Inequality in global production and trade: a proposal for measurement
(draft)

by
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Abstract
Inequality is traditionally considered as a problem concerning the distribution of disposable income. Production and trade, in contrast, are deemed to be distributionally neutral. With the new World Input Output Database, at hand, it is now possible to challenge such division of topics. The paper shows how, by joining purchasing power parities to WIOD, one can define and substantiate a measure of inequality in international trade. The measure is then used to review two old theories about inequality in world trade, in the first part of the paper, and in its second part an experimental compilation of trade between eight major countries demonstrates how the size of real value added, in each country, is affected by inequality in the terms at which its products are exchanged, with other countries.

1. Introduction

The topic of unequal exchange in international trade does not belong to the core of economics teaching, today. The science of economics is built on the assumption that trade is always equal, otherwise it would not take place. But there has been a time when inequality of exchange was at the political order of the day, namely when the former colonies of the European empires became aware of the fact that gaining independence from colonial rule did not open the road towards economic development and growth, by itself. This was in the 60' and 70' of the last century. The idea that inequality in international trade may be a constraint to self-sustained growth came up as an effort to understand the unexpected continuing of global economic asymmetry. It led to policies of import substitution and trade restrictions. When these policies failed, and were replaced by their opposite, namely, export promotion and globalisation of markets, the idea of inequality in exchange was dropped together with the old policy so that it is not under discussion, today.

I believe though that discarding the topic of inequality has been premature. The theories that have been developped in its support may have been wrong in their political application, but correct in themselves. For part of the problem has been of an empirical nature. It was not possible, at the time, to determine equality or unequality of a trade relationship on the basis of given data. There was no agreed statistical definition, and where a theoretical definition was proposed, data to fill it were absent. Meanwhile the situtation has changed. The newly developed, and generally accepted, technique of compiling purchasing power parities for most economies of the world in a coherent and standardised manner together with the creation of other global databases such as WIOD now allow to address the topic of unequal exchange in a statistically well defined and informed way. In this paper I want to show how two of the old theories about inequality in international trade may be submitted to statistical verification by way of applying the newly developed data bases.

In textbooks on international trade we find little reference to our problem. (Bhagwati 1998), for example, neither mentions the term nor addresses the issue of unequal trade , the basic proposition of the book confessedly being that „some trade is better than no trade", or, after some modification „free trade is better than no trade" (p. 268). The concern of the book is then to define and discuss „distortions" of free trade, brought about by government

intervention. An interesting point comes up when the possibility of „immiserising growth“ is being discussed, an idea thought about by Hicks, implying that a gain from economic growth may be offset by a loss in terms of trade. The observation is noteworthy because it relates international trade to domestic valuation of production and growth, but it does not lead to a definition of unequal trade. Mikic (1998) deals with terms of trade rather extensively, sparing a special page box for the issue of unequality. Referring to (Emmanuel 1972) he detects a „common fallacy about comparative advantage“. It is said that developing countries are being exploited since they give more units of labour embodied in their exports goods than they receive in return through their imports, but, he adds, unless the terms of trade coincide with autarcy prices of any one country, both countries will gain. In passing he gives a definition of „equal exchange“ which occurs if the double factorial terms of trade are equal to one between two countries. (Horvath 1999) devotes a whole chapter to „Unequal Exchange“ relating it to (Emmanuel 1972) again, whose compilation procedure he criticises, offering his own model in return. From it he derives the statement that „balanced trade in international prices means unequal exchange because international values contain less of foreign more productive labour and more of domestic less productive labour of less developed countries. It follows that equal exchange at international prices implies exploitation of underdeveloped countries. Nevertheless trade is still beneficial for underdeveloped countries (in the absence of monopolies) because imports make possible use of less costly commodities and so net output and consumption increase“ (p. 122). Negishi (2001) speaks about exploitation (ch. 7) as well as about immiserising growth (ch. 16). Being concerned with the developments of theory, which he presents in form of lectures, he finds no room for discussing a statistical definition of these concepts. Wood (1994) deals directly with North-South trade and inequality, but only with respect to employment effects, another possible, but altogether different meaning of inequality.

Among books specifically entitled „unequal trade“, (Pomfret 1988) has it mean „discrimination“. Observing the evolution of international trade in the second half of the 20th century, he finds it in contradiction to the principles laid down in the GATT. Equality then means the absence of preferential treatment of anyone trading partner, a typical problem of multinational trade, while international trade theory and the issue of equality show up in a bi-national framework, already. Lincoln (1990) studies „Japan’s Unequal Trade“, as the title says, implying that the bi-national trade imbalance expresses this unequality. In fact, Japan having been qualified as an „unfair trading nation“ under the US Trade Act of 1988, this unequality has reached the political arena. But Lincoln does not generalise and take up the question of whether any trade balance surplus is a sign of unfairness, in theory. (Nakajima and Izumi 1995) present a measurement of unequal trade between US, Japan, and South Korea. On the basis of national input-output tables they calculate the average labour content of each country’s exports to its partners, and the ratio of these labour inputs is taken as measure of inequality of exchange. Thus US exports to Japan contained 350 manhours/$1000 in 1960, and 64 in 1985. In contrast, Japanese exports to US contained 3030 manhours/$1000 in 1960, and 112 in 1985. The findings „confirm the existence of unequal exchange of labor among nations and show that such unequal exchange among nations decreases with economic development in the case of US, Japan and South Korea.“ (p. 92) Raffer (1987), Amin (1973) and Emmanuel (1972) are probably the most influental writers about unequal trade, but aiming at criticising standard theory, they offer little material for defining an empirical variable within the framework of national accounts. For this reason we do not enter into details here. More empirically oriented studies have been evoked by the Prebish-Singer hypothesis that developing countries are experiencing falling terms of trade. Somehow this hypothesis has lost publicity in the profession, rermaining at a stage of being neither corroborated nor falsified (Szirmai, A. 1997, pp 239ff, Koch 1997, pp. 16ff, 65ff). Being most

closely related to the data we analyse here we will return to it at a later stage. Finally, (Reich 2007) in a paper that earned the Sir Richard Stone prize of the Journal of Economic Systems Research has made a first step in an empirical direction showing how trade data together with data on purchasing power parities may be used to define and measureof inequality in international trade. The method developed there also serves us in here.

I shall review two theories of unequal trade both of which originated in the years around 1960, namely, the theory of falling terms of trade proposed by Raúl Prebish and Hans Singer, and the theory of wage differentials elaborated by Arghiri Emmanuel. If you read their papers you find they have each had a sharp eye for what is going on in the world economy, but their conceptual tools were inadequate to clearly define what they were trying to explain. Had they had at their disposal the accounting methodology that exists today their theories might have become more convincing and applicable to the actual economy. The new accounting methodology is complex and hardly manageable for an individual researcher. I will offer some experimental calculations as a prove that inequality of exchange in international trade can be measured, and thus become a reasonable topic in international economics.

If we want to be precise our problem is actually not one of international trade alone, but one of value theory, in general, because there is a paradox: Standard theory of economic value says that the value of a commodity is determined in one, and only one way, namely, by exchanging it against some other commodity. Inequality of value in exchange is thus logically impossible, because it is exchange itself that determines value. There is no value other than exchange value. This then cannot be unequal because in relation to what should it be unequal, other than itself?

On the other hand, there is, outside the science of economics, an every day experience of buying and selling valuable goods. And that experience includes the possibility of inequality. As not quite serious a demonstration let me quote an old fairy tale, known in Germany, I don't know whether it exists elswehere. It is called "Hans im Glück" (Hans in fortune?). Hans, after seven years of loyal service to his master, is delivered and sent home with a chunk of gold as reward. He shoulders it, but after marching for a while in the heat of the day he grows tired, and when a rider on his high horse passes by, easy going, he lets himself talk into exchanging the gold for the horse. Happy about that business he mounts the horse and rides off, but not having learned how to ride, he has difficulty commanding the horse, and when a farmer taking a cow to the market passes by he exchanges the horse for the cow, enjoying its milk. But he runs into trouble again in milking the cow, which makes him give away the cow for a goat, the goat for a chicken, and finally he looses even the chicken, and covers the last mile to his home empty-handed, and – that is the gist of the story, - happy.

The tale poses several questions to the trained economist. Does Hans act rationally? Does he maximise welfare, individual or social? Is he a good economist? A good business man? Is economic value an objective or a subjective concept? And finally are the trades equal? The topic of unequal exchange is about this Gordian knot, and while I do not attempt to cut, less to resolve it, I want to discuss it, applying a new statistical tool through which more light may be shed on it.

2. The Prebish-Singer hypothesis: Falling terms of trade

The earliest attempt to search for some hidden mechanism explaining a persistent cleavage in the world economic system stems from Raul Prebish and Hans Singer. Observing persistent stagnation in the development of Latin American economies they came to the hypothesis that

lacking development of these countries resulted from their occupying a position of disadvantage in world trade caused by the fact that their terms of trade are falling in the long run.
An economy's terms of trade determine what volume of imports a country receives in exchange for its exports. They are said to be "favourable" when that volume is high, and "unfavourable" when it is low. This language implies two propositions, firstly, terms of trade favouring one country in a trade relationship necessarily disfavour the other, by definition, and secondly, there must be a middle between the two where both countries are neither favoured nor disfavoured. Finding this middle comes close to looking for equality in trade. But this is not what Prebish and Singer have in mind. They are concerned with the idea that terms of trade are falling for developing countries whatever the initial stage may have been. In searching for a theoretical explanation of such movement Prebish and Singer find a combination of four economic mechanisms at work here:

(1) Price elasticities of demand are different for primary commodities and manufactured ones. They are low for the first, and high for the second. Developing countries exporting mainly primary commodities, and importing manufacturing, they find themselves in an asymmetric situation. When commodity prices fall, their export earnings will fall in proportion, with little countervailing effect on the quantity side, while import quantities will rise and their value with them, putting the balance of payments out of order. In addition, low elasticity of demand, especially when combined with low elasticity of supply means that there is great instability of primary commodity prices both upward and downward, impeding any smooth long term development.

(2) Elasticity of income is also low for primary commodities as compared to manufactures. As a result demand for the first is bound to expand less than demand for the second with overall economic growth. For agricultural products this is the working of Engel's law, while technical progress reduces the inputs of all primary goods into manufactured goods, in general. The tendency towards balance of trade deficits for developing countries arising from such divergent demand trends will enforce currency depreciations which will introduce a further circle of terms-of-trade deterioration.

(3) Technological superiority of the industrial countries means that their exports embody a sophisticated technology the control of which is located there and especially in their large multinational companies. This means that the prices of manufactured commodities embody, besides a rent element for innovation, a monopolistic profit element because of the size and power of these firms.

(4) The structure of both commodity markets and labour markets is different in industrial and developing countries. In the industrial countries labour is organised in trade unions and producers in producers' organisation, which dampen competition. This means that increased productivity is largely absorbed in higher factor incomes rather than lower prices for the consumers. In the developing countries, to the contrary, labour is unorganized while the rural surplus population and its partial transfer into urban unemployment create a situation in which increased productivity is likely to show in lower prices, benefiting the overseas consumer rather than the domestic producer.

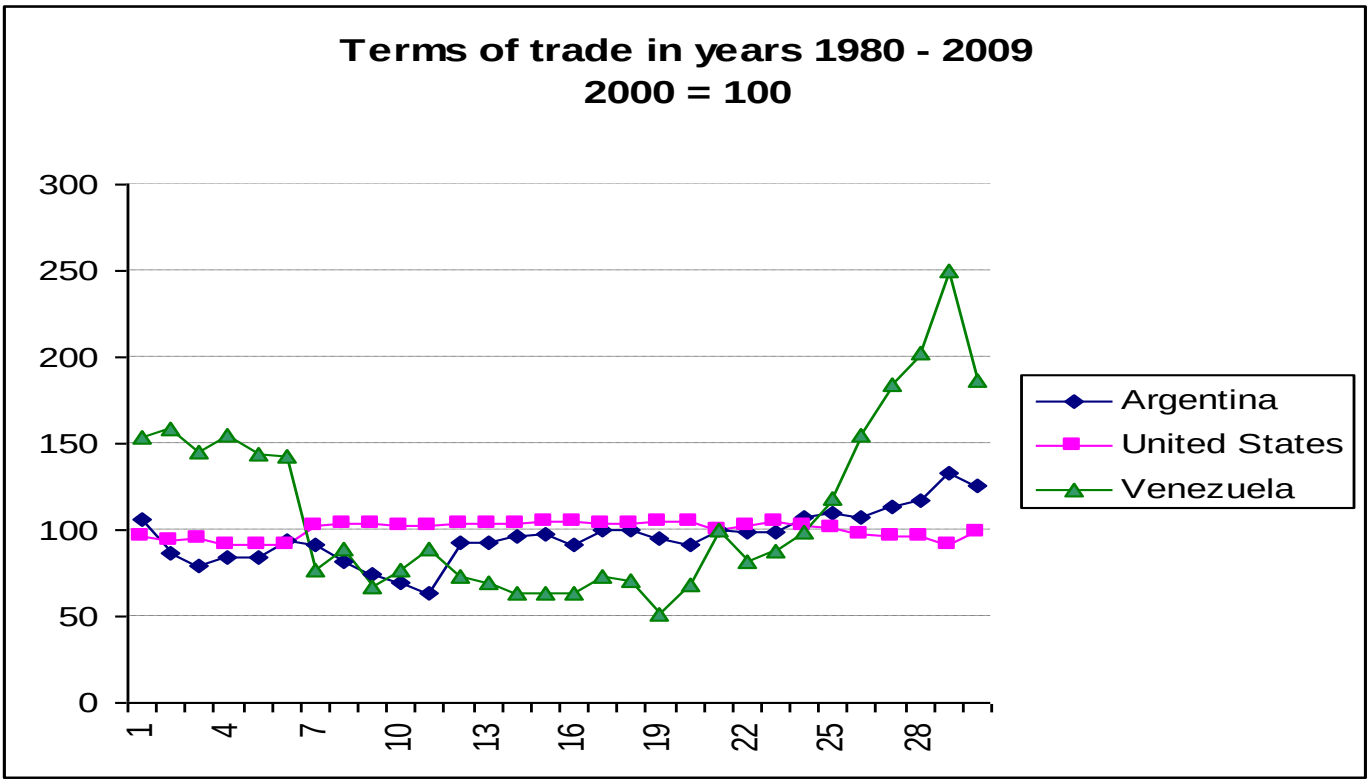
The theory of falling terms of trade was widely debated and exerted considerable political influence. Scientifically it remained somewhat in the open, mainly because the facts have not been clear. "The general consensus on the statistical debate that has arisen on this issue is that there has *not* been any discernable secular trend for the commodity terms of trade of the

developing countries to deteriorate, ” says The New Palgrave Dictionary of Economics (Findlay 1998, p.626). But you also read two pages later: “Declining terms of trade of developing countries or of primary products, in confirmation of the Prebish-Singer hypothesis, can of course be taken as established only if oil prices are excluded” written by Singer (1998, p. 627) himself.

The failure of the theory to win general acceptance may have to do with its internal structure. Focussing on the change of an economy over time rather than the state existing at a certain time, it suffers from the usual base year effect. If a time series is irregular you can always construct an upward movement starting from a low year, or a downward movement, from a high year. This happened, indeed, when more empirical data on terms of trade longer more time periods were collected. The downward movement assumed by Prebish and Singer lost its general evidence, apart from the fact that the mere classification of some 150 countries into two groups of industrial and developing countries induces its own heterogeneity of data.

Independent of any politics the scientific challenge raised by Prebish and Singer had one positive effect. International organisations have since made it a regular task of theirs to collect and publish data about terms of international trade for practically all countries of the world. Figure 1 shows data published by UNCTAD for three countries over the last three decades, asan example. In their variety and irregularity they do convey the message that a typical and persistent fall of terms of trade for a particular group of countries is hard to ascertain.

Figure 1



Another point is more important in our context. All three time series seem to meet at year 2000 (year 21 in the graph), giving the impression as if terms of trade were equal in this year, and Venezuela had favorable terms of trade, thereafter . The impression is wrong: normalize the series at year 1980 (year 1 in the graph), and you get a different picture. Venzuela’s terms of trade then run below the other countries, all the time, and the peak at the end appears much

lower, too. Base year dependency of terms of trade analysis is well known, but a remedy, - arriving at a valid international comparison of terms of trade ruling at a given year, not just their movement, - has not yet been found, or even searched for. It has now been made possible by involving purchasing power parities.

3. Essence of unequal trade: From nominal to real value added

The nternational terms of trade of a country are defined as follows:

(1) $$t.o.t = \frac{ep_x}{p_m},$$

where p_x denotes prices of exports, p_m prices of imports, and e is the exchange rate (units of foreign currency per unit of national currency). There are thus three independent variables figuring in the determination of terms of trade. Prebish and Singer consider only two, namely the national prices ruling in each country. But these prices are not directly comparable, each being expressed in their own currency. Comparability is achieved by means of exchange rate *e.* This rate is not determined by the same forces of production and consumption that determine prices of the real economy. Exchange rates between currencies, rather, are set on markets of the monetary economy, attending to financial needs and speculative advantage more than to product performance (less than 5 percent of the daily turnover of foreign exchange markets serve trade in goods and services). But it is obvious from equation 1 that supply and demand for a nation's currency bears directly on the value at which products are exchanged between nations, and this quite independently of productivity, or of consumption preferences, on either side.

When it is obvious that the exchange rate is a factor in terms of trade, ameliorating them when it rises and worsening them when it falls, there must be an exchange rate at which the currencies of both partners are equal. Let this rate be called the parity rate of exchange ε. We may then define equality in exchange by the condition that the market exchange rate e corresponds to the purchasing power parity rate ε, namely

(2) $$e = \varepsilon .$$

In words, international trade is on equal terms when its partners exchange at equal purchasing power of their currencies. This equality is not the case, in reality. It may not even be desirable under certain economic circumstances, but it may be defined and measured, this way. How then is such parity rate of currency exchange to be determined? An extremely simplified example may illustrate the method.

Take three countries 1, 2, 3, and assume there is only one industry producing and trading in only one product group (so-called inter-industry trade). The flows are measured in a common world currency unit, such as the Special Drawing Rights of the International Monetary Fund (SDR's), for example. Table 1 illustrates the resulting statistics. The rows show where the products are produced, the columns show where they are used. A value of x_{11} billion SDR's is produced and used in country 1, which also exports a value of x_{12} billion SDR's to country 2 and of x_{13} billion SDR's to country 3. GDP_1 of country 1 is then given by

(3) $$GDP_1 = x_{11} + x_{12} + x_{13} - x_{21} - x_{31},$$

and similarly for the other countries. GDP for the world as a whole is given by

(4) $$GDP = x_{11} + x_{22} + x_{33} ,$$

as the international trade flows cancel. In the last row of table 1 there is the trade balance, defined as balance between exports and imports of a country.

Table 1: Production of, and trade between, three countries

(billion SDR's)

	Used in			
Produced in	1	2	3	Total
Country 1	x_{11}	x_{12}	X_{13}	x_1
Country 2	x_{21}	x_{22}	X_{23}	x_2
Country 3	x_{31}	x_{32}	X_{33}	x_3
Trade balance	b_1	b_2	B_3	

The values x_{ij} are compared at current exchange rates between SDR's and national currencies, determined by the corresponding foreign exchange markets. They may correctly be called "nominal values". As exchange rate are determined by financial interests rather than by supply and demand of goods and services they do not provide an appropriate measurement unit for the latter. In the International Comparison Project (ICP) of Pennsylvania University and the United Nations, therefore, purchasing power parities are established which, simply speaking, operate in the following way: A specific, and typical, homogeneous good is chosen from all goods within the product group to represent the group. Its price is observed in every country, and compared to the price of some base country, chosen arbitrarily. It defines purchasing power parity for country 2 in the following way,

(5) $$ppp_2 = e_2\, p_2 / e_1\, p_1 ,$$

and similarly for ppp_3, implying that the products of all countries are valued at the price of country 1. These purchasing power parities are then applied to the nominal values of countries 2 and 3, transforming them into real values. The meaning of "realness", in this sense, does not entail that such values are more real than nominal values. On the contrary, nominal values are the real ones in that they have been produced by the working of the actual economy; real values are result of a statistical imputation employed for a certain analytical purpose, namely to measure economic value in terms of products ("res" in Latin), rather than money. The imputation is made on the assumption "a potato is a potato", which means that a price representative is deemed to incorporate the same economic value no matter in which country it is produced or consumed. Difficult as it is, the establishing of such representativity, in practice, remains the underlying axiom without which any international price comparison would be meaningless.

Applying purchasing power parities to table 1 yields real GDPs for countries 1, 2, 3, namely

(6)
$$\text{real } GDP_1 = x_{11} + x_{12}/ppp_2 + x_{13}/ppp_3 - x_{21} - x_{31}$$
$$\text{real } GDP_2 = x_{22}/ppp_2 + x_{21} + x_{23}/ppp_3 - x_{12}/ppp_2 - x_{32}/ppp_2$$
$$\text{real } GDP_3 = x_{33}/ppp_3 + x_{31} + x_{32}/ppp_2 - x_{13}/ppp_3 - x_{23}/ppp_3 .$$

Real GDP equals nominal GDP for country 1, as it serves as the base country to which the others are compared. For the world as a whole this yields

(7) $$\text{real GDP} = x_{11} + x_{22}/ppp_2 + x_{33}/ppp_3 .$$

We may say trade is equal, in this one-product example, if the price of the representative product, as expressed in SDR's, is the same in all countries. This gives a rule for the parity exchange rates, namely

(8) $$\varepsilon_2 p_2 = \varepsilon_3 p_3 = \varepsilon_1 p_1 = e_1 p_1 .$$

Trade is equal, we thus say, if it proceeds at parity exchange rates, implying that value added is measured not in money, but in terms of its product, in a uniform way all over the world. The balance between trade at actual, and trade at parity exchange rates then yields a measure of inequality of trade.

In the general, and realistic, case of dealing with more than one product i = 1,…, the ppp-system is given by the Geary-Khamis index. Define the volume of a transaction as

(9) $$q_{ij}^k = \frac{x_{ij}^k}{ppp_i^k}$$

the index then defines a world price π^k for every product group *k*, and simultaneously, a parity rate ε_j for every national currency *j* in the following way

(12) $$\pi^k \sum_i q_{ii}^k = \sum_k \left[\varepsilon_i x_{ii}^k + \sum_j (\varepsilon_i x_{ij}^k - \varepsilon_j x_{ji}^k) \right], k = 1,...$$

(13) $$\sum_k \pi^k \left[q_{ii}^k + \sum_j \left(q_{ij}^k - q_{ji}^k \right) \right] = \sum_k \left[\varepsilon_i x_{ii}^k + \sum_j (\varepsilon_i x_{ij}^k - \varepsilon_j x_{ji}^k) \right], \quad i = 1,... .$$

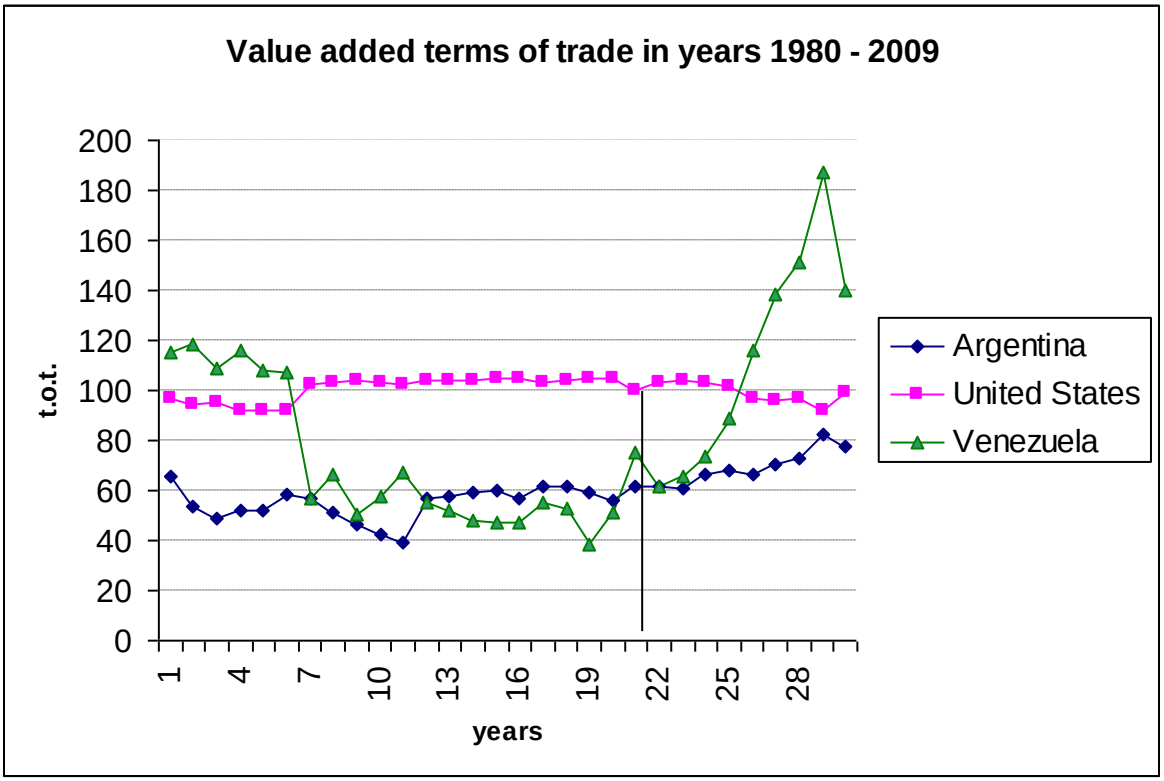
While in actual practice, a simpilified version of dealing with the national trade balance is employed (Feenstra et.al 2009) the interpretation is the same. Equations 12 say that for each product, a world price is formed as an average of country prices, dividing the volume of world output into its sum of national supplies (net, i.e. domestic use plus trade balance) if these are valued at parity exchange rates.Equations 13 say that this parity exchange rate of each country i is set in such a way that the volume of its GDP, measured at world prices, equals its real GDP, measured at its own prices, but adjusted for over- or undervaluation of currency.

Returning to Prebish-Singer, we are now able to decide about not only the relative development, but also about the absolute level of terms of trade. As explained in (Reich 2007) purchasing power parities for year 2000 may be used to scale the t.o.time series, meaningfully, instead of putting the scale at 100, arbitrarily. In year 2000, external purchasing power of Argentina's peso was 62% of its internal purchasing power. For Venezuela the corresponding ratio was 75%, and 100% for the United States. Instead of

arbitrarily equalizing all times series at year 2000 ("2000 = 100"), as has been done in Figure 1 we now gauge them at their purchasing power parities, which yields figure 2.

In figure 2 the three times series have been normalized to values of 100, 75, 62 for the United States, Venezuela and Argentina, respectively, at year 2000 (year 21 in the graph), this adjustment corresponding to the difference in external purchasing power of the three national currencies. One can see in year 2000 external purchasing power of the US dollar was at parity so its terms of trade with the world were equal, as they where over most of the considered period. Venezuela's terms of trade improved over the last decade, which is what Prebish and Singer would observe, but only in the last years they have become favorable (above 100), having remained below parity for most of the time before. Argentina's terms of trade have always been below parity, between 60 and 80 percent, although they were stable in respect to the Prebish-Singer hypothesis. It implies value added in Argentina is devalued when embodied in products to be exported. Or put differently, Argentina contiunuously exports more value added per dollar than it imports, value added being measured in real terms.

Figure 2



4. The Emmanuel hypothesis: Inequality of wage rates

Our second author, Arghiri Emmanuel, has actually coined the term "unequal exchange", and as he writes within a Marxian context, this is perhaps a reason why the term is not accepted in textbooks for students. Emmanuel begins by observing that there is always a certain kind of unequal exchange, in a capitalist economy, in that values are different from prices. There are. in Marxist economics, two kinds of value systems, labour values and production prices. As has been pointed out before, it is impossible to criticise a value system other than by setting up a second one, from which to assess the first. In this way, unequal exchange always exists in a capitalist economy, because exchange of commodities is regulated on the basis of

production prices, which deviate from labour values. As a result an exchange which appears equal on the basis of production prices, is unequal, in the sense that the two commodities exchanged represent different labour values and thus different labour content.

Emmanuel does not regard the exchange of labour values at different production prices as unequal. What he calls "Non-equivalence in the strict sense" is a value transfer based on unequal rates of surplus value ("operating surplus" in modern national accounts), caused by unequal wage rates, at equal capital endowment. The exchange of labour values at production prices, he writes, "is subject to the assumption of mobility of capital and an equal rate of wages as between countries A and B, the latter resulting either from mobility of labor or from a bioeconomic law, common to the two countries, which even without such mobility, causes wages to equalize themselves at the physiological level. If the first assumption – competition of capitals and equalization of profits – can be retained as realistic enough under the conditions of the modern world, the second, that of equality of wages, whether it be the effect of one or the other of the causes set out above, is absolute unrealistic and frivolous. In the world of today the notion of subsistence minimum is sufficiently elastic for no tendency to automatic equalization downward to be possible, and national frontiers are sufficiently tight for equalization through international competition among the workers to be quite out of the question." And he continues: "Inequality of wages as such, all other things being equal is alone the cause of inequality in exchange."

Emmanual demonstrates his case by means of a blackboard example (Table 2). Countries A and B produce the same output in national prices with the same intermediate consumption, and hence the same value added. The distribution, however, of value added between capital and labour is different. Assuming that it is the same quality of labour employed in both countries, meaning that a worker from A could produce the same value added in B as in A, and vice versa, workers in A are rewarded at a lower wage rate in B than in A. As a result they generate a larger operating surplus, and when this surplus is equalized between the countries through the global capital market (uniform profit rate, $\frac{20+100}{240+240} = 25\%$) B looses a value of 40 to A. Its GDP falls to 130, and A's GDPrises gto 210.

Table 2 The mechanism of inequality in exchange according to A. Emmanuel

Country	**A**		**B**
Output at national prices	170		170
Intermediate consumption	50		50
Compensation of employees	100		20
National operating surplus	20		100
Capital stock	240		240
World rate of profit		25%	
International operating surplus	60		60
Output at international prices	210		130

We may summarize the argument of Emmanuel as follows: Inequality of exchange exists within a capitalist economy, but it is not relevant there, because it is only operating surplus that is being reallocated, all workers being subjects of the same labour market and receiving the same wage rate. In international relations, however, wage rates differ as a result of

seggregated labor markets.and when production prices are allocating the generated surplus in proportion to capital invested, an exchange across borders will necessarily exchange products of different labour content between national economies.

Emmanuel's theory has an advantage over that of Prebish and Singer in that it is static. It does not only look at a process between two periods of time, but allows to assess a situation at a certain point in time. The theory is thus able to answer the question of whether terms of trade are favourable or unfavourable, and for whom, in a certain year. International trade is equal, in this argument, when workers of equal productivity receive equal wage rates in the trading countries. Furthermore, Emmanuel's theory does not consider the superficial level of trade alone, but connects trade of products to the factors of production in each country. This is where national accounting, and input-output tables, in particular, come in. They allow to determine the factor value contained in each product group, and thus to measure total national factor value embodied in a nation's export goods, and to compare it to the foreign value added embodied in imports.

5. Measuring real value added flows in international trade

Summarising our exposition, at this point, we may say that inequality in international trade occurs because rates of foreign currency exchange markets deviate from purchasing power parity. As a result countries whose currencies are traded above parity enjoy an advantage in international trade, at the expense of countries whose currencies are traded below their parity value. Such statement about inequality implies no judgement about optimality or desirability of such state, a question that is decided by politics rather than by accounting; it helps to analyse the situation, no more.

As said before the method envisaged for such measurement consists in combining world input-output tables, as they have now been provided, with purchasing power parities calculated between countries. These PPP's are collected at the elementary product level for every country; they say how much of a certain product you can buy in the base country with the amount of money you pay for it in your own country. We begin with a simple example for illustration. Let the economic world consist of two countries 1 and 2, and two products x and y. The corresponding input-output tables look as follows:

Table 3: Input-output tables of a two-country, two-product world with no trade between them

Product	Country 1 (bill. A$)	
x:	IC1	x_1
y:		y_1
	VA1	

Country 2 (bill. B$)	
IC2	x_2
	y_2
VA2	

We deliberately begin with two economies completely closed in order to show that a parity rate of exchange may be calculated by comparing prices for the same product in each country, even without any trade betweeen them. In this world all supply is domestic, as is all intermediate and final use. Accounting identities are

(12) $$VA1 = x_1 + y_1,$$

and

(13) $VA2 = x_2 + y_2,$

by definition. We ignore intermediate consumption IC1 and IC2, because we are concerned with value added only. Each economy is closed and works within its own currency's realm. In this representation, the two countries are uncomparable, as there is no common measurement unit. Such unit can be derived, however, from the production structure if you have measured purchasing power parities between the countries for each product X and Y. Let the price observers find the price of product X in country 2 to be 50 percent higher than the price in country 1 while it is 30 percent lower for product Y, country 1 being chosen as the base country,

$$PPPx = Px_2/Px_1 = 1.50 \text{ [B\$/A\$]}$$
(14) $$PPPy = Py_2/Py_1 = 0.70 \text{ [B\$/A\$]}$$

The corresponding Geary-Khamis system is

$$\pi^x(x_1 + x_2/1.5) = x_1 + \varepsilon\, x_2$$
(15) $$\pi^y\,(y_1 + y_2/0.7) = y_1 + \varepsilon\, y_2$$

and $$\varepsilon\,(x_2 + y_2) = \pi^x\, x_2 + \pi^y\, y_2.$$

Assuming all transaction flows x, y are equal to 1, the system yields the following equations for world prices π^x and π^y, and for the real, or parity exchange rate ε,

$$\pi^x\,(1 + 1/1.5) = 1 + \varepsilon$$
(16) $$\pi^y\,(1 + 1/0.7) = 1 + \varepsilon$$
and
$$2\varepsilon = \pi^x + \pi^y,$$
the solution of which is
$$\pi^x = 1.208$$
(17) $$\pi^y = 0.829$$
and
$$\varepsilon = 1.014 \text{ [A\$/B\$]}$$

For real value added in the two economies we find

(18) $VA1 = 2.000,$
and
$VA2 = 2.024.$

Country 2 produces less x-products and more y-products than country 1; in the aggregate it is slightly more productive. If a market of foreign exchange establishes a rate of $e > \varepsilon$ this creates a trading advantage for country 2, and one for country 1 in the opposite case. The parity rate can be computed independently of any market values, and derived from the production structure only. To repeat, its fundamental, and inevitable axiom is that the volume value of a product is the same all over the world independent of where it is produced. This is not foreign to the market concept, but on the contrary, it expresses well what is to be understood under one global market, namely homogeneity of market forces across the world. Correcting for purchasing power inequality, in this way, yields real value added, which is valued added measured in goods and services, as opposed to nominal value added measured in national currencies and valued at rates of foreign exchange.

All these accounting results may be achieved without any actual connection between the two economies, establishing a joint unit of measurement between them simply for the purpose of comparison. World Bank figures are produced and published with this aim. International trade analysis demands to go one step further, extending the example of table 3 to table 4.

Table 4: Input-output tables of a two-country, twoproduct-world with trade between them

Product	Country 1 (bill. A$)			
X	IC1		x_{11}	x_{12}
Y			y_{11}	y_{12}
	VA1			
Imports	ex_{21}	ey_{21}		

Country 2 (bill. A$)			
E IC2		ex_{22}	ex_{21}
		ey_{22}	ey_{21}
eVA2			
x_{12}	y_{12}		

In this economy x_{11} and y_{11} represent domestic final use of products in country 1, and x_{22} and y_{22} similarly for country 2. x_{12} and y_{12} are exports of country 1 to country 2, counter-balanced by imports x_{21} and y_{21}. A foreign exchange market has been established to finance the trade, producing an exchange rate e [A$/B$] . In this way all tables can be expressed in A$s. Table 4 exposes the crucial role the exchange rate plays in this comparison determining the relative size of the economies towards each other. It also means that nominal flows are not necessarily in proportion to the underlying volumes of commodities exchanged. The Geary-Khamis system which establishes such parity now reads

$$\pi^x(x_{11}+\frac{e}{ppp^x}x_{22})=x_{11}+\varepsilon\, ex_{22}$$

$$\pi^y(y_{11}+\frac{e}{ppp^y}y_{22})=y_{11}+\varepsilon\, ey_{22} \qquad (19)$$

$$\pi^x(e\frac{x_{22}+x_{21}}{ppp^x}-x_{12})+\pi^y(e\frac{y_{22}+y_{21}}{ppp^y}-y_{12})=\varepsilon\, e(x_{22}+x_{21}+y_{22}+y_{21})-x_{12}-y_{12}$$

For a numerical example let be

$$\begin{aligned} x_{ij} &= y_{ij} = 1 \\ e &= 1 \\ ppp^x &= 0.5 \\ ppp^y &= 0.8 \end{aligned} \qquad (20)$$

This means that with the money you need to buy one unit of X in country B you buy only half a unit in country A, at the given exchange rate e = 1. The corresponding Geary-Khamis system looks as follows,

$$\pi^x\left(1+\frac{1}{0.5}\right)=1+\varepsilon$$

(21) $$\pi^y\left(1+\frac{1}{0.8}\right)=1+\varepsilon$$

$$\pi^x\left(\frac{2}{0.5}-1\right)+\pi^y\left(\frac{2}{0.8}-1\right)=4\varepsilon-2$$

The solution of the system of three linear equations is

$$\pi^x = 0.857$$

(22) $$\pi^y = 1.143$$

$$\varepsilon = 1.172$$

At exchange rate e = 1 the currency of country 2 is undervalued, its parity exchange rate being 17.2 percent higher. The world price of X as an average of both country prices would be 85.7 percent of the price in country 1, and for Y it would be 14.3 percent higher than actually there. Tables 5a and 5b illustrate the modification introduced by going from nominal to real values in a world accounting system. In table 5a all values are measured in currency of base country 1, which values depend linearly on the applied exchange rate. This dependency introduces a bias in that a certain amount of money buys different volumes of a certain product in different parts of the world. Under the hypothesis implied in the concept of a world market, namely that every unit of a product is worth the same no matter where it is is produced, or consumed, the nominal exchange rate must be replaced by a parity or real exchange rate, and national prices must be averaged to a world price. All these operations together transform table 5a into table 5b. Output of country 2 has increased matching that of country 1 in terms of product so that its value added and GDP are now much higher than before (4.929 A$), as a result, while they have decreased to 1.179 billion A$ for country 1.

The difference between value corrected for exchange rate (ε eX22, “real value”) , and value corrected for price (π^x eX22/ppp^x, “volume”) can be interpreted as a difference in price, caused by different circumstances of production and of consumption in each country. If the price is above one, meaning real value exceeds volume, this indicates that production is harder or demand is stronger in this country than average in the world, and the reverse.

In summary, the figures show how world accounts change when you apply the homogeneity principle over all countries consistently, and what comparative advantage in international trade a high exchange rate provides. The computation is particular pertinent for small open economies (developing countries). They experience a continuous real value added loss.

Table 5: Compiling value added of a two country, two product-economy

a) in nominal terms (at current exchange rates)

Product	Country 1 (bill. A$)			
X	IC1		1	1
Y			1	1
Value added	2			
Imports	1	1		

Country 2 (bill. A$)		
eIC2	1	1
	1	1
2		
1	1	

b) in real terms (at parity exchange rates and common world prices)

Product	Country 1 (bill. A$)			
X	π^x IC1		.857	.857
Y	π^y IC1		1.572	1.572
Value added	1.179			
Imports	1.714	1.965		

Country 2 (bill. A$)		
π^x eIC2/ppp^x	1.714	1.714
π^y eIC2/ppp^y	1.965	1.965
4.929		
.857	1.572	

6 Experimental compilation of real value added for eight selected countries

Modern accounting techniques may help clarify, and add to old theories of inequality in global trade. Whether inequality is good or bad cannot be decided at this stage, but it seems worthwhile to embark on a deeper analysis than before, by joining the new WIOD data with PPP data prepared already at the World Bank. WIOD has domestic use, exports and imports of countries broken down into 59 products, measured in US dollars at current exchange rates. By way of applying 59 appropriate purchasing power parities in the manner outlined above one ought to be able to establish a network of real value added flows that complement the picture of nominal value added flows known so far. It means employing something like a deflating procedure for prices differing over space, in analogy to what is current practice in analysing development of economic prices over time.

As a provisional application and aproximation to what precise data might deliver at a later stage one can work with existing data in the following way (Reich 2007). The World Bank publishes GDP of countries at current exchange rates, and at purchasing power parities. The ratio yields a real exchange rate ε. Table 6 shows these figures for four major OECD countries Germany, France, Japan, USA, and four BRIC countries Brazil, China, India, and Russia.

Table 6: Gross National Income of selected countries 1995
(billion US$)

	BRA	CHN	DEU	FRA	IND	JAP	RUS	USA
At current exchange rates	0,628	0,644	2,332	1,495	0,361	5,187	0,392	7,480
At purchas-ing power parities	1,001	1,783	1,818	1,199	1,090	2,901	0,825	7,337
Real exchange rate (ε)	1.594	2.769	0.780	0.802	3.019	0,559	2.105	0.981

Source: World Bank and own calculations

WIOD details transactions between countries for 85 commodity groups. Summing over all groups yields table 7, iving an accounts of the product trade between these eight countries. The trade is valued at current exchange rates. If you revalue it at parity exchange rates you receive trade of the real value added contained in traded products (table 8).The resulting figures are quite different. China, for example, exports a nominal value of 64,485 billion $ to Japan,but in terms offactor content this is worth 178,559 $.

Table 7: Trade between BRIC and selected OECD countries 1995, at current exchange rates
(billion US$)

To: From:	BRA	CHN	DEU	FRA	IND	JAP	RUS	USA
BRA	--	809	3,870	2,108	330	3,983	269	15,780
CHN	1,266	--	14,748	7,212	2,630	41,277	2,356	64,485
DEU	7,533	6,972	--	55,624	4,430	14,822	8,342	42,405
FRA	2,241	3,609	51,975	--	1,510	8,136	2,205	23,647
IND	136	641	2,893	1,219	--	2,975	783	6,405
JAP	3,199	31,410	27,432	10,648	2,536	--	1,637	123,681
RUS	658	2,110	9,879	3,789	1,179	4,999	--	4,816
USA	14,803	17,084	48,758	31,779	4,526	84,239	4,364	--

Source: WIOD and own calculations

Table 8: Trade between BRIC and selected OECD countries 1995, at purchasing power parities

(billion US$)

To: From:	BRA	CHN	DEU	FRA	IND	JAP	RUS	USA
BRA	--	1,290	6,169	3,360	0,526	6,349	0,429	25,153
CHN	3,506	--	40,837	19,970	7,282	114,296	6,524	178,559
DEU	5,876	5,438	--	43,387	3,455	11,561	6,507	33,076
FRA	1,797	2,894	41,684	--	1,211	6,525	1,768	18,965
IND	0,411	1,935	8,734	3,680	--	8,982	2,364	19,337
JAP	1,788	17,558	15,334	5,952	1,418	--	0,915	69,138
RUS	1,385	4,442	20,795	7,976	2,482	10,523	--	10,138
USA	14,522	16,759	47,832	31,175	4,440	82,638	4,281	--

Source: WIOD, World Bank, and own calculations

Tables 7 and 8 may be summarised in individual trade balances. Nominal trade balances, compiled on the basis of current exchange rates are displayed in table 9. The corresponding real trade balances, compiled at parity exchange rates are given in table 10.The resulting deviations are striking. Brazil has a modest deficit in nominal value added (-2,687 bill. US$), but it actually imports factor value from abroad, net (13,991 bill.US$). China's well-known nominal surplus rises more than fourfold in real terms; undervaluation of one's currency may be a political goal, but it is at the expense of factor rewards. Emmanuel was not far from the truth in his analysis. Germany and France import a little more in factor content than in products. India's nominal trade balance is negative, but it actually exports factor value abroad (24, 628 billUS$), mainly to USA (14,897 bill. US$). Japan's nominal trade surplus of 40,112 bill. US$ turns into a deficit of 128,770 bill.US$ in factor exchange, which is mainly due to trade with China (-96,738 billion US$). Russia's trade balance is positive, it adds an amount of 7,474 billion US$ to its financial reserves (expected, or future product, so to speak), but its pays for it 34,957 US$ in actual product.

Table 9: Nominal trade balances betweeen BRIC and selected OECD countries 1995
(current exchange rates, billion US$)

With: Of:	BRA	CHN	DEU	FRA	IND	JAP	RUS	USA	Sum
BRA	0	-0,457	-3,663	-0,133	0,194	0,784	-0,389	0,977	-2,687
CHN	0,457	0	7,776	3,603	1,989	9,867	0,246	47,401	71,339
DEU	3,663	-7,776	0	3,649	1,537	-12,61	-1,537	-6,353	-19,427
FRA	0,133	-3,603	-3,649	0	0,291	-2,512	-1,584	-8,132	-19,056
IND	-0,194	-1,989	-1,537	-0,291	0	0,439	-0,396	1,879	-2,089
JAP	-0,784	-9,867	12,61	2,512	-0,439	0	-3,362	39,442	40,112
RUS	0,389	-0,246	1,537	1,584	0,396	3,362	0	0,452	7,474
USA	-0,977	-47,401	6,353	8,132	-1,879	-39,442	-0,452	0	-75,666

Table 9: Real trade balances betweeen BRIC and selected OECD countries 1995
(at purchasing power parities, billion US$)

With: Of:	BRA	CHN	DEU	FRA	IND	JAP	RUS	USA	Sum
BRA	0,000	-2,216	0,293	1,563	0,115	4,561	-0,956	10,632	13,991
CHN	2,216	0,000	35,399	17,076	5,347	96,738	2,082	161,800	320,658
DEU	-0,293	-35,399	0,000	1,703	-5,279	-3,773	-14,289	-14,756	-72,085
FRA	-1,563	-17,076	-1,703	0,000	-2,469	0,573	-6,207	-12,210	-40,655
IND	-0,115	-5,347	5,279	2,469	0,000	7,564	-0,118	14,897	24,628
JAP	-4,561	-96,738	3,773	-0,573	-7,564	0,000	-9,608	-13,501	-128,770
RUS	0,956	-2,082	14,289	6,207	0,118	9,608	0,000	5,857	34,952
USA	-10,632	161,800	14,756	12,210	-14,897	13,501	-5,857	0,000	-152,718

6 Conclusion and proposal

The above exercise affirms certain old theories maintaining the existence of inequality in trade between the nations of the world. It does so by defining and applying a parity rate of exchange between nations compiled on the basis of their production structure. WIOD has proved to play a major role in compiling such figures together with current data of purchasing power parities[1]. Full compatibility could be achieved if WIOD were supplemented with a table of the following format:

Table 11 Desirable supplement to WIOD: Purchasing power parities of countries by product

	(1) Australia			…….					(40) USA
(1) Products of agri-culture, hunting, and fishing									
. . .				ppp_{ij} , i=1,... 59, j=1,…40					
(59) Domestic services									

Attaching a vector of purchasing power parities of each country to WIOD may allow calculating volume components of product transmitted in exchange between countries, in a similar way, as national price indexes are employed to determine such volume within the

[1] Let it be added that on this first trial WIOD has shown to be transparent, and easily accessable, even for an old software on an old computer.

national economy when moving over time. From these product volumes a real exchange rate may by compiled, coherent within over-all WIOD accounting rules. Figures of national real value added, calculated as a result, may then be used to compile value added chains in real terms.

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