as mentioned above, steel can be recycled, as its life cycle is unlimited and does not lose its elementary properties, meaning that it is sustainable. These features make it the most recycled component globally, with an estimated 40 percent of all world steel production coming from scrap. The relevance of steel is so great that it is possible to find it in products as diverse as surgical materials for hospitals, bicycles, cars, buildings, and endless utilities for their uses and sustainability (CANACERO, 2021). It has also become one of the pillars for the construction industry (Benavides, 2016).

The steel sector in Mexico represents 61 percent of total demand in the construction industry, followed by the automotive industry with a demand for steel of 11 percent. Approximately 18.8 mln tonnes of steel are produced annually, making the country the 15th-largest producer worldwide (CANACERO, 2016). Annual production in Mexico equals 1.5 mln tonnes, representing 1.6 percent of the world's manufacturing, according to data from the Confederation of Industrial Chambers of the United Mexican States (CONCAMIN). In 2015, the global steel industry experienced a critical period: prices fell by up to 30 percent compared to the previous year, a result of overproduction in Asia, the leading supplier of various countries in the world. For Mexico, a country with an annual production of 18.8 mln tonnes of crude steel, according to data from CANACERO, such a drop was difficult. During that year, the overproduction of steel, mainly from China, sold at meagre prices, caused imports of this metal in the country to increase by 7.9 percent compared to 2014, obtaining a 43 percent share in the Mexican market.

However, in 2016, the statistics began to improve for Mexico. According to figures from CANACERO, steel production showed an increase of 4.3 percent. In the same year, exports of steel products also increased (CANACERO, 2016).

One factor that enabled the steel industry's recovery was that Mexican steel producers focused on competing with foreign manufacturers on prices, generating strict cost control, and paying particular attention to quality and service (Benavides, 2016).

There are other factors that helped the Mexican steel industry stay afloat. One of them was the rise in the price of the metal in 2016 recorded on the world market (which, as a commodity, fluctuated according to supply and demand), as well as the anti-dumping measures undertaken by the government to prevent unfair import. To boost the consumption and competitiveness of national steel, from October 7, 2015, the federal authorities, through the Ministry of the Economy, announced the imposition of a temporary 15 percent tax on steel imports from countries with which Mexico has no trade treaties, such as China. This measure caused steel imports to fall by more than 15 percent during the fourth quarter of the year. In 2016, when the decree was twice renewed, in April and October, there was a decrease of 2.8 percent in total imports in the same period (Benavides, 2016). In this context, we could conclude that the Mexican steel industry is currently experiencing a specific state of protectionism, a phenomenon that we can also see in other countries, such as the United States.

It is a relief to have this type of protection for domestic industry, as it allows the domestic market to be competitive with imports from countries like China, which are sold at a meagre cost. During 2017, the Mexican steel sector was expected to continue a positive trend, stemming from the announcement in April of that year that the 15 percent tariff would continue, as well as the growth of national consumption, driven by the automotive industry, transport, pipe manufacturing, (CANACERO, 2021). Unlike the global stagnation of developed economies or the downward trend of countries like China, the outlook for steel demand continues to be positive in Mexico. In 2016, according to CANACERO statistics, apparent national consumption was 29.6 mln tonnes, 2.5 percent higher than in 2015 (Benavides, 2016).

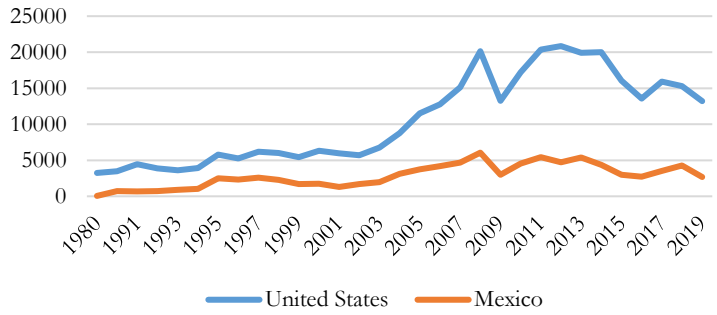
Generally, in Mexico, there are many social, economic, or political factors that make this country the 13th steel producer in the world. However, the volatility of international prices of this metal will be the factor that determines the profitability of domestic producers.

As mentioned before, aluminum and steel can be recycled repeatedly without losing their original properties, such as lightness, durability, conductivity, and impermeability. Thus, they are considered ecological materials. This explains the industry's global ambition to double the use of available scrap. Such strategies are followed in markets such as the European Union (EU), where the recovery rate of aluminum scrap is about 85 percent. Reprocessing this material at the end of its lifecycle to transform it into new raw material represents a market that generates profits of $4 bln per year. According to the Circular Aluminum Action Plan of the European Aluminum agency, the use of "post-consumer" aluminum meets 36 percent

of the demand for this metal in the EU. By 2050, it is expected that 50 percent of the demand will be satisfied with reused material (CAPOEAA, 2021), giving Mexico an advantage and presence in international markets.

Figure 1

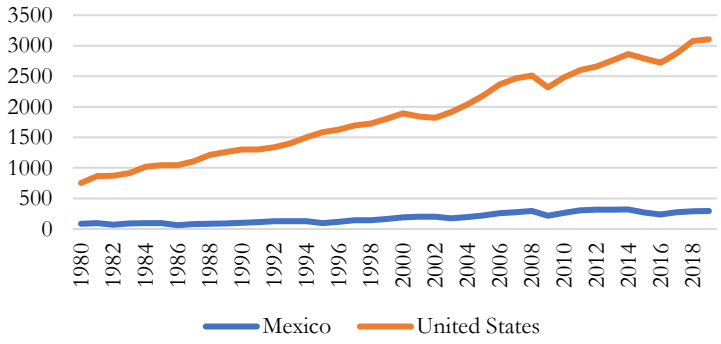
Annual merchandise exports of steel and aluminium, 1980-2019 ($ mln)



Source: Own-calculations based on US Census Bureau and WTO data

Figure 2

Gross domestic product by kind of economic activity: Mining, manufacturing, utilities, annual, 1980- 2019 ($ bln at current prices)



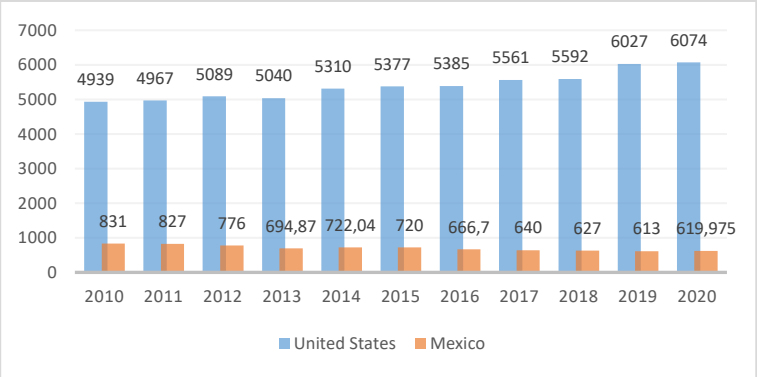
Source: Own calculations based on UNCTAD

In 2019, Mexico's steel exports totaled $9.9 bln, representing 2 percent of the country's total export value. In terms of employment, there were 672,000 people employed directly or indirectly in this industry. There were 11,332 jobs in the iron and steel industry, 82 percent of whom belonged to the category of workers, 18 percent to employees (administrative or secretarial), and 32 percent to subcontracted jobs (outsourcing). For every paid job, a surplus of more than $251,595 was generated, which was nine times the average value of the manufacturing industry's operating surpluses. On the other hand, the productivity of the paid workforce is the second-highest in the manufacturing sector; the automotive sector is first (Instituto Nacional de Estadística y Geografía, 2016).

Concerning the labor requirements of the primary iron and steel industry, there has been a steady decline over time, and in 2019 there was a sharp drop, which strongly affected the manufacturing sector as a whole; the total decrease in paid jobs in manufacturing was more than 500,000 paid places.

Figure 3

Wage-earners in Mexico and the United States, mining and quarrying, 2010- 2020 ($)



Source: own-calculations based on: ILO-STATISTICS - Microdata processing | Age coverage - minimum age: 14 years old, 20/03/2021

The United States is far from being self-sufficient in steel and aluminum, with imports accounting for over 30 percent of the consumed metals. Given the industrial importance of these metals, tariffs imposed on imports will significantly increase production costs for American manufacturers across various industry sectors. Soon after the tariffs were announced, the price of steel in the US jumped to levels far above most countries worldwide, e.g., 50 percent above European prices and 80 percent above Chinese ones. In the first quarter of 2018, about 80,000 and 56,800 people in the United States were employed in the steel and aluminum industry, respectively. Concurrently, over 3.4 mln people are employed in steel- and aluminum-consuming sectors, such as fabricated steel products, machinery, and transportation equipment. These sectors will experience a direct increase in production costs because of the tariffs (US Department of Commerce, 2018). Even though prices are likely to drop slightly over the long term as domestic mills expand production, prices will likely remain well above international levels.

The tariffs make it cost-prohibitive to import steel. As a result, there is an associated cost burden for US industrial sectors that are dependent on steel as a raw material, weakening the competitiveness of American manufacturers and potentially leading to job losses. Besides directly damaging the import sectors, tariffs on steel and aluminum would also lead to inflationary pressures for the US economy. The increase in production costs will ultimately be reflected in consumer prices. Retailers (such as Best Buy and JC Penney) and manufacturers (such as solar panel companies) will need to increase prices. This may prompt the Federal Reserve to accelerate the pace of its rate hikes to be part of inflation and avoid risking an economic slowdown (US Department of Commerce, 2018).

2.2. Industry context

Mexico is a major auto parts producer; a quarter of the vehicles imported into the United States come from this trading partner. Almost 80 percent of Mexico's exports go to its northern neighbor. Despite this, the United States imposed tariffs on imports of steel (25 percent) and aluminum (10 percent) from Mexico, Canada, and the EU from June 1, 2016, under the national security criterion under section 232 of its legislation (CANACERO, 2016).

Donald Trump's presidency was accompanied by launching and continuing a protectionism policy to discourage imports, especially in the fragile and heavily-weighted import structure industries, including steel and aluminum, which meet both these criteria. Officially driven by national security concerns, the US

administration imposed additional duties on steel (25 percent) and aluminum (10 percent) from Canada, Mexico, and the EU, effective June 1, 2018. These measures were one of several implemented under Trump's presidency. Yet, in Mexico's case, the against-import policy was a blend of statements, announcements, and premises with very few import-restricting decisions. While these import taxes were being put into effect, the United States, Mexico, and Canada were renegotiating NAFTA, confirming the goodwill of all three parties to facilitate trade and tighten economic relations. Thus, the American decision was even more surprising for the other member states.

The choice of industries to be covered by restrictions was justified by a mixture of the need to guarantee national security and protect the internal economy, including companies that operate in the steel and aluminum industries. The US Department of Commerce (2018) ran an investigation that concluded that steel and aluminum are essential to US national security, and that the volumes of imports (in 2018 and before) adversely impacted the economic welfare of the US aluminum industry. Yet, even though Mexico was hit with the import duties, the United States had a trade surplus in trade with aluminum products ($2.1 bln in 2016). The employment decline in the American primary aluminum sector was accompanied by employment growth in other industry segments, giving 3 percent growth.

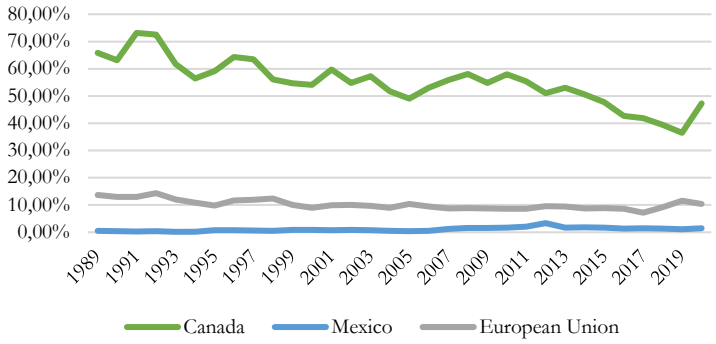
The research preceding the decision to impose extra duties was accompanied by hearings from several stakeholders, including commerce representatives and other diplomatic units (Scott, 2017, 2018a, 2018b). During the public hearing, the Chinese representative confronted the official justification with the facts regarding the US aluminum industry, emphasizing that national security requirements for this material are entirely supplied by domestic production. Thus, imports do not impair national security. Due to this sector's development in the US, domestic suppliers could provide the required volumes of aluminum for defense and national security. Thus, imports did not pose a threat to these sectors, nor did they contribute to the decline in employment, which steadily rose by approximately 3 percent annually from 2013. Sourcing primary aluminum materials from foreign suppliers was also accompanied by the American export of semi-finished and final goods. These goods have mainly civilian applications, which does not correspond with the official arguments.

The US Administration's decision was aimed at three economies: Canada, Mexico, and EU member states. The EU is America's primary source of imported steel, while Canada is the top aluminum supplier. To understand the US decision to impose tariffs on these economies, it is worth paying attention to the share of these countries in the American imports of aluminum (Figure 4) and steel, respectively (Figure 5). In both figures, the data only include products covered with duties[1].

[1] Aluminum: 7601, 7604, 7605, 7606, 7607, 7608, 7609, 7616.99.51.60 and 7616.99.51.70.
Steel: 20610 - 721650, 721699 - 730110, 730210, 730240 - 730290, and 730410 – 730690.

Figure 4

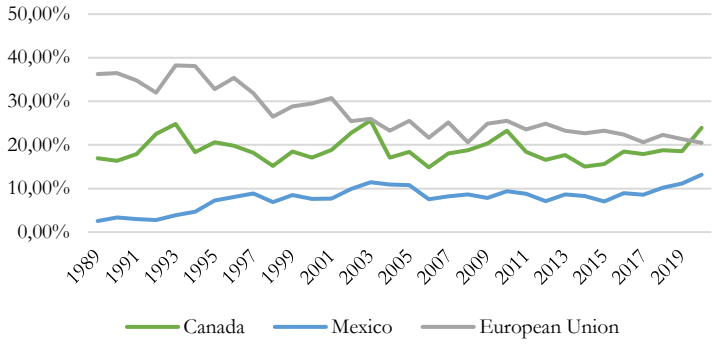
The share of Canada, Mexico, and the European Union in US imports of aluminum products, 1989-2020 (%)



Source: own-calculations based on US Census Bureau

Figure 5

The share of Canada, Mexico, and the European Union in US imports of steel products, 1989-2020 (%)



Source: own-calculations based on US Census Bureau

Figures 4 and 5 show that all these economies, to various extents, are significant suppliers of aluminum and steel products on the US market. Imposing duties provided noticeable protection to the domestic manufacturers and carried considerable potential damage to foreign trading partners. In contrast, the United States Trade Representative (USTR) reported that it had reduced the quota for imports of semi-finished steel products from Brazil from 350,000 to 60,000 tonnes by 2020.

Previously, on August 11, 2019, the USTR announced it would reimpose tariffs of 10 percent on US imports of raw non-alloy aluminum from Canada, to which the Canadian government replied that it would impose reprisals against US products for about $2.7 bln.

US Department of Commerce Bureau of Industry and Security Office of Technology Evaluation (2020) also published an agreement requiring automatic permits to be processed before the export of 63 different types of steel products. Mexico and the United States successfully concluded consultations under the mechanism established in their May 17, 2019, Joint Statement to address the increases in imports from Mexico of three steel products: standard pipe, mechanical pipe, and semi-finished products. Under the agreement, a quota on aluminum imports was not imposed, but if imports increased dramatically compared

with historical volumes, the United States reserved the right to reimpose the tariff while Canada and Mexico reserved the right to reimpose retaliatory measures (Chappell, 2019). Aluminum imports from all countries except Argentina, Australia, Canada, and Mexico remained subject to the 10% ad valorem tariff as of early December 2021.

3. METHODOLOGY

The econometric modeling and estimations were done through the linear model

$$\boldsymbol{Y_t = X_t \beta + U_t}$$

Where Y refers to a vector of data on imports of aluminum and steel (in logarithms), from the United States and from all over the world. Matrix X includes variables of exports of aluminum and steel from Mexico to the United States, or equivalently, their imports from Mexico (in logarithms), as well as dummy variables, which allow modeling of the effect of the tariff shock by the United States. It also includes lagged exports to capture the dynamics of export processes. U is a vector of stochastic disturbance. The method of estimation is ordinary least squares.

Thus, the Chow test has also been incorporated, making it possible to collect information on the possibility of a structural effect on exports derived from the tariff shock by the United States. The data are in monetary units (US dollars) and physical units (kilograms). The information comes from the database of the US Census Bureau and covers the period January 2017-January 2021. We consider the set of goods covered with duties according to the respective HTS codes[2].

4. EMPIRICAL RESULTS AND DISCUSSION

To identify the possible structural effect derived from a shock that alters the behavior dynamics of one or more variables in the model, we conducted the Chow test. For model 1 presented in Table 1, the result of this test indicates that with the US's implementation of tariffs on aluminum imports from Mexico, a structural effect is observed derived from this shock, starting in June 2018. Likewise, the value of the parameters obtained shows that they are statistically significant to explain the behavior of total imports in monetary units ($).

Model 2 presented in Table 1 shows that by incorporating a dichotomous variable, which models the imposition of tariffs on US imports of aluminum from Mexico, it is statistically significant but with a negative sign. This allows us to infer that the tariff policy launched in June 2018 by the United States adversely affected its imports of aluminum from Mexico. The coefficients obtained for the variable representing American imports from Mexico show that with tariffs, it is reduced from 0.38 to 0.20 percent,

[2] For aluminum, each variable includes HTS codes: 7601,7604, 7605, 7606, 7607, 7608 and 7609. For steel each variable includes HTS codes: 7206.10, 7206.90, 7207.11, 7207.12, 7207.19, 7207.20, 7208.21, 7208.22, 7208.23, 7208.24, 7208.42, 7208.43, 7209.13, 7209.22, 7209.23, 7209.24, 7209.42, 7209.90, 7210.31, 7210.39, 7210.49, 7210.70, 7210.90, 7211.19, 7211.22, 7211.29, 7211.30, 7211.41, 7211.90, 7212.21, 7212.29, 7212.30, 7212.40, 7213.10, 7213.31, 7213.41, 7214.20, 7214.40, 7214.50, 7215.10, 7215.90, 7216.10, 7216.21, 7216.22, 7216.31, 7216.32, 7216.33, 7216.40, 7216.50, 7217.11, 7217.12, 7217.19, 7217.32, 7218.90, 7219.31, 7219.32, 7219.33, 7219.34, 7219.35, 7220.12, 7220.20, 7220.90, 7222.10, 7222.40, 7223.00, 7224.90, 7228.30, 7228.50, 7228.60, 7228.80, 7302.10, 7302.90, 7304.10, 7304.20, 7304.31, 7304.39, 7304.59, 7304.90, 7305.11, 7305.12, 7305.19, 7305.31, 7305.39, 7305.90, 7306.10, 7306.20, 7306.30, 7306.40, 7306.50, 7306.60, 7306.90.

which implies a fall in the relative participation of Mexico as an aluminum supplier. The value of the parameter obtained for the dichotomous variable, being negative, shows that with the presence of the tariff shock (punitive duties) on the imports of aluminum from Mexico to the United States, the latter loses about 0.18 percent in the supply of aluminum in Mexico in monetary values.

In the light of these results, it is possible to suggest that a tariff shock, such as the one presented by US aluminum imports from Mexico, is leading this country to a trade diversion if it wants to maintain its aluminum export levels.

Table 1

The effect of tariffs on Mexican aluminum exports to the United States

Variable	**Parameters**	**Coefficient Model 1**	**Coefficient Model 2**
Constant	b_0	14.72 (1.77) [8.31] p-value: 0.0000	16.10 (1.48) [10.84] p-value: 0.0000
Exports from Mexico to the US	b_1	0.36 (0.10) [3.35] p-value: 0.0016	0.28 (0.08) [3.19] p-value: 0.0025
Dummy	b_2		-0.24 (0.05) [-4.83] p-value: 0.0000
		Determination Coefficient: 0.19	Determination Coefficient: 0.46
Chow test:	Null Hypothesis: No breaks at specified breakpoints	F-statistic: 14.80 F(2,45) p-value: 0.0000	

The variables are expressed in logarithms to obtain the elasticities, with monthly information. The dichotomous variable acquires unit values from the date that the United States imposed tariffs on Mexican aluminum.
Source: Authors' compilation with data from the US Census Bureau

The United States' tariff policy had unfavorable effects on the Mexican steel export to that country (see Table 2). This is demonstrated in model 1, where, by employing the Chow test, it is possible to state that implementing the steel tariff in June 2018 has had a long-term effect on steel imports from Mexico to the United States. The relevance of Mexican exports over those of the United States is observed since the coefficient for the variable of Mexican imports is significant.

Model 2 includes a dichotomous variable that aims to identify whether the tariff shock has harmed US imports. As can be seen, the coefficient is statistically significant, which shows that with the imposition of tariffs, the monetary value of imports is reduced since the coefficient is lower than that of model 1. Likewise, the dichotomous variable has a negative coefficient, indicating that with the tariff imposition, the value of imports was reduced by 0.28 percentage points. Finally, model 3 becomes more dynamic by incorporating the import variable from Mexico, which is lagged one period, to observe if it affects modeling. The result is that it also influences imports from Mexico, reducing the value of the parameter of the contemporary variable, as an effect on the dichotomous is marginally affected.

Based on the above, it can be argued that a tariff shock to aluminum and steel imports into the United States from Mexico has an adverse effect, possibly causing a trade diversion by Mexico, whether its objective is to maintain the same levels of export of these metals.

Table 2

The effect of tariffs on Mexican steel exports to the United States

Variable	**Parameters**	**Coefficient Model 1**	**Coefficient Model 2**	**Coefficient Model 3**
Constant	b_0	3.89 (3.15) [1.23] p-value: 0.2227	6.41 (2.50) [2.56] p-value: 0.0137	3.13 (2.76) [1.13] p-value: 0.2632
Export from Mexico to the US	b_1	0.91 (0.16) [5.55] p-value: 0.0000	0.79 (0.13) [6.07] p-value: 0.0000	0.59 (0.14) [4.05] p-value: 0.0002
Dummy	b_2		-0.28 (0.05) [-5.56] p-value: 0.0000	-0.29 (0.05) [-5.83] p-value: 0.0000
Import from $Mexico_{t-1}$	b_3			0.37 (0.14) [-2.60] p-value: 0.0126
		Determination Coefficient: 0.39	Determination Coefficient:: 0.63	Determination Coefficient: 0.68
Chow Test	Null Hypothesis: No breaks at specified breakpoints	F-statistic: 11.74 F(2,45) p-value: 0.0001		

The variables are expressed in logarithms to obtain the elasticities, with monthly information. The dichotomous variable acquires unit values from the date of the United States' imposition of tariffs on Mexican aluminum.
Source: Authors' compilation with data from the US Census Bureau

The results of our study correspond with other authors' findings. Hodge (2018) calculated the potential impact of the imposed tariffs assuming that the imports in 2018 equaled the respective values in 2017. For example, for steel, whose total value of imports in 2017 was approx. $2.5 bln, the 25 percent tax would total approx. $625 mln. Meanwhile, for aluminum, the value of imports was approx. $208 mln, and the estimated impact of a 10 percent tariff would be approx. $20 mln According to these projections, the value of affected imports was reduced by approximately $13 bln.

Hodge (2018) also provides calculations on these tariffs, aggregating data for Mexico and Canada, both affected by these extra import taxes. He indicates that these tariffs were harmful to the American manufacturing sector, especially the downstream US steel and aluminum consuming companies, as they increased prices and lead times for both domestic and imported steel and aluminum.

Amiti, Redding, and Weinstein (2019) researched the impact of the US's 2018 tariffs on prices and welfare. Their analysis does not cover import tax, which was the subject of our investigation. However, it is worth noticing that these import tariffs were almost wholly passed through into US domestic prices with no repercussions on prices received by foreign suppliers. They estimated that in 2018, the cumulative deadweight welfare cost, understood as a reduction in real income, accounted for $8.2 bln. It additionally

created a cost of $14 bln to domestic consumers and importers in the form of tariff revenues transferred to the government.

5. CONCLUSION

The study discussed the consequences of import duties on bilateral trade. Using statistical and mathematical methods of analysis, it identified the effect of the 2018 tariff shock on imports of aluminum and steel into the United States. The shock had a structural effect, which has been verified for both aluminum and steel imports. Likewise, the unfavorable impact in both monetary and physical units of the tariffs on both categories of goods has been shown, as reported by the estimated models.

As far as bilateral trade is concerned, the effect is differentiated. The United States may achieve its objective to protect the local industry and shift imports towards domestically produced goods. However, by impacting the domestic prices of these metals upwards, it could also influence the prices paid by the final consumer. For Mexico, trade could be diverted or its export capacity reduced, adversely affecting the trade balance of these metals.

Our estimations of the consequences of the US trade war correspond with the conclusions presented by other authors. However, it is hard to make direct comparisons due to the very narrow scope of the investigation. Nevertheless, the trade war between the United States and Mexico follows the perspective that the specific actions of the US administration do not find symmetrical reactions on the Mexican side. The results of this study are consistent with existing empirical evidence but contradict the argumentation of Riezman and Kennan (1988).

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