Inequality in Global Production and Trade: A Proposal for Measurement

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Abstract
Inequality is traditionally treated as a problem of income distribution, in economics. 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 this division of topics. The paper shows how, by joining Purchasing Power Parities to WIOD, one can define and substantiate a measure of equality (or inequality) in international trade. An experimental compilation of trade between eight major countries demonstrates how real value added of each country is affected by inequality of the terms at which its products are traded with other countries. Three practical conclusions follow from the analysis. First, employ a nationally neutral world currency unit (such as SDR) as the numeraire of PPPs, second, add PPPs to WIOD for compiling value added chains in real terms, and third, accept the possibility of wage rates below productivity as an alternative for explaining the characteristic clift of the world economy, besides the Balassa-Samuelson hypothesis.

1. Introduction

International trade differs from national trade in that it transgresses, and crosses, the territorial boundaries which contain, and define a national economy. As a consequence, and additional difficulty, there is no common currency within which to process a business of this sort. Markets of foreign exchange serve as a remedy to overcome the barrier, but they also create a dynamics of their own in that rates of exchange they establish are governed less by need of paying for products than by the purpose of trading objects of finance. Only a very small fraction (less than 5 percent) of the daily turnover of the world's foreign exchange markets pay for exports and imports. Actual exchange rates, therefore, deviate from parity exchange rates, with the effect that there is no common unit of the measurement of value, in the world.

A new statistical technique has been developed and implemented, over the last thirty years, which creates such a common unit of measurement. Initiated by the University of Pennsylvania, international agencies carry out a regular international comparison program (ICP) which measures equivalence of national currencies against each other on a detailed level of product disaggregation. ICP collects prices in countries around the world, and uses them to calculate price index numbers or purchasing power parities (PPPs), which determine how much local currency is needed to buy as much as does the currency in the "numeraire country", usually the US dollar, at given national prices, and foreign exchange rates. The data are used, so far only, for comparing GDP and economic growth between countries in real terms, eliminating the bias contained in a comparison in nominal terms, at actual exchange rates, and caused by the double role of a national currency, as means of payment, on the one hand, and, as means of measurement of value, on the other.

In the paper, application of PPPs is extended beyond the mere comparison of GDP and growth to analysing terms of trade. These terms are directly proportional to the rate at which domestic and foreign currencies are exchanged against each other, and depending on it they may be favorable or unfavorable for a particular nation. The paper defines equality as a situation in which these two options are balanced, and in equilibrium with each other, which is the case when the external and the internal purchasing power of a national currency are equal. This condition makes the national currency a homogeneous unit of measurement througout the world. It does not imply, of course, that all individual prices are equal across borders, but their average is. It also does not imply that equality of terms of trade is always politically desirable. It may be more desirable for a country, to undersell its competitors, in order to enter, or remain in, a market. But the concept of equal terms of trade helps measure the opportunity costs involved in such a strategy.

Studies of a similar nature have been performed, but addressed trading positions of only one, or two countries (Antille, G. and Fontela, E (2003), Lincoln, E. (1990)). A global comparison requires to look at global data. The paper proceeds as follows: Section 2 re-iterates basic rules of the Geary-Khamis system of linear equations by means of which a common world currency unit is being computed, and imputed, in standard ICP. Section 3 applies the GK-system to a "world" of four OECD-countries, as a plain example for discussing the concept of equality in international trade. This discussion is part of section 4. It is shown how ICP data may be used to supply a rule of distribution of gains of trade to the classical model of comparative advantage, filling a lacuna that has been with this theory all along its years. In section 5, finally, the example is broadened to including four non-OECD-countries whose terms of trade are clearly different from those of the first group. Section 6 concludes. In essence, we embark on an economic and statistical analysis of what in national accounting is known as the terms-of-trade effect on GDP.

2. Geary-Khamis system of purchasing power parities

A country's terms of international trade are defined as follows:

(1) $$t.o.t. = e\frac{p_{ex}}{p_{im}},$$

where p_{ex} and p_{im} denote the price indexes of exports and imports, respectively, and e is the rate at which foreign currency is exchanged against its domestic counterpart. Terms of trade, therefore, are governed by two kinds of variables, prices at product markets, and rates of foreign exchange at financial markets. We are interested in the latter.

It follows from definition 1 that terms of trade are high, or "favorable" for a country when its exchange rate e is high. A revaluation of national currency increases the advantage a country enjoys in international trade in that it may buy more imports for its exports. The opposite, a trading disadvantage, follows from devaluation. This does not contradict the fact that for reasons of competition an unfavorable exchange rate may be preferable, and even necessary, in order to enter an international market. But once participation is assured earning a high price is always advantageous against earning a low one, just like in any other business. An advantage in terms of trade implies, by nature of the bilateral business relationship, a disadvantage for the partner. The question hence arises is there, in this situation of

conflict, an equilibrium, i.e. an exchange rate ε which makes that gains of trade are divided equally between the partners, so that advantage and disadvantage balance for either side. As we want to show in the following, such an equilibrium point exists and may be established by means of the statistical tool of purchasing power parities (PPPs). These are employed only for measuring GDP of nations, at present, but they may be usefully be applied to a wider range of purposes.

International comparison of national GDP proceeds in two steps (Deaton, Heston 2009). First, individual PPPs are established, at the elementary-heading level, for every country participating in the project. This is by far the most tedious and expensive part of the program (OECD 2009). Specific homogeneous products must be selected which are able to represent all neighboring products contained within their specific heading, and their prices must be collected widely enough to represent the national market. Secondly, the data collected this way are assembled in a system of linear equations which defines a world price index $\pi_i, i = 1,...m$ for every product group *i*, and an index that may be called "parity index" $\varepsilon^j, j = 1,...,n$ for every country *j*, simultaneously:

(2) $$\pi_i \sum_j q_i^j = \sum_j \varepsilon_j x_i^j, \quad i = 1,...,m,$$

(3) $$\varepsilon_j \sum_i x_i^j = \sum_i \pi_i q_i^j, \quad j = 1,...,n.$$

π_i and ε^j are the unknowns in this system (OECD 2009). The data from which they are compiled are given by x_i^j, and q_i^j, the first of which represent the nominal value of transactions in product group *i* in country *j* as registered in the national accounts. The second set of variables q_i^j denote the corresponding volumes, which are determined by means of the purchasing power parity of a national currency *j* in respect to product *i* in country *j*, namely ppp_i^j,

(4) $$q_i^j = x_i^j / ppp_i^j, i = 1,...,m; \; j = 1,...,n.$$

On the basis of this system of equations we may define a position of equality in international trade in the following way: International trade of a nation *j* is carried out at equal terms if its parity index ε^j equals 1; it is under this condition that the external and the internal purchasing power of a national currency are equal in that a unit of the currency buys the same amount of good and services when exchanged abroad as it does at home.

It helps to establish conceptual clarity if we emphasise a certain distinction of terms, at this point. All national accounting derives from nominal values. These constitute the measurement of product the economy engenders itself through its markets. Nominal values are the actual values. From them we may derive "volumes" which are defined as nominal values divided by price indexes, compiled sepataely for every specific product group. Volume measures value in terms of physical units of a certain homogeneous commodity selected as representing the total of a specific, but still heterogeneous commodity group (cerials in terms of kg corn, alcoholic beverages in

terms of pints a certain brand of wisky etc.). Another concept let us call “real value”. It is formed by dividing a universal price index into all tansactions across the board of an accounting system. The two terms “volume” and “real value” are often employed as synonyms, but folllowing (Durand 2004) it is worth insisting on the distinction, because they address two different economic phenomena. Volumes measure a change in output of a certain product, separating out what may be due to a change in its specific price. Real values correct nominal values for change in the measurement unit, the national currency, thus monitoring a monetary, rather than a productive phenomenon. This measure of currency inflation, or deflation, is based on a standard aggregate commodity basket, usually private consumption expenditure or GDP. It folllows that real value and volume are identical for this particular basket, by definition, but for all other aggregates, especially at a low level of aggregation, they may very much diverge, differing by their relative price changes.

Two questions must then be answered when applying the mathematical system of equations (2), (3) to actual national accounting data. Which aggregate x_i^j from national accounts is to serve as the standard “commodity basket” underlying the currency comparison, and what is an appropriate rule of normalisation? Equations (2) and (3) forming a homogeneous system of linear equations, there is one equation in excess of what is needed to solve it. It must be replaced by an additional equation of normalisation specifying the concrete economic unit of measurement, and with it the economic meaning of the mathematical system of equations. These choices matter; they are conveniently discussed within the framework of a small example.

3. Four countries

Table 1 answers the first question. It shows final consumption expenditure of households in a “world” of four major OECD-countries for year 2005, each measured in their own national currency.

Table 1 Final consumption expenditure of Germany, Japan, United Kingdom, and United States in year 2005 (billions, Japan trillions, of national currencies)

	GER	JAP	UK	USA
Final consumption expenditure of households on the territory	1238	283	783	8589
Food and nonalcoholic beverages	136	39	68	576
Alcoholic beverages, tobacco, narcotics	43	8	29	169
Clothing and footwear	64	10	44	327
Housing, water, electicity, gas and other fuels	299	69	156	161
Furnishing, household equipment, and maintanance	82	12	45	431
Health	54	11	12	1614
Transport	175	32	113	961
Communications	36	7	18	187
Recreation and culture	116	30	92	814
Education	11	6	10	171
Restaurants and hotels	67	18	81	531
Miscellaneous goods and services	157	41	113	120

source: OECD national accounts

It is reasonable to take final consumption expenditure of households as the commodity basket supporting the Geary-Khamis system of equations, for this is the commodity basket most widely used to measure the internal purchasing power of a

currency, and its change through time (monetary inflation). The choice deviates from traditional PPP-practice where the overall aggregate of GDP plays this role, in correspondence to some countries that measure their rate of inflation by means of this (implicit) price index. Final consumption expenditure of households is the only aggregate within GDP for which preference orderings, or individial utility functions through which formulas for economic price indices may be theoretically justified actually exist, and are accessable[1]. From a monetary point of view this aggregate is to be preferred over the mixtum compositum of GDP, for defining real exchange rates, as it adresses transactions where money has actually been exchanged against some product, exercising its purchasing power, in this way.

If table 1 defines the commodity basket for variables x_i^j of the Geary-Khamis system table 2 adds the required purchasing power parities ppp_i^j. In reality, PPPs are defined and collected at a much lower level of aggregation, so that a much higher number of them exists and is entered into the GK-system, but for purpose of illustration, and simplicity we assume the headings shown here are "basic headings," and treat them as such in the following.

Table 2 Purchasing power parities of individual consumption expenditure of households in Germany, Japan, United Kingdom and United States by groups of products (national currency unit / US$)

	GER	JAP	UK	USA
Food and nonalcoholic beverages	0,96	238	0,71	1
Alcoholic beverages, tobacco, narcotics	0,80	97	0,98	1
Clothing and footwear	0,98	167	0,67	1
Housing, water, electicity, gas and other fuels	0,87	128	0,53	1
Furnishing, household equipment, and maintanance	0,88	167	0,68	1
Health	0,57	65	0,43	1
Transport	1,29	162	1,01	1
Communication	0,86	127	0,51	1
Recreation and culture	0,99	121	0,68	1
Education	0,76	91	0,48	1
Restaurants and hotels	1,09	179	0,93	1
Miscellaneous goods and services	0,89	133	0,66	1

source: 2005 ICP

Exchange rate (SDR's/unit of national currency)	0,8699	0,0063	1,2335	0,6507

Source: IMF January 4, 2005

USA is taken, traditionally, as what is called the "numeraire country" in ICP. Actually, the choice implies more than setting a numeraire, it also defines the unit of measurement.[2] The numeraire in table 2 is the US$ of year 2005. Hence all PPPs of this country equal 1, by definition. The unit of measuerment in each heading is thus the volume of products contained in the heading that you bought for one US$ in the

[1] Compare, for example, the difficult process of finding a price index for the balance of foreign trade (Feenstra et al. 2009).

[2] The two concepts are often confounded. For illustration, measuring in m or km is choosing a numeraire. Meassuring in m or kg is choosing an unit of measurement, namely whether you want to measure length or weight.

USA, in year 2005. For food, for example, you must expend either 0.96 euros, or 238 yen, or 0.71 pounds in order to buy what you get in the US for one dollar. Each heading's volume is thus measured in a different unit of measurement (for more explanation see Durand 2004).

This takes us to the other issue that must be discussed, namely how to normalise the GK-system of homogeneous equations. Assigning this role to a particular country introduces an asymmetry that must be questioned. The choice may be irrelevant in terms of simply finding a numeraire, because that is all what is needed to solve the system mathematically (defining a "scale"). In economics, however, you want not only to find a scale, but you want know what the scale means (a scale of "what?"). The dollar is not invariant over time. In order to serve as a unit of measurement its change in *internal purchasing power* must be monitored and controlled in the compilation. Values of later years are, therefore, adjusted by the rate of US inflation. But there is another bias to be guarded against, namely the change of the dollar in respect to its external purchasing power, abroad, reflected in re- or devaluation of the national currency. Imagine a general devaluation of the dollar against the other currencies by 10 percent from one year to another, all national prices remaining the same so that national values x_i^j remain unaffected. All ppp_i^j will fall by 10 percent, as you need 10 percent less of other national currencies to buy a dollar's worth of product. All volumes q_i^j will increase by 10 percent except for the United States. They will thus simulate a growth that has not actually existed.

In order to correctly identify variation in the unit of value measurement it is preferable, therefore, to choose a nationally neutral unit of account, such as Special Drawing Rights, issued by the IMF (SDR), which have no internal purchasing power to control, as they do not pertain to any particular country. Their only purpose is to be exchanged for other national currencies. All nominal transactions x_i^j, therefore, are expressed in SDRs, here, applying the corresponding exchange rate (last row in table 2). Global development may then be decomposed intro three parts, growth of GDP, - the only ICP concern at present, - inflation of national currencies, and international re- or devaluation of SDRs against these currencies, paving the way to a full-fledged and coherent world accounting system.

Instead of leaning the global Geary-Khamis system on one particular national currency, we find our rule of normalisation by means the following argument: Nominal world GDP, the sum of all national GDP, forms the actual value of world production as measured by the ecomomy itself. The idea sometimes spreaded that it is the statistician who measures economic value is not without presumption. All the statistician can do is to observe and collect the values. They are true values in the sense that these are the values along which the economy works, and which are originally generated by it. We then add some reasonable imputations to the observations in statistics, for the purpose of economic analysis. One of these imputations is the concept of real value, which is meant not as representing the actual value established by the economy, but a value measured, not in money, in products (lat.:"res") of a certain bundle (commodity basket). The convenient product bundle is the basket of final consumption expenditure of the world's households. Such an imputation must not increase the total value of world product, it can only transform their relative position. We normalise the homogeneous system (2) –(4) by equation (5),

(5) $$\sum_i \sum_j \varepsilon^j x_i^j = \sum_i \sum_j x_i^j = 5{,}589 \left[billion\ SDR \right] \ .$$

saying that total real value of our "four-country world" consumption expenditure equals its nominal value. With this normalisation we arrive at the results of table 3. It shows transactions x_i^j (in SDR) and volumes q_i^j (in SDR) observed in four countries, and compiles a "world" price index π_i for each product group (last column in table 3), and a parity exchange rate ε^j for each country (last row in table 3), from these data. The evidence is that within this group of four major OECD countries the US currency is undervalued, its trade with the other three countries suffers from a small disadvantage of about ten percent, to the benefit of the partners whose currencies are overvalued, and therefore enjoy an advantage of the same size in their trading. Their currencies must be graded down in order to bring their external purchasing power in line with their internal one. International price indexes π_i are generally higher than 1, reflecting the same fact that a country of undervalued currency (in this context of four) has served as the base country for determining PPPs. In summary, terms of trade are roughly balanced. Market exchange rates are not far away from parity between these four countries.

Table 3 Data and results of the Geary-Khamis system of equations

	xij (billion SDR)				qij (billion SDR)					
	GER	JAP	UK	USA	GER	JAP	UK	USA	Sum	π_i
Food, nonalc. beverages	118	248	84	375	92	107	62	375	636	1,250
Alcoholic bev., tobacco	37	51	36	110	35	55	19	110	219	1,041
Clothing and footwear	55	62	55	213	42	38	43	213	336	1,136
Housing, water, electicity	260	436	192	1045	224	350	192	1045	1810	1,054
Furnishing, equipment	71	75	56	280	61	46	43	280	430	1,120
Health	47	70	15	1050	61	111	18	1050	1242	1,022
Transport	152	201	139	625	88	128	73	625	914	1,215
Communications	31	46	23	122	27	37	23	122	210	1,047
Recreation and culture	101	191	114	530	76	162	88	530	857	1,084
Education	9	41	13	111	9	46	14	111	180	0,973
Restaurants, hotels	58	114	100	346	40	65	57	346	508	1,206
Miscellaneous	137	257	139	782	115	198	111	782	1206	1,090
Sum	1078	1792	965	5589						
ε^j	0,897	0,824	0,858	1,101						

You can go further and multiply the four left-hand columns by last row of parity exchange rates ε^j which gives you the real value of the column, i.e. the volume at its national price, but corrected for external over- or undervaluation of the national currency. And you may multiply the four right-hand columns by the last column of π_i and get the volumes of the transactions valued at a unique world (average) price. The ratio or the two gives you a national price level for each product group in each country (see table 2 in ICP2005).

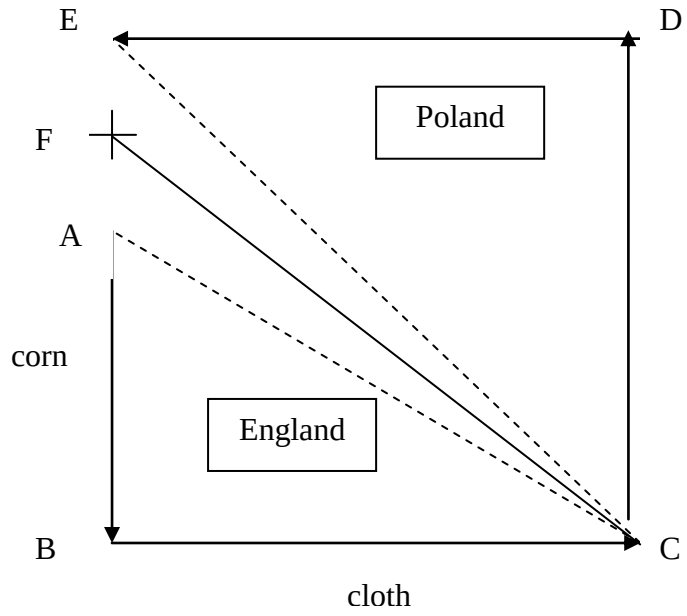
All of this represents standard Geary-Khamis technique (except for the modifications mentioned above). The new idea is to extend the technique beyond compiling just

GDP in total, the main goal at present, to an analysis of one of its components, international trade. In its preparation it is advisable to briefly review some basic notions of international trade.

4. International trade

The problem of equity is rarely addressed, directly, in the theory of international trade[3]. Implictly, however, it has been with it ever since its beginnings. Figure 1 recalls the classical view exemplified at the model of a two-product, two-country economy that usually serves this purpose. Two countries, say England and Poland produce two products, say corn and cloth, but their productivity is different. One hour of labor yields one unit of cloth (m) in either country; and it yields one unit of corn (kg) in Poland, but only two thirds of a unit of corn in England. Therefore, if England shifts an hour of labour from production of corn (AB) to production of cloth (BC), and Poland, in reverse, shifts an hour's labor from production of cloth (DE) to production of corn (CD) there is a gain in corn (AE). "The practical conclusion may be commodiously and correctly stated thus: Whenever the purchasing power of any commodity with respect to another is less, in one of two countries, than it is in the other, it is the interest of those countries to exchange these commodities with one another." (Mill 1844, p. 124). And more generally, " when both countries can produce both commodities, it is not greater absolute, but greater relative, facility, that induces one of them to the production of one of the commodities, and to import the other." (Mill 1844, p.123) This is the famous conclusion first discovered by David Ricardo.

Figure 1 Comparative advantage in a two-country, two-product model



When the potential for a gain is there, it takes another condition to make the gain come true; countries must agree on a distribution of the gain. Distribution of the gain is implicitly fixed by the terms at which trading takes place. There is an intervall of

[3] For exceptions see Amin (1973), Emmanual (1972), Lincoln, E. (1990), Pomfret (1988) and others, each assigning it a different meaning.

possible solutions the limits of which are visualised by slopes CA and CE in figure 1. If the additional corn produced in Poland (CD) earns just as much cloth, in trade, as has been given up in the labour shift (DE) "the whole of the advantage would be on the part of England and Poland would gain nothing, paying as much for the cloth she received from England, as the cost of producing it herself." Trade would not be of advantage to Poland. If, on the other hand, terms of trade were such that a unit of cloth would be exchanged against 2/3 units of corn (CA) there would be no incentive to trade on the side of England. Classical authors let markets decide: "The result of competition would be to divide the advantage equally between them." (Mill, p.122). Translated back into figure 1 this means that the gain AE is divided in half, AF, AE, and terms of trade adjust accordingly (slope CF). In textbook economics the problem is solved within the Edgeworth box (Yarbrough 2000, p.98).

The terms at which trade takes place are thus a crucial element in deciding whether to embark on international trade or not are. In figure 1 these terms are given by the ratio of the price of cloth relative to the price of corn where prices are determined by costs of production. As the price for cloth is 1 unit of corn per unit of cloth in Poland, and 1.5 units of corn per unit of cloth in England. It follows that in order to induce trade a price must be found between these two limits

(6) $1 < p < 1.5$ [units of corn / units of cloth].

The question is where to set the line: The closer it comes to $p = 1$ the more it is of advantage to England, and the more it increases to $p = 1.5$ the more advantage goes over to Poland. At the border-lines, trade is of no advantage at all to one country, while all of the gain accrues to the partner. The intuitive solution assumed in classical economics is equality, i.e. both countries profit from trade in equal shares. Mill assumes this result is brought about by competition. Modern trade theory shows how imperfect competition usually is, in reality. It is not natural, therefoe, that terms of trade find equality, and if not so, the difficulty arises of determining what, under actual market conditions, may be defined as equality in trade. It is still clear that "an increase in terms of trade raises the welfare of a country, a diminuation of its real terms of trade decreases it" (Krugman/Obstfeld). Under the assumption of continuity there must be an optimum, but where is it?

Later theories of trade shift their focus. Heckscher and Ohlin study factor composition rather than country benefits, Krugman discovers effects of scale and monopolistic competition as important drivers of trade, and Balassa and Samuelson look at different levels of development (Krugman, Obstfeld 2000). Yet, for its simplicity, the classical view of comparative advantage forms a major pillar, still, in the proposition of international trade while the question of equality of trade is lost out of sight. It comes back when we now apply the Geary-Khamis system to the classical model. Table 4 assumes some convenient figures.

Table 4 Two-country, two-product model

	Nominal values		Nominal prices		Quantities		
	Eng	Pol	Eng	Pol	Eng	Pol	Total
Corn	120 sh.	80 zl.	1.5 sh./kg	1 zl./kg	80	80	160 kg
Cloth	200 sh.	90 zl.	1 sh./m	1 zl./m	200	90	290 m
Total	320 sh.	170 zl.					

The corresponding GK-system of equations looks as follows:

$$
\begin{aligned}
&-160\,\pi_1 + 120\,\varepsilon^1 + 80\,\varepsilon^2 = 0\\
&-290\,\pi_2 + 200\,\varepsilon^1 + 90\,\varepsilon^2 = 0\\
&80\,\pi_1 + 200\,\pi_2 - 320\,\varepsilon^1 = 0\\
&80\,\pi_1 + 90\,\pi_2 - 170\,\varepsilon^2 = 0\\
&320\,\varepsilon^1 + 170\,\varepsilon^2 = 490 \text{ [ounce of silver]}
\end{aligned}
\qquad (7)
$$

where we have assumed

$$1 \text{ shilling} = 1 \text{ zloty} = 1 \text{ ounce of silver}, \qquad (8)$$

taking silver as the international means of payment required to complete the trade.

Solving system (7) yields

$$
\begin{aligned}
\pi_1 &= 1.262 \text{ [ounces of silver / kg corn]}\\
\pi_2 &= 0.993 \text{ [ounces of silver / m cloth]}\\
\varepsilon^1 &= 0.936 \text{ [ounces of silver / shilling]}\\
\varepsilon^2 &= 1.120 \text{ [ounces of silver / zloty]}
\end{aligned}
\qquad (9)
$$

The parity exchange rate between shilling and sloty is thus given by

$$\varepsilon^1 / \varepsilon^2 = 0.836 \text{ [zloty / shilling]}. \qquad (10)$$

England exports cloth, and imports corn. Under the market exchange rate regime, terms of trade for England are

$$t.o.t = e\frac{p_{ex}}{p_{im}} = 1\left[zloty / shilling\right] \times \frac{1\left[shilling / m\right]}{1\left[zloty / kg\right]} = 1\left[kg / m\right] \ . \qquad (10)$$

The trade is 1 m of cloth against 1 kg of corn. England gains all the advantage from trade as it now pays 1 shilling abroad instead of 1.5 at home, for corn.

Under a parity rate regime the terms are

$$t.o.t = \varepsilon\frac{p_{ex}}{p_{im}} = 0.836\left[zloty / shilling\right] \times \frac{1\left[shilling / m\right]}{1\left[zloty / kg\right]} = 0.836\left[kg / m\right] \qquad (12)$$

For Poland the situation is the opposite. Under market exchange rates it trades 1 m of cloth for 1 kg of corn, which is of no advantage against the domestic price relationship. Under parity rates Poland's terms of trade are

(13) $$t.o.t = \frac{1}{\varepsilon}\left[shilling\ /\ zloty\right]\frac{p_{ex}\left[zloty/kg\right]}{p_{im}\left[shilling\ /\ m\right]} = \frac{1}{0.836}\times\frac{1}{1} = 1.196\left[m/kg\right]$$

Terms of trade of 1.196 m cloth / kg corn (or 0.836 kg corn / m cloth) define a line of equality in trade derived from the GK-system. ICP data, in this way, supply a rule of distribution to the classical model of comparative advantage which closes a lacuna that has been carried on, and left open all through its years.

5. Global disparity

We return to our four countries Germany, Japan, United Kingdom and United States. The fact that, in year 2005, the currency of USA was undervalued with respect to the other currencies has already been remarked. A parity factor $\varepsilon^j < 1$ means the country's currency embodies a smaller purchasing power abroad than at home. Its currency looses purchasing power (devalues) when exchanged against other currencies needefor buying imports. If ε^j, the real exchange rate, is employed, replacing the nominal rate e^j, this shift in valuation assures that all currencies envolved bear the same purchasing power abroad as they do at home. We have defined and imputed a homogeneous unit of measurement for the world. The adjustment is shown in table 6. In this compilation use has been made of the rather new statistical project WIOD which documents trade flows between nations world-wide, by product group. As this work refers to year 1995 only its proportions have been used, and adjusted to the absolute value of total exports as registered in OECD statistics.

Table 6 Trade flows 2005 (bill. SDR)

	at market exchange rates					at parity exchange rates				
	GER	JAP	UK	USA	sum exp	GER	JAP	UK	USA	sum exp
GER	0	20	91	76	187	0	18	82	68	168
JAP	54	0	32	221	308	45	0	27	183	254
UK	65	15	0	68	148	55	13	0	58	127
USA	96	114	74	0	284	106	125	82	0	313
sum imp	215	149	197	365	927	206	157	190	309	861

Source: OECD, WIOD and own calculations

As noted before, market exchange rates obey forces of financial markets, and are thus biased in respect to product exchange. Multiplying market values by the corresponding parity rates derived from the GK-system (last line in table 3) yields real exchange rates, which eliminate the intrinsic financial bias by equating external value of every national currency to its internal purchasing power, establishing a universal, homogeneous unit of measurement between them, in this way. In table 3 the US currency is undervalued in respect to the other three countries, so that US real exports turn out to be higher than their nominal exports (313 as against 284 billion SDR), and real imports are lower than their nominal ones (309 against 365 bill. SDR) while the opposite holds for her partners. It means the opportunity cost of

consumption fore-gone for a dollar of export is higher than the opportunity cost of a dollar's worth of imports, incurred by the partners.

Table 7 Trade balance in nominal (a) and in real (b) terms between four countries (billion SDR)

	a) nominal					b) real				
	GER	JAP	UK	USA	sum	GER	JAP	UK	USA	sum
GER	0	-34	27	-20	-28	0	-27	26	-38	-39
JAP	34	0	17	108	159	27	0	13	57	97
UK	-27	-17	0	-7	-50	-26	-13	0	-24	-63
USA	20	-108	7	0	-81	38	-57	24	0	4

Source: table 6

We see the US trade deficit of 81 billion SDR in nominal terms is partly due a low dollar value abroad, as compared to its internal purchasing power. In real terms, i.e. if currency value is corrected for this bias the USA enjoy a small trade surplus of 4 (billion SDR) signifying that USA exports more own value added than it imports foreign value added, in real terms. Japan's large nominal surplus (159 billion SDR) consists, in part, of an advantage in its nominal terms of trade, and shrinks to 97 billion SDR when adjusted for purchasing power difference of currencies. To put it differently, the opportunity cost of exports in terms of domestic use fore-gone is smaller than the nominal trade balance suggests, for Japan. Or putting it in still a diferent way, the nominal trade balance shows the overall surplus or need of international finance, the real trade balance, in contrast shows the loss of domestic real value added contained in exports as against the gain of foreign real value added through imports, both measured in terms of their own national commodity standard valued at common world prices.

The 4 - country compilation above exhibits trading relationships among these countries, but it defines an artifical "world" of only these four countries. The countries are connected with many more, not to say with all countries of the world, in reality, and their trading position cannot be adequately analysed within such a limited construct. In the following, therefore, we extend the analysis, discussing how the concept of equality in terms of trade may work within a more realistic context. In table 8 four BRIC countries are added to four OECD countries, for that purpose.

Table 8 reproduces trade flows between the eight countries as registered in the World Input Output Database, in nominal terms (US$). Instead of solving the GK-system of equations directly we have resorted to some short-cut approximation (table 9). Parity rates ε^j were estimated by dividing published PPP-GDP into nominal GDP, according to equation 3. The resulting parity rate was then multiplied by nominal values of trade flows between countries retrieved from WIOD. The result (table 10) is not exact, but it gives a picture of the situation worth to be dicussed. A summary of the figures is given in table 10 which contrasts trade balances in real terms (i.e. at uniform currency purchasing power) with those in nominal terms.

The balance is negative for all four OECD countries and positive for all BRIC countries,meaning the first group trade at relatively advantageous terms with the world, at large, while the latter enjoy a significant disadvantage in their terms of trade. Surely, this undervaluation may be a condition of participating in world trade, at all,

but is comes at a significant opportunity cost. Roughly half of the value added embodied in domestic products is lost when the products are sold on the international market. The phenomenon is well-known and reflects a characteristic division of the world economy in the sense that the share of OECD-countries in world GDP shrinks when comparison is carried out at purchasing power parities. But if this discrepancy is being accepted as holding for GDP in total, it also holds for its components, and it is now possible to quantify this clift in economic conditions for exports in the same way as for GDP.

Undervaluation of currencies of developing countries is explained by the Balassa-Samuelson hypothesis, in university textbooks. With the data now at hand, we may be able throw a new light on this explanation. The argument runs as follows (Yarbrough and Yarbrough 2000, p. 777): PPPs and GDP are compiled for all kinds of goods and services, not all of which participate in international trade. It so happens that export industries of developing countries have low productivity as against their competitors in OECD-countries. Their wage rate is low, in correspondence to productivity, while ppp for these products is the same as for OECD countries. In industries,however, whose products are not traded internationally ("hair-cuts"), productivity may be similar to industrialised countries, but the trading industries determine the national labour market, so that even more productive industries earn the same low wage, which is an underpayment causing the PPP value of output to stand above the market value, but is inevitable.

Wide-spread as it is the Balassa-Samuelson hypothesis names only one possible condition under which the observed inequality may become true. The condition is sufficient, but not necessary. It does not follow that because a parity cleft exists in the world economy the hypothesis is true. A different condition might suffice to explain the divide equally well. It could be, for example, that productivity in trading industries is not different from other parts in the world, but that their pay is. Possible reasons of such underpayment have been advanced, in the literature:

(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.

(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) The 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. (Prebisch, R. 1950, Singer 1950).

If Poland, in our example, receives not 1.196 m of cloth in exchange for 1kg of corn, the equality rate of trade, but only 0.558 m because of low foreign exchange value of its national currency she sells implicitly 2 hours of its own (average) labor for 1 hour of foreign (average) labor where both are of equal productivity as certified by PPPs.

Both theories, the one of low productivity, and the other of low pay have been widely discussed in the literature (e.g. Singer, H.W. (1998)). A final test between them is difficult, and probably would demand another International Comparison Program, not of commodities, but of the world's labour force, in all its diverse specialisations and qualifications to be carried out.

Table 8 Trade between 8 countries 1995 (billion US-dollars, at market exchange rates)

to from	DEU	FRA	JAP	USA	BRA	CHN	IND	RUS
DEU	--	55.6	14.8	42.4	7.5	7.0	4.4	8.3
FRA	52.0	--	8.1	23.6	2.2	3.6	1.5	2.2
JAP	27.4	10.6	--	123.7	3.2	31.4	2.5	1.6
USA	48.4	31.8	84.2	--	14.8	17.1	4.5	4.3
BRA	3.9	2.1	4.0	15.8	--	0.8	0.3	0.3
CHN	14.7	7.2	41.3	64.5	1.3	--	2.6	2.4
IND	2.9	1.2	3.0	6.4	0.1	0.6	--	0.8
RUS	9.9	3.8	5.0	4.8	0.7	2.1	1.2	--

Source: OECD, WIOD and own calculations

Table 9 Gross national income 1995 (billion dollars)

	DEU	FRA	JAP	USA	BRA	CHN	IND	RUS
Ar market exchange rates	2,332	1,495	5,187	7,480	628	644	361	392
At purchasing power parities	1,818	1,199	2,901	7,337	1,001	1,783	1,090	825
Parity index (ε^j)	0.780	0.802	0.559	0.981	1.594	2.769	3.019	2.105

Source: World Bank and own calculations

Table 10 Trade between 8 countries 1995 (billion international dollars, at purchasing power parities, calculated as table 8 times parity index)

to: from:	DEU	FRA	JAP	USA	BRA	CHN	IND	RUS
DEU	--	43.4	11.6	33.1	5.9	5.4	3.5	6.5
FRA	41.7	--	6.5	19.0	1.8	2.9	1.2	1.8
JAP	15.3	6.0	--	69.2	1.8	17.6	1.4	0.9
USA	47.8	31.2	82.6	--	14.5	16.6	4.4	4.2
BRA	6.2	3.4	6.3	25.1	--	1.3	0.6	0.4
CHN	40.8	20.0	114.3	178.6	3.5	--	7.3	6.5
IND	8.7	3.7	9.0	19.4	0.4	1.9	--	19.3
RUS	20.8	8.0	10.5	10.1	1.4	4.4	2.5	--

Source: OECD and own calculations

Table 11 Trade balances 1995 summarised (billion $)

Valued at:	DEU	FRA	JAP	USA	BRA	CHN	IND	RUS
Market ex-change rates	-19.4	-19.1	40.1	-75.7	-2.7	71.3	-2.0	7.5
Purchasing power parities	-72.1	-40.7	-128.7	-152.7	14.0	320.6	24.2	35.0
Balance	-52.7	-21.6	-168.8	-77.0	16.7	249.3	26.2	27.5

Source: Tables 8, 10

6. Conclusion

The paper explores new opportunities of economic analysis created by modern statistical developments such as measurement of international purchasing power and the world input-output database. While the compilations carried out in this paper are of an examplary, rather, than of a true statistical nature they prove that a proper combination of the two databases may lead to fruitful co-operation and further insights into the structure of the world economy. A practical recommendation is therefore, to supplement WIOD by PPPs, allowing compilation of value added chains not only in nominal, but also in real terms, in this way.

Our analysis makes it a point to clearly distinguish between “volume” and “real value”, in order better separate monetary from real phenomena in economic statistics. This means, more precisely, to distinguish between the price of a product and the purchasing power of a currency, the first being measured by means of specific price indexes, fitted to a particular product group and leading to volumes, the second being measured by a general, and universal, standard price index based on a certain product basket, preferably individual consumption expenditure of households, and leading to real values, accounting for monetary variation of the currency which is used as measurement unit.

It has also become apparent that normalisation of the Geary-Khamis system should not employ a particular national currency, because normalisation entails more than the choice of a mere numeraire, namely, it determines the unit of measurement of economic value, and no national currency is safe against devaluation abroad. A world currency unit that has not national attachment to a particular economy would be preferable, because its devaluation could easily be separated from that of national currencies.

Furthermore, it has been demonstrated how classical theory of comparative advantage explicating a rule of efficient production may by complemented by a rule of equal distribution of the gains of trade, as an important desideratum in any production theory.

Finally, it has been pointed out that the commodious Balassa-Samuelson hypothesis names only a sufficient condition for explaining the remarkable clift of strong and

weak currencies into which the world economy is divided, and that an hypothesis of underpayment, namely pay below productivity is also sufficient to bring about such phenomenon. If another ICP could begin surveying PPPs of national wage rates in the same detail of labor qualifications, as has been achieved in comparing national products the controversy between the two explanations could be decided.

In concluding it ought to be repeated that defining, and working with, a measure of equality in international trade does not make this concept a political goal, automatically. Economics is always a two-sided affair, and rather than not participating in world trade, at all, a country may be better off by trading at an unfavorable exchange rate. But is now possible, and, we believe advisable, to measure the opportunity costs of such an arrangement.

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