

Production of commodities

by means of labour –

A theory of international relations

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1. Introduction

Economics, as any other science, looks for truth. Unfortunately, its investigation – as in any other *social* science - faces a dilemma. What is certainly true is most of the time obvious, and what is not obvious is not true for certain. That is why a dose of common sense is still used in practicing economics. At least in practicing real life economics.

Samuelson (1994) brings the principle of comparative advantages as an example to argue that it is not all like this. The Ricardian principle – a theoretical landmark in the last two centuries – show precisely that in economics – as in physics - it is possible to assert something certainly true, that it is not obvious. It is not obvious that a country has always an advantage to trade, even when its sectoral productivities are all around better (or worse) of the trading partner(s).. But, despite being not obvious, the Ricardian principle appears to be an unquestionable truth.

Is it? In this paper I put under scrutiny precisely the principle of comparative advantages. I do this by relaxing many of the restrictions (i.e. assumptions) which are necessary to obtain the so called “gains from trade”, and by questioning the degree of the empirically

relevance of such assumption. Samuelson and many of his pupils may not totally agree, but the truth which sciences should look for is empirical, not less than logical.

If being critical is a desirable feature of science, being constructive is a pleasant one. There are no serious cases among the scientific community in which a theory has being thrown out without having already a replacement. Therefore this paper, rather than focuses on pure criticisms of the Ricardian principle, proposes a *pars construens* in which the comparative advantage is analytically examined in a dynamic setting of a multisectoral economy.

The framework in building my theoretical argument will be that of a pure labour economy, in which labour is the only factor of production. This is just like Ricardo's example and more systematically Pasinetti's work in the field of international relations.

2. Theoretical background

Before moving to the essence of this paper, it is worth giving a brief review of the literature that relates with it. The activity of science is a collective enterprise. When a concept is placed at the centre of a scientific discipline is because that concept has received and is receiving the praise and the acceptance of the majority of scientists. The principle of comparative advantages fills perfectly this mounting pattern of success.¹ But any powerful concept needs also to resist and confront with criticisms. Again, the case of comparative advantages is not an exception. The background theoretical framework of this paper should be found in this latter literature.

Pasinetti has dealt with this principle in his two key books on structural change (Pasinetti 1981 and 1993). The analysis he carried out is not (mathematically) formalized, but the conclusions that he reaches are logically constructed and may be summarized as follows.

a) First, the primary benefits of international trade are not based on the gains from trade, but on the international learning. It is the opportunity that the backwards countries have to learn (in terms of technology and economic organization) from the leaders that constitutes

¹ The principle of comparative advantage is at the foundation of the Classical theory (Ricardo 1817 and Mill 1848) as well as the Neoclassical theory of international trade, usually labelled with the acronym H-O-S (Hecksher 1919, Ohlin 1933 and Samuelson 1948). Also the "new" trade theory, à la Krugman (1979, 1991), does move from the same premises, though it adds a dynamic flavour with the concept of "increasing returns".

the real gains from trade. In fact the backwards countries have a more expeditious way of acquiring new knowledge: that of obtaining it from the stock of knowledge already in use in the more advanced countries. Everything equal, it is less costly to learn technological knowledge than to create it.

b) Second, the emphasis on international learning makes the situation – Pasinetti argues - asymmetric between nations with a different stage of development. The asymmetry consists on the fact that the less developed countries may see to the international relations with interest, while there is less interest (or no interest at all) for the advance countries in looking at the primary benefits for trade.

c) Third, gains from comparative advantages in this context do not play a pivotal role. Obviously they are a source of growth, but this growth is only seen as the secondary benefits from trade. The reason is that the gains from trade generated by comparative advantages are gains obtained "once for all" -- something that happens when the country opens up its frontiers, but that do not persist afterwards.

d) Fourth, contrary to the traditional set of hypothesis which assume that only goods in the commodity market may be subject to international movement, the Pasinettian formulation of international relations highlights the high incentives for people to move cross borders, namely from poor to rich countries, and how these incentives may be of one sign (a positive sign) for the individual stand point and of opposite sign (a negative sign) for the country that sees its labour force emigrate.

e) Fifth, the conclusion is that international relations should focus on the transmission, diffusion and acquisition of knowledge. In this way those nations that remained behind have the chance to speed up their processes of learning. This is the way that may allow them to grow and catch up.

A group of economists, mainly of Brazilian origin, and collected under the direction of Joaˆo Teixeira have taken on and develop the Pasinettian approach in two directions.

First they formalized the above main propositions in a mathematical form. The crucial reference in this respect is Araujo and Teixeira (2003 and 2004a), where the basic equations of the price and quantity system in an open economy are re-formulated.

Second, they have inquired the implications of the Pasinettian approach from a South (rather than a North) point of view. As we have seen, the asymmetry between develop and underdeveloped countries in the field of international learning offers a powerful and an expeditious way for the backward countries to organize a process of catching up with the economic leaders (See Araujo and Teixeira 2004b).

There are moreover at least other two approaches of international relations that out of mainstream have some points of contact with the present analysis. I refer to the "neo-technological approach" of Freeman (1982, 1997), Dosi, Pavitt, and Soete (1990). The point of contact between their approach and the present paper is on the emphasis put on technology in delivering and promoting international competitiveness. To achieve the latter, they argue, a country should be confronted with absolute advantages, and not just with comparative advantages. The analysis does not offer a formal model, but it offers an appreciative theorising enriched with an abundant host of empirical analysis.

For the emphasis deserved to the role of international demand, this work share many views also with the Kaldorian approach that has been renamed after the works of MacCombie and Thirlwall (1994) on "the balance of payment constraints". Exports are seen as a relatively independent component of demand that can stimulate the supply side and promote growth. This role of demand is discussed in the following model, although we are not entering to the problems that an excess of exports over import may cause to the balance of payments.

3. The model

3.1. Assumptions

The model presented here is that of an open pure labour economy subject to structural change. It is a pure labour economy, in the sense that only labour is used in production without any presence of intermediate goods. This simplification may sound unusually unrealistic, because the modern economies (both developed and underdeveloped) do use many other factors of production, not just labour. In fact it is an abstraction of reality, which aims however to highlight some of the crucial aspects of it. One may figure out at least three reasons that induces to keep the abstraction as such.

The first is logical consistency. Working with an economy of pure labour, allows, analytically to avoid all the complications of capital theory, while maintaining intact internal consistency. And this is a feature that certainly matters in determining the degree of survival of theory in the present modern trade literature.

The second reason is essentiality. Occam's razor suggests to accept the simplest theory that works, without unnecessary complications. Focusing on the labour alone allows us to concentrate on the key factor of an economy which is behind (directly or indirectly) all productive processes and productive changes. The loss of generality is limited, since theoretically it is always possible to consider in a pure labour economy the role of capital

and other intermediate factors of production. As long as a factor of production is itself produced (like capital equipment) it can be reduced to dated labour.

The third reason is relevance. Not only labour is the only factor that *directly* and *indirectly* affects all productive activities. It is in the current industrial evolution also much more relevant than it is used to be. Therefore the *direct* error that arises from excluding other factors is smaller than it would otherwise be.

From these premises it should be clear, therefore, that the pure labour economies we shall consider are not those of a "primitive state of society" to use Adam Smith's (1776) words. They are rather economic systems with two crucial features of modernity. Namely:

- a) division of labour which is here captured by many and differentiated industrial sectors;
- b) an uneven process of learning across sectors, that affects both the demand side (per capita consumption will change over time) and the supply side (a process of differentiated technical change is undergoing).

These two features give to the economic system the typical flavour of structural change. The unbalanced growing process occurs in a differentiate number of sectors, which are changing over time at their own pace in terms of demand, production, prices, employment. Even the number of sectors themselves are subject to change. To keep the analysis manageable (yet, hopefully, still interesting) we shall suppose that there are just two countries (one may say a developed and a less developed country or region) and that in each of them will be no change of population.

In short we may identify the model here outlined as $2 \times n(t) \times 1$ model, i.e. two countries, n goods (changeable over time), one factor of production. As we have already noticed, to the extent that the factors of production are themselves produced (like capital equipment) there would be no theoretical impossibilities to extend the model to $j(t) \times n(t) \times m(t)$. In any case, the bulk of the arguments can be carried out substantially intact also in our simplified framework.

The table below, succinctly, gives the list of symbols employed in the foregoing analysis.

Table 1 Legend of symbols

Symbol	Definition
BASIC VARIABLES	
t	time
m	number of sectors and number of goods

k	number of sectors and goods with comparative advantages.
n	number of sectors and number of goods of country B
$l_i(t), l_{\#}(t)$	Labour coefficient of sector i , and average labour coefficient of the economy.
$L_i(t), L_{Tot}(t)$	Labour employed in sector i , and Total Labour employed.
$p_i(t), p_{\#}(t)$	Labour productivity of sector i , and average labour productivity of the economy.
$c_i(t)$	Per capita consumption of good i .
$C_i(t)$	Total consumption of good i .
$Q_i(t)$	Production of sector i .
$N(t)$	Population.
$p_i(t), p_{\#}(t)$	Price of good i , and average level of price of the economy.
$w(t)$	Uniform unit wage.
$I_i(t)$	Share of labour employed in sector i .
$x_i(t)$	Ratio between population of country A over B
$e_i(t)$	Rate of exchange (quantity of foreign currency necessary to buy a unit of domestic currency)
COEFFICIENTS of VARIATION	
$r_i, r_{\#}(t)$	Rate of growth of labour productivity in sector i and on average of the economy .
r_i	Rate of change of per capita consumption of good i .
s_w	Rate of change of the wage rate.
e_i	Rate of change of employment in sector i .
$u(t)$	Unemployment rate.
g	Rate of change of population.
g, g_{pc}	Rate of change of total and per capita income.
$i(t)$	Inflation rate.
SUPERSCRIPT	
No apex	Variables and coefficients of country A.
*	Variables and coefficients of country B.
BT	Variables and coefficients of country A before trade (BT) when they are compared to situations after trade.

3.2. Before trade

To begin with, let us examine the economy before trade. This allows us to clarify the mechanics of the model in a close economy², but it gives us also the necessary elements to study the possible evolution that economy would face *without* trade. In this way a comparison *before* and *after* trade will be later possible. The situation at time, t , in terms of production, demand, prices, and employment is the following.

The sectoral demand of the quantity system is given by:

$$C_i(t) = c_i(0) \cdot e^{r_i t} \cdot N(0) \cdot e^{g t} = c_i(0) \cdot N(0) \cdot e^{(r_i + g)t} \quad 1$$

While the sectoral production from the supply side is expressed by:

$$Q_i(t) = \frac{L_i(t)}{l_i(t)} = p_i L_i(t) = p_i(0) L_i(0) e^{(e_i + r_i)t} \quad 2$$

According to the Keynesian principle of effective demand (Keynes 1936), the quantity of consumption goods determines the level of sectoral production:

$$Q_i(t) = \bar{C}_i(t) \quad 3$$

The level of production is subject to the constraint of full employment. However this is just a ceiling constraint. Unemployment it is always a possibility in our system.

$$\sum_{i=1}^m c_i(t) l_i(t) = c_i(0) l_i(0) e^{(c_i - r_i)t} \leq 1 \quad 4$$

Other two crucial variables of a dynamic multisectoral economy, are the sectoral prices and the level of wages. The price system can be written in terms of cost of production:

$$p_i(t) = l_i(t) w(t) = l_i(0) w(0) e^{(s_w - r_i)t} \quad 5$$

while unit wages, which are also expressed in the domestic monetary unit:

$$w(t) = w(0) \cdot e^{s_w t} \quad 6$$

² The core of the model here expressed from equation 1 to equation 6 is presented in greater detailed and breath of explanations in Pasinetti 1993. See also Pasinetti 1981.

The unit wage is uniform across sectors and it is fixed at time zero and left to move according to institutional factors (firms representatives and trade unions arrangements). By fixing exogenously the level and dynamic of wages the price system is fully determined.

Turning our attention again to the quantity system, we are able, from the above equations 1-3, to derive the level of sectoral employment, and total employment which are respectively:

$$L_i = c_i(t)l_i(t)N(t) = c_i(0)l_i(0)N(0)e^{(r_i+g-r_i)t} \quad 7$$

$$L_T = N(t)\sum_{i=1}^m c_i(t)l_i(t) = N(0)\sum_{i=1}^m c_i(0)l_i(0)e^{(r_i+g-r_i)t} \quad 8$$

Other important macroeconomic variables that can be derived from the above quantity system are the level of average (labour) productivity, the average level of prices, and their respective rates of change. Therefore, the average labour productivity will be a weighted average of the sectoral productivities, where the weight can be expressed both in terms of sectoral labour shares or in terms of sectoral income shares (they in fact coincide):

$$p_{\#}(t) = \frac{\sum_{i=1}^m \left[c_i(t)l_i(t) \cdot \frac{1}{l_i(t)} \right]}{\sum_{i=1}^m c_i(t)l_i(t)} = \frac{\sum_{i=1}^m c_i(t)}{\sum_{i=1}^m c_i(t)l_i(t)} \quad 9$$

The rate of change of the average labour productivity, will result also as a weighted average of the sectoral rate of change of productivities:

$$r_{\#}(t) = \frac{\sum_{i=1}^m [c_i(t)l_i(t) \cdot r_i(t)]}{\sum_{i=1}^m c_i(t)l_i(t)} \quad 10$$

The average level of prices follows, *mutatis mutandis*, the same criteria of calculation:

$$p_{\#}(t) = \frac{\sum_{i=1}^m [c_i(t)l_i(t)p_i(t)]}{\sum_{i=1}^m c_i(t)l_i(t)} = \frac{w(t)\sum_{i=1}^m c_i(t)l_i^2(t)}{\sum_{i=1}^m c_i(t)l_i(t)} = w(t)l_{\#}(t) = \frac{w(t)}{p_{\#}(t)} \quad 11$$

Though it will not be examined in detail here, there is the possibility of having not only a demand below the full employment threshold, but also a potential demand above that threshold: that is, a demand that is higher than the maximum level of production at full

capacity. In this latter case, prices will be affected. They will not be expressed only in terms of the sectoral cost of production. They will contain also an additional component of scarcity. The average level of prices in this special case will be:

$$p_{\#}(t) = w(t) \sum_{i=1}^m c_i(t) l_i^2(t) \frac{\sum_{i=1}^m c_i(t) l_i(t)}{\sum_{i=1}^m c_i(t) l_i(t)} = w(t) l_{\#}(t) \sum_{i=1}^m c_i(t) l_i(t) = \frac{w(t)}{p_{\#}(t)} \sum_{i=1}^m c_i(t) l_i(t) \quad 12$$

In general the level of inflation in the economy is determined by the dynamics of wages and average productivity:

$$\dot{\mathbf{i}}_{\#} = \mathbf{s}_w - \mathbf{r}_{\#} \quad 13$$

In the special case in which the potential aggregate demand is above the full capacity threshold, the level of inflation will be affected also by a third addendum that counts for the level of scarcity.

$$\dot{\mathbf{i}}_{\#} = \mathbf{s}_w - \mathbf{r}_{\#} + \left[\frac{\sum_{i=1}^m c_i(t) l_i(t)}{\sum_{i=1}^m c_i(t-1) l_i(t-1)} - 1 \right] \quad 14$$

It may be interesting to observe that individual prices move constantly, and are affected by two components. The first component is due to a monetary effect (see equation 13), the second component is due to the structural effect, which is of technological nature, and cannot be avoided:

$$\dot{\mathbf{i}}_i = \mathbf{s}_w - \mathbf{r}_i = (\mathbf{s}_w - \mathbf{r}_{\#}) + (\mathbf{r}_{\#} - \mathbf{r}_i) = \dot{\mathbf{i}}_{\#} \pm \Delta \mathbf{r}_i \quad 15$$

Crucially important is the determination of the level of per-capita income. In the case that we are examining with aggregate demand equal or below full employment conditions, the level of per capita income will be:

$$y_{\#}(t) = \sum_{i=1}^m c_i(t) p_i(t) = w(t) \sum_{i=1}^m c_i(t) l_i(t) = p_{\#}(t) \sum_{i=1}^m c_i(t) l_i(t) \quad 16$$

In the special case of potential demand above full capacity, per-capita income will be:

$$y_{\#}(t) = w(t) \sum_{i=1}^m c_i(t) l_i(t) = p_{\#}(t) \sum_{i=1}^m c_i(t) l_i(t) \quad 17$$

Total income will be therefore:

$$Y_{\#}(t) = y_{\#}(t)N(t) = w(t)N(t)\sum_{i=1}^m c_i(t)l_i(t) = \mathbf{p}_{\#}(t)p_{\#}(t)N(t)\sum_{i=1}^m c_i(t)l_i(t) \quad 18$$

Moreover, by knowing the rate of change of average productivity and the average rate of inflation we can calculate the rate of growth of per-capita income:

$$\mathbf{g}_{pc} = \mathbf{r}_{\#} + \mathbf{i}_{\#} \quad 19$$

and the rate of growth of total income.

$$\mathbf{g}_{Tot} = \mathbf{r}_{\#} + \mathbf{i}_{\#} + g \quad 20$$

Obviously speaking about performance we are interested in the level of (total and per-capita) income, and to its rate of change, expressed in real terms not in nominal ones. To clean up our variables from variations due only to nominal changes, we may impose two conditions that simplifies our analysis. Namely, \mathbf{f} at time zero *a)* we let the level of unit wages be equal to the average level of productivity, and *b)* we impose that the level of wages raises at the average rate of change of productivity, this will imply that nominal and real values of our (monetary) variables coincide.

Formally, we can write

$$\text{Imposed condition:} \quad w(0) = \mathbf{p}_{\#}(0) \quad 21a$$

$$\mathbf{s}_w = \mathbf{r}_{\#} \quad 21b$$

$$\text{Consequence of the condition:} \quad \mathbf{i}_{\#} = 0 \quad 22a$$

$$p_{\#}(t) = 1 \quad 22b$$

The consequence is quite interesting. If the level of wage and its dynamic path will follow equation 21a and b, not only all monetary variables at aggregate level, will be expressed in real terms, but also the average level of prices will become our numeraire. In other words, the monetary measure (called it Euro, for instance) with which all other prices are expressed, is expressed precisely by the average level of prices of the economic system.

3.3. Open to trade with another country

The country (let call it A) examined so far will now be open to trade with another country or group of countries (let call it B). The latter country or countries will be represented with

the same set of equations that we have developed for country A. There are two differences in this new set of equations: one difference is substantial, the other is just of notation.

1) The number of sectors of country B may not be necessary equal of country A. Therefore we made explicit that :

$$m(t) \geq n(t) \tag{23}$$

Where $n(t)$ is the number of sectors of country B. Usually, the most develop country, among the two, will have a number of sectors higher than the less developed country. The developed country may enjoy of some new sectors that are not present in the other country. The new sectors may be highly innovative, which require a more advanced level of science and technology. For the while however let us suppose that the number of sectors are in the two countries the same. In some comments we can remove explicitly this restriction.

Having highlighted the differences introduced, let us also mention that there is no constraint in the values that the exogenous variables of country B will assume as compared to country A. If we shall stick to the opening paragraph of this section, it may be realistic to assume that, technology, demand, income, will be higher in one country than in the other, but there is no imposed assumptions in this direction.

3.4. Fixing the rate of exchange in PPP

When two economies open up their frontiers to trade, there is the immediate need to fix the rate of exchange between the monetary units of the two countries. In our case the monetary units, the numeraire, are express by $p_{\#}$ for the economy A, and $p_{\#}^*$ for the economy B. The rate of exchange between the two monetary units will be express in terms of parity purchasing power (PPP).

A rate of exchange fixed in PPP is obtained in such a way that through arbitrage the monetary unit of country A (B) will be able to buy on average the same quantity of goods domestically as well as in the foreign country.

The level of the rate of exchange, in real terms, in these conditions is obtained as the ratios between the two average productivities. Namely :

$$e = \frac{p_{\#}}{p_{\#}^*} \tag{24a}$$

From condition 21a and b, and 22a and b, where wages are equated dynamically to average productivities, one can rewrite the formula of the rate of exchange in terms of ratios between wages, that is

$$e = \frac{w}{w^*} \quad 24b$$

When there is no inflation as we have supposed so far (or when the two countries face the same rate of inflation) equations 24a and b will give exactly to the same result. When there is a differential of inflation equation 24a gives the real rate of exchange, while equation 24b gives the nominal rate of exchange. For the time being, however, condition 21a-b is in place.

3.5. International Prices and comparative advantages

Knowing the rate of exchange allows to express the price of each good with a single currency, and hence to compare internationally the prices of goods. The equality between rate of exchange and ratios between average productivities in our model allows to measure the comparative advantages indifferently in terms of ratios between sectoral productivities and rate of exchange or even easier by simply comparing the international prices of goods. to make a close connection between international prices and relative productivities between the two countries: both ratios will indicate (but with opposite sign) where the comparative advantages lie.

Take, for instance, one sector whose production is present in both countries. If the ratio between the sectoral productivity of country A versus country B is higher than the rate of exchange, i.e. the ratio of the average productivities, than such a good will be produced in country A, otherwise it will be produced in country B.

With this logic it is possible to compare all sectors that are in activity in both countries before trade. Some of them will be above the level of the rate of exchange, e , i.e. the ratio of average productivities, others will be below the level of e . The former will be produced by country A, the latter will be produced by country B.

The same conclusion can be achieved by simply comparing in a single currency prices of the same good of the two countries. The cheaper price will capture the market and the specialization in producing that good will follow by the country which enjoys this cheaper price.

3.6. Existence and non existence of the comparative advantages

In textbook analysis, the comparative advantages, as against absolute advantages, show always a theoretical feature of symmetry. It always occur that one country enjoys comparative advantages in some goods, and another country enjoys comparative advantages in other goods. The specialization involves both countries accordingly. There cannot be a situation in which a country is relatively better in producing everything, and another country does not have advantage in producing anything at all.

Translating this feature in our model, it means that the rate of exchange, i.e. the ratio between average productivities falls always within the range of values made up by the ratio between sectoral productivities. It can be shown that this is certainly true only in the case in which the average productivity is calculated as a simple average. When the average productivity is calculated –as it should be, and as it is in our case – in terms of weighted average between productivities there is no assurance that the ratio between average productivities always seats within the ratios of sectoral productivities. This may still occur, but just as a possibility. It may happen also otherwise.

It is therefore advisable distinguish three cases:

1. Case of no trade
2. Case of trade with multilateral comparative advantages
3. Case of trade with unilateral comparative advantages.

3.6.1. Case of no trade: no comparative advantages for any country.

There is just one very artificial case in which despite being the economies open there is no incentives to trade. It is the case analyzed by Pasinetti (1981, 1993) in which there is the crucial hypotheses, which is made for analytical purposes, in which:

- a) Country A has ten times the average productivity of country B
- b) Country A has still ten times the sectoral productivity of country B in producing each individual good.

Being the ratio between all productivities (and in particular between the ratio of the average productivity of the two economies and the individual productivities of each sector) equal to ten times, the international prices will be exactly the same, and there no advantage to trade for any country.

Pasinetti (1981, 1993) utilizes this example to show that despite no being incentives to trade there are incentives (above all for the underdeveloped country –B in the above

example) to leave open from an economic point of view its frontiers towards the most developed economy. It may learn something from it.

3.6.2. Case of multilateral comparative advantages

The case of no comparative advantages analyzed in the previous sub-section (3.6.1) is only an artificial exercise –useful because it allows us to focus on other aspects of international relations, not just trade.

However, in practice it will be virtually impossible to have a perfectly identical level of relative prices between all goods produced abroad and those produced at home. If differences of relative prices exist, the law of comparative advantages suggest that the m sectors of the economy A, and the n sectors of economy B will be split in two. Those that will have a level of international price lower than the competition, which production will increase, by acquiring also the foreign demand; and those that will have an international price higher than the international competition, which will be no longer domestically produced because it will be imported from abroad.

3.6.3. Case of unilateral comparative advantages

Albeit being accepted without discussion, the previous case may not cover all cases, and hence it may result incomplete. It is indeed possible that an economy shows favourable comparative advantages in all sectors, such that the level of its international prices allows her to be superior of the foreign competition in all sectors.

The simpler case to examine is that of differences in demand between the two countries. If differences of demand exist, it is rather straightforward to show that the case of unilateral comparative advantages is indeed possible.

To show this occur, let us suppose that we are in the situation described by section 3.6.1. Yet as compared to that case let us also suppose to have for country A a demand all shifted towards the sector with lower productivity, and for country B a demand all shifted towards the sector with higher productivity. The result will be that the ratio between the two productivities will not be equal to ten. It will be lower than that. Hence country A has a comparative advantage in all sectors.

Moreover it can be shown that such a possibility is also possible when there is a equal structure of demand between the two countries. In this latter case what plays a crucial role is the different structure of technology that exist between country A and country B.

To sum up there are three possible cases when two countries open up their economies and the principle of comparative advantage is applied.

CASE 1: no comparative advantages, which is just a very hypothetical case

CASE 2: existence of comparative advantages for both country A and B that induces a process of sectoral specialization in both countries

CASE 3: existence of comparative advantages for just a country, that induces an economy to produce all the range of goods, and the other economy to produce nothing, making it not vital.

3.7. Consequences of the process of specialization to the level of quantities and prices.

3.7.1. Quantities and employment levels

Let us suppose that CASE 2 (shared comparative advantages) is what actually happens. Then, country A will specialize its economy in those sectors that show a relative level of sectoral productivities - compare to country B - above the rate of exchange, e . Country B will specialize otherwise to the rest of the economy.

The new level of quantities produced will be:

$$\begin{cases} Q_i = c_i N + c_i^* N^* \\ \vdots \\ Q_k = c_k N + c_k^* N^* \end{cases} \quad 25$$

With some further elaborations and by fixing the ratio between the population N of country A and population N^* of country B, in terms of

$$\mathbf{x}(t) = \frac{N(t)}{N^*(t)} \quad 26$$

we are able to write the level of the new effective demand:

$$\begin{cases} Q_i = \left(c_i + \frac{c_i^*}{\mathbf{x}} \right) N \\ \vdots \\ Q_k = \left(c_k + \frac{c_k^*}{\mathbf{x}} \right) N \end{cases} \quad 27$$

Accordingly, the level of employment at sectoral level will be:

$$\begin{cases} L_i = \left(c_i + \frac{c_i^*}{\mathbf{X}} \right) l_i N \\ \vdots \\ L_k = \left(c_k + \frac{c_k^*}{\mathbf{X}} \right) l_k N \end{cases} \quad 28$$

while the total employment will be equal to:

$$L_{Tot} = N \sum_{i=1}^k \left(c_i + \frac{c_i^*}{\mathbf{X}} \right) l_i \quad 29$$

By re-formulating the equation of employment before trade, so as to shift it in two parts – those sectors in which the country is going to specialize and those sectors which goods are now completely imported - it is possible to re-write equation 29

$$L_{Tot} = N \sum_{i=1}^k \left(c_i + \frac{c_i^*}{\mathbf{X}} \right) l_i \quad 29$$

in terms of the situation before trade. The following equation does precisely this:

$$\begin{aligned} L_{Tot} &= L_{Tot}^{BT} + N \sum_{i=1}^k \left(\frac{c_i^*}{\mathbf{X}} \right) l_i - N \sum_{i=k+1}^m c_i l_i \\ &= L_{Tot}^{BT} + N \left[\sum_{i=1}^k \left(\frac{c_i^*}{\mathbf{X}} \right) l_i - \sum_{i=k+1}^m c_i l_i \right] \end{aligned} \quad 30$$

Equation

$$\begin{aligned} L_{Tot} &= L_{Tot}^{BT} + N \sum_{i=1}^k \left(\frac{c_i^*}{\mathbf{X}} \right) l_i - N \sum_{i=k+1}^m c_i l_i \\ &= L_{Tot}^{BT} + N \left[\sum_{i=1}^k \left(\frac{c_i^*}{\mathbf{X}} \right) l_i - \sum_{i=k+1}^m c_i l_i \right] \end{aligned} \quad 30$$

gives the level of employment after trade, in terms of the situation before trade. The level of employment after trade is made up of three addenda.

- a) The level of employment before trade
- b) The gains of employment due to the exports
- c) The loss of employment due to imports

The consequence in terms of employment in opening an economy is dubious. Compared to the situation before trade, it can be better off as well as worst off. In an open economy to enjoy a situation of full employment this condition must be fulfilled:

$$\sum_{i=1}^k \left(c_i + \frac{c_i^*}{\mathbf{x}} \right) l_i = 1 \quad 31$$

If before trade a situation of full employment was already existent, it is necessary to not change this condition simply that:

$$\sum_{i=k+1}^m c_i l_i = \sum_{i=1}^k \frac{c_i^*}{\mathbf{x}} l_i \quad 32$$

In order to maintain full employment both conditions and should be kept as such not just for one year but for each year under examination. Therefore the two conditions could be expressed in dynamic terms, where the rate of changes r_i and r_i of the two countries play a crucial role in determining the final result.

3.7.2. Average Productivity after trade

Other variable that needs to be re-examined is the average productivity of the two countries. Since the average productivity in each country is obtained as a weighted average of the sectoral productivities, and since the opening of countries to trade drives their economies towards specialization, this will result in a change of the weighted average.

The average labour productivity after trade will be:

$$\mathbf{p}_{\#}(t) = \frac{\sum_{i=1}^k \left[\left(c_i(t) + \frac{c_i^*}{\mathbf{x}} \right) l_i(t) \cdot \frac{1}{l_i(t)} \right]}{\sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{x}} \right) l_i(t)} = \frac{\sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{x}} \right)}{\sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{x}} \right) l_i(t)} \quad 33$$

That can be expressed, more interestingly by connecting it with the level of average productivity before trade:

$$\mathbf{p}_{\#}(t) = \frac{\left(\mathbf{p}_{\#}^{BT} - \sum_{i=k+1}^m c_i(t) \right) \sum_{i=1}^m c_i(t) l_i(t) + \sum_{i=1}^k \frac{c_i^*}{\mathbf{x}}}{\sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{x}} \right) l_i(t)} \quad 34$$

As in the case of employment, the equation may show a negative as well as a positive term at the nominator. Therefore the level of average productivity after trade may result both higher or lower as compared to the case before trade.

It may be interesting to examine a simplified version of the above equation, under the condition of full employment both before and after trade. In such a case the normalization is not required, and equation will turn to be simply:

$$\mathbf{p}_{\#}(t) = \mathbf{p}_{\#}^{BT} - \sum_{i=k+1}^m c_i(t) + \sum_{i=1}^k \frac{c_i^*}{\mathbf{X}}(t) \quad 35$$

In the case of a level of unemployment before and after trade that remains unchanged, the result is quite similar:

$$\mathbf{p}_{\#}(t) = \mathbf{p}_{\#}^{BT} - \sum_{i=k+1}^m c_i(t) + \frac{\sum_{i=1}^k \frac{c_i^*}{\mathbf{X}}(t)}{1-u(t)} \quad 36$$

Where u , the rate of unemployment is in this case equal to:

$$u(t) = 1 - \sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{X}}(t) \right) l_i(t) = 1 - \sum_{i=1}^m c_i(t) l_i(t) \quad 37$$

In both case 35 and 36, we cannot say in general if the average productivity of labour is moved upwards or downwards. This may indeed be surprising, because the specialization pattern followed by the country has been made according with the comparative advantages, and therefore one would expect of gains of productivity.

Dynamically, the rate of change of average productivity will be:

$$\mathbf{r}_{\#}(t) = \frac{\sum_{i=1}^k \left[\left(c_i(t) + \frac{c_i^*}{\mathbf{X}} \right) l_i(t) \cdot \mathbf{r}_i(t) \right]}{\sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{X}} \right) l_i(t)} \quad 38$$

As it was done before we could express the new rate of change of labour productivity in terms of the situation before trade:

$$\mathbf{r}_\#(t) = \frac{\left(\mathbf{r}_\#^{BT}(t) - \sum_{i=k+1}^m c_i(t) l_i(t) \mathbf{r}_i(t) \right) \sum_{i=k+1}^m c_i(t) l_i(t) + \sum_{i=1}^k \left[\frac{c_i^*}{\mathbf{X}} l_i(t) \cdot \mathbf{r}_i(t) \right]}{\sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{X}} \right) l_i(t)} \quad 39$$

In the simplified case of full employment both before and after trade we have:

$$\mathbf{r}_\#(t) = \mathbf{r}_\#^{BT}(t) - \sum_{i=k+1}^m c_i(t) l_i(t) \mathbf{r}_i(t) + \sum_{i=1}^k \frac{c_i^*}{\mathbf{X}} l_i(t) \cdot \mathbf{r}_i(t) \quad 40$$

3.7.3. Level of income after trade

The average productivity is not very sensitive to the level of unemployment, because it measures only the productivity of those workers that are actually employed, not those that are unemployed. This lack of sensitivity towards the level of unemployment is captured however when we turn to the analysis of per capita income.

The average level of per capita income will be:

$$y_\#(t) = \sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{X}} \right) p_i(t) = w(t) \sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{X}} \right) l_i(t) \quad 41$$

Equation 41 makes clear the direct loss that unemployment causes. Symmetrically of the case of no trade, to avoid inflationary effects the level of unit wage should be equal to the average productivity. After substitutions we end up with

$$w(t) = \mathbf{p}_\#(t) \quad 42$$

Therefore the level of real per capita income will be equal to:

$$y_\#(t) = \mathbf{p}_\#(t) \sum_{i=1}^k \left(c_i(t) + \frac{c_i^*}{\mathbf{X}} \right) l_i(t) \quad 43$$

In the simplified case of full employment, formula 43 suggests that also after trade exists a perfect coincidence between level of average productivity and level of per capita income.

As we did with productivity, we could also replicate the connection between the level of per capita income before and after trade:

$$y_\#(t) = y_\#^{BT} - \sum_{i=k+1}^m c_i(t) \sum_{i=1}^m c_i(t) l_i(t) + \sum_{i=1}^k \frac{c_i^*}{\mathbf{X}} l_i(t) \quad 44$$

In the simplified case of full employment the above equation turns out to be:

$$y_{\#}(t) = y_{\#}^{BT} - \sum_{i=k+1}^m c_i(t) + \sum_{i=1}^k \frac{c_i^*}{\mathbf{X}}(t) \quad 45$$

The rate of growth after trade can also be compared with the situation before trade. Namely, it will be

$$\mathbf{g}_{pc} = \mathbf{r}_{\#} + \frac{\sum_{i=1}^k \frac{\partial}{\partial t} \left[\left(c_i(0) + \frac{c_i^*}{\mathbf{X}}(0) \right) l_i(0) e^{(r_i+r_i^*-r_i)t} \right]}{\sum_{i=1}^k \left(c_i(0) + \frac{c_i^*}{\mathbf{X}}(0) \right) l_i(0) \cdot e^{(r_i+r_i^*-r_i)t}} \quad 46$$

$$\mathbf{g}_{pc} = \mathbf{r}_{\#} + \frac{\sum_{i=1}^k (r_i+r_i^*-r_i) \left[\left(c_i(0) + \frac{c_i^*}{\mathbf{X}}(0) \right) l_i(0) e^{(r_i+r_i^*-r_i)t} \right]}{\sum_{i=1}^k \left(c_i(0) + \frac{c_i^*}{\mathbf{X}}(0) \right) l_i(0) \cdot e^{(r_i+r_i^*-r_i)t}}$$

The above equation is affected by two broad addenda. The first is the average rate of change of productivity in the sectors in which the economy is specialized. The second is due to the possible levels of unemployment which negatively affects the overall level of growth. In fact the second addendum is the rate of change of employment, that become negative when unemployment rises. Therefore, we can simplify the equation as:

$$\mathbf{g}_{pc} = \mathbf{r}_{\#} + \frac{1}{(1-u)} \frac{d}{dt} (1-u) \quad 47$$

$$\mathbf{g}_{pc} = \mathbf{r}_{\#} - \dot{u} \frac{u}{1-u}$$

This is a quite meaningful solution to the quest if, and to what extent, trade goes hand in hand with economic growth. Equation tells the answer, which is not necessary positive. It is dependent on the two broad factors. The first is the (average) dynamics of the sectors in which the economy is going to specialize after trade. The other factor is the rate to which the employment is going to grow or (to put it in another way) the weighted rate in which the unemployment is going to reduce.

A final step could be made by comparing the rate of growth before and after trade:

$$\mathbf{g}_{pc} = \mathbf{g}_{pc}^{BT} + \sum_{i=1}^k \frac{c_i^*}{\mathbf{X}}(t) l_i(t) r_i - \sum_{i=k+1}^m c_i(t) l_i(t) r_i - \left[\dot{u} \frac{u}{(1-u)} - \dot{u}^{BT} \frac{u^{BT}}{(1-u^{BT})} \right] \quad 48$$

The rate of growth of per capita income after trade can vary in both directions as compared to the situation in place before trade. It can increase if the compound effect of productivity growth and the employment gains in the export sector are superior to the compound effect of productivity growth and the loss of the level of employment in the sectors that have been abandoned. Moreover a further effect is played by the eventual rate of change of unemployment as compared to the situation that was in place in absence of international trade. As long as the rate of change of unemployment will be positive, the effect on the rate of growth of per-capita income will be negative.

To simplify equation , we could imagine a situation before trade and just after trade, in a situation of full employment. In that case we would have the following equation that describes the rate of per capita income, which also include addenda with positive as well as negative sign.

$$\mathbf{g}_{pc} = \mathbf{g}_{pc}^{BT} + \sum_{i=1}^k \frac{c_i^*}{\mathbf{x}}(t)l_i(t)\mathbf{r}_i - \sum_{i=k+1}^m c_i(t)l_i(t)\mathbf{r}_i - \dot{u} \quad 49$$

4. Discussion of the results

The connection between trade and growth in a pure labour economy subject to structural change and specialization is not a simple matter. The patterns of trade, in our model, are made according to the Ricardian comparative advantages, while per capita income and its growth are measured in real terms by per capita income. The following observations are derived from the analysis above.

1. When the rate of exchange between currencies reflects the actual (average) productive capacity of an economy, or to put it shortly, it is fixed in terms of PPP, it is possible to deal with comparative advantages in terms of international prices, that is by turning all prices of one country in that of another country, and then compare what is cheaper. If this is done the international market works efficiently in the sense that it reveals the comparative advantages, by simply looking at international prices.

2. However, when we allow for many sectors, different technology, different demand, there is no guarantee that the comparative advantages exists for both countries. There is the possibility, which is not just hypothetical, of *unilateral* comparative advantages, rather than *bilateral* (or with many countries *multilateral*) comparative advantages. The case of *unilateral* comparative advantage means that one country will possess an international advantage (in terms of costs) to sell – and to produce, before to sell – every possible good,

and the other country (or countries) will have on the international market no advantage at all.

3. If comparative advantages exist for all parties (in our case for both parties), a pattern of international specialization made according to this principle will produce some gains from trade. These gains to be positive need the support of strong hypotheses, the main of which is that each country that takes "advantage" of the Ricardian principle, and specializes accordingly, should not drop its level of employment. In an industrial world where the under-utilization of productive capacity is a constant issue, this assumption as much is crucial in the model, as it is absurd in reality.

4. Even if – a big "if" – the above assumption of full employment (or no drop of employment) is fulfilled, a system of international relations based on prices equal costs and exchange rate equal Purchasing power, as described above, does not guarantee that the *global* "gains from trade" are shared by all the parties involved. There is instead the constant possibility that some countries (or a country in our case) capture all the global "gains from trade" and even more than that, and the other countries do not have any positive gain, and possibly suffer negative "gains" from trade. In other words, it is not true that the international market allows positive gains from trade for all participants. International trade, for some of them, may systematically result in a "negative game".

5. The gains from trade are typical global gains "once for all", in the sense that they appear just in the switch from no-trade to trade situations. However the pattern of specialization involved according to the comparative advantage principle, do have long term consequences on the *dynamics* of each economy. There is no guarantee either that each country that opens to trade will enjoy an higher long run rate of growth than in a situation of no-trade. It is indeed possible that the opposite occurs, that is that the rate of growth of an open economy could suffer. It also emerges a clause of no correlation between the possible gains "once for all" and the possible "dynamic" gains from international trade specialization. All possible combinations are possible. A country may gain in the short run and pay a lower growth in the long run, it may not gain (and even lose) in the short run and gain a faster growth in the long run, it may have both in the short and in the long run a win-win situation, but it cannot exclude also a lose-lose situation as compared to the case of no-trade.

5. Limitations and possible extensions

In summing up the main results, or at least those that appear from my point of view more relevant, there is the impression that the message which emerges is not precisely in line

with the one proposed by mainstream economics. This may not surprise completely practical people, which deal daily with the problem of international competition, but it may appear striking enough for the theoreticians.

Did the model here proposed impose *ad hoc* assumptions such as to drive specifically these results? Or to put it in another way, what are the limitations of the model? The abstraction of a "pure labour economy" has been already made clear in the title and discussed at the beginning, so here I shall focus on other possible limitations.

First, the model does not touch the chapter of international finance. It simply focuses on the real aspects of the economies. It discusses (briefly) prices but mainly with the purpose of finding (or avoiding) inflationary or deflationary effects in a world where the price of each good changes overtime and there is no way to keep individual prices constant. Leaving aside finance means that some of our variables that in reality are affected by it (think at the exchange rate), in our model do not. And this does not count as a plus for the model.

Second, if the intermediate goods do not present an insurmountable problem for this model, natural resources and more in general non reproducible goods do present a problem. The latter follow a theory of scarcity, and not a theory of labour value – their price is proportional not with the "effort" spent in producing them, but with the degree of "rarete", to use Walras expression, with which they appear in the market. Since a share of international exchange is made by these commodities, it would be advisable to include them in the picture when discussing of economic international relations. But they did not in the present model.

Third, the model has assumed many sectors, but within each sector it has assumed a unique way of producing it. If this may be acceptable as a first approximation, it is less acceptable, when the real life shows sectors with thousand or at least hundreds of industrial units, each of which with its own "production function". What this variety of industrial units will allow to explain is the intra-industrial trade, and not just as we did the inter-industrial trade, with full specialization.

Forth, Having focused almost exclusively on the real aspects of the matter, the model also leaves out any discussion of practices of "strategic" trade, in which countries tweak the price of goods, or the exchange rate in the view of gaining share market. Some of these practices are very interesting to discuss, because highlights the problems of "free riding" but also the problems of different internal (and legitimate) institutional arrangements, with drive very important international consequences.

Fifth, the model does not discuss what happens either in those markets that are not the commodity market. For instance the labour market, and the issue of possible migration from one economy to another has not been dealt with. The knowledge “market” and the problem of international learning has been only touched briefly. Yet these are issues that in a globalized world appear of big interest, because what moves from one country to another are not only goods, but also people and ideas.

And finally we do not pay much attention to the institutional problem that the economic international relations arise. In our discussion we have pointed out how troublesome can be the gains for trade, but we did not turn our analyses in discussing if – and what – international institutions would be able to make all trading participants happy, and not just a few of them.

As much these limitations need to keep in mind when discussing the results, as they appear interesting topics when looking at the possibility of extending the model. With the possible exclusion of the first limitation, which earthquakes the foundation of the production paradigm that our model implies, all other limitations are indeed integrable in the theory here proposed. Some job in this direction is already begun, and for what can be argued any of the extension – with the exception possibly of finance – seem to displace the bulk of the results we have to offer.

6. Conclusions

This paper presented a model on economic international relations. Focus has been given to the issue of short and long term effects on economic growth. A multisectoral, pure labour economy has been examined *before* and *after* trade and the consequences of international specialization discussed. Under scrutiny was the principle of comparative advantages – still the main theoretical driving force in international economics.

Ricardo (1817) formulated this principle, just when the British crown was starting to establish its commercial and military power at global level. Yet the principle passed through with an anti-mercantilist attitude (as it was) and with a message of hope. No matter how bad or poor countries were, international trade could do something good for each of them, because trade is a positive-sum game. If the principle of comparative advantages is not violated, and few other conditions are fulfilled, there are gains from trade which lead to an increase in welfare for all parties involved – a typical case of what economists call (sometimes reluctantly) a free lunch.

What emerges from our analysis is that the “free lunch” may not be for all, and it does not certainly last for ever – at least when one considers strictly the gains from trading

commodities. There is in the principle of comparative advantages, as we have examined it, a sort of "Trilussa's paradox". On average it may be that international trade offers an additional chicken (to be fare, the free lunch in terms of commodities' gain is not so abundant), but this is just an average of different potential situations. It may be that some trading countries count a surplus of two chickens, others count almost nothing, and still some other countries lose the chicken(s) they were previously hatching.

When the unit of analysis is the individual economy, trade may promote as well as may endanger growth. This is not a call for protectionism, but it is not a call for an unquestionable liberalization either. It seems to create room for a political economy at international level. Practical people probably know the problems discussed in this paper much better of what theoretical economist are used to.

When, some forty years ago, Max Corden (1965) surveyed the field of international trade, he already perceived an unsatisfactory atmosphere surrounding the discipline:

'It must be confessed, in conclusion, that the pure theory of international trade has suffered from bad public relations. Some of its main conclusions are often misunderstood, and, even when understood, very often disagreed with. There are two reasons for this. Firstly, the models of the pure theory usually make a large number of assumptions, some of which when stated explicitly sound so unrealistic as to discredit the whole model from the start, while others tend to be forgotten.(...) The second reason for the poor image in some countries of trade theory is the commitment to free-trade liberalism of many of the leading theorists.'

Since then, some important progress has been made, and a new folk of models took the fashionable name of "new trade theory". However these "new" models largely belong to the same basic paradigm with which Corden (1965) confronted to. What we have attempted here is to tackle the problem of international relations from a different paradigm: the one that belongs to Classical-Keynesian economics, where production - not exchange - is central, and where the demand side - not the supply side - sets the level of activity of each economic system.

7. References

(to be revised)

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