Does US trade liberalization explain Puerto Rico's deindustrialization?

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Abstract. This paper studies the possible role of US trade liberalization in explaining Puerto Rico's deindustrialization. In order to address this issue, time series techniques were used. The results of the Granger Causality Test suggest that the imports made by the US from Mexico, Canada, Ireland, and Costa Rica do not explain Puerto Rico's deindustrialization. Therefore, no causal relationship was found between the imports made by the US from its NAFTA partners and the countries where the corporations that benefited from Section 936 relocated with the deindustrialization of Puerto Rico. Besides, the impulse response exercise suggests that in the first period, deindustrialization explains its variability by 100%, and in the final period, it explains 95.47%.

Key Words: international trade; liberalization; deindustrialization; Puerto Rico.

¿La liberalización comercial de Estados Unidos explica la desindustrialización de Puerto Rico?

Resumen. Este trabajo estudia el posible papel de la liberalización comercial de Estados Unidos en la desindustrialización de Puerto Rico. Para alcanzar el objetivo, fueron usadas técnicas de serie de tiempo. Los resultados de la prueba de causalidad de Granger sugieren que las importaciones a Estados Unidos de México, Canadá, Irlanda y Costa Rica no explican la desindustrialización de Puerto Rico. Por lo tanto, no se encontró una relación causal entre las importaciones a Estados Unidos de sus socios del TLCAN y de los países donde se reubicaron las corporaciones que se beneficiaron de la Sección 936 con la desindustrialización de Puerto Rico. Además, el ejercicio de impulso respuesta sugiere que, en el primer periodo, la desindustrialización explica su variabilidad en 100%, mientras al final del periodo lo hace en 95.47%.

Palabras clave: comercio internacional; liberalización; deindustrialización; Puerto Rico.

Clasificación JEL: F140; F130; F6; C5.

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1. Introduction

The relationship between the United States of America (US) and Puerto Rico has laid the foundations for the economic strategies established since the post-war period on the island. Besides, the economic model established in Puerto Rico during the second half of the 20th century was based on the attraction of manufacturing corporations through tax incentives (Caraballo-Cueto, 2021). According to Quiñones-Pérez and Seda-Irizarry (2016), the transition from an agricultural economy to an industrialized one was based on export-focused industrialization, dependent on foreign direct investment from the US. Then Puerto Rico was proposed as a model for the rest of the "underdeveloped" countries during this period. However, from the 1970s, the image as a proposed model deteriorated (Villamil, 1981).

Between the 1950s and 1970s, Puerto Rico experienced an annual economic growth rate of around 4.9%, but with the 1973 oil embargo, the economy entered a period of instability and stagnation (Rodríguez and Toledo, 2007). Subsequently, the US Congress approved a new tax regime for US corporations; this regime was Section 936 of the Internal Revenue Code. Under this new regime, US corporations received full credit from income due to conducting business in a US possession, such as Puerto Rico (Feliciano, 2018). The tax exemption expanded manufacturing, especially export-oriented manufacturing (Meléndez, 2018). Also, it is essential to clarify that electronics, medical devices, pharmaceutical, and chemical products were the primary manufacturing industries in the Section 936 era (Caraballo-Cueto and Lara, 2018; Quiñones-Pérez and Seda-Irizarry, 2016; Rodríguez and Alemar, 2021). During the moment of most success of this regime, manufacturing represented 42% of the GDP of Puerto Rico and 17% of total employment on the island (Caraballo-Cueto and Lara, 2018).

However, Luciano (2005) points out that for many economists, the cause of the instability has been the exhaustion of the model. In addition, the author points out that these economists attribute the instability mainly to the deterioration of the comparative advantages that Puerto Rico had and the recession that the US experienced in the 1970s. Quiñones-Pérez and Seda-Irizarry (2020) add that during the establishment of this model, industrial policies that meet the needs of Puerto Ricans have not been correctly defined. Subsequently, Section 936 was eliminated in 1996 (with a transition of ten years), and with the arrival of the 21st century, Puerto Rico has experienced one of the major economic crises in its history.

Within the different analyses that have been carried out on this crisis, some studies link deindustrialization with the debt crisis (Caraballo-Cueto and Lara, 2018). However, there may be different positions on the origin of deindustrialization. First, it is necessary to recognize the stagnation Puerto Rico experienced after 1973. Besides, according to Caraballo-Cueto and Lara (2018), critics of Section 936 within the US complained about the tax base erosion caused by this tax regime. Feliciano (2018) adds that Section 936 was eliminated because, despite the jobs generated, the program did not justify the tax revenues losses. Therefore, when Section 936 was eliminated, the electronics, medical devices, pharmaceutical, and chemical products industries were affected. Quiñones-Pérez and Seda-Irizarry (2021) argue that there are multiple explanations for the factors that led Puerto Rico to the crisis; one of the explanations indicates that in recent decades the global economy has undergone transformations that have allowed capital to move with greater flexibility.

The different perspectives on the origin of deindustrialization make an excellent case to know: Did the trade liberalization of the US help forecast the deindustrialization of Puerto Rico? The main objective of this study is to determine if the trade liberalization of the US help to explain the deindustrialization of Puerto Rico. As a hypothesis for this study, the trade liberalization of the US should not allow to explain the deindustrialization of Puerto Rico. Because before trade liberalization, the island was already showing signs that its model was experiencing exhaustion and stagnation.

Knowing if the paradigm shifts associated with globalization reveal the deindustrialization of Puerto Rico would allow the evaluation of one of the aspects of the current economic crisis on the island. Time series techniques will be used to answer this study's question. Particularly a Vector Error Correction Model (VECM), this methodological approach will allow us to examine the long-term relationships between the proxy variable for deindustrialization in Puerto Rico and US trade liberalization.

This paper is organized as follows: the second section presents a literature review of the US trade liberalization and the current economic crisis in Puerto Rico. The third section presents a literature review of the methodology, the fourth section presents the data and methods to be used, and finally, the fifth and sixth sections present this study's results and the concluding remarks.

2. US TRADE LIBERALIZATION AND THE CURRENT ECONOMIC CRISIS IN PUERTO RICO

Puerto Rico is part of the US customs system; therefore, it is a unified market with free trade characteristics (Martínez and Rivera, 2005). According to Luciano (2005), between 1972 and 1987, the sectors of the Puerto Rican economy most dependent on the US were manufacturing, mining, and construction; this is highly relevant because manufacturing was the core of the economic model. However, even though manufacturing had one of the highest dependency indices, these experienced decreases, which the changes and amendments to Section 936 can explain. Additionally, it is curious that while the dependency indices of the Puerto Rican economy, particularly those associated with manufacturing, decreased, North America took the first steps to officially sign the North American Free Trade Agreement (NAFTA).

Lara (1996) argues that with the emergence of NAFTA in 1994, Puerto Rico observed the rise of Mexico with concealed fear since it could displace the island from traditionally dominated markets and monopolize international capital investment. In addition, the fact that NAFTA entered into force affected Puerto Rico's effectiveness in attracting foreign direct investment since Mexico effectively competed with the island (Caraballo-Cueto and Lara, 2018). While Pantojas (2008) points out that in some Caribbean countries their exports to the US decreased after NAFTA came into force, while Mexican exports increased rapidly. However, it is essential to clarify that Romero-Ramírez (2023) found that between 1965 and 1990, the integration of Mexico and Canada with the US increased over time. Therefore, it could be interpreted that the loss of competitiveness for Puerto Rico did not start abruptly in 1994.

This erosion in Puerto Rico's competitiveness has intensified due to other initiatives arising from globalization, such as the Dominican Republic-Central America Free Trade Agreement (Lara and Rivera, 2005). However, there have been more comprehensive explanations of Puerto Rico's dilemmas since the 1990s. Among the factors that could have affected Puerto Rico's position in the world economy are the possible normalization of bilateral relations between Cuba and the US, the elimination of Section 936, the emergence of newly industrialized countries in the Pacific and Ireland, and the emergence of NAFTA (Quiñones-Pérez, 1993). In this context, Romero (2022), using Input-Output matrices regarding international trade, found that between 1995 and 2011, the US had significant trade relations with Mexico, Canada, and Ireland.

The first two countries should not be surprised due to NAFTA. Nevertheless, the case of Ireland (along with Costa Rica) is significant since this is one of the countries where the corporations associated with Section 936 chose to relocate their operations after the tax regime was eliminated (Caraballo-Cueto and Lara, 2018). However, after the US continued trade liberalization, Lawrence and Lara (2006) found that Puerto Rican exports to the US are associated with low external tariffs; this could suggest a low probability that Puerto Rican exports will be significantly affected by new Free Trade Agreements (FTAS).

In this context, Toledo (2017), using a methodology to determine structural breaks, found that the reduction in manufacturing employment in Puerto Rico began after 1996. Therefore, the author argues that the end of Section 936 appears to be the main reason for the decline in manufacturing employment. Furthermore, the author suggests that the reduction in labor-intensive manufacturing industries could be explained by NAFTA or another event associated with globalization since these industries experienced reductions in employment before 1996. It is important to note that since 2006, Puerto Rico has faced one of the biggest economic crises in its history. This crisis has had fiscal, debt, demographic, and deindustrialization characteristics. Many explanations for the crisis in modern Puerto Rico have focused on 2006 since that was when Section 936 ended (Quiñones-Pérez and Seda-Irizarry, 2020).

Furthermore, Caraballo-Cueto and Lara (2018), using time series techniques with a breakpoint in 1995, found that the indebtedness of Puerto Rico is primarily related to the island's deindustrialization. In other words, with the end of Section 936, a new economic program for the island that substituite the previous one, was not elaborated. As a consequence, the production capacity of the island decreased, along with employment and tax collections (Ríos, 2021). In response to the debt crisis, different governments in the last 16 years have established public policies to reduce public spending and increase tax collections. However, Ríos (2021) states that austerity policies have not generated the expected recovery. When Puerto Rico defaulted on its public debt, some sectors, and individuals began to lobby for the US Congress to impose a financial oversight board on Puerto Rico. Finally, this happened, and the board took away the little autonomy that Puerto Rico had (Quiñones-Pérez and Seda-Irizarry, 2020).

This study aims to assess whether the trade liberalization established by the US could help to understand the deindustrialization of Puerto Rico. Manufacturing employment was chosen as a proxy variable for the deindustrialization of Puerto Rico. Manufacturing exports were chosen because they represent another manufacturing characteristic, as Caraballo-Cueto and Lara (2018) did in their study. Imports made by the US from Mexico and Canada after the establishment of NAFTA will be used as proxy variables for trade liberalization. Imports made by the US from Ireland and Costa Rica will also be used since these two countries were some places where the corporations that benefited from Section 936 relocated.

Variables associated with other FTAS will not be included since many of these were negotiated after the deindustrialization of Puerto Rico began. Besides, variables associated with the tax base erosion experienced by the US and variables associated with the exhaustion of the model of Puerto Rico, such as manufacturing productivity and investment, will not be included either. This decision was made because most of the data for Puerto Rico exists only with annual observations. Even studies linked to the deindustrialization of Puerto Rico indicate that it is necessary to improve the quality of macroeconomic data (Caraballo-Cueto and Lara, 2018).

It is also important to note that variables related to demographic characteristics will not be used in this study because the population of Puerto Rico began to decrease in 2005, while deindustrialization began in the late 1980s (Santos-Lozada *et al.*, 2020; Caraballo-Cueto and Lara, 2018). In addition, there are currently many challenges associated with the availability of demographic data in Puerto Rico; for example, the majority of population databases are cross-sectional, and there are some panel datasets available that follow individuals over time, but they are not representative of the population (Caraballo-Cueto, 2020). Due to these data limitations, this study will only be able to examine the relationship between the deindustrialization of Puerto Rico and US trade liberalization and, alternatively, the relationship of deindustrialization with US imports from the countries in which the corporations that benefited from Section 936 were relocated.

3. METHODOLOGICAL LITERATURE REVIEW: VAR AND VECM

Causal inference aims to assess whether the manipulation of one variable can affect the results of another variable while keeping other factors constant and is based on controlled variation (Heckman, 2008); this is a different concept from other approaches to causality that base their analysis on prediction (Granger, 1969; Sims, 1972). Dufour and Taamouti (2010) argue that causality could be defined as the predictability at horizon 1 of a given variable

X from its past values, the past values of variable *Y*, and possibly vector *Z* of auxiliary variables. Besides, according to Götz *et al.* (2016), Granger Causality is often used within the Vector Autoregression (VAR) model. Gujarati and Porter (2009) argue that VAR is a model that resembles simultaneous equation models since they consider several endogenous variables together. It is important to note that each variable is explained by its lagged values and the other variables' lagged values in the model. Hamilton (1994) adds that the VAR model represents a statistical description of the dynamic interrelations between *n* different variables. In addition, the author points out that these models do not use previous theoretical ideas about how the model's variables should be related to each other.

However, Granger Causality can also be used under VECM analyses; an example is a study by Shahbaz *et al.* (2016). The VECM incorporates the cointegration restrictions to the VAR models (Konstantakis *et al.*, 2016; Ma *et al.*, 2018). According to Nugraha and Osman (2019), cointegration is the combination of the linear relationship between variables that are not stationary at the level; the authors add that since the variables must be cointegrated at the same level, it is interpreted that the variables are in a similar stochastic trend, which is why they have the same direction of movement in the long term. This model modification allows the interpretation of the equilibrium of the variables in their steady state.

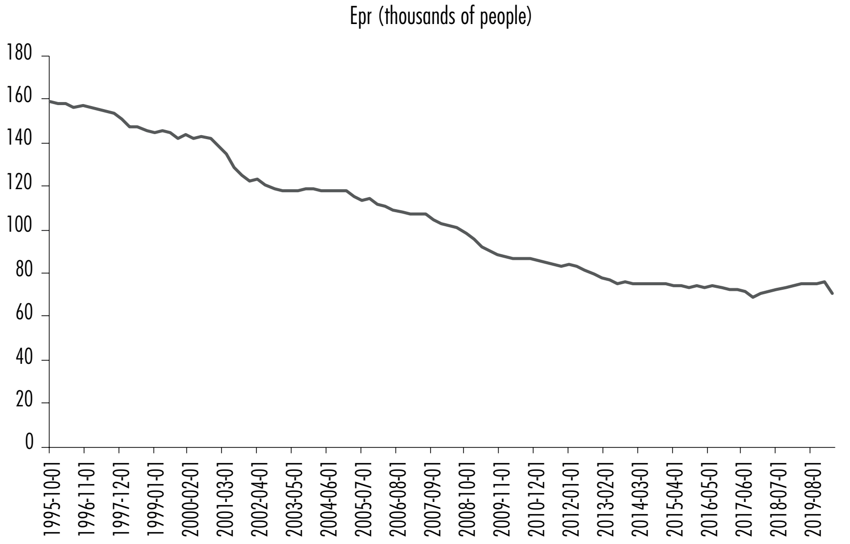
In summary, it is essential to note that the VECM is designed for its use with non-stationary time series that are cointegrated and, therefore, VECM is applied when the variables are cointegrated and the VAR model when they are not cointegrated (Khanna *et al.*, 2015; Konstantakis *et al.*, 2016). Also, other analyses can be performed within the VECM and VAR models. For example, variance decomposition estimates show how much the variables in the model affect each other in terms of percentage (Meher *et al.*, 2022). Besides, variance decomposition does not vary according to the order of the variables in the model; this makes it easier to measure the contagion effects of total and directional volatility (Candelo-Viáfara and Oviedo-Gómez, 2020). Therefore, the VECM or VAR model has the necessary characteristics to carry out the proposed analysis of this study.

4. Data and methods

The model used in this paper will consider six variables: Manufacturing Employees in Puerto Rico (*Epr_t*), Manufactured Exports of Puerto Rico (X*pr_t*), US imports from Mexico (*Mmx_t*), Canada (*Mcn_t*), Ireland (*Mil_t*), and Costa Rica (*Mcr_t*) from 1995Q4 to 2020Q2. The six variables are from the Federal Reserve Economic Data (FRED). Figure 1. shows the deindustrialization of Puerto Rico over time. As the figure shows, manufacturing employment in Puerto Rico has followed a decreasing trajectory; this downward trend coincides with the entry into force of NAFTA.

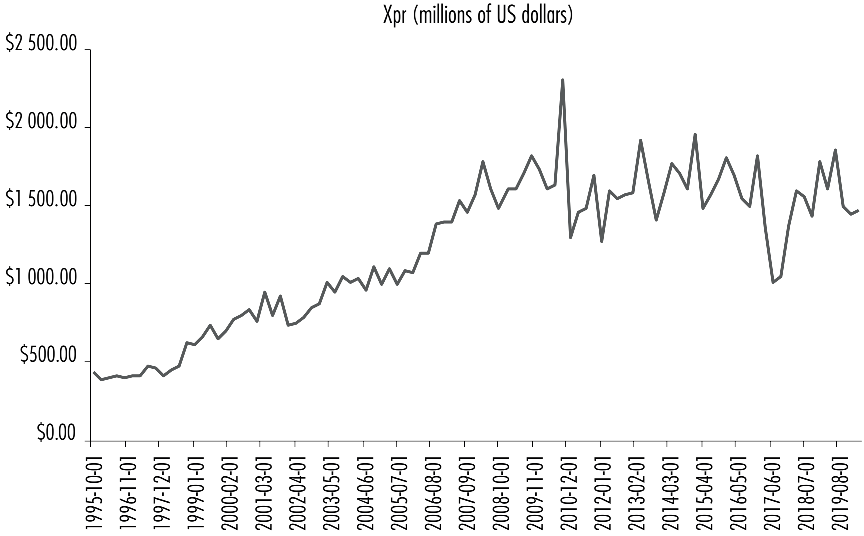
Figure 2 shows another proxy of the behavior of manufacturing on the island over time. In the figure it is possible to suggest that due to technological changes, innovation, or productivity increases, manufacturing production was not affected by the dramatic loss of employment in manufacturing. Subsequently, particularly between 2012 and 2020, significant volatility can be observed in manufacturing exports. Besides, figure 3 shows the behavior of the US trade liberalization over time.

Figure 1. Manufacturing employees in Puerto Rico



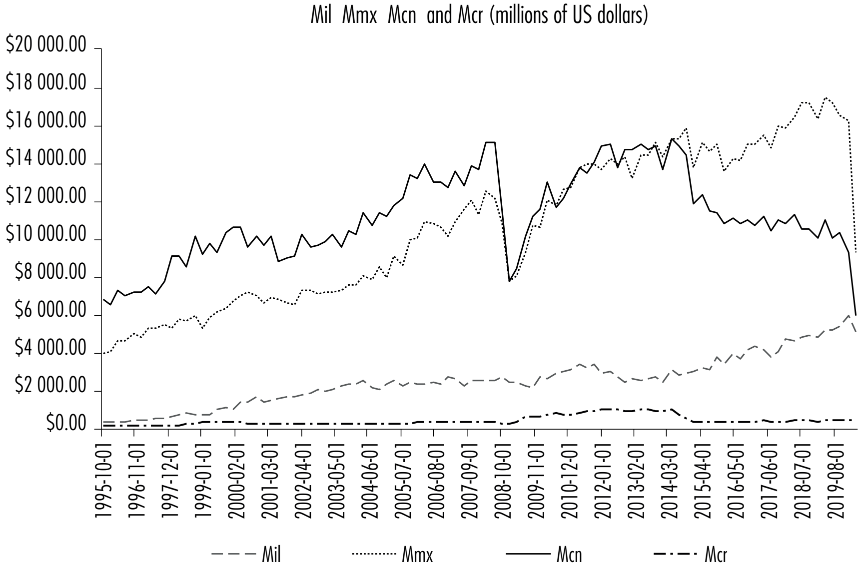
Source: own elaboration using data from FRED (2022a).

Figure 2. Manufactured exports for Puerto Rico



Source: own elaboration using data from FRED (2021a).

Figure 3. US imports from Ireland, Mexico, Canada, and Costa Rica



Source: own elaboration using data from FRED (2021b, 2021c, 2022b and 2022c).

In terms of methodology, when performing a time series analysis, it is necessary to determine if the variables are cointegrated. To reach this determination, it is necessary to perform the Johansen Cointegration Test; which could have the following form:

$$J_{Trace} = -T \sum_{i=r+1}^{n} ln(1-\hat{\lambda}_i) \tag{1}$$

$$J_{Maximum} = -T\, ln(1-\hat{\lambda}_{r+1}) \tag{2}$$

Under the Johansen Cointegration Test, T is the sample size, and $\hat{\lambda}_i$ represents the largest canonical correlation. The Maximum eigenvalue test tests the null hypothesis of r cointegrating vectors against an alternative hypothesis of $r+1$ cointegrating vectors. In contrast, the Trace test tests a null hypothesis of r cointegrating vectors against its alternative hypothesis of n cointegrating vectors. In addition, it is necessary to mention that the cointegration analysis is essential when the variables present a similarity in the order of integration (Rodríguez, 2002); this similarity in the order of integration suggests that it is necessary to use series that coincide with obtaining unbiased and consistent estimators and with solving the problem of spurious regressions (Rodríguez, 2001). Also, if cointegration is found, it can be interpreted that the variance of the residual in the parameter space is minimized, and the estimators also turn out to be very consistent since they converge to their actual value (Rodríguez, 2001; Novales, 1993; Maddala, 1996). According to Ortiz (2019), the multivariate model of order 1 is known as VAR (1). Where the $m\,x\,1$ vector of random variables, y_t, follow a VAR (1) process with $m\,x\,m$ coefficients matrix Ψ if,

$$y_t = \Psi y_{t-1} + \epsilon_t, \qquad t = 1, 2, 3, \ldots, n \tag{3}$$

where ϵ_t is an $m\,x\,1$vector of error terms.

To provide a general form for the model using the variables of interest:

$$Epr_t = \Theta_{11}\, Epr_{t-p} + \Theta_{12}\, Xpr_{t-p} + \Theta_{13} Mmx_{t-p} + \Theta_{14}\, Mcn_{t-p} + \Theta_{15}\, Mil_{t-p} + \Theta_{16}\, Mcr_{t-p} + \epsilon_{Epr} \tag{4}$$

$$Xpr_t = \Theta_{21}\, Epr_{t-p} + \Theta_{22}\, Xpr_{t-p} + \Theta_{23} Mmx_{t-p} + \Theta_{24}\, Mcn_{t-p} + \Theta_{25}\, Mil_{t-p} + \Theta_{26}\, Mcr_{t-p} + \epsilon_{Xpr} \quad (5)$$

$$Mmx_t = \Theta_{31}\, Epr_{t-p} + \Theta_{32}\, Xpr_{t-p} + \Theta_{33} Mmx_{t-p} + \Theta_{34}\, Mcn_{t-p} + \Theta_{35}\, Mil_{t-p} + \Theta_{36}\, Mcr_{t-p} + \epsilon_{Mmx} \quad (6)$$

$$Mcn_t = \Theta_{41}\, Epr_{t-p} + \Theta_{42}\, Xpr_{t-p} + \Theta_{43} Mmx_{t-p} + \Theta_{44}\, Mcn_{t-p} + \Theta_{45}\, Mil_{t-p} + \Theta_{46}\, Mcr_{t-p} + \epsilon_{Mcn} \quad (7)$$

$$Mil_t = \Theta_{51}\, Epr_{t-p} + \Theta_{52}\, Xpr_{t-p} + \Theta_{53} Mmx_{t-p} + \Theta_{54}\, Mcn_{t-p} + \Theta_{55}\, Mil_{t-p} + \Theta_{56}\, Mcr_{t-p} + \epsilon_{Mil} \quad (8)$$

$$Mcr_t = \Theta_{61}\, Epr_{t-p} + \Theta_{62}\, Xpr_{t-p} + \Theta_{63} Mmx_{t-p} + \Theta_{64}\, Mcn_{t-p} + \Theta_{65}\, Mil_{t-p} + \Theta_{66}\, Mcr_{t-p} + \epsilon_{Mcr} \quad (9)$$

This is a VAR (p) representation because we must test the selection criteria for the optimal lag term p in the term: $(t-p^{*})$ to establish the lagged term for all the variables. In addition, it will be necessary to do a cointegration test to know if the variables are cointegrated. If necessary, the VECM could have the following form:

$$\Delta\, Epr_t = \propto_1 + \sum_{i=1}^{m} \beta_1 \,\Delta\, E_{pr_{t-i}} + \sum_{i=1}^{m} \beta_2 \,\Delta\, Xpr_{t-i} + \sum_{i=1}^{m} \beta_3 \,\Delta\, M_{mx_{t-i}} + \sum_{i=1}^{m} \beta_4 \,\Delta\, M_{cn_{t-i}} + \sum_{i=1}^{m} \beta_5 \,\Delta\, M_{il_{t-i}} + \sum_{i=1}^{m} \beta_6 \,\Delta\, M_{cr_{t-i}} + \beta_7 \mu_{t-1} + \epsilon_{1t} \quad (10)$$

$$\Delta\, Xpr_t = \propto_2 + \sum_{i=1}^{m} \beta_8 \,\Delta\, Xpr_{t-i} + \sum_{i=1}^{m} \beta_9 \,\Delta\, E_{pr_{t-i}} + \sum_{i=1}^{m} \beta_{10} \,\Delta\, M_{mx_{t-i}} + \sum_{i=1}^{m} \beta_{11} \,\Delta\, M_{cn_{t-i}} + \sum_{i=1}^{m} \beta_{12} \,\Delta\, M_{il_{t-i}} + \sum_{i=1}^{m} \beta_{13} \,\Delta\, M_{cr_{t-i}} + \beta_{14} \mu_{t-1} + \epsilon_{2t} \quad (11)$$

$$\Delta M_{mx_t} = \propto_3 + \sum_{i=1}^{m} \beta_{15} \Delta M_{mx_{t-i}} + \sum_{i=1}^{m} \beta_{16} \Delta E_{pr_{t-i}}$$
$$+ \sum_{i=1}^{m} \beta_{17} \Delta Xpr_{t-i} + \sum_{i=1}^{m} \beta_{18} \Delta M_{cn_{t-i}} + \sum_{i=1}^{m} \beta_{19} \Delta M_{il_{t-i}}$$
$$+ \sum_{i=1}^{m} \beta_{20} \Delta M_{cr_{t-i}} + \beta_{21}\mu_{t-1} + \epsilon_{3t} \tag{12}$$

$$\Delta M_{cn_t} = \propto_4 + \sum_{i=1}^{m} \beta_{22} \Delta M_{cn_{t-i}} + \sum_{i=1}^{m} \beta_{23} \Delta E_{pr_{t-i}}$$
$$+ \sum_{i=1}^{m} \beta_{24} \Delta Xpr_{t-i} + \sum_{i=1}^{m} \beta_{25} \Delta M_{mx_{t-i}} + \sum_{i=1}^{m} \beta_{26} \Delta M_{il_{t-i}}$$
$$+ \sum_{i=1}^{m} \beta_{27} \Delta M_{cr_{t-i}} + \beta_{28}\mu_{t-1} + \epsilon_{4t} \tag{13}$$

$$\Delta M_{il_t} = \propto_5 + \sum_{i=1}^{m} \beta_{29} \Delta M_{il_{t-i}} + \sum_{i=1}^{m} \beta_{30} \Delta E_{pr_{t-i}}$$
$$+ \sum_{i=1}^{m} \beta_{31} \Delta Xpr_{t-i} + \sum_{i=1}^{m} \beta_{32} \Delta M_{mx_{t-i}} + \sum_{i=1}^{m} \beta_{33} \Delta M_{cn_{t-i}}$$
$$+ \sum_{i=1}^{m} \beta_{34} \Delta M_{cr_{t-i}} + \beta_{35}\mu_{t-1} + \epsilon_{5t} \tag{14}$$

$$\Delta M_{cr_t} = \propto_6 + \sum_{i=1}^{m} \beta_{36} \Delta M_{cr_{t-i}} + \sum_{i=1}^{m} \beta_{37} \Delta E_{pr_{t-i}}$$
$$+ \sum_{i=1}^{m} \beta_{38} \Delta Xpr_{t-i} + \sum_{i=1}^{m} \beta_{39} \Delta M_{mx_{t-i}} + \sum_{i=1}^{m} \beta_{40} \Delta M_{cn_{t-i}}$$
$$+ \sum_{i=1}^{m} \beta_{41} \Delta M_{il_{t-i}} + \beta_{42}\mu_{t-1} + \epsilon_{6t} \tag{15}$$

Equations 10-15 compose a bivariate VAR in first differences augmented by the error correction terms; this indicates that VECM and cointegration are equivalent representations (Khanssa *et al.*, 2018). In VAR and VECM, they are different ways to analyze the estimations. However, in this paper, the focus will be on Granger Causality and variance decomposition. While testing the Granger Causality, they are four possible results. The different outcomes are the following: Unidirectional Granger Causality from Y_t to X_t, Unidirectional Granger Causality from X_t to Y_t, Bi-directional causality, and No causality. The second technique to be used is variance decomposition; as mentioned above, this technique shows how much the variables in the model affect each other in terms of percentage (Meher *et al.*, 2022).

As previously mentioned, Toledo (2017), in his study on manufacturing in Puerto Rico, found a structural change in manufacturing employment in 1996. This finding by Toledo (2017) led us to consider including a dummy variable after 1996. However, it was decided not to incorporate this specification into our model because the series of our study begins in the fourth quarter of 1995, while Toledo (2017) used a database with a monthly frequency between 1991 and 2013. Something similar happened in the study of Caraballo-Cueto and Lara (2018), where the authors used a regime-switching regression approach to consider a breakpoint after 1995 and found that deindustrialization and indebtedness were more connected after 1995. Nevertheless, we must mention that Caraballo-Cueto and Lara (2018) used annual data for 1975-2014.

Therefore, in the studies by Toledo (2017) and Caraballo-Cueto and Lara (2018), there was enough information from the past to carry out their analyses. While in our study, we have data limitations, mainly on US imports from Mexico and Canada and manufacturing exports from Puerto Rico, since these data are only available after NAFTA came into force. In addition, the main contribution of this study is to identify which bilateral relationship of the US with some of its main trading partners could have affected the deindustrialization of Puerto Rico, for which the focus of this study is different from finding a structural change.

5. Results

When performing a time series analysis, it is necessary to pay attention to the dynamic structure of the series. Besides, economic variables are usually non-stationary, so the presence of unit roots must be tested before estimating the model. Several tests can be used to detect the presence of unit roots; for this paper, the Augmented Dickey-Fuller (ADF) and Phillips-Perron tests were used. These tests will allow us to determine if the first differences are enough to make the series stationary. Table 1 presents the results of the Unit Root Test-Augmented Dickey-Fuller and table 2 presents the results of the Unit Root Test-Phillips-Perron. The results suggest that the six variables are of order I(1).

Since the variables are stationary at the same level of integration, it is possible to perform the Johansen Cointegration Test. Table 3 shows the results of the Johansen Cointegration Test-Trace; these results suggest that the variables are cointegrated at the 5% significance level; this implies that the series maintains a stable relationship in the long term and the variables are in a similar stochastic trend, which is why they follow the same direction of movement in the long term. Also, it is essential to mention that from the results of table 3, it can be interpreted that there are two cointegrated equations for which the Trace Test suggests that a VECM should be estimated and not a VAR model.

Table 1. Unit Root Test-Augmented Dickey-Fuller*

Variable	*t-Statistic*	*P-Value*	*Decision*
Manufacturing Employees in Puerto Rico (Epr)			First Difference for Epr
Level	-1.7252	0.4154	
1st difference	-6.3592	0.0000	
Manufactured Exports for Puerto Rico (Xpr)			First Difference for Xpr
Level	-1.7582	0.3990	
1st difference	-9.8958	0.0000	
US imports from Canada (Mcn)			First Difference for Mcn
Level	-2.0116	0.2815	
1st difference	-6.8436	0.0000	
US imports from Mexico (Mmx)			First Difference for Mmx
Level	-1.8154	0.3711	
1st difference	-8.1881	0.0000	
US imports from Costa Rica (Mcr)			First Difference for Mcr
Level	-1.8331	0.3625	
1st difference	-7.5043	0.0000	
US imports from Ireland (Mil)			First Difference for Mil
Level	0.2700	0.9756	
1st difference	-14.4404	0.0001	

Note: *the lag length and the specification of the ADF Test can be found in the Appendix of this paper.
Source: own elaboration.

Table 2. Unit Root Test-Phillips-Perron

Variable	*Adj. t-Stat*	*P-Value*	*Decision*
Manufacturing Employees in Puerto Rico (Epr)			First Difference for Epr
Level	-1.8869	0.3372	
1st difference	-6.5866	0.0000	
Manufactured Exports for Puerto Rico (Xpr)			First Difference for Xpr
Level	-2.3521	0.1581	
1st difference	-22.4007	0.0001	
US imports from Canada (Mcn)			First Difference for Mcn
Level	-1.9432	0.3115	
1st difference	-9.3529	0.0000	
US imports from Mexico (Mmx)			First Difference for Mmx
Level	-1.8088	0.3743	
1st difference	-8.3841	0.0000	
US imports from Costa Rica (Mcr)			First Difference for Mcr
Level	-1.6218	0.4677	
1st difference	-7.4656	0.0000	
US imports from Ireland (Mil)			First Difference for Mil
Level	-0.2298	0.9299	
1st difference	-14.4404	0.0001	

Source: own elaboration.

Table 3. Johansen Cointegration Test-Trace

Series: D(Mcn) D(Epr) D(Mil) D(Mcr) D(Mmx) D(Xpr)

Lags interval (in first differences): 1 to 8

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	*Eigenvalue*	*Trace Statistic*	*0.05 Critical Value*	*P-Value*	*Decision*
None	0.4081	117.5784	95.7536	0.0007	
At most 1	0.3053	70.9032	69.8188	0.0409	
At most 2	0.2005	38.4770	47.8561	0.2816	
At most 3	0.1077	18.5601	29.7970	0.5249	
At most 4	0.0519	8.4135	15.4947	0.4223	
At most 5	0.0403	3.6677	3.8414	0.0555	Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

Source: own elaboration.

In comparison, table 4 shows the results of the Johansen Cointegrating Test-Max-eigenvalue; like the results of table 3, it is suggested that the variables are cointegrated at the 5% significance level. It is also important to clarify that the interpretations made of table 3 also apply to the results of table 4, except that the Max-eigenvalue suggests that there is only one cointegrated equation. These different results must be considered because when the VECM is specified, the number of cointegrated equations must be indicated, and it must be decided which test can be more powerful. It is important to note that in the literature, it is indicated that the Trace Test tends to have more power than the Max-eigenvalue; this is because the Trace Test takes account of all $(p-r)$ of the smallest eigenvalues (Serletis and King, 1997).

Therefore, to estimate the VECM, it was decided to specify the model with two cointegrated equations. The next step was to determine the optimal lag, then several criteria were used, such as Akaike, Schwartz, and Hannan-Quinn, among others. According to these criteria results, one lag is the optimal scenario for the model. These results and the VECM estimations can be found in the Appendix.

Besides, this section presents the main results of the Granger Causality Test; these results are summarized in table 5. VECM Granger Causality Test and

Table 4. Johansen Cointegration Test-Max-eigenvalue

Series: D(Mcn) D(Epr) D(Mil) D(Mcr) D(Mmx) D(Xpr)

Lags interval (in first differences): 1 to 8

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	*Eigenvalue*	*Max-Eigen Statistic*	*0.05 Critical Value*	*P-Value*	*Decision*
None	0.4081	46.6751	40.0775	0.0079	
At most 1	0.3053	32.4262	33.8768	0.0737	
At most 2	0.2005	19.9168	27.5843	0.3469	
At most 3	0.1077	10.1465	21.1316	0.7308	
At most 4	0.0519	4.7458	14.2646	0.7735	
At most 5	0.0403	3.6677	3.8414	0.0555	Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

Source: own elaboration.

only consider the variables associated with Puerto Rico, such as Manufacturing Employees in Puerto Rico (Epr_t) and Manufactured Exports for Puerto Rico (Xpr_t). It is essential to mention that the results of the Granger Causality Test for the relationships between variables not associated with Puerto Rico can be found in the Appendix. Table 5 shows the results for each pair of variables in both possible directions of causality. The first pair of variables that can be observed is Manufacturing Employees in Puerto Rico (Epr_t) and US imports from Canada (Mcn_t); these results suggest that US imports from Canada (Mcn_t) does not cause Manufacturing Employees in Puerto Rico (Epr_t) and vice versa. Therefore, there is no causal relationship in either direction.

The same interpretation can be made for the rest of the relationships examined between Manufacturing Employees in Puerto Rico (Epr_t) and US imports from Mexico (Mmx_t), Costa Rica (Mcr_t), and Ireland (Mil_t). Moreover, neither do Manufacturing Employees in Puerto Rico (Epr_t) cause Manufactured Exports for Puerto Rico (Xpr_t), and *vice versa*. Therefore, there is no causal relationship in either direction. In other words, these results indicate that both variables (in each pair) do not directly predict the potential patterns in each other, and none of the variables Granger Cause the deindustrialization of Puerto Rico.

Table 5. VECM Granger Causality Test

Null Hypothesis	*Chi-sq*	*df*	*P-Value*	*Decision*	*Type of causality*
D(Mcn) does not Granger Cause D(Epr)	0.535460	1	0.4643	Do not reject	
D(Epr) does not Granger Cause D(Mcn)	0.233460	1	0.6290	Do not reject	No causality
D(Xpr) does not Granger Cause D(Epr)	0.018099	1	0.8930	Do not reject	
D(Epr) does not Granger Cause D(Xpr)	1.261163	1	0.2614	Do not reject	No causality
D(Mmx) does not Granger Cause D(Epr)	0.014759	1	0.9033	Do not reject	
D(Epr) does not Granger Cause D(Mmx)	2.532452	1	0.1115	Do not reject	No causality
D(Mcr) does not Granger Cause D(Epr)	0.315459	1	0.5743	Do not reject	
D(Epr) does not Granger Cause D(Mcr)	0.049333	1	0.8242	Do not reject	No causality
D(Mil) does not Granger Cause D(Epr)	0.873716	1	0.3499	Do not reject	
D(Epr) does not Granger Cause D(Mil)	1.924686	1	0.1653	Do not reject	No causality
D(Mcn) does not Granger Cause D(Xpr)	5.313614	1	0.0212	Reject	
D(Xpr) does not Granger Cause D(Mcn)	0.615174	1	0.4328	Do not reject	Unidirectional causality from Mcn to Xpr
D(Mcr) does not Granger Cause D(Xpr)	14.13346	1	0.0002	Reject	
D(Xpr) does not Granger Cause D(Mcr)	1.843579	1	0.1745	Do not reject	Unidirectional causality from Mcr to Xpr
D(Mil) does not Granger Cause D(Xpr)	2.900969	1	0.0885	Do not reject	
D(Xpr) does not Granger Cause D(Mil)	0.287784	1	0.5916	Do not reject	No causality
D(Mmx) does not Granger Cause D(Xpr)	0.368673	1	0.5437	Do not reject	
D(Xpr) does not Granger Cause D(Mmx)	1.014209	1	0.3139	Do not reject	No causality

Source: own elaboration.

However, when we look at the results of the relationships between Manufactured Exports for Puerto Rico (Xpr_t) and US imports from Canada (Mcn_t), Costa Rica (Mcr_t), Ireland (Mil_t), and Mexico (Mmx_t), different behavior can be observed. For example, it is possible to observe in table 5 that the null hypothesis was rejected on two occasions. In particular, causality was found from US imports from Canada (Mcn_t) to Manufactured Exports of Puerto Rico (Xpr_t) and from US imports from Costa Rica (Mcr_t) to Manufactured Exports of Puerto Rico (Xpr_t). These results suggest that the trade ties of the US with Canada and Costa Rica directly predict potential patterns of manufacturing production in Puerto Rico measured through Manufactured Exports of Puerto Rico (Xpr_t). It is essential to clarify that these results on manufactured exports do not suggest that the US trade ties with Canada and Costa Rica Granger cause the deindustrialization of Puerto Rico; this is because, as mentioned above, Manufactured Exports of Puerto Rico (Xpr_t) did not experience an abrupt drop as Manufacturing Employees in Puerto Rico (Epr_t) did since the late 1980s.

The other methodological approach of this paper is the variance decomposition; we discuss the results of the impulses of Manufacturing Employees in Puerto Rico (Epr_t) and Manufactured Exports of Puerto Rico (Xpr_t). These results are summarized in table 6 and table 7. In the case of table 6, the results suggest that the most important impulses for Manufacturing Employees in Puerto Rico (Epr_t) are their impulses. Given that in the first period, the impulses of Manufacturing Employees in Puerto Rico (Epr_t) explain the variability by 100%, and in the final period, they explain 95.47%.

Similar behavior can be observed for the rest of the periods. However, from the sixth period, it is possible to observe that US imports from Costa Rica (Mcr_t) begin to explain more than 1% of the variability of Manufacturing Employees in Puerto Rico (Epr_t), even for the last period it explains more than 2.65% of the variability. Finally, the variance decomposition suggests that the impulses of US imports from Canada (Mcn_t), Ireland (Mil_t), Mexico (Mmx_t), and Manufactured Exports for Puerto Rico (Xpr_t) on Manufacturing Employees in Puerto Rico (Epr_t) are minimal.

Table 7 presents results that show another reality. For example, in the first period, Manufactured Exports for Puerto Rico (Xpr_t) only explained 95.91% of its variability. This percentage decreased each period to the point that in the last period, Manufactured Exports for Puerto Rico (Xpr_t) only explained 46.25% of its variability. Also, US imports from Costa Rica (Mcr_t) represent an essential part of the impulses of Manufactured Exports for Puerto Rico

(Xpr_t) since they represented more than 10% of the impulses between the second and fourth periods.

However, subsequently, the percentage decreased; at the same time, this behavior occurred, it can be observed that the US imports from Canada (Mcn_t), Ireland (Mil_t), and Manufacturing Employees in Puerto Rico (Epr_t) (in that order) became more important in explaining the variability of the impulses of Manufactured Exports for Puerto Rico (Xpr_t). Even for the last period, the US imports from Canada (Mcn_t), and Ireland (Mil_t), explain more than 20 and 15% of the variability of the impulses of Manufactured Exports for Puerto Rico (Xpr_t). Besides, these results suggest that US imports from Mexico (Mmx_t) explain the lowest percentage of Manufactured Exports for Puerto Rico (Xpr_t) variability. In summary, the Granger Causality and variance decomposition results suggest that manufacturing production is more sensitive to international trade than manufacturing labor on the island.

Table 6. Variance Decomposition of Manufacturing Employees in Puerto Rico (Epr)

Period	*S.E.*	*Epr*	*Mcn*	*Mcr*	*Mil*	*Mmx*	*Xpr*
1	1.383759	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	2.369116	99.37177	0.298970	0.151633	0.138313	0.013030	0.026284
3	3.161709	98.94809	0.463998	0.443795	0.080516	0.021552	0.042044
4	3.812856	98.53919	0.579845	0.718186	0.055676	0.019614	0.087488
5	4.358843	98.11613	0.655545	0.998005	0.064578	0.020387	0.145359
6	4.828041	97.69749	0.702522	1.270979	0.094651	0.020477	0.213878
7	5.240132	97.28224	0.727247	1.535841	0.147590	0.021225	0.285856
8	5.608926	96.88197	0.736609	1.788087	0.212201	0.022054	0.359081
9	5.944217	96.49822	0.735264	2.026742	0.285936	0.023161	0.430673
10	6.253035	96.13514	0.726936	2.250595	0.363421	0.024378	0.499526
11	6.540563	95.79330	0.714190	2.459615	0.442464	0.025715	0.564719
12	6.810667	95.47341	0.698872	2.653984	0.520681	0.027104	0.625948

Source: own elaboration.

Table 7. Variance Decomposition of Manufactured Exports for Puerto Rico (Xpr)

Period	*S.E.*	*Epr*	*Mcn*	*Mcr*	*Mil*	*Mmx*	*Xpr*
1	169.4571	0.013522	0.161220	0.758550	1.795767	1.355445	95.91550
2	190.9543	0.103416	0.129411	10.85052	1.998049	1.653576	85.26503
3	207.8592	0.094674	2.225396	10.90118	2.125780	2.667348	81.98562
4	220.3786	0.192425	5.089232	10.50410	2.299004	2.733749	79.18149
5	233.1039	0.534840	8.390282	9.674728	3.479728	2.861516	75.05891
6	245.5701	1.194489	11.62103	8.791197	4.861290	2.875895	70.65610
7	258.6022	2.185828	14.36347	7.933281	6.658915	2.868017	65.99049
8	271.8500	3.453474	16.57011	7.181880	8.504363	2.830477	61.45969
9	285.4380	4.923974	18.22470	6.536846	10.38706	2.785790	57.14163
10	299.1642	6.516763	19.41769	5.996650	12.17468	2.735188	53.15904
11	312.9838	8.160939	20.23107	5.545713	13.84948	2.685227	49.52757
12	326.7812	9.801280	20.75643	5.170119	15.37874	2.636976	46.25646

Source: own elaboration.

6. Concluding remarks

The results of the Johansen Cointegration Test suggest that the variables used in our model are cointegrated at the 5% significance level. These results suggest that the series maintain a stable relationship in the long term, are in a similar stochastic trend, and follow the same direction of movement in the long term. In comparison, the results of the Granger Causality Test suggest that there is no causal relationship between the trade liberalization proxy variables (US Imports from Mexico and Canada) and US imports from the countries in which the corporations that benefitted from Section 936 relocated (Ireland and Costa Rica) with deindustrialization (reduction of Manufacturing Employees in Puerto Rico).

These results should not be surprising if we consider that the economies of Mexico and Canada showed significant integration with the US during the NAFTA period, and this integration is manifested in manufacturing industries linked to textiles, leather, footwear, rubber and plastics, machinery, among others (including chemical products) (Romero, 2022). While during the Section 936 era in Puerto Rico, the primary industries linked to said section were electronics, medical devices, pharmaceutical, and chemical products (Caraballo-Cueto and Lara, 2018; Quiñones-Pérez and Seda-Irizarry, 2016; Rodríguez and Alemar, 2021). Therefore, it could be interpreted that with the increase in the integration that Mexico and Canada have had with the US over time (Romero, 2022; Romero-Ramírez, 2023); the only Puerto Rican industry that the entry into force of NAFTA could have displaced was chemicals products.

However, the results linked to the bilateral relationship that the US maintains with Ireland and Costa Rica are surprising because, in the literature, it has been reported that the corporations that benefited from Section 936 relocated their operations to Ireland and Costa Rica. Besides, through the variance decomposition methodological approach, it was possible to estimate that the primary impulses of deindustrialization were their impulses. Also, it is essential to highlight that regarding the rest of the variables in the model, only US imports from Costa Rica exceeded 1% of the explanation in the variability of the deindustrialization of Puerto Rico.

The main limitation of this paper was the availability of data since it was impossible to incorporate proxy variables to the exhaustion of the model of Puerto Rico and the tax base erosion in the US that had the same frequency as the data that was finally used. Besides, time series data on the demographic characteristics of Puerto Rico were not available. Also, data on imports made by the US from Mexico and Canada before NAFTA were not found, so it was impossible to make estimates considering a more extended period. If the availability of these data improves, the possible role of endogenous factors in the model of Puerto Rico, the role of the tax base erosion, and demographic factors in the deindustrialization of the island could be studied. In addition, the analysis could be extended if there were more extensive series on US imports from Mexico and Canada.

Appendix

Table A.1. Lag Length and Specification of the Augmented Dickey-Fuller (ADF) Test

Variable	*Lag Length*	*Specification*
Manufacturing Employees in Puerto Rico (Epr)		
Level	1	Epr(-1) and D(Epr(-1))
1st difference	0	D(Epr(-1))
Manufactured Exports for Puerto Rico (Xpr)		
Level	3	Xpr(-1), D(Xpr(-1)), D(Xpr(-2)), and D(Xpr(-3))
1st difference	2	D(Xpr(-1)), D(Xpr(-1),2), and D(Xpr(-2),2)
US imports from Canada (Mcn)		
Level	0	Mcn(-1)
1st difference	2	D(Mcn(-1)), D(Mcn(-1),2), and D(Mcn(-2),2)
US imports from Mexico (Mmx)		
Level	0	Mmx(-1)
1st difference	0	D(Mmx(-1))
US imports from Costa Rica (Mcr)		
Level	5	Mcr(-1), D(Mcr(-1)), D(Mcr(-2)), D(Mcr(-3)), D(Mcr(-4)), and D(Mcr(-5))
1st difference	0	D(Mcr(-1))
US imports from Ireland (Mil)		
Level	1	Mil(-1) and D(Mil(-1))
1st difference	0	D(Mil(-1))

Source: own elaboration.

Table A.2. Lag length criteria

Endogenous variables: D(Mcn) D(Epr) D(Mil) D(Mcr) D(Mmx) D(Xpr)
Exogenous variables: C

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-3343.257	NA	8.49e+24	74.42793	74.59458*	74.49514*
1	-3295.997	87.16902*	6.62e+24*	74.17770*	75.34428	74.64813
2	-3268.517	47.02017	8.08e+24	74.36705	76.53355	75.24071
3	-3236.839	49.98050	9.14e+24	74.46310	77.62952	75.73999
4	-3219.630	24.85826	1.46e+25	74.88066	79.04701	76.56078
5	-3185.943	44.16677	1.68e+25	74.93207	80.09835	77.01542
6	-3161.442	28.85722	2.47e+25	75.18760	81.35380	77.67417
7	-3134.851	27.77240	3.72e+25	75.39670	82.56282	78.28650
8	-3100.321	31.46075	5.10e+25	75.42936	83.59541	78.72239

Notes: *indicated lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final Prediction Error; AIC: Akaike Information Criterion; SC: Schwarz Information Criterion; HQ: Hannan-Quinn Information Criterion.
Source: own elaboration.

Table A.3. VEC model estimates

Cointegrating Eq:	*CointEq1*	*CointEq2*
Epr(-1)	1.000000	0.000000
Mcn(-1)	0.000000	1.000000
Mcr(-1)	0.015284	-2.925749
	(0.01298)	(2.31297)
	[1.17715]	[-1.26493]
Mil(-1)	0.011902	-0.462451
	(0.00509)	(0.90732)
	[2.33687]	[-0.50969]
Mmx(-1)	0.003365	0.677166
	(0.00191)	(0.34015)
	[1.76207]	[1.99078]

Cointegrating Eq:	*CointEq1*	*CointEq2*				
Xpr(-1)	0.008590	-6.667913				
	(0.00888)	(1.58166)				
	[0.96748]	[-4.21576]				
C	-188.1422	-7901.765				
Error Correction	*D(Epr)*	*D(Mcn)*	*D(Mcr)*	*D(Mil)*	*D(Mmx)*	*D(Xpr)*
CointEq1	-0.011748	-22.62102	-564234	-4.097805	-42.43062	-6.344858
	(0.01798)	(12.0678)	(0.67518)	(3.06657)	(11.7338)	(2.20197)
	[-0.65334]	[-1.87450]	[-0.83568]	[-1.33628]	[-3.61610]	[-2.88145]
CointEq2	3.46E-05	-0.109683	-0.007754	0.001233	-0.000651	0.046007
	(8.2E-05)	(0.05520)	(0.00309)	(0.01403)	(0.05367)	(0.01007)
	[0.42086]	[-1.98704]	[-2.51084]	[0.08787]	[-0.01213]	[4.56778]
D(Epr(-1))	0.355373	38.00411	0.977437	27.72878	121.7049	16.11739
	(0.11720)	(78.6547)	(4.40067)	(19.9871)	(76.4782)	(14.3519)
	[3.03232]	[0.48318]	[0.22211]	[1.38733]	[1.59137]	[1.12302]
D(Mcn(-1))	0.000173	0.190598	0.011590	0.012280	0.334345	-0.066612
	(0.00024)	(0.15837)	(0.00886)	(0.04024)	(0.15399)	(0.02890)
	[0.73175]	[1.20351]	[1.30799]	[0.30515]	[2.17125]	[-2.30513]
D(Mcr(-1))	-0.001667	0.767326	0.283117	-0.427712	2.149844	1.366643
	(0.00297)	(1.99226)	(0.11147)	(0.50626)	(1.93713)	(0.36352)
	[-0.56166]	[0.38515]	[2.53995]	[-0.84485]	[1.10981]	[3.75945]
D(Mil(-1))	0.000601	-0.561927	-0.009411	-0.388328	-0.584508	0.134117
	(0.00064)	(0.43155)	(0.02414)	(0.10966)	(0.41960)	(0.07874)
	[0.93473]	[-1.30213]	[-0.38979]	[-3.54116	[-1.39300]	[1.70322]
D(Mmx(-1))	-3.65E-05	-0.255136	-0.032859	-0.019757	-0.454291	-0.022353
	(0.00030)	(0.20175)	(0.01129)	(0.05127)	(0.19617)	(0.03681)
	[-0.12149]	[-1.26459]	[-2.91100]	[-0.38537]	[-2.31578]	[-0.60718]
D(Xpr(-1))	0.000100	0.392388	-0.038005	0.068199	0.489884	-0.279824
	(0.00075)	(0.50028)	(0.02799)	(0.12713)	(0.48644)	(0.09129)
	[0.13453]	[0.78433]	[-1.35778]	[0.53645]	[1.00708]	[-3.06537]

Continue

Table A.3. VEC model estimates (*continuation*)

Cointegrating Eq:	*CointEq1*	*CointEq2*				
C	-0.631940	80.40620	7.575157	97.38385	229.8886	20.81532
	(0.17739)	(119.051)	(6.66081)	(30.2524)	(115.757)	(21.7229)
	[-3.56252]	[0.67539]	[1.13727]	[3.21905]	[1.98596]	[0.95822]
R-squared	0.134143	0.199327	0.292160	0.210063	0.274546	0.373767
Adj. R-squared	0.055428	0.126539	0.227811	0.138250	0.208595	0.316837
Sum sq. resids	168.5015	75898403	237586.3	4901008.	71756074	2526981.
S.E. equation	1.383759	928.6990	51.96002	235.9942	903.0005	169.4571
F-statistic	1.704170	2.738444	4.540231	2.925158	4.162911	6.565346
Log likehood	-164.4204	-795.7915	-516.1104	-662.9037	-793.0695	-630.7765
Akaike AIC	3.575678	16.59364	10.82702	13.85368	16.53752	13.19127
Schwarz SC	3.814569	16.83253	11.06591	14.09258	16.77641	13.43016
Mean dependent	-0.906873	-5.615501	2.730442	48.72531	53.97786	11.09822
S.D. dependent	1.423781	993.6951	59.12994	254.2206	1015.053	205.0205
Determinant resid covariance (dof adj.)	1.90E+24					
Determinant resid covariance	1.06E+24					
Log likehood	-3508.765					
Akaike Information Criterion	73.70650					
Schwarz Criterion	75.45837					
Number of coefficients	66					

Notes: Standard errors in ( ) & t-statistics in [ ].

Source: own elaboration.

Table A.4. VECM Granger Causality Test

Null Hypothesis	*Chi-sq*	*df*	*P-Value*	*Decision*	*Type of causality*
D(Mil) does not Granger Cause D(Mcn)	1.695537	1	0.1929	Do not reject	
D(Mcn) does not Granger Cause D(Mil)	0.093118	1	0.7603	Do not reject	No causality
D(Mcr) does not Granger Cause D(Mcn)	0.148343	1	0.7001	Do not reject	
D(Mcn) does not Granger Cause D(Mcr)	1.710827	1	0.1909	Do not reject	No causality
D(Mmx) does not Granger Cause D(Mcn)	0.615174	1	0.4328	Do not reject	Unidirectional
D(Mcn) does not Granger Cause D(Mmx)	4.714334	1	0.0299	Reject	Causality from
					Mcn to Mmx
D(Mcr) does not Granger Cause D(Mil)	0.713770	1	0.3982	Do not reject	
D(Mil) does not Granger Cause D(Mcr)	0.151940	1	0.6967	Do not reject	No causality
D(Mmx) does not Granger Cause D(Mil)	0.148507	1	0.7000	Do not reject	
D(Mil) does not Granger Cause D(Mmx)	1.940451	1	0.1636	Do not reject	No causality
D(Mmx) does not Granger Cause D(Mcr)	8.473904	1	0.0036	Reject	Unidirectional
D(Mcr) does not Granger Cause D(Mmx)	1.231674	1	0.2671	Do not reject	Causality from
					Mmx to Mcr

Source: own elaboration.

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