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A Critical Assessment of Comparative Advantages

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# A CRITICAL ASSESSMENT OF COMPARATIVE ADVANTAGES

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## ABSTRACT

Literature on international trade agrees that comparative advantages (CA) regulate the pattern of trade across countries. What is not usually stressed is that, for this to be possible, CA must be identified *ex-ante by* some *ranking* of international competitiveness. Otherwise, they become a tautology: countries are said to possess CA in those sectors that have managed to become internationally competitive. In this work, we show that when there is production of capital goods, in particular of *imported* means of production, and even under a zero profit rate: (a) the ranking of industries on the basis of autarky comparative costs may not be a good predictor of CA; (b) no ranking of industries exists, in general. The overall conclusion of the article is that CA cannot explain the pattern of trade and, therefore, an alternative explanation must be searched for.

**KEYWORDS:** COMPARATIVE ADVANTAGE – COMPARATIVE COSTS- IMPORTED CAPITAL GOODS – PATTERN OF SPECIALIZATION

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## 1. INTRODUCTION

Comparative advantages (CA) is still one of the basic concepts in the standard theory of international trade. Paul Samuelson went so far to argue that CA is the appropriate answer to the search of a proposition in social sciences that is "both true and non-trivial" (1969, p. 9). But fifty years later, and after considerable development in the field, Alan Deardorff, another authoritative scholar on the subject, advanced essentially the same claim when he affirmed that

> comparative advantage is certainly one of the most basic ideas in economics, underlying much of our understanding both of why countries trade the way that they do and why they benefit from doing so. (Alan Deardorff, 2005, p. 1004)

This does not necessarily exclude, of course, that under certain conditions a country may find itself unable to produce and export, competitively, at least one commodity (i.e. that it has absolute costs disadvantages in the production of *all* commodities). What those who adhere to CA do argue is that this situation will not last. Since the country would exhibit partial or total unemployment, the argument runs, the "disequilibrium" in factor markets should sooner than later trigger a fall in the respective rental prices, and the cheapening of domestic costs of production *vis a vis* the rest of the world would allow the economy in question to reach the sufficient competitiveness to participate in international trade. This mechanism, in other words, would allow the manifestation of CA as the *truly persistent* determinant of international trade across countries[1].

Now, it is also true that this result has been questioned on several grounds. In the first place, a group of scholars (Brewer, 1985; Gibson, 1981 and Shaikh, 1980, among others) have argued that, since distribution is mainly determined by non-market forces (political, institutional and cultural factors), it *need not* adjust to correct supply-and-demand imbalances in factor markets, with the implication that CA may only remain *latent*, but do not necessarily have to manifest themselves. This criticism has been reinforced by a second one -in this case,

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[1] An example of this reasoning can be found in Robert Feenstra's (2016) graduate textbook in trade theory: "The reason that is still possible for the home country [the country that has absolute disadvantages in both goods] to export", Feenstra explains, "is that its wages *will adjust* to reflect its productivities: under free trade, wages are lower than those abroad" (Feenstra, 2016, p. 3, italics added; see also Krugman 1991, p. 811).

born as a byproduct of the 'Cambridge Controversies' of the 1960's. Steedman and Metcalfe (1977) have shown that, in the presence of capital goods, the adjustment in distribution will not necessarily change the proportions in which productive factors are employed in the direction adduced by CA. Finally, the third group of contributions has recently emphasized the possibility that, even if the adjustment were not the outcome of market forces, but the result of deliberate public policy[2], it may well be the case that, due to the presence of imported capital goods, a country may not be able to specialize in the production of those commodities in which it has CA; the reason being in this case that it would be unable to compensate with low –even zero– wages, its technological backwardness with respect to the rest of the world (cf. Parrinello, 2010, Bellino and Fratini, 2019 and Crespo et al., 2019).

Our position is that, by themselves, these three criticisms are sufficiently strong to annul the validity of CA as a general explanation of the observed patterns of trade across countries. However, we also believe that none of them go to the *root* of the question: the reason is that they accept, more or less explicitly, the possibility to determine in which sectors a country has greater CA. It is precisely here where our contribution lays. It starts from the preliminary observation –also noticed by Maneschi (1998)-, that it is not easy to find a precise and sufficiently general definition of CA[3]. This deficiency is particularly clear in the *New Palgrave* entry on CA (cf. Findlay, 2008), precisely the place where one would expect to find such a definition. All this seems to be *symptomatic* that there might be difficulties with the concept that go beyond, and are deeper than, the mere possibility either a) to deny the existence of a distributive mechanism (first two criticisms) or b) to affirm the existence of an objective limit below which prices cannot fall (third criticism), which prevent CA from manifesting themselves.

Now, to be useful as an explanation of the pattern of trade –to be, borrowing Samuelson's own words, "non-trivial"- CA cannot be identified ex-post, namely based on those industries that, after trade, have *already* managed to become competitive. To be a truly determinant of trade, it must be possible to identify them *ex ante*.

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[2] In fact, some non-neoclassical economists have relied on CA to explain why macroeconomic policies that attempt to decrease the real wage (e.g. a real devaluation) may help diversifying the productive structure of the economy (cf. Razmi, 2012).

[3] The author, however, does not go beyond the observation of this fact.

In the usual presentations we find in textbooks and treatises on international trade, in which it is assumed that production requires unassisted labour alone, or non-produced inputs only, the issue is solved because it is possible to build a purely "technical" ranking of sectorial competitiveness within a country, which allows identifying which sectors are relatively more "efficient" or "productive" than the rest of the world: precisely these sectors that a) either require relatively less labour per unit of output, as in the so-called "Ricardian models"; or alternatively, b) that are intensive in the employment of those factors in which the country is relatively abundant, as in the Heckscher-Ohlin kinds of models[4]. This ordering of sectors is, in a second stage of the analysis, employed to predict how the productive structure is *diversified* when distribution changes: in other words, the claim is made that, not only does a fall in domestic rates of remuneration allow preserving the competitiveness of the "old" industries (if any); it also allows the *incorporation* of new sectors that were not profitable at the previous distributive configuration.

However, the current consensus seems to be that CA not only do work in these relatively simple cases but that they can also accommodate without major difficulties more general contexts, that do acknowledge the presence of capital goods. In this respect, we find again Alan Deardorff asserting that:

> …comparative advantage can [be] derive[d] just as well from a country having low intermediate input requirements for a particular good as for requiring relatively small amount of labor. (2005, p. 22)[5]

Even Steedman and Metcalfe, who must be thanked for clarifying the difficulties and limitations of traditional theories of international trade in the presence of capital goods, seem to believe that these problems are *exclusively* due to the existence of a positive profit rate, but not to the presence of capital goods themselves[6].

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[4] It is to be noted, however, that in Heckshcher-Ohlin trade models, one must add the additional hypothesis of absence of factor intensity reversals to identify CA.

[5] cf. also Samuelson (1953-1954, 2001).

[6] "In the standard analysis, with a zero rate of profit, it is not important whether one assumes that the factors produce the commodities directly or that there are produced means of production" (Steedman & Metcalfe, 1977, p. 202).

In this work we critically face this issue; and affirm that, contrary to the dominant vision, both among critics and defenders of CA, the presence of capital goods does prevent the theory from giving a *non-trivial* definition of CA, even under the simplifying assumption that the profit rate is zero. The whole argument will turn around the possibility to show that the presence of capital goods invalidates a central property of the models in which production requires unassisted labour alone or non-produced inputs: the independence of production conditions in one industry from the production conditions of the rest. The absence of this property and, in particular, the existence of imported means of production, is sufficient to hinder the building of a purely technical ranking of sectorial competitiveness.

The argument will be developed in the following way: to settle the grounds of the discussion, in section 2 we present a simple model of two countries, where production requires unassisted labour alone; and we show why, in this case, not only does the ranking of industries exist, but it can be also inferred by autarky relative costs. In section 3 we give a first glance to the limitations of the simple model of section 2, by considering the presence of capital goods. We first show that their presence entails an important difference with respect to the case of production by unassisted labour alone because available techniques under conditions of autarky do not necessarily coincide with the whole spectrum of technical choices under conditions of trade. As a result, due to the possibility to import a cheaper capital good from abroad, a sector with absolute cost disadvantages in autarky may achieve international competitiveness without relying on any adjustment in income distribution. In section 4 we give a step further and show that autarky comparative costs may fail to predict the pattern of trade. Finally, in section 5, we generalize this result by showing that it might be simply impossible to construct a sectorial ordering of international competitiveness. Section 6 both resumes the argument and presents the main conclusions of the article.

## 2. COMPARATIVE ADVANTAGES IN A SIMPLE "RICARDIAN" MODEL

To settle the grounds of the discussion, let us consider the production side of one of the workhorses in international trade theory: the so-called Ricardian Trade model (see Matzuyama, 2008), with two countries, *A* and *B*, and *N* consumption goods, indexed by *z*. Production requires unassisted labour alone and constant returns to scale prevail in every industry. We further keep the standard assumptions of labour immobility across countries

(and labour mobility within industries of the same country) and one common currency to abstract from exchange-rate considerations. If $l_z^x$ and $w^x$ stand, respectively, for the unitary labour requirement of commodity $z$ and the level of money wages in country $x$; then, if wages are paid at the end of the production cycle, the cost of production of $z$ in country $x$, $c_z^x$, is determined by:

$$c_z^x = l_z^x w^x \tag{1}$$

Notice then that, since labour is the only input used in production, production costs exhibit two properties that are worth mentioning: they are independent both of [a] the methods employed in other industries and [b] the level of distributive variables in the other country. We will exploit their implications below.

For the moment, let us define the relative wage and the relative labour coefficients, as $\omega \equiv w^A / w^B$ and $\lambda_z \equiv l_z^A / l_z^B$. Then, the *comparative cost* of the same commodity in countries $A$ and $B$, $cc_z \equiv \frac{c_z^A}{c_z^B}$, is:

$$cc_z = \lambda_z \omega \tag{2}$$

## 2.1. Absolute advantages

Clearly, commodity $z$ will be produced in country $A$ if $cc_z < 1$, namely when $c_z^A < c_z^B$. In this case, country $A$ is said to have *absolute cost advantages* in the production of $z$. On the same footing, when the condition $cc_z > 1$ holds, country $A$ will have absolute cost disadvantages in $z$. Consequently, $cc_z = 1$ defines a *competitiveness threshold* in the production of $z$. For given labour coefficients, an industry $z$ in country $A$ will be above or below this threshold depending on the level of the relative wage $\omega$. It can be immediately noticed that the threshold will be reached when $\omega = \lambda_z^{-1}$, which depends on technical coefficients of sector $z$ *alone.* This is a consequence of the abovementioned property [a].

Then, commodity $z$ will be produced only in country A (country A will have absolute cost advantages in the production of z) when the relative wage satisfies:

$$\omega < \omega_z \tag{3}$$

Where, to avoid cumbersome notation, we have denoted $\lambda_z^{-1}$ with $\omega_z$, the level of the relative wage that equalizes production costs of commodity $z$ in both countries. While commodity $z$ will be produced only in country $B$ when:

$$\omega > \omega_z \qquad (3')$$

Notice that comparative costs $cc_z$ unambiguously increase with $\omega$ (see equation (2)). This means that, if sector $z$ is above the competitiveness threshold, a decrease in $\omega$ reduces its competitiveness gap (i.e. absolute cost disadvantages of commodity $z$ in country $A$ decrease). While if it is below the threshold, a fall in $\omega$ widens the gap (i.e. absolute cost advantages increase). This is tantamount to saying that it cannot be the case that a fall in $\omega$ hampers competitiveness of any sector in country A. While this seems to be a well-established result in standard international-trade theory, we shall see in section 5 below that this proposition is not always true when more general production conditions are considered.

## 2.2. Comparative advantages

We can now proceed to identify *comparative advantages* (CA). To this end, consider the *ratio* of comparative costs in two different industries, $i$ and $j$:

$$\frac{cc_i}{cc_j} = \frac{\lambda_i}{\lambda_j} \qquad (4)$$

Notice that, although comparative costs depend on the relative wage, $\omega$ -see equation (2)-, their ratio as defined by (4) is independent of it[7]. The implication is the following: assuming, without loss of generality, that the relative labour requirement in industry $i$ is smaller than in industry $j$, i.e. $\lambda_i < \lambda_j$, then $cc_i < cc_j \ \forall \omega$. Therefore, whenever country $A$ has absolute costs advantages in the production of commodity $j$, it must also have them in the production of $i$. Formally:

$$cc_j < 1 \Rightarrow cc_i < 1 \qquad (5)$$

Likewise, if $cc_i > 1$ then $cc_j > 1$. Namely, whenever country $A$ has absolute costs disadvantages in the production of $i$, it must also have them in the production of $j$. Formally,

$$cc_i > 1 \Rightarrow cc_j > 1 \qquad (5')$$

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[7] As it will be clear below, this is a consequence of property [b].

All this can be summarized in the following way: under the hypothesis that country $A$ requires, compared to country $B$, relatively less labour in the production of commodity $i$ than in commodity $j$, what conditions (5) and (5)' show that it is possible to *order* industries on an international competitiveness basis.

To further illustrate the argument, consider the hypothetical situation in which the condition $cc_z > 1$ holds for $z = i, j$. Namely, country A has absolute costs disadvantages in the production of both commodities and, therefore, country A imports them from $B$. Consider next a notional decrease in the relative wage, $\omega$. What condition (5) says is that, between $i$ and $j$, the former will be the commodity to be produced in country A *first*, since the competitiveness of the latter implies the competitiveness of the former. Likewise, if the condition $cc_z < 1$ initially holds for both industries and, in this case, we consider a notional increase in $\omega$, condition (5)') implies that industry $j$ will cease to be competitive in country A before sector $i$.

In other words, under the specific conditions of production considered so far (i.e. commodities being produced by labour alone), industries can be ranked according to their comparative costs, $cc_z$ -or, what is the same thing under the conditions of production assumed, according to their relative labour content-. Then, it has been shown that this ranking allows predicting the order in which the productive structure of country A diversifies. On the basis of comparative costs, therefore, one can define comparative advantages: $cc_i < cc_j$ implying that country $A$ has greater CA in the production of commodity $i$.

The argument developed so far involved a pairwise comparison of any two sectors. But it can be easily extended to the case of more than two commodities. Indeed, we can build a so-called c*hain of comparative advantages.* To this end, notice first that it is possible to rank any arbitrary number of commodities by their relative labour content (which, recall, exactly correspond to the ranking according to comparative costs for any level of $\omega$). Thus, we can index commodities such that:

$$cc_1 < \cdots < cc_z < \cdots < cc_N \tag{6}$$

And the previous argument can be immediately extended to the case of $N$ commodities: country $A$ has the greatest CA in the production of commodity 1, then in 2, etc.; while $B$ has the greatest CA in commodity $N$, then in commodity $N - 1$, and so on.

## 2.3. "Horizontal Ordering" and "Vertical Ordering" of commodities

The above discussion can be summarized by introducing a distinction between what we will call the "Horizontal Ordering" (henceforth, HO) of commodities, and their "Vertical Ordering" (henceforth, VO). Consider Figure 1, which shows how comparative costs of the different industries $z$, $cc_z$, vary with the relative wage.

**Figure 1. Comparative costs**
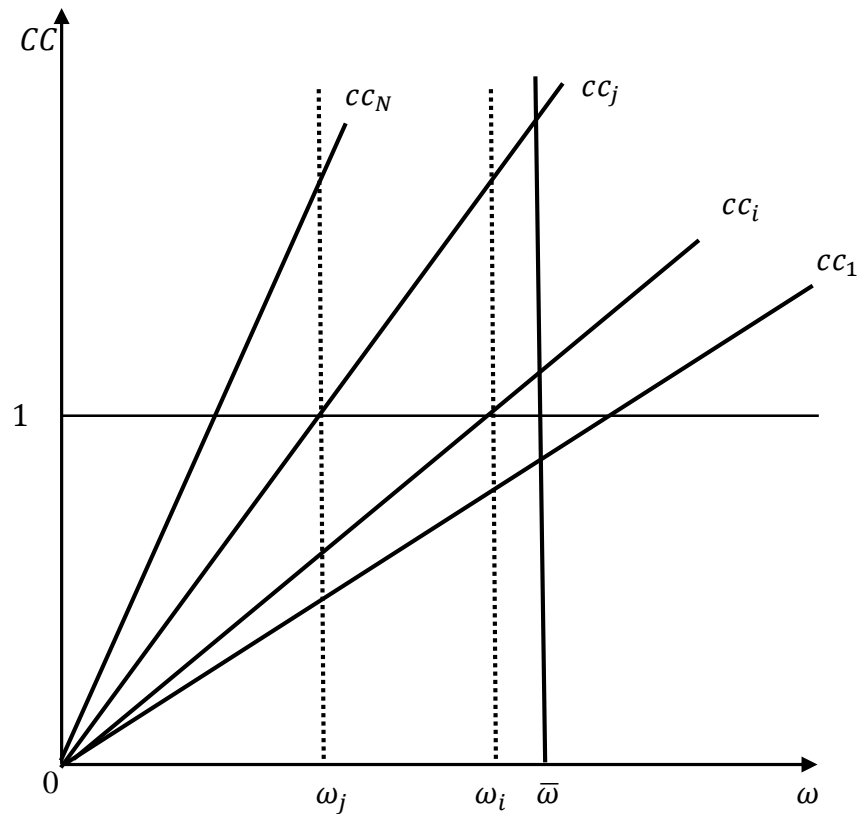


The figure allows us to highlight several properties of comparative costs, derived from the fact that these are all linear functions of $\omega$, with slope equal to their relative labour content, $\lambda_z$, and all intersecting at the origin (see equation (2)): ($i$) there is a unique ordering in which the $cc_z$ curves intersect the competitiveness threshold, $cc_z = 1$ (represented by the horizontal line). Seen from "right to left", this is the "Horizontal Ordering" of commodities, summarized by the respective $\omega_z$. Precisely, HO shows, as the relative wage, $\omega$, decreases,

the order in which commodities are *incorporated* into the productive structure of country $A$[8]; ($ii$) for an arbitrarily chosen level of the relative wage, say $\bar{\omega}$, HO coincides with the vertical ordering (VO) which, seen in this case from "bottom to top" at the given relative wage, ranks industries by their comparative costs, $cc_z$. This implies that, since for $\omega = \bar{\omega}$, $cc_i < cc_j$, then the maximum level of $\omega$ compatible with international competitiveness in country $A$ of commodity $i$ ($\omega_i$) is higher than the corresponding level for commodity $j$ ($\omega_j$). Hence, the sequence in which country A will diversify its productive structure (the HO) when the relative wage *changes*, can be accurately *predicted* by the ranking of comparative costs for *any* given level of the relative wage (the VO). Finally, ($iii$) since this prediction can be done for any level of the relative wage, it follows that it will hold in particular for the *autarky* relative wage. What all this means is that comparative advantages, HO, can be accurately deduced by observing autarky comparative costs, i.e. VO, alone.

## 3. PRODUCTION WITH CAPITAL GOODS: A FIRST GLANCE

We now move to examine whether the possibility to *infer* CA by means of autarky comparative costs is still possible when capital goods are allowed in production. We will consider the case in which there are only purely circulating capital goods. And we will assume that the rate of profits is equal to zero.

If $a_{jz}^x$ denotes the amount of commodity $j$ required to produce a unit of $z$ in country $x$ and $\pi_j^x$ is its ruling price, then the cost of production of $z$ in country $x$, $c_z^x$, is now given by:

$$c_z^x = w^x l_z^x + \sum_{j=1}^{N} a_{jz}^x \pi_j^x \tag{7}$$

Notice however that $\pi_j^x$ may generally differ across countries under conditions of autarky, and it will generally change with $\omega$, as we shall see below.

In the second place, notice that none of the two properties [a] and [b] (see equation (1) in section 2) holds anymore. This is because the presence of $a_{jz}^x$ implies that the costs of production of $z$ now depend on the conditions of production of commodity $j$ (absence of

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[8] In the example, commodity 1, having the greatest $\omega_z$, is the first commodity to be produced by country A, then commodity $i$, and so on.

property [a]); while, were commodity $j$ an imported capital good, production costs in country A will depend on the level of wages in country B (absence of property [b]).

## 3.1. Absolute advantages and imported capital goods

Consider first a situation of autarky, in which each country $x$ produces the whole spectrum of commodities. As is well known, when the rate of profits is zero, the cost of commodity $z$ is proportional to the amount of both direct and indirect labour embodied in production. This means, denoting with an upper bar the level of variables under conditions of autarky, that comparative costs can be expressed as:

$$\overline{cc}_z = \frac{\overline{w} l_z^A + \sum_{j=1}^{N} a_{jz}^A \bar{c}_j^A}{\overline{w}^B l_z^B + \sum_{j=1}^{N} a_{jz}^B \bar{c}_j^B} = \overline{\omega} \frac{\overline{L}_z^A}{\overline{L}_z^B} \tag{8}$$

Where $\overline{L}_z^x$ stands for the total quantity of labour (both direct and indirect) used in the production of a unit of $z$ in country $x$. As anticipated above, the price of the same capital good $j$ may differ across countries. That is, assuming commodity $j$ is a capital good in the production of $z$ in both countries, $\pi_j^x$ will be equal to $\bar{c}_j^A$ in the numerator of (8), and equal to $\bar{c}_j^B$ in the denominator. But then, when both economies engage in international trade, the action of competition will tend to establish only the lowest of these prices. The implication is the following: assume that the level of $\omega$ is fixed and that for any two commodities, $\overline{cc}_i > 1$ and $\overline{cc}_j > 1$. Therefore, country $A$ cannot produce any of these goods. However, if commodity $j$ is a capital good used in the production of commodity $i$ in country A, imports of commodity $j$ from B will reduce production costs of $i$ in country A. By itself, this may result in commodity $i$ being less costly in country A than in country B, i.e. $cc_i < 1$, at $\omega = \overline{\omega}$. That is, it is not *necessary* that distribution changes to render the production of $i$ competitive in country A. The following example illustrates this possibility:

**Table 1. Technical coefficients**

| $x$ | Country A | | Country B | |
|---|---|---|---|---|
| $z$ | $i$ | $j$ | $i$ | $j$ |
| $a_{jz}^x$ | 1 | 0 | 2 | 0 |

| $l_z^x$ | 1 | 3 | 1 | 1 |
|---------|---|---|---|---|

It is easy to see that, if the level of wages under autarky is $\bar{w}^A = \bar{w}^B = 1$, then:

$$\bar{c}_j^A = 3 > \bar{c}_j^B = 1$$
$$\bar{c}_i^A = 4 > \bar{c}_i^B = 3$$

For the given level of the relative wage, $\bar{\omega} = 1$, one should expect that country A will import both commodities, as it has an absolute cost disadvantage in their production. But it can be shown that, once the capital good is imported from B (i.e. when $\pi_j^A = \bar{c}_j^B$), the costs of production become:

$$c_j^A = 3 > c_j^B = 1$$

$$c_i^A = 2 < c_i^B = 3$$

which means that country A can (and will) start producing commodity $i$.

Notice then that, contrarily to what happened in the simple model of section II, in this case country A manages to produce and export a commodity whose autarky costs were higher than the costs of production in country B, *without any adjustment* in its relative wage.

The reason is that, when production uses capital goods –and these capital goods can be imported- the set of autarky technical choices is only a *subset* of the whole set of technical choices (for instance, the method of production of commodity $i$ in country A that employs labour of country $A$ and the capital good $j$ imported from country B, was not available under conditions of autarky and becomes available only when both countries can trade). A graphical representation of the example is provided in Figure 2 below.

**Figure 2: $CC$ curves under autarky and trade with capital goods**
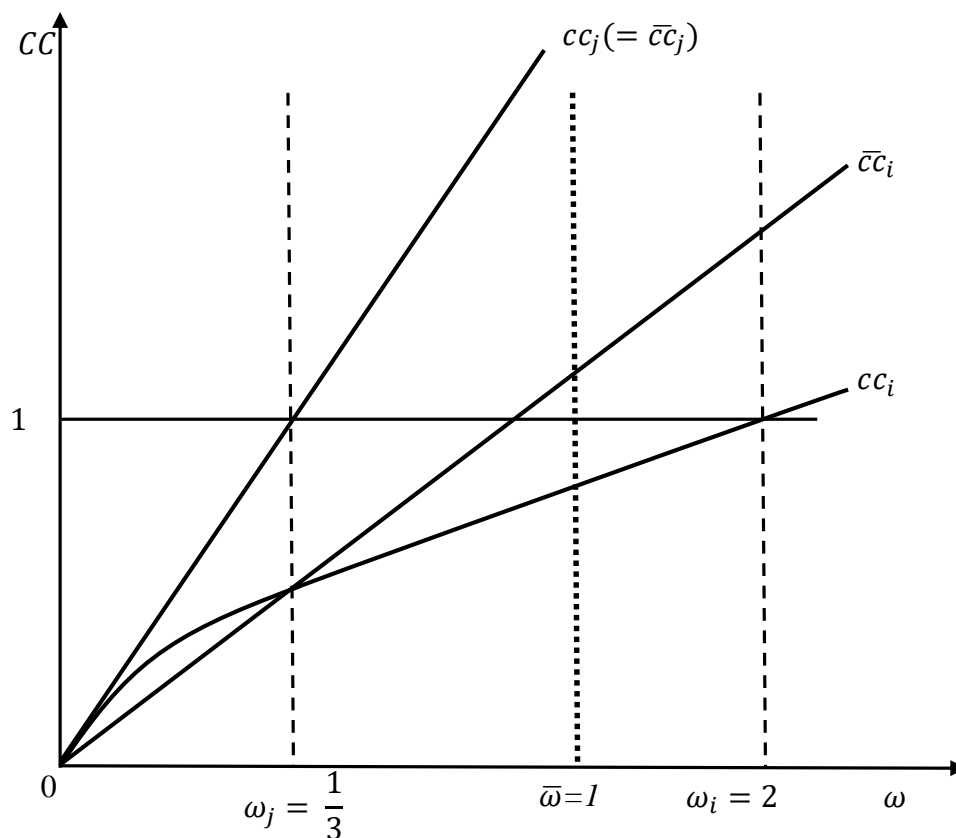


The figure shows, precisely, the effect of the opening of trade on technical choices, and therefore on the $cc$ curve of the consumption good $i$. Namely, how the possibility of importing the capital good $j$ shifts the $cc_i$ curve from autarky (the $\overline{cc}_i$ straight line) to trade (the $cc_i$ curve)[9]. The former considers the techniques available under autarky *only* (and therefore, allows the same commodities to have different prices (see equation (8)); while the latter includes the *broader* set of choices under trade conditions. Therefore, the $cc_i$ curve duly takes into account the fact that, due to the action of competition, only the *lowest* price of the capital good $j$ will prevail. In other words, that commodity $j$ is produced in B when $\omega > 1/3$ and in country A otherwise (see $cc_j$ curve). Consequently, at the given relative wage $\overline{\omega} = 1$, the opening to trade allows comparative costs of $i$ under autarky to "jump", so to speak, below the competitiveness threshold. This, contrarily to what could have been

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[9] Notice that due to the presence of imported capital goods, the $cc_i$ curve is no longer linear. The consequences of this will be explored in the following section

wrongly inferred by a naïve observation of autarky-costs alone, indicates that consumption good $i$ will be produced in country A, even without a change in $\omega$. An example like this has been used by Deardorff (2005) and Samuelson (2001) to assert that not only comparative advantages can be defined in the presence of capital goods but, more importantly, that they may even *arise* due to their presence.

## 4. VERTICAL ORDERING (VO) AND HORIZONTAL ORDERING (HO), RECONSIDERED

Interesting as it is, if any, the previous example only seems to reinforce the validity of CA. In fact, we have concluded that autarky technical choices do not include the whole spectrum of available techniques under conditions of trade; yet, comparative autarky costs (what we have called VO, $\overline{cc}_i < \overline{cc}_j$, which suggests that country A had CA in the commodity $i$) were still a good predictor of the pattern of trade, since in effect country A ended up exporting commodity $i$ and importing commodity $j$. The reason is that the inclusion of the whole set of technical choices did not change what we have called HO of commodities (in the example, the relative wage that allowed commodity $i$ to be produced in country A was still higher than the corresponding one for commodity $j$).

However, as we shall proceed to examine, this is a result that does not hold in general. Consider the situation in which, besides commodities $i$ and $j$, which are produced with the same technical coefficients of the previous example, there is also a third commodity, $k$, a pure consumption good, whose technical coefficients are specified below:

**Table 2. Technical coefficients of commodity $k$**

|  | Country A | Country B |
|---|---|---|
| $a_{jk}^x$ | 5 | 4 |
| $l_j^x$ | 1 | 4 |

For the same autarky wages as in the previous example, autarky costs of commodity $k$ are:

$$\bar{c}_k^A = 16 > \bar{c}_k^* = 8$$

Furthermore, we have that:

$$1 < \overline{cc}_i < \overline{cc}_k < \overline{cc}_j \tag{9}$$

With: $\quad\quad\quad\quad \overline{cc}_i = 4/3 \,; \overline{cc}_k = 2; \overline{cc}_j = 3$

Clearly, by inspection of autarky relative costs, since all are greater than 1, one should conclude that country A will, at least initially, import the three commodities. We have seen that this is not the case, since the possibility to import the capital good allows country A to produce (at least) commodity $i$.

More important is, however, to notice that, if autarky comparative costs accurately reflected CA -if, in other words, VO and HO coincided-, then a gradual decrease in $\omega$ would allow country $A$ to produce commodities in a specific manner: first commodity $i$, then $k$, and finally $j$. We can now proceed to assess whether this proposition holds.

Let us assume, as before, that the relative wage does not change, initially: we already know that, once the capital good $j$ is imported in country $A$, industry $i$ becomes competitive in that country. It is straightforward that the same thing happens with the other consumption good, $k$, since $cc_k = 3/4\,(<1)$. This implies that once the capital good is imported in country A, while $\omega$ is still equal to 1:

$$cc_i < cc_k < 1 < cc_j \tag{10}$$

Therefore, for $\omega = 1$, the opening of the economy to international trade –and therefore, the consideration of the whole set of technical choices- does not seem to alter the order of commodities as predicted by autarky comparative costs (the VO as identified by (9) is maintained in (10)).

But, does this ordering still hold when the relative wage changes? Indeed, if, e.g. $\omega$ rises, supporters of comparative advantages would expect commodity $k$ to be expelled from country A's productive structure *before* commodity $i$, since $\overline{cc}_i < \overline{cc}_k$.

Let us assume, in particular, a rise in the relative wage such that $2 < \omega < 3$. In this case, we would have that:

$$cc_k < 1 < cc_i < cc_j \tag{11}$$

We, therefore, see that, contrarily to what was expected, commodity $i$ was expelled from country A's productive structure *before* commodity $k$. This means that autarky comparative costs (VO) do not accurately predict how commodities are, in this case, expelled (recall that $\omega$ has risen) from the productive structure of country A. The reason for this "anomaly" can be more easily understood by inspecting Figure 3.

**Figure 3: vertical and horizontal orderings, reconsidered**
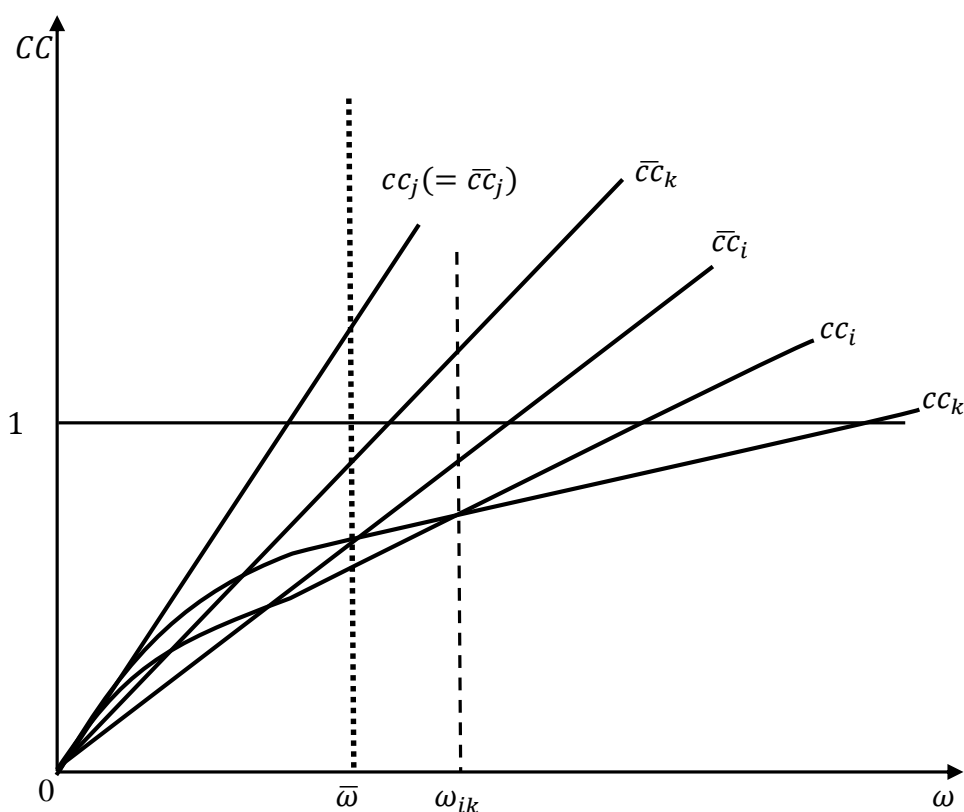


As the figure shows, the $cc_z$ curves are no longer straight lines that intersect only at the origin (as it was the case in our simple model of section 2, due to properties [a] and [b]). In particular, the $cc_z$ curves of commodities $i$ and $k$ — $cc_i$ and $cc_k$— have two features that must be stressed: they intersect ($i$) at a *positive level of the relative wage*, $\omega = \omega_{ik}$ and ($ii$) *below* the competitiveness threshold. Feature ($i$) shows that VO is no longer *independent* of the actual level of the relative wage in a given situation, and therefore, it *need not coincide* with

HO. While feature $(ii)$ implies that, if the autarky (initial) relative wage, $\bar{\omega}$ is *lower* than $\omega_{ik}$, VO and HO *necessarily differ*; therefore, that autarky comparative costs do not accurately predict the possible patterns of trade as the relative wage rate gradually changes.

Notice finally that this difference between the raking of autarky comparative costs (VO) and comparative advantages (HO) would still *not invalidate* the predictions of the pattern of trade by means of VO if, e.g., the intersection of the $cc_z$ curves would have happened *above* the competitiveness threshold. For, in this case, if $\bar{\omega}$ were again lower than $\omega_{ik}$, VO and HO would have still coincided. In fact, the abovementioned feature $(i)$ would still hold while feature $(ii)$ would not. Then, even though the curves would have intersected at a positive value of $\omega$, the ordering on the basis of autarky relative costs (VO) would still accurately predict comparative advantages (HO). (Symmetrically, both rankings would have also coincided had the intersection between the curves occurred below the threshold, and $\omega_{ik} < \bar{\omega}$). The following table resumes the possible cases for a pairwise comparison between any two industries $i$ and $k$.

**Table 3. Autarky relative wage and intersection relative wage**

|  | Intersection above threshold | Intersection below threshold |
|---|---|---|
| $\omega_{ik} > \bar{\omega}$ | $VO = HO$ | $VO \neq HO$ |
| $\omega_{ik} < \bar{\omega}$ | $VO \neq HO$ | $VO = HO$ |

In sum, the presence of capital goods implies that VO and HO do not always coincide, and therefore, CA *cannot* generally be predicted by autarky relative costs. Of course, it should be clear by now that with more than two sectors, there would be no level of $\bar{\omega}$ such that VO and HO coincide if one intersection of the respective $cc_z$ curves were *above* and the other *below* the competitiveness threshold.

## 5. NON-EXISTENCE OF A RANKING OF SECTORIAL COMPETITIVENESS

So far, we have concluded that the ordering of sectors on the basis of autarky comparative costs (VO), will not accurately predict, in general, CA, namely, how commodities will be incorporated into the productive structure of country A (HO). We have not shown yet, however, that *no such (horizontal) ordering exists,* in general.

In fact, it could be argued that, even though comparative costs change with the relative wage, it would be enough to determine, for each commodity $z$, the value $\omega_z$: the relative wage that renders industry $z$ equally profitable in both countries, $cc_z = 1$. On this basis, comparative advantages could still be identified: the commodity with the highest $\omega_z$ being the one with the greatest comparative advantage. In the previous example, industry $k$ is internationally competitive when $\omega = 3$, while those values are, respectively 2 and 1/3 for industries $i$ and $j$. This would suggest that country A has comparative advantages in $k$, then in $i$ and, finally, in commodity $j$.

By means of a relatively simple example, we will now show, however, that this criterion is not exempt from difficulties, either. There are three commodities, whose technical coefficients are indicated in Table 4 below.

**Table 4. Technical coefficients**

| $x$ | Country A | | | Country B | | |
|---|---|---|---|---|---|---|
| $z$ | $i$ | $j$ | $k$ | $i$ | $j$ | $k$ |
| $l_z^x$ | 1 | 2 | 1 | ½ | 1 | 2 |
| $a_{jz}^x$ | 1 | - | - | - | - | - |
| $a_{kz}^x$ | - | - | - | 3/2 | - | - |

The corresponding $cc_z$ curves are represented in Figure 4 below.

**Figure 4. Non-existence of a HO**
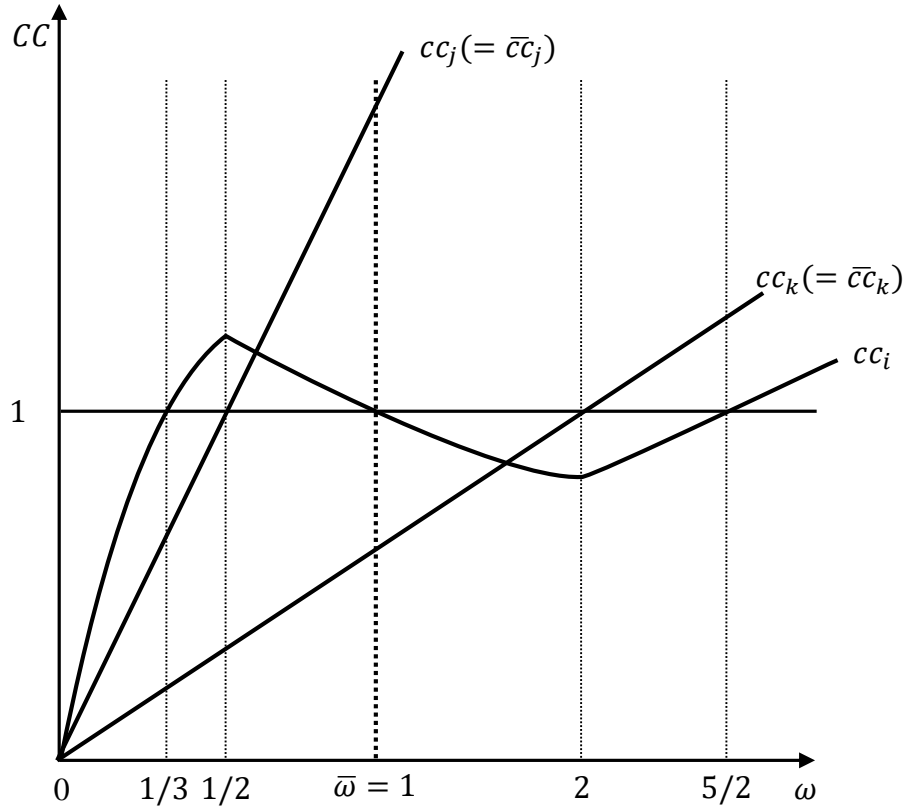


As can be seen, for $\omega$ sufficiently large, no commodity can be profitably produced in country A. Then, at $\omega = 5/2$, sector $i$ is incorporated into its productive structure and, for $\omega \leq 2$, country A starts producing commodity $k$ too. However, if the relative wage continues decreasing, when $\omega < 1$ (and until $\omega \leq 1/3$) sector $i$ is expelled from A's productive structure. Finally, when $\omega \leq 1/2$ sector $j$ is incorporated before sector $i$ can be profitably produced again, at the level $\omega \leq 1/3$.

In sum, although the corresponding levels of $\omega_z$ for industries $j$ and $k$ are well-determined (and respectively equal to $\omega_k = 2$ and $\omega_j = 1/2$), there are three values of the relative wage that satisfy the condition $cc_i = 1$. Those levels are: $\frac{5}{2}$, 1 and $\frac{1}{3}$. What we have found is that, contrarily to what we have tentatively speculated, there is no unambiguous way to ordering commodities according to their comparative advantages: *no Horizontal Ordering exists*. Commodity $i$ is the first one to be incorporated into the productive structure of country A, for levels of $\omega$ sufficiently close to $5/2$, while it is the last one for levels of $\omega$ that move

around $1/3$. Then, one should have to conclude that country $A$ *simultaneously* has the greatest and the lowest CA in the production of commodity $i$.

The reason behind this behaviour is that the comparative costs of commodity $i$ do not increase monotonously with $\omega$. For $1/2 < \omega < 2$, commodity $j$ (i.e. the capital good used in the production of commodity $i$ in country A) is produced in country B; conversely, commodity $k$ (i.e. the capital good required in the production of commodity $i$ in country B) is produced in country A. That is, had any of the two countries produced any of the consumption goods, it would have been more convenient to import the capital good from the other country. Within this range of the relative wage, commodity $i$ is in country A "intensive in labour of country B", while in country B it is "intensive in labour of country A". Therefore, contrarily to what one might have expected, an increase in $\omega$ increases relatively more the costs of production of commodity $i$ in country B than in country A. This explains the decreasing section of curve $cc_i$.


## 6. CONCLUSIONS

In the present paper we have critically examined two closely connected aspects of CA: first, the empirical (and more policy-oriented) question of how comparative advantages can be identified in the real world by observable magnitudes, i.e. comparative costs; and, second, the notion of comparative advantages themselves.

Regarding what we may call the "identification problem" of CA, we have argued that comparative autarky costs (the "Vertical Ordering", VO) may fail to predict the productive structure of the economy under conditions of trade. However, it could be argued that, as a *purely* empirical problem, this issue does not, by itself, invalidate the logic behind CA. In other words, it does not exclude the possibility that a "Horizontal Ordering" (HO) exists. Had our criticism being entirely restricted to address this first issue, two implications would follow. First, one could not escape the conclusion that, whatever the level of income distribution, the actual pattern of specialization could not but to conform to the pattern predicted by CA. But no only. More importantly, even if the policy-maker were not able to observe, so to speak, the sectors in which the economy had CA, she would still be certain that a decrease in the home wage relative to foreign countries (either through the action of

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market forces or due to deliberate economic policy) would undoubtedly *improve sectorial competitiveness* and therefore allow the *diversification* of the productive structure in an already *predetermined* way. She would not, in other words, hesitate in recommending a decrease in the domestic wage to boost exports, improve the trade balance and, most likely, the level of employment.

This seems, in effect, to be the current dominant vision among trade theorists. Already in the 1980s some of them have shown that autarky relative costs cannot work as a predictor of CA, since they cannot predict the pattern of trade across countries; yet, without the continuing belief in CA, the attempt to solve the problem by means of the construction of alternative rankings that are expected to work only "on average", that is, expressed as the simple negative *correlation* between relative autarky costs and net exports of a country (Deardorff; 1980; Dixit and Norman, 1980), would be hard to explain.

This same faith in the existence of a HO is what allows us to understand why some non-orthodox economists rely on CA to recommend wage devaluations to diversify the productive structure and induce structural change (e.g. Razmi, 2012). Finally, and more generally, this faith is what seems to explain why CA is the cornerstone on which the dominant theory of international trade is still currently taught. This has been accurately summarized by Krugman (1993), when he declared that CA encompasses *all* an undergraduate student should know about international trade, arguing that the rest is just "pop internationalism"[10].

The above suggests that, had our aim limited to address the "identification" problem, the scope of our criticism would have not been very relevant, and certainly not new. But we have shown more than that. In fact, the most important result of the article is that the notion itself of CA is a *chimera*. It is either a tautology –i.e. a country is said to have a comparative advantage whatever the sectors become competitive ex-post–, or, simply, impossible to properly (ex-ante) define. In other words, we have shown that HO *does not exist*, in general. Indeed, the moment capital goods are admitted in production –even if the rate of profits is zero-, the same sector could be competitive for low and high values of the real wage, but not

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[10] Even among the critics on standard theory of international trade, there seems to be some oscillation with respect to CA. For instance, Parrinello (2010) has suggested that, in general, CA cannot be determined by autarky relative labour coefficients alone. But he did not reach the more general conclusion that no possible ranking of commodities generally exists.

for levels in between. Therefore, even disregarding, for the sake of argument, Keynesian-type of results that link the effects of higher wages with higher domestic productivity -e.g. through multiplier-accelerator effects of higher wages on output and hence on the average level of productivity, if increasing returns prevail-, our analysis has shown that, when there are imported capital goods, it is a rise in relative wages rather than a decrease, what may allow gaining domestic competitiveness in some sectors of the economy.

Now, that in the actual conditions, capital goods are a very relevant part of international trade, is a fact on which there seems to be an agreement in the literature (according to UNCTAD, trade of capital goods represents more than 60% of international trade across countries, and the percentage is rising). Therefore, we face the following dilemma: on the one hand, trade of produced means of production can no longer be ignored by a plausible theory of international trade; on the other hand, we have just seen that their inclusion substantially modifies standard results, even when the profit rate is zero.

We may, therefore, conclude with the following two remarks: first, our analysis provides one more piece of evidence that the attempt, born with the supply-and-demand approach to value and distribution, to treat capital as a factor of production analogous to labour and land, is doomed to fail. However, our contribution does not strictly concern the irresoluble problems that the marginalist theory faces with the treatment of capital, in this case in an open-economy framework. As we have mentioned in the introduction, this work has been already satisfactorily done by other scholars. What we have done here is something more: for we have gone to what seems to be the root of the problem, by pointing out the impossibility to build any (meaningful) ranking of sectoral competitiveness, on which the pattern of trade could be a priori determined, independently of the underlying theory of prices and distribution adopted in the analysis. Therefore, the implications of all this go beyond the marginalist approach to international trade.

The second, more positive, remark, is the following: if not by CA, how is the pattern of trade determined? Should we start from scratch? The answer is a definite "no". Since the revival of the surplus approach in the 1960's, a growing literature has been insisting that the pattern of trade can be determined by the same data that determines relative prices and income distribution within a close economy: the available technology, effectual demands and

exogenously –non market- determined level of income distribution. Our final suggestion is therefore to start paying more serious attention to all these contributions.

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