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Absolute cost advantage and sectoral competitiveness: Empirical evidence from NAFTA and the European Union

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ABSTRACT

Following the theory of absolute cost advantage, the present study aims to verify the hypothesis that, during 2000-2014, the real effective exchange rates of the United States and German manufacturing sectors *vis-à-vis* their North American and European partners, respectively, have been governed by the relative vertically integrated unit labour costs. To this purpose, the second generation of panel cointegration techniques to control for both cross-sectional dependence and slope heterogeneity is applied in our empirical analysis. The long-run equations are estimated by the mean group, the common correlated effects mean group, and the augmented mean group. The findings suggest that the cost-competitiveness of both US and German manufacturing sectors is positively associated with the decrease in the relative vertically integrated unit labour costs over the 2000-2014 period.

1. Introduction

The North American Free Trade Agreement (NAFTA) and the Maastricht Treaty, officially the Treaty of European Union (EU-28), signed in the 1990s, share an economic characteristic, namely, free movement of commodities and capital. Under this condition, economic theory predicts a long-term process of convergence in productivity and per capita income among countries (Barro and Sala-i-Martin, 1992; Baumol, 1986; Mankiw et al., 1992). Empirical evidence, however, disputes the different versions of such convergence hypothesis, as uneven development has intensified, wage gaps have widened, and trade imbalances increased among NAFTA and EU-28 countries (Gereffi et al., 2009; Perrotini-Hernández and Vázquez-Muñoz, 2019; Ponte et al., 2019; Ricci, 2019; Tsaliki et al., 2018; Tsoulfidis and Tsaliki, 2019).

In addition, the United States (US) and Germany, the hegemonic economies of NAFTA and the EU-28, respectively, have followed totally opposite paths. In 2018, the US's goods trade deficit with NAFTA reached 184,853 million US dollars, whereas in 2017 Germany's surplus with its European Community partners reached 67,591 million euros (OECD, 2019). Moreover, in the third quarter of 2018, Germany's current account surplus surpassed that of the EU-28 as a whole, and the US's deficit accounted for 89.57% of NAFTA's current account deficit (OECD, 2019).

From a political economy viewpoint, capital accumulation, the driving force of world economic development, is responsible for the increasing asymmetries within both the EU-28 and NAFTA. Similarly, the predominance of intrasectoral over intersectoral trade suggests that the real terms of trade are not governed by the principle of comparative advantage, but by that of absolute cost advantage (Martínez-Hernández, 2017, 2010; Shaikh, 2016).

Following the theory of absolute cost advantage (Shaikh, 2016; Smith, 1776), our hypothesis contends that the real effective exchange rates (REERs) of the manufacturing sectors of both the US and Germany *vis-à-vis* those of their respective NAFTA and EU-28 partners[1], were governed by relative vertically integrated unit labour costs (RVIULCs) during the 2000-2014 period. The paper's main contribution to the field is that, to the best of our knowledge, it contains the first empirical test (using the WIOD database) of the

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[1] According to the World Trade Organisation (WTO, 2020), Mexico and Canada are the largest US trade partners, representing 29.2% percentage of total trade in 2019. The US trade with the EU reached 39.40% of the total in 2019. Therefore, near 70% of the US trade is undertaken with Mexico, Canada, and the EU. Likewise, the WTO (2020) reports that German trade with the EU corresponded to 68.5% of the total in 2019.

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theory of absolute cost advantage for the two main economic areas of the world economy. Another contribution of this study consists of using for the first time the second generation of panel cointegration techniques to test the absolute cost advantage theory put forth by Anwar Shaikh.

The remainder of the paper is organised as follows: Section 2 briefly discusses the theories of competition and the concepts of absolute cost advantage. Section 3 introduces the utilised model and the source of our data followed by a preliminary analysis. Section 4 presents and critically evaluate the derived results. Section 5 summarises and makes some concluding observations and remarks about future research efforts.

2. Theoretical framework

In the works of the classical political economists there are several passages explaining that market prices, as determined by supply and demand forces, "are continually gravitating" towards "the natural price" (Smith, 1776, chap. VII, Book I). The natural price "is only another name for cost of production" (Ricardo, 1821, p. 46) and it depends on "the more permanent forces of production conditions and of income distribution" (Steedman, 1998, p. 148). According to Ricardo (Ricardo, 1821, p. 90), competition, "the principle which apportions capital to each trade in the precise amount that is required", and profitability push market prices to natural prices.

Thereby, the Classics (Ricardo, 1821; Smith, 1776) and Marx (1894) established a twofold dimension of competition, namely: i) intrasectoral competition and ii) intersectoral competition. As for within sector competition, firms struggle to conquer as large a market share as possible, lower prices and advertising become the weapons to attract the largest possible number of consumers (Shaikh, 2016, p. 261). The struggle to produce cheaper commodities, cutting costs by means of adopting more efficient methods of production,[2] implies that homogeneous commodities will tend to be sold at the same price in the long term[3], while extraordinary profits *vis-à-vis* the social average will accrue to firms enjoying the lowest production cost.

Ergo, a disparate constellation of profit rates emerges from intrasectoral competition. Intersectoral competition, conversely, tends to level off profit rates through capital movements. Capital withdraws from sectors with the worst profitability conditions and migrates towards those in which profit rates are higher than the social average. These movements usually alter the relationship between supply and demand and tend to drive market prices towards production prices until equalisation of profit rates economy-wide is achieved.

According to Shaikh (2016, p. 265), these two seemingly contradictory trends coexist as those capitals with the best generally reproducible technical conditions of production in every sector operate as regulating capitals or *price leaders*. Therefore, the profit rates and production prices of regulating capitals are the long-term centres of gravitation for money-capital flows and market prices, respectively.

The relative prices of any two commodities, P_i and P_j, gravitate towards the production prices of the regulating capitals of sectors i and j, P_i^* and P_j^*, respectively, in the long run (Martínez-Hernández, 2017, 2010; Shaikh, 2016):

$$\frac{P_i}{P_j} \simeq \frac{P_i^*}{P_j^*} \quad (1)$$

[2] Price wars encourage firms to adjust cost structures through continuous technical change and relative wages. Classical economists and Marx emphasise that in the long-term, the influence of wages on the creation of new value tends to decrease due to the development of labour productivity and increasing returns.

[3] Shaikh (2016, p. 262) defines this trend as the law of correlated prices (LCP).

Given that P_i and P_j are governed by P_i^* and P_j^*, Shaikh (2016, p. 318, 1984, p. 65), who follows Smith (1776), emphasises that production prices could be resolved into wages and profits. Supposing that production prices are defined as the sum of unit labour costs (wL), profits (π), and input costs (M), the price of any commodity may be initially expressed as follows:

$$P = wL + \pi + \mathrm{M} \quad (2)$$

In Eq. (2), w stands for the wage rate and L is the labour required per unit output, π is profit per unit output, while M includes both unit materials and depreciation. Along these lines, Smith (1776, chap. VI, Book I) states that the price of means of production may be decomposed into wages and profits, which means that the natural price of any commodity will be determined exclusively by these two components. Smith's decomposition of natural prices is formalised by Shaikh (1984, 2016), showing that M can be decomposed into unit labour costs, profits, and the unit input costs of the original input bundle, repeating the process until prices will be resolved into wages and profits:

$$\begin{aligned} P = wL + \pi + M &= wL + \pi + wL^{(1)} + \pi^{(1)} + M^{(1)} = \mathrm{wL} + \pi \\ &+ wL^{(1)} + \pi^{(1)} + wL^{(2)} + \pi^{(2)} + M^{(2)} + \ldots = wL + wL^{(1)} \\ &+ wL^{(2)} + wL^{(3)} \ldots \pi + \pi^{(1)} + \pi^{(2)} + \pi^{(3)} \ldots \end{aligned} \quad (3)$$

Following the notion of vertically integrated sectors by Pasinetti (1973, 1977), we can derive from Eq. (3) the vertically integrated unit labour costs (henceforth, vr) and the vertically integrated unit profits (henceforth, vπ). Since vr and vπ are the sum of direct and indirect unit labour costs ($vr = wL + wL^{(1)} + wL^{(2)} + wL^{(3)} \ldots$) and the sum of direct and indirect unit profits ($v\pi = \pi + \pi^{(1)} + \pi^{(2)} + \pi^{(3)} \ldots$) respectively, Eq. (2) may be rewritten as follows:

$$P = vr + v\pi = a_n (I - A)^{-1} \hat{W} \cdot (1 + \sigma_{PW}) \quad (4)$$

where a_n denotes the row vector of the n direct labour coefficients, which are the ratio between direct labour requirements measured in total hours worked by employees and gross output of each i-th sector[4]. $(I - A)^{-1}$ is the inverse matrix[5] of total inputs requirements to produce commodities, which includes both intermediate inputs consumption per unit of gross output and fixed capital consumption per unit of gross output. As noted by Pasinetti (1977, p. 75), each i-th column of $(I - A)^{-1}$ represents the commodities consumed -directly and indirectly- to produce the commodities of the i-th sector as final goods.

The *vertically integrated labour coefficients* -*i.e.*, the amounts of direct and indirect labour necessaries to produce commodities- are obtained by multiplying each i-th column of the total inverse matrix by the vector of the n direct labour coefficients: $a_n (I - A)^{-1}$ (Pasinetti, 1977, p. 76). The *vertically integrated unit labour costs* result from multiplying the *vertically integrated labour coefficients* by

[4] It should be highlighted that in the derivation of the vector of the n direct labour coefficients, the difference between complex and simple labour within a sector is not considered, reducing the labour force into a homogenous commodity. Guerrero (2000) notes that Bródy (1970) developed a solution to this issue by enlarging the matrix A of order nxn to a matrix A of order $(n + m)x(n + m)$, where m denotes the rows of the direct labour coefficients corresponding to each kind of labour. At the same time, Guerrero states that we can obtain a matrix B of order $(n + m)x(n + m)$, including the consumptions of inputs necessaries to maintain each kind of labour forces. Although Bródy and Guerrero appear to resolve this theoretical problem, the lack of information to obtain the matrices A and B of order $(n + m)x(n + m)$ may hinder an empirical application distinguishing between simple and complex labour within a sector. For practical reasons, we will assume that the labour force is a homogeneous commodity.

[5] This inverse matrix differs from the Leontief inverse matrix insofar as this latter only considers intermediate inputs consumption. However, in this research, the Leontief inverse matrix is applied instead of the total inverse matrix, given that the WIOD database only provides information on intermediate inputs consumption per unit gross output.

$\hat{W}$, which is a diagonal matrix with real wages on the main diagonal and zeros elsewhere.

Hence, by summing each i-th column of $a_n(I-A)^{-1}\hat{W}$, the *vertically integrated labour coefficients* of each i-th sector can be derived. Finally, σ_{PW} is the vertically integrated profit–wage ratio calculated as:

$$\sigma_{PW} = \frac{\upsilon\pi}{\upsilon r} \tag{5}$$

Therefore, Eq. (1) can be extended as follows:

$$\frac{P_i}{P_j} \cong \frac{P_i^*}{P_j^*} \cong \frac{\upsilon r_i^*}{\upsilon r_j^*} \cdot \chi_{ij} \tag{6}$$

Where υr_i^* and υr_j^* are the *vertically integrated unit labour costs* of the regulating capitals of sectors i and j respectively; $\chi_{ij} = \frac{1+\sigma_{PW_i}}{1+\sigma_{PW_j}}$ is the ratio of the regulating disturbance term (Shaikh, 2016, p. 518), whereas σ_{PW_i} and σ_{PW_j} are the vertically integrated profit–wage ratio in sectors i and j respectively.

Since the linkages between industries are strong, Shaikh (2016, p. 518) assumes that the disturbance term is relatively small[6]. That is, even huge variations between P_i and P_j barely produce slight variations in relative prices in relation to RVIULCs (Martínez-Hernández, 2017, p. 570). Thus, χ_{ij} is not a relevant variable to explain the long-term level of relative prices, and we can approximate Eq. (6) as follows:

$$\frac{P_i}{P_j} \cong \frac{\upsilon r_i^*}{\upsilon r_j^*} \tag{7}$$

Shaikh (2016, pp. 386–389) and Martínez-Hernández (2017, p. 517) point out that Eq. (7) is a good approximation of industrial national terms of trade because it reflects that the relative amounts of direct and indirect labour to produce commodities i and j rule their exchange value in a period of time.

It should also be noted that while Smith and Marx are agreeable on this issue, (*i.e*, industrial national terms of trade are regulated by Eq. (7)), the consensus breaks down once we move to international trade. Ricardo (1821, p. 133) states that: "The same rule which regulates the relative value of commodities in one country does not regulate the relative value of the commodities exchanged between two or more countries". To demonstrate this assertion, Ricardo discusses two mechanisms that will level off the trade balance *post festum*.

First, following the quantitative theory of money put forth by Hume, the international prices of commodities vary as a function of the amount of gold in circulation, *i.e.,* a country exhibiting a trade deficit will experience gold outflows and become more competitive thereby, and vice versa. Later on, considering events of his own time, Ricardo (1821, pp. 136–137) asserts that international capital flows face a multitude of obstacles. While regretting this fact, he acknowledges that this is a *conditio sine qua non* to level off trade balances in the long run as, otherwise, capital would tend to migrate towards countries with profit rates above the global average, thus condemning countries with the worst profitability conditions to a grim fate. Ricardo concludes that intersectoral comparative advantage overrides intrasectoral absolute advantage as a regulator of the real terms of trade between countries.

In this vein, as noted by Humphrey (1979), Ricardo adhered to the purchasing power parity (henceforth, PPP) hypothesis, which posits, in the absence of transaction costs and barriers to international trade, the equalisation of the prices of a set of similar tradable goods among countries through international competition (Weber and Shaikh, 2021).

Since the PPP hypothesis is based on the law of one price (LoP), it should assume that both the bundles of goods and the non-tradable price ratio are the same among countries, which means that real exchange rates should be stationary both in the short and long-term (Antonopoulos and Shaikh, 2012; Martínez-Hernández, 2010; Shaikh, 2016; Weber and Shaikh, 2021). However, empirical evidence seems to contravene the PPP hypothesis, suggesting that actual exchange rates may be non-stationary as the commodities baskets are heterogeneous across countries (Antonopoulos and Shaikh, 2012, pp. 204–205; Boundi Chraki, 2017; Isard, 1995, pp. 63–65; Martínez-Hernández, 2010, pp. 60–62).

Shaikh (2016, pp. 520–522), in turn, strongly objects to Ricardoś two mechanisms. Following the monetary approach entertained by Sir James Steuart and Marx, Shaikh counters Ricardo's arguments contending that an increase in the amount of gold in circulation does not necessarily result in an increase in the general price level; instead, it will raise commercial banks reserves and decrease bank interest rates. Shaikh maintains that his view is consistent with Harrod's (1957) insightful observation according to which trade flows are inseparable from financial flows. More precisely, trade deficits are offset by financial capital inflows in the balance of payments, thereby refuting the Ricardian disjunction between international trade and international finance.

Shaikh argues that long-term real exchange rates are determined by the RVIULCs of regulating capitals. In other words, the country with the best general technical conditions of production and the lowest relative wages will have an absolute cost advantage in some sectors.[7] Along these lines, Guerrero (1995) emphasises that the most productive country will be more competitive than the country with the lowest wage rate, provided productivity differentials are higher than wage differentials. Ricci (2019), in turn, contends that absolute cost advantage, as a source of asymmetric trade, reproduces uneven development among nations. Furthermore, given that within a national economy there exists a set of commodities which are non-tradable (Martínez-Hernández, 2017, p. 572; Shaikh, 2016, p. 519), Eq. (7) should be rewritten by adjusting the general price level (ipc) to price level of tradable commodities (pct):

$$\frac{P*}{P} \cong \left(\frac{\upsilon r*}{\upsilon r}\right).\left(\frac{\frac{ipc*}{pct*}}{\frac{ipc}{pct}}\right) \tag{8}$$

Including the nominal effective exchange rate in Eq. (8), we can mathematically express the long-term relationship between the REERs and the RVIULCs:

$$REER \equiv e \cdot \frac{P*}{P} \approx \left(\frac{\upsilon r*}{\upsilon r}\right).\left(\frac{\tau*}{\tau}\right) \tag{9}$$

where e is the nominal effective exchange rate[8] (national currency/ foreign currency); the symbol * indicates a foreign country; $P*$ and P are the prices of foreign and domestic tradable commodities, $vr*$ and vr stand for the RVIULCs of the foreign export sectors and domestic export sectors, $\tau*$ and τ are the adjustments of non-tradable commodities to tradable commodities, respectively. The principle of absolute cost advantage, in this manner, shows that uneven development in the world economy stems from the move-

[6] Shaikh (1984, 2016) and Martínez-Hernández (2017) highlight that the assumption that χ_{ij} is close to 1 does not mean that the capital-labour ratios across sectors are the same neither the rates of profit are zero. In such a framework, prices are not equal to vertically integrated unit labour costs.

[7] In this sense, the absolute cost advantage is not to be reduced just to a labour productivity advantage.

[8] The nominal effective exchange rate may be defined as the value of the domestic currency *vis-à-vis* the weighted value of a foreign currencies bundle. The weights are based on the share of foreign countries in the trade of the domestic country.

Table 1
NAFTA and EU-28 countries by year of integration.

NAFTA	EU-28			
2000-2014	2000	2004	2007	2013
Mexico	Austria	Cyprus	Bulgaria	Croatia
Canada	Belgium	Czech Republic	Romania	
US	Denmark	Estonia		
	Finland	Hungary		
	France	Latvia		
	Germany	Lithuania		
	Greece	Malta		
	Ireland	Poland		
	Italy	Slovakia		
	Luxembourg	Slovenia		
	Netherlands			
	Portugal			
	Spain			
	Sweden			
	United Kingdom*			

Note: *The United Kingdom (UK) withdrew from the European Union on 31 January 2021. During the period of our statistical analysis, the UK was formerly a member state of the European Union.

ment of money-capital and real competition[9] on a global scale, as capital accumulation (productive reinvestment of the surplus) spurs economic development: regions possessing competitive advantages will grow faster than those lacking such competitive lead.

This reasoning is consistent with Myrdal's (1957) principles of circular and cumulative causation, Hirschman's (1958) strategy of unbalanced growth and Kaldor's (1970) growth laws. Given increasing returns in the export manufacturing sectors, Myrdal emphasises that the growth rate of labour productivity in dynamic regions tends to be higher than that of the global social average due to production upgrades, technical change and the introduction of innovations which bring in new productive investments. Hirschman, in turn, adds that technical change does not occur simultaneously in all regions, but instead it first appears in regions that tend to concentrate money-capital flows and labour force, which explains their higher growth rates *vis-à-vis* the global average.

Kaldor maintains that capital flows, increasing returns and economies of agglomeration reduce the real unit labour costs (ULCs) of dynamic regions at a below-average rate, thereby reinforcing their competitive advantages in the long term. It can be argued that, following the lead of the Classics, Myrdal, Hirschman and Kaldor also contributed to lay the foundations of the theory of absolute cost advantage while dealing with the stylised facts of differential regional economic growth, uneven development, and balance of payments disequilibria.

3. Databases, model, and preliminary analysis

As mentioned before, our aim is to test the hypothesis that the REERs of both the US and German manufacturing sectors *vis-à-vis* those of their NAFTA and EU-28 partners (see Table 1), respectively, were regulated by the RVIULCs over the 2000-2014 period:

$$REER_{i,t} \equiv e_t \cdot \frac{P^*_{i,t}}{P_{i,t}} \cong RVIULC_{it} \equiv \frac{vr^*_{i,t}}{vr_{i,t}} \equiv \frac{a^*_{n,t}(I-A)^{-1*}\hat{W}^*_{i,t}}{a_{n,t}(I-A)^{-1}\hat{W}_{i,t}} \tag{10}$$

In Eq. (10), $REER_{i,t}$ stands for the REER of the i-th US or German manufacturing sector with respect to those of their respective n-th NAFTA and EU-28 partner at $t = 2000, 2001, \ldots 2014$; e_t denotes the nominal effective exchange rate (US or German currency[10]/currency of the NAFTA or EU-28 partner); and the symbol * refers to every n-th American or European partner. $P^*_{i,t}$ and $P_{i,t}$ are the price indices of the i-th manufacturing sector, 2010 is the base year, and $RVIULC_{i,t}$ is the RVIULCs, wherein vr^*_i and vr_i are the sum of the column vector of the RVIULCs corresponding to the i-th manufacturing sector; $a^*_{n,t}$ and $a_{n,t}$ are the row vectors of *direct labour coefficients*; $(I-A)^{-1*}$ and $(I-A)^{-1}$ indicate the foreign and domestic Leontief inverse matrices, respectively; and $\hat{W}^*_{i,t}$ and $\hat{W}_{i,t}$ identify each i-th element of diagonal matrix with real hourly wages at constant 2010 dollars on the main diagonal and zeros elsewhere.

However, as earlier mentioned, international movement of money-capital and uneven technical progress among countries can impact on real terms of trade. To control the influence of both international movement of money-capital and uneven technical progress on the REERs, we include in our model the relative vertically integrated profit rates and the relative vertically integrated output-capital ratios. More specifically, to compute the influence of the free movement of money-capital on $REER_{it}$, the following ratio that measures the profitability gap is defined:

$$R_{i,t} = \frac{vp^*_{i,t}}{vp_{i,t}} = \frac{\pi^*_{n,t}(I-A)^{-1*}\hat{K}^*_{i,t}}{\pi_{n,t}(I-A)^{-1}\hat{K}_{i,t}} \tag{11}$$

$R_{i,t}$ is the ratio of intrasectoral vertically integrated profit rates; vp^*_{it} and vp_{it} denote the vertically integrated profit rates[11] of the i-th foreign and domestic manufacturing sectors. $\pi^*_{n,t}$ and $\pi_{n,t}$ are the row vectors of *direct gross operating surplus-gross output ratios*, while $\hat{K}^*_{i,t}$ and $\hat{K}_{i,t}$ denote the i-th element of the diagonal matrix with gross capital stock-gross output ratios at constant 2010 dollars of each i-th manufacturing sector on the main diagonal and zeros elsewhere. Therefore, the vertically integrated profit rates of each i-th foreign and domestic manufacturing sector were obtained by summing each i-th column of $\pi^*_{n,t}(I-A)^{-1*}\hat{K}^*_{i,t}$ and $\pi_{n,t}(I-A)^{-1}\hat{K}_{i,t}$ (Miller and Gowdy, 1998).

As a proxy of the effect of technical change on $REER_{i,t}$, the relative vertically integrated output-capital ratio is calculated as:

$$YK_{i,t} = \frac{vyk^*_{i,t}}{vyk_{i,t}} = \frac{yk^*_{n,t}(I-A)^{-1*}}{yk_{n,t}(I-A)^{-1}} \tag{12}$$

$YK_{i,t}$ is the ratio of intrasectoral vertically integrated output-capital ratios; $vyk^*_{i,t}$ and $vyk_{i,t}$ are the vertically integrated output-capital ratios of the i-th foreign and domestic manufacturing sectors. $yk^*_{n,t}$ and $yk_{n,t}$ stand for the row vectors of *direct output-capital ratios*, which are the ratio between gross output and gross capital stock at constant 2010 dollars of each i-th manufacturing sector. Thus, by summing each i-th column of $yk^*_{n,t}(I-A)^{-1*}$ and $yk_{n,t}(I-A)^{-1}$, we derived the vertically integrated output-capital ratios of each i-th foreign and domestic manufacturing sector.

The data used to estimate $REER_{i,t}$, $RVIULC_{i,t}$, $R_{i,t}$ and $YK_{i,t}$ were retrieved from the national input-output tables (NIOTs) and socio-economic accounts (SEAs) of the WIOD Release 2016 converted

[9] As previously exposed, the meaning of competition in the works of the Classical economists and Marx implies a dynamic and turbulent process characterised by uneven profit rates within sectors and the tendency toward equalising profitability across sectors. Shaikh (2016, pp. 14–31) dubbed the classical theory of competition as real competition in contrast to perfect and imperfect competition rooted in marginalist economic thought.

[10] The nominal exchange rate between the currencies of the Eurozone countries was fixed in 1999, and the euro entered into circulation on January 1, 2002. Ever since, Germany has shared its currency with Austria, Belgium, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, the Netherlands, and Portugal. Subsequently, Slovenia (2007), Cyprus (2008), Malta (2008), Slovakia (2009), Estonia (2011), Latvia (2014) and Lithuania (2015) joined the Eurozone. Thus, the REERs between Euro Area Member States is affected by relative prices only. This situation may be equated with Eq. (9) described in Section 2.

[11] The methodology to calculate the vertically integrated profit rates is based on Miller and Gowdy (1998), pp. 556–557.

Table 2
Manufacturing Sectors.

Sector	Code**
Manufacture of food products, beverages, and tobacco products	C10-C12
Manufacture of textiles, wearing apparel and leather products	C13-C15
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	C16
Manufacture of paper and paper products	C17
Printing and reproduction of recorded media	C18
Manufacture of coke and refined petroleum products	C19
Manufacture of chemicals and chemical products	C20
Manufacture of basic pharmaceutical products and pharmaceutical preparations	C21
Manufacture of rubber and plastic products	C22
Manufacture of other non-metallic mineral products	C23
Manufacture of basic metals	C24
Manufacture of fabricated metal products, except machinery and equipment	C25
Manufacture of computer, electronic and optical products	C26
Manufacture of electrical equipment	C27
Manufacture of machinery and equipment n.e.c.	C28
Manufacture of motor vehicles, trailers and semi-trailers	C29
Manufacture of other transport equipment	C30
Manufacture of furniture; other manufacturing	C31-C32

Note: ** The codes correspond to ISIC Rev. 4.
Source: Authors, based on the WIOD.

Table 3
Correlation matrix.

	LOG(REER)	**LOG(RVIULC)**	**LOG(R)**	**LOG(YK)**
NAFTA				
LOG(REER)	1.000			
LOG(RVIULC)	0.539	1.000		
LOG(R)	-0.052	-0.108	1.000	
LOG(YK)	0.242	0.154	-0.412	1.000
EU-28				
LOG(REER)	1.000			
LOG(RVIULC)	0.049	1.000		
LOG(R)	-0.004	-0.220	1.000	
LOG(YK)	0.048	-0.230	0.530	1.000
NAFTA+EU-28				
LOG(REER)	1.000			
LOG(RVIULC)	0.085	1.000		
LOG(R)	-0.001	0.224	1.000	
LOG(YK)	0.091	-0.238	-0.540	1.000

Table 4
VIF test.

Variable	NAFTA VIF	EU-28 VIF	NAFTA+EU-28 VIF
LOG(RVIULC)	1.22	1.42	1.44
LOG(R)	1.21	1.41	1.43
LOG(YK)	1.03	1.07	1.07
Mean VIF	1.15	1.30	1.32

into constant 2010 dollars. The WIOD includes NIOTs expressed in current dollars (industry-by-industry) from the US, Germany and other NAFTA and EU-28 countries with a level of disaggregation of 56 sectors catalogued according to the International Standard Industrial Classification revision 4 (ISIC Rev. 4) from 2000 to 2014 (Timmer et al., 2016, 2015). We organise the data into three balanced panel data that consist of eighteen manufacturing sectors[12] from the NIOTs for NAFTA and EU-28 countries (see Table 2).

We collected information from the SEAs on sectoral producer price indices, base year 2010, employee compensation, the number of hours worked by employees, and stock of capital of all NAFTA and EU-28 countries, for the 2000-2014 period.

We use the consumer price indices (CPIs), base year 2010, from the Bureau of Economic Analysis (BEA, US), the National Institute of Statistics and Geography (*Instituto Nacional de Estadística y Geografía* – INEGI, Mexico) and Statistics Canada-*Statistique Canada* (STATCAN) to determine NAFTA hourly wages. To determine EU-28 hourly wages, we use the CPIs from the European Statistical Office[13] (Eurostat). We are able to construct three econometric balanced panel data models with this information. The first one corresponds to NAFTA, and the US is considered the domestic country. The second model corresponds to the EU-28, and Germany is considered the domestic country[14]. The third one combines NAFTA and EU-28 countries and defines the US as the domestic country. Thus, we derive the following functional equations of $REER_{i,t}$:

$$NAFTA : REER_{i,t} = f(RVIULC_{i,t}, R_{i,t}, YK_{i,t}) \quad (13)$$

$$EU28 : REER_{i,t} = f(RVIULC_{i,t}, R_{i,t}, YK_{i,t}) \quad (14)$$

$$NAFTA + EU28 : REER_{i,t} = f(RVIULC_{i,t}, R_{i,t}, YK_{i,t}) \quad (15)$$

Our econometric models estimated by ordinary least squares (OLS) are written as:

$$NAFTA: \ LOG(REER_{i,t}) = \beta_0 + \beta_1 LOG(RVIULC_{i,t}) + \beta_2 LOG(R_{i,t}) + \beta_3(YK_{i,t}) + \varepsilon_{i,t} \quad (16)$$

$$EU28: \ LOG(REER_{i,t}) = \beta_0 + \beta_1 LOG(RVIULC_{i,t}) + \beta_2 LOG(R_{i,t}) + \beta_3(YK_{i,t}) + \varepsilon_{i,t} \quad (17)$$

[12] The reparation and installation of machinery and equipment sector was excluded because it is a non-tradable services sector.

[13] Although the EU is, since the Maastricht treaty, a free trade area that allows freedom of movement of capital, commodities, and labour force, the commodity bundles are heterogeneous among member countries. Therefore, the CPIs has not the same composition across the European countries, overriding the PPP hypothesis (see section 2).

[14] The data used for the EU-28 model has not been converted into euros to maintain consistency between the three econometric models.

Table 5
Pesaran (2020) CD test.

Variable	NAFTA CD-test	p-value	corr	abs (coor)	EU-28 CD-test	p-value	corr	abs (coor)	NAFTA+EU-28 CD-test	p-value	corr	abs (coor)
LOG(REER)	31.45	0.000***	0.324	0.533	56.71	0.000***	0.789	0.800	841.54	0.000***	0.571	0.674
LOG(RVIULC)	16.87	0.000***	0.174	0.512	15.69	0.000***	0.215	0.363	61.66	0.000***	0.042	0.429
LOG(R)	2.47	0.013**	0.013	0.025	25.35	0.000***	0.349	0.467	99.27	0.000***	0.067	0.364
LOG(YK)	14.5	0.000 ***	0.149	0.513	69.48	0.000***	0.972	0.972	70.42	0.000***	0.048	0.442

Note: *** Denotes rejection at 1%. ** Denotes rejection at 5%. We applied the *xtcd* command by Eberhardt (2011a).

Table 6
Pesaran-Yamagata (2008) test.

	NAFTA Delta	p-value	EU-28 Delta	p-value	NAFTA+EU-28 Delta	p-value
	12.604	0.000***	9.259	0.000***	6.165	0.000***
adj.	15.436	0.000***	12.618	0.000***	8.401	0.000***

Note: *** Denotes rejection at 1%. We used the *xthst* command by Bersvendsen and Ditzen (2020).

Table 7
Blomquist-Westerlund (2013) test.

	NAFTA Delta	p-value	EU-28 Delta	p-value	NAFTA+EU-28 Delta	p-value
	12.413	0.000***	-13.093	0.000***	24.997	0.000***
adj.	15.203	0.000***	-17.843	0.000***	34.066	0.000***

Note: *** Denotes rejection at 1%. We used the *xthst* command by Bersvendsen and Ditzen (2020).

$$NAFTA + EU28: \ LOG(REER_{i,t}) = \beta_0 + \beta_1 LOG(RVIULC_{i,t}) + \beta_2 LOG(R_{i,t}) + \beta_3 (YK_{i,t}) + \varepsilon_{i,t} \quad (18)$$

where LOG is the Napierian logarithm, β_0 is a constant, β_1, β_2, and β_3 are the multiple coefficients of determination, whereas $\varepsilon_{i,t}$ is the error term. Preliminary data analysis starts checking whether a multicollinearity problem exists in the three models. We employ both the correlation matrix and the multicollinearity test based on the variance inflation factor (henceforth, VIF) to test whether the independent variables are correlated. Table 3 shows that the correlation coefficients among the explanatory variables are smaller than 0.8, suggesting that the problem of multicollinearity may not affect the three models. By taking VIF = 5 as a threshold, the results outlined in Table 4 indicate that independent variables are not correlated in our three models. Therefore, the three models appear not to exhibit a collinearity problem among the regressors.

It should be stressed at this juncture that the recent econometric literature shows that, in the context of macroeconomics and financial data, it is not reasonable to assume cross-sectional independence (Banerjee and Carrion-i-Silvestre, 2017; Urbain and Westerlund, 2006). Given that the linkages among countries, region and sectors are strong because world economic integration has increased over the last decades, cross-sectional dependence frequently arises in the data (Banerjee and Carrion-i-Silvestre, 2017).

Hence, the first generation of unit root tests and cointegration tests can incur in the so-called size distortion problem, leading to deceptive results (Banerjee et al., 2005). Using the cross-sectional dependence (CD) test developed by Pesaran (2020), we proceed to explore whether there exists cross-sectional dependence in the data. Table 5 reports that the Pesaran CD test strongly rejects the null hypothesis of cross-sectional independence for all the variables, revealing that cross-sectional dependence should be considered in the analysis.

It is worth mentioning that, in the presence of cross-sectional dependence, slope heterogeneity in panel data may arise (Pesaran and Smith, 1995). Then, we turn to test the null hypothesis of slope homogeneity by applying the Pesaran and Yamagata test (2008) and the Blomquist and Westerlund (2013) test. As we can see in Tables 6 and 7, both tests can reject the null hypothesis at any significance level, suggesting that we should also consider the slope heterogeneity in the empirical assessment.

Given that the preliminary data analysis disclosed the existence of both cross-sectional dependence and slope heterogeneity, the econometric strategy to be applied for testing the hypothesis is based on the second generation of panel cointegration techniques[15]. The first step is to verify whether the variables at level are non-stationary applying the Cross-Sectional Augmented Im, Pesaran and Shin (CIPS) test by Pesaran (2007).

As a second step, we examine whether the series are cointegrated using the panel cointegration test and the error correction model (ECM) cointegration test by Westerlund (2007). Lastly, the long-run relationships between the variables are estimated employing the mean group (MG) by Pesaran and Smith (1995), the correlated effects MG (CCEMG) by Pesaran (2006), and the augmented MG (AMG) developed by Eberhardt and Teal (2010).

4. Analysis of results

The Pesaran (2007) CIPS test represents those unobservable processes that lead to cross-sectional dependence through a single common factor, thereby obtaining results more robust than the first generation of panel unit root tests. Table 8 outlines the results from such test. In the case of NAFTA, the Pesaran CIPS test rejects only the null hypothesis of the existence of a unit root at lag 0 for LOG(REER) (without trend), and lag 0 for LOG(R) (with trend). The analysis of the findings for the EU-28 suggests that the variables at level contain a unit root, insofar as we cannot reject the null hypothesis in most cases.

In the NAFTA+EU-28 model, the results appear to support that the series are nonstationary since the null hypothesis cannot be rejected for most lags (see Table 8). The Pesaran CIPS test rejects the null hypothesis in most cases when the variables are transformed into their first difference. Therefore, the findings point out that the variables may be stationary and integrated of order I(0) in first differences (see Table 8). In sum, there is prevailing evidence in the three models that the variables are nonstationary at level and integrated of order I(1). However, it should be highlighted that a set of nonstationary variables should be cointegrated to be economically significant. We employ the second generation of panel coin-

[15] Although other econometrical strategies may overcome some limitations derived from using the first generation of panel cointegration techniques, they also fail to control cross-sectional dependence. For instance, the dynamic panel generalised method of moments (GMM) or the autoregressive distributed lag (ARDL) assume cross-sectional independence. As Banerjee and Carrion-i-Silvestre (2017) note, cross-sectional dependence is endemic in panel data.

Table 8
Pesaran (2007) CIPS test.

	Without trend				With trend			
lags	LOG(REER)	LOG(RVIULC)	LOG(R)	LOG(YK)	LOG(REER)	LOG(RVIULC)	LOG(R)	LOG(YK)
NAFTA								
0	-2.191 (0.014**)	1.009 (0.844)	-1.182 (0.119)	1.598 (0.945)	-0.475 (0.317)	5.142 (1.000)	-2.181 (0.015**)	1.775 (0.962)
1	1.084 (0.861)	-0.697 (0.243)	0.943 (0.827)	2.895 (0.998)	3.139 (0.999)	6.239 (1.000)	-0.506 (0.306)	3.128 (0.999)
2	3.370 (1.000)	2.896 (0.998)	2.136 (0.948)	4.278 (1.000)	8.389 (1.000)	6.631 (1.000)	-1.493 (0.068*)	5.382 (1000)
3	-0.459 (0.323)	1.921 (0.973)	4.636 (1.000)	1.946 (0.974)	21.405 (1.000)	21.405 (1.000)	21.405 (1.000)	21.405 (1.000)
4	23.835 (1.000)	23.835 (1.000)	23.835 (1.000)	23.835 (1.000)	21.405 (1.000)	21.405 (1.000)	21.405 (1.000)	21.405 (1.000)
EU-28								
0	1.451 (0.927)	-1.831 (0.034**)	-14.901 (0.000***)	-9.197 (0.000***)	17.141 (1.000)	4.710 (0.000***)	-6.735 (0.000***)	0.256 (0.399)
1	-30.411 (0.000***)	3.532 (1.000)	-5.170 (0.000***)	-5.002 (0.000***)	-27.057 (1.000)	5.031 (0.000***)	3.807 (1.000)	4.258 (1.000)
2	-1.415 (0.111)	9.473 (1.000)	7.709 (1.000)	4.575 (1.000)	0.486 (0.687)	2.439 (0.993)	18.565 (1.000)	15.627 (1.000)
3	-7.021 (0.000***)	13.632 (1.000)	3.663 (1.000)	4.652 (1.000)	78.369 (1.000)	78.369 (1.000)	78.369 (1.000)	78.369 (1.000)
4	87.283 (1.000)	87.283 (1.000)	87.283 (1.000)	87.283 (1.000)	78.369 (1.000)	78.369 (1.000)	78.369 (1.000)	78.369 (1.000)
NAFTA+EU-28								
0	-7.395 (0.000***)	-1.831 (0.034**)	-13.027 (0.000***)	2.763 (0.997)	-2.916 (0.002***)	6.867 (1.000)	-9.210 (0.000***)	-1.927 (0.027**)
1	-6.346 (0.000***)	-0.492 (0.312)	-1.814 (0.035**)	5.026 (1.000)	-2.200 (0.014)	10.236 (1.000)	-2.210 (0.014**)	-4.018 (0.000***)
2	-4.189 (0.000***)	5.749 (1.000)	5.248 (1.000)	12.122 (1.000)	2.369 (0.991)	18.836 (1.000)	10.669 (1.000)	8.317 (1.000)
3	92.014 (1.000)	4.141 (1.000)	3.026 (0.999)	7.306 (1.000)	82.617 (1.000)	82.617 (1.000)	82.617 (1.000)	82.617 (1.000)
4	92.014 (1.000)	92.014 (1.000)	92.014 (1.000)	92.014 (1.000)	82.617 (1.000)	82.617 (1.000)	82.617 (1.000)	82.617 (1.000)
				First difference				
	Without trend					With trend		
lags	ΔLOG(REER)	ΔLOG(RVIULC)	ΔLOG(R)	ΔLOG(YK)	ΔLOG(REER)	ΔLOG(RVIULC)	ΔLOG(R)	ΔLOG(YK)
NAFTA								
0	-10.016 (0.000***)	-5.166 (0.000***)	-12.090 (0.000***)	-6.910 (0.000***)	-7.943 (0.000***)	-4.536 (0.000***)	-9.589 (0.000***)	-6.069 (0.000***)
1	-5.803 (0.000***)	-8.354 (0.000***)	-3.495 (0.000***)	-3.259 (0.000***)	-10.569 (0.000***)	-3.764 (0.000***)	-2.051 (0.007***)	-3.773 (0.000***)
2	-5.663 (0.000***)	-3.964 (0.000***)	-5.292 (0.000***)	-5.627 (0.000***)	-2.816 (0.002***)	-1.967 (0.000***)	-5.862 (0.000***)	-3.189 (0.000***)
3	-6.003 (0.000***)	2.791 (0.997)	-5.799 (0.000***)	-5.076 (0.000***)	-2.858 (0.000***)	21.405 (1.000)	-3.099 (0.000***)	21.405 (1.000)
4	2.198 (0.986)	-3.748 (0.000***)	23.835 (1.000)	0.165 (0.434)	-1.215 (0.000***)	21.405 (1.000)	21.405 (1.000)	21.405 (1.000)
EU-28								
0	-22.985 (0.000***)	-39.972 (0.000***)	-47.516 (0.000***)	-36.266 (0.000***)	-26.657 (0.000***)	-31.174 (0.000***)	-36.317 (0.000***)	-27.567 (0.000***)
1	-37.949 (0.000***)	-20.747 (0.000***)	-20.138 (0.000***)	-16.345 (0.000***)	-22.611 (0.000***)	-13.725 (0.000***)	-12.533 (0.000***)	-11.602 (0.000***)
2	-8.971 (0.000***)	-8.120 (0.000***)	-20.101 (0.000***)	-8.711 (0.000***)	-8.727 (0.000***)	-2.846 (0.000***)	-14.168 (0.000***)	-6.335 (0.000***)
3	-7.771 (0.000***)	-8.846 (0.000***)	-7.099 (0.000***)	-7.882 (0.000***)	0.219 (0.413)	-7.025 (0.000***)	-5.286 (0.000***)	-6.347 (0.000***)
4	-6.486 (0.000***)	-6.849 (0.000***)	-5.627 (0.000***)	4.952 (1.000)	78.369 (1.000)	-5.121 (0.000***)	-3.820 (0.000***)	-3.070 (0.001***)
NAFTA+EU-28								
0	-36.013 (0.000***)	-32.422 (0.000***)	-50.842 (0.000***)	-36.372 (0.000***)	-22.844 (0.000***)	-23.229 (0.000***)	-39.495 (0.000***)	-26.772 (0.000***)
1	-15.113 (0.000***)	-9.219 (0.000***)	-22.661 (0.000***)	-21.041 (0.000***)	0.618 (0.268)	-1.403 (0.080*)	-14.280 (0.000***)	-17.871 (0.000***)
2	-2.295 (0.011**)	-2.199 (0.000***)	-1.396 (0.081*)	-4.067 (0.000***)	-14.280 (0.000***)	-15.116 (0.000***)	-1.476 (0.080*)	-6.261 (0.000***)
3	-2.129 (0.000***)	-2.165 (0.000***)	-1.468 (0.080*)	-3.343 (0.000***)	-6.261 (0.000***)	-3.736 (0.000***)	-1.472 (0.080*)	-6.762 (0.000***)
4	-2.110 (0.000***)	-22.661 (0.000***)	-1.906 (0.033**)	-3.555 (0.000***)	82.617 (1.000)	82.617 (1.000)	-3.325 (0.000***)	-3.533 (0.000***)

Note: *** Denotes rejection at 1%. ** Denotes rejection at 5%. * Denotes rejection at 10%. P-values are reported within parentheses. The symbol Δ represents the first difference. We employed the multipurt routine by Eberhardt (2011b) based on Lewandowski's (2007) pescadf.

Table 9
Westerlund (2007) cointegration test.

	NAFTA	EU-28	NAFTA+EU-28
Variance ratio	3.237	15.168	28.236
p-value	0.000***	0.000***	0.000***
Panels	36	485	539
Avg. number of periods	15	15	15

Note: *** Denotes rejection at 1%. We applied the *xtcointtest westerlund* command included in Stata 16.

tegration test developed by Westerlund to control for both cross-sectional dependence and slope heterogeneity.

Table 9 shows that the Westerlund cointegration test rejects the null hypothesis of no cointegration for the panel models as the p-value is much lower than the 0.05 value, supporting the alternative hypothesis of some panels being cointegrated.

As Persyn and Westerlund (2008) state, the ECM panel cointegration test overcomes the limitations of most residual based cointegration tests as it does not impose common-factor restrictions. Thereby, this test can obtain robust results, even in the presence of cross-sectional dependence and slope heterogeneity. Following Persyn and Westerlund (2008), we use the Bartlett kernel window $\approx$ 3 and robust p-values with 800 bootstrap replications to compute the ECM panel cointegration test.

Table 10 indicates that most statistics can reject the null hypothesis of no cointegration as the p-value is much lower than the 0.05 value, favouring the alternative hypotheses that the panel is cointegrated as a whole (G_t and G_a) or at least one unit is cointegrated (P_t and P_a). Hence, the statistical information supports the hypothesis of a stable long-term relationship among the four series.

We turn to test the plausibility of the hypothesis by estimating the long-run equations. Although the MG estimator is robust in the presence of slope heterogeneity, it does not consider cross-sectional dependence. Therefore, the robustness of our estimates depends on CCEMG and AMG results. It should be highlighted that the CCEMG estimator and AMG estimator not only control for cross-sectional dependence, but they are also robust to unobserved common factors and structural breaks. To provide greater robustness, we include in the analysis the coefficient averages calculated as outlier-robust means.

The estimates of the long-run equations outlined in Tables 11, 12, and 13 are interpreted below. In accordance with our theoretical framework, the coefficients of the variable of interest (*i.e.*, LOG(RVILUC)) have the expected sign and are significant in most cases. For NAFTA, a *ceteris paribus* 1% increase in LOG(RVIULC) decreases the LOG(REER) by a range between 0.047% (AMG robust) and 0.119% (MG robust) in the long run (see Table 11). Conversely, LOG(R) and LOG(YK) may not be significant. The latter result does not contravene the hypothesis, because LOG(R) and LOG(YK) were included to control the influences of both international movements of money-capital and uneven technical change across countries. Therefore, both variables are of no direct interest for our research.

As for the EU-28, a 1% increase in LOG(RVIULC), *ceteris paribus*, brings about a decrease in LOG(REER) by a range between 0.201% (MG robust) and 0.023% (CCEMG robust) (see Table 12). Unlike the NAFTA model, in the EU-28, the control variables are statistically significant, which means that the movements of money-capital and technical change may influence the German manufacturing sectors' long-term cost-competitiveness. This difference can be mostly attributed to the fact that the EU-28 model has more observations than the NAFTA model (7,275 and 540, respectively). Another explanation might lie in that the European integration process implies a free-trade zone that includes a single currency area and a common employment policy.

The cointegration relationships of the model combining NAFTA and EU-28 point out that a 1% increase in LOG(RVIULC) induces a *ceteris paribus* depreciation in LOG(REER) by a range between 0.109% (MG robust) and 0.013% (AMG robust) (see Table 13). Interestingly, the estimators report that LOG(R) has strong statistical significance. The findings suggest that a 1% increase in LOG(R) may reduce the cost-competitiveness of the US manufacturing sectors by a range between 0.050% (MG not robust) and 0.019% (AMG robust) *vis-à-vis* those of their North American and European competitors. This result is fundamentally explained by the fact that the model NAFTA+EU-28 is the largest in our research (8,085). As the sample size increases, the estimates' confidence tends to increase (Wooldridge, 2010).

Furthermore, the US was the largest recipient of foreign direct investment (FDI) worldwide during the 2000-2014 period (UNCTAD, 2019). This means that foreign firms invest in the US expecting to obtain the highest rate of profit. This could have an impact on cost-competitiveness. Although the evidence on horizontal and vertical spillovers from FDI is not conclusive, several studies suggest that foreign firms may improve labour productivity through backward linkages (Gorg, 2004; Newman et al., 2015; Smeets, 2008). Concretely, an augmented foreign firms' demand on local suppliers' inputs can increase output and labour productivity in the long-run (Hirschman, 1958). Similarly, from a Classical political economy standpoint, the export of capital may positively affect recipient countries' cost-competitiveness because it develops their domestic manufacturing production by inserting them into the international division of labour (Smith 1776; Marx 1894).

Our empirical analysis points out that the decrease in unit costs of production of both the US and German manufacturing firms improves cost-competitiveness regarding their commercial partners, consistent with the theory of absolute cost advantage.

On the other hand, assuming the US and German manufacturing sectors' profitability is lower than that of their trading partners, the ensuing money-capital outflow from these countries will tend to curb the long-term growth of the volume of fixed capital investment. This would slow technological change and halt the introduction of new production techniques that could, *pari passu*, improve general production technical conditions and lower relative wages below both the NAFTA and EU-28 average.

Our results are consistent with other studies that have econometrically tested the hypothesis of absolute cost advantage. Using a multivariate procedure for time series by Johansen, Martínez-Hernández (2010, pp. 80–81) obtains a cointegration vector revealing that, *ceteris paribus*, a 1% increase in the real unit labour cost (ULC) ratio index causes Mexico's REER to decrease by 0.704% *vis-à-vis* the US.

Using the same method for multivariate time series cointegration, Boundi (2017, pp. 513–515) finds that Spain's REER declines, *ceteris paribus*, by approximately 0.8% when its ULC increases by 1%. Applying panel cointegration techniques, Boundi (2019, pp. 135–136) highlights that, *ceteris paribus*, Spain's manufacturing sectors REER decrease *vis-à-vis* those of its EU-28 partners by approximately 0.069% (DOLS) and 0.102% (FMOLS) when the RVIULC increases by 1%. Employing the dynamic panel generalized method of moments (GMM), Boundi (Boundi Chraki, 2021, pp. 1334–1335) finds that a 1% increase in RVIULCs provokes, *ceteris paribus*, a decrease in REERs by a range between 0.071% (Mexico) and 0.267% (the US).

By means of the autoregressive distributed lag technique in combination with the error correction model (ARDL-ECM), Shaikh[16] (2016, pp. 532–535) shows that, *ceteris paribus*, Japan's

[16] Shaikh estimates the REER and the ULC using the inverse of the approach here employed. Therefore, the real ULCs of the domestic country are located in the numerator, and those of the foreign country are located in the denominator.

Table 10
Westerlund (2007) ECM panel cointegration test.

Statistic	NAFTA Value	Z-value	Robust p-value	EU-28 Value	Z-value	Robust P-value	NAFTA+EU-28 Value	Z-value	Robust p-value
G_t	-4.390	-7.648	0.000***	-4.211	-5.039	0.000***	-3.209	-5.119	0.000***
G_a	-8.782	0.394	0.080*	-7.003	0.105	0.383	-8.135	-0.030	0.011**
P_t	-21.007	-10.371	0.000***	-10.081	-3.401	0.021**	-13.111	-7.010	0.000***
P_a	-13.274	-7.809	0.000***	-10.018	-3.581	0.016**	-7.118	-2.167	0.010***

Note: *** Denotes rejection at 1%. ** Denotes rejection at 5%. * Denotes rejection at 10%. We used the *xtwest* command by Persyn and Westerlund (2008).

Table 11
MG, CCEMG and AMG (NAFTA).

Dependent variable: LOG(REER) Variables	NAFTA MG Not robust	Robust	CCEMG Not robust	Robust	AMG Not robust	Robust
LOG(RIVULC)	0.177	0.119	0.122	0.128	0.074	0.047
	(0.041)	(0.044)	(0.048)	(0.046)	(0.023)	(0.020)
	[4.330] ***	[2.700] ***	[2.510] **	[2.770] ***	[3.220] ***	[2.340] **
LOG(R)	-0.093	-0.078	-0.037	-0.018	-0.025	-0.005
	(0.024)	(0.021)	(0.031)	(0.020)	(0.021)	(0.016)
	[-3.810] ***	[-3.780] ***	[-1.200]	[-0.890]	[-1.220]	[-0.300]
LOG(YK)	-0.133	-0.041	0.033	0.076	0.224	0.052
	(0.083)	(0.052)	(0.080)	(0.071)	(0.073)	(0.040)
	[-1.600] *	[-0.800]	[0.410]	[1.070]	[-0.020]	[1.290] **
CDP					0.844	0.847
					(0.069)	(0.071)
					[12.320] ***	[11.910] ***
Trend	0.008	0.006	-0.005	-0.001	-0.003	-0.002
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
	[2.690] ***	[2.260] **	[-1.280]	[-0.360]	[-0.950]	[-0.780]
Intercept	-1.520	-1.420	-0.338	-0.307	-1.624	-1.547
	0.276	(0.268)	(0.283)	(0.298)	(0.257)	(0.261)
	[-5.500] ***	[-5.300] ***	[-1.190]	[-1.030]	[-6.310] ***	[-5.920]
Observations	540	540	540	540	540	540
Wald chi2 (p-value)	22.21 (0.000***)	31.44 (0.000***)	7.940 (0.000***)	9.610 (0.000***)	11.76 (0.008***)	7.20 (0.066*)
CD-test (p-value)	15.8 (0.000***)	15.8 (0.000***)	2.800 (0.005***)	2.800 (0.005***)	3.32 (0.001***)	3.32 (0.001***)
Root Mean Squared Error (sigma)	0.041	0.041	0.027	0.027	0.032	0.032

Note: *** Denotes rejection at 1%. ** Denotes rejection at 5%. * Denotes rejection at 10%. Standard errors are reported in parentheses, while statistics are informed within brackets. CDP stands for the common dynamic process. Cross-sectional averaged regressors are excluded since they are not relevant for the assessment. We used the xtmg command by Eberhardt (2012).

Table 12
MG, CCEMG and AMG (EU-28).

Dependent variable: LOG(REER) Variables	EU-28 MG Not robust	Robust	CCEMG Not robust	Robust	AMG Not robust	Robust
LOG(RIVULC)	0.160	0.201	0.013	0.023	0.074	0.057
	(0.195)	(0.074)	(0.017)	(0.012)	(0.021)	(0.016)
	[0.820]	[2.730] ***	[0.770]	[1.940] *	[3.530] ***	[3.520] ***
LOG(R)	0.002	-0.039	-0.031	-0.008	-0.028	-0.014
	(0.063)	(0.022)	0.008	(0.004)	(0.008)	(0.005)
	[0.030]	[-1.790] *	[-3.970] ***	[-1.980] **	[-3.530] ***	[-2.760] ***
LOG(YK)	0.306	-0.085	-0.028	-0.023	-0.043	-0.057
	(0.243)	(0.082)	(0.019)	(0.013)	(0.024)	(0.016)
	[1.260]	[-1.030]	[-1.450]	[-1.840] *	[-1.820] *	[-3.540] ***
CDP					1.002	-0.874
					(0.135)	(0.011)
					[7.420] ***	[-78.210] ***
Trend	0.072	0.008	0.002	0.001	0.001	0.001
	(0.011)	(0.005)	(0.002)	(0.001)	(0.002)	(0.002)
	[6.780] ***	[1.720] *	[0.760]	[0.860]	[0.470]	[0.830]
Intercept	-1.576	-1.033	0.008	-0.182	-1.548	-1.389
	(0.139)	(0.096)	(0.138)	(0.142)	(0.104)	(0.105)
	[-11.300] ***	[-10.760] ***	[0.050]	[-1.290]	[-14.820] ***	[-13.190] ***
Observations	7,275	7,275	7,275	7,275	7,275	7,275
Wald chi2 (p-value)	3.74 (0.292)	11.70 (0.008***)	19.00 (0.000***)	11.10 (0.011**)	30.97 (0.000***)	32.55 (0.000***)
CD-test (p-value)	37.07 (0.000***)	37.07 (0.000***)	2.80 (0.005***)	2.80 (0.005***)	0.25 (0.804)	0.25 (0.804)
Root Mean Squared Error (sigma)	0.500	0.500	0.038	0.038	0.058	0.058

Note: *** Denotes rejection at 1%. ** Denotes rejection at 5%. * Denotes rejection at 10%. Standard errors are reported in parentheses, while statistics are informed within brackets. CDP stands for the common dynamic process. Cross-sectional averaged regressors are excluded since they are not relevant for the assessment. We used the xtmg command by Eberhardt (2012).

Table 13
MG, CCEMG and AMG (NAFTA+EU-28).

Dependent variable: LOG(REER)		NAFTA+EU-28				
Variables	MG		CCEMG		AMG	
	Not robust	Robust	Not robust	Robust	Not robust	Robust
LOG(RIVULC)	0.107	0.090	0.034	0.020	0.019	0.013
	(0.032)	(0.028)	(0.018)	(0.011)	(0.014)	(0.009)
	[3.360] ***	[3.200] ***	[1.910] *	[1.810] *	[1.300]	[1.760] *
LOG(R)	-0.050	-0.042	-0.043	-0.019	-0.042	-0.019
	(0.010)	(0.008)	(0.007)	(0.004)	(0.006)	(0.003)
	[-4.950] ***	[-5.010] ***	[-6.050] ***	[-4.350] ***	[-6.590] ***	[-5.59] ***
LOG(YK)	-0.178	-0.160	-0.048	-0.027	0.002	0.007
	(0.030)	(0.028)	(0.019)	(0.014)	(0.015)	(0.011)
	[-5.880] ***	[-5.640] ***	[-2.510] **	[-1.960] **	[0.150]	[0.690]
CDP					1.006	1.056
					(0.027)	(0.018)
					[37.940] ***	[59.820] ***
Trend	0.020	0.019	0.000	-0.001	0.001	-0.001
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	[12.650] ***	[13.660] ***	[-0.220]	[-1.180]	[0.820]	[-0.740]
Intercept	-0.639	-0.218	0.022	0.654	-0.735	-0.090
	(0.060)	(0.041)	(0.062)	(0.028)	(0.060)	0.020
	[-10.560] ***	[-5.34] ***	[0.350]	[23.050] ***	[-12.340] ***	[-4.430] ***
Observations	8,085	8,085	8,085	8,085	8,085	8,085
Wald chi2 (p-value)	79.46 (0.000***)	67.21 (0.000***)	47.68 (0.000***)	25.98 (0.000***)	45.43 (0.000***)	33.9 (0.000***)
CD-test (p-value)	455.59 (0.000***)	455.59 (0.000***)	26.22 (0.000***)	26.22 (0.000***)	28.61 (0.000***)	28.61 (0.000***)
Root Mean Squared Error (sigma)	0.082	0.082	0.036	0.036	0.046	0.046

Note: *** Denotes rejection at 1%. ** Denotes rejection at 5%. * Denotes rejection at 10%. Standard errors are reported in parentheses, while statistics are informed within brackets. CDP stands for the common dynamic process. Cross-sectional averaged regressors are excluded since they are not relevant for the assessment. We used the xtmg command by Eberhardt (2012).

REER increases by 1.3533% when raising the ULC by 1%, while, *ceteris paribus*, a 1% increase in the ULC causes the US's REER to increase by 0.91982%.

In the context of the unequal exchange in international trade and using different methodologies, other studies obtain empirical evidence supporting the absolute cost advantage. For instance, Tsoulfidis and Tsaliki (2019, pp. 317–319) find that the actual term of trade between China and the US appear to be regulated by the relative vertically integrated unit labour cost over the 2000-2014 period, thereby contravening the argument that Chinese commodities enter into the US market by maintaining an artificially low Yuanś exchange rate.

In the same way, Tsaliki, Paraskevopoulou and Tsoulfidis (2018, pp. 1054–1061) reveal that the German economy holds an absolute cost advantage over the Greek economy as its unit labour costs were lower during the 1995-2011 period, thus explaining, in turn, Germanyś trade surplus in goods with Greece.

5. Concluding Remarks

The statistical evidence here found suggests that the increasing asymmetries among NAFTA and EU-28 countries are rooted in domestic cost structures, international competition, and capital flows. Therefore, persistent trade imbalances between countries in both economic areas derive from disparities in the technical conditions of production and relative real wages.

It should be noted that according to the cointegration relationships (*i.e*, MG, CCEMG, and AMG), the effect of an increase in LOG(RVIULC) is similar in the US and Germany. Both the US and German manufacturing sectors tend to benefit *vis-à-vis* their NAFTA and European partners from a reduction in production unit costs. During the 2000-2014 period, the cumulative annual growth rate of the US trade deficit with NAFTA averaged 5.69%, while the cumulative annual growth rate of the German trade balance surplus with the EU averaged 0.9% (see Appendix graphs A1 and A2).

Considering the above, it can be inferred that the cost-competitive position of the US manufacturing firms has worsened *vis-à-vis* that of Canadian and Mexican firms. However, several studies indicate that the US trade deficit with Mexico is, *stricto sensu*, a deficit with US subsidiary companies operating in the Mexican territory (Gereffi et al., 2009; Perrotini-Hernández and Vázquez-Muñoz, 2019; Ponte et al., 2019). In this vein, the rapid expansion of global value chain (GVC) reduced the manufacturing contribution in total gross value added for the US by approximately -12.59% in the 2000-2014 period (Liboreiro et al., 2021, p. 139). Conversely, US manufacturing imports from Mexico increased by approximately 117.56% (data from the US Census Bureau[17]), suggesting a strong delocalisation process of US firms over the last decades (Gereffi et al., 2009; Ponte et al., 2019).

Two sub-periods were identified for Germany. From 2000 to 2007, the cumulative annual growth rate of the German trade balance surplus with the EU was 15.40% (see Appendix graph A2). Conversely, from 2008 to 2014, the trade surplus showed an annual average decrease of -9.96% (see Appendix graph A2). In the first sub-period, Germany managed to widen the gap between real wages and labour productivity at a faster rate than its EU partners did, to a great extent due to employment pacts and competitiveness (PECs), research and development (R&D) cooperation, the use of agglomeration economies through clusters, the reorganisation of production in global supply chains, the outsourcing of industrial services, the adoption of above-EU-average production techniques, and the design of more efficient methods of labour organisation (Götz and Jankowska, 2017).

During the second sub-period, the strong contraction of aggregate demand the EU experienced in the recession years (2008-2014), the short-term gains in cost-competitiveness Spain and Italy achieved after more intensely applying wage deflation (Grodzicki and Skrzypek, 2020; Serrano and Myro, 2019), and the

[17] Detailed information can be found in the following link: https://www.census.gov/foreign-trade/balance/c2010.html

boom in exports from the Czech Republic, Slovakia, Poland and Hungary were the main reasons for the drastic decline in Germany's trade surplus (WTO, 2020).

Overall, we conclude that i) RVIULCs are a good measure for intrasectoral cost-competitiveness; ii) the free movement of money-capital and technical change in NAFTA and the EU-28 strengthen the position of countries with absolute cost advantage in some manufacturing sectors and, therefore, weaken the positions of other countries; and iii) even when the wage deflation strategy is able to bring about short-term cost-competitiveness gains, as long as the technical conditions of production do not improve relative to those of the competitors, these gains will fade away in the long term.

Thus, both North American and European policymakers should promote policy frameworks and strategies for improving cost-competitiveness focused on those factors that affect, in the long-run, the technical conditions of production, instead of imposing wage adjustments that may increase income inequality. Further research should empirically test the validity of absolute cost advantage theory including in the model more countries and using different panel cointegration techniques suitable to control cross-sectional dependence and slope heterogeneity.

Declaration of Competing Interest

No potential conflict of interest was reported by the authors.

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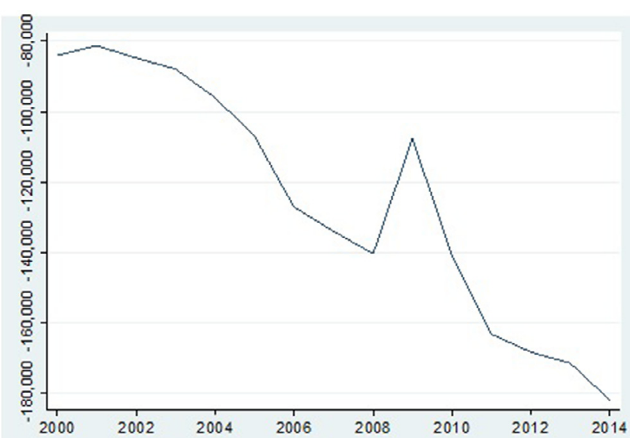
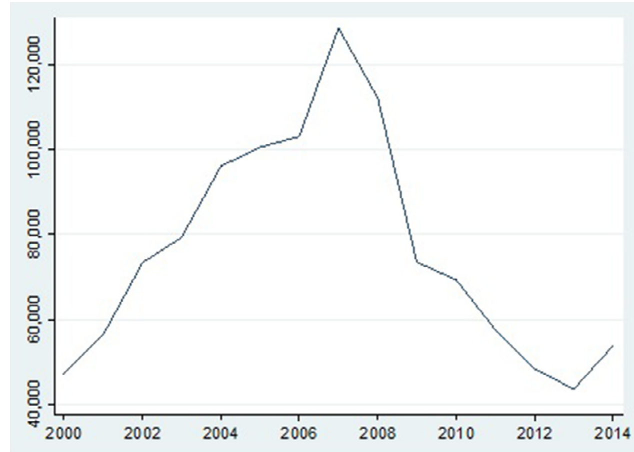
Appendix

Graph A1, Graph A2



Graph A1. US trade in goods* with NAFTA, 2000-2014.
Note: * millions of US dollars on a nominal basis.
Source: Authors, based on BEA.



Graph A2. German trade in goods* with EU, 2000-2014.
Note: * in millions of euros on a nominal basis.
Source: Authors, based on Eurostat.

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