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Inequality in Exchange: The Use of a World Trade Flow Table For Analyzing the International Economy
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Abstract
Inequality in international trade, if it exists, must be defined. It means inequality in the terms of trade. Their measurement follows a long tradition and produces impressive detail. It is, however, restricted in scope, because the first derivative, the change of the terms in time is observed only. The absolute levels depends on which year is chosen as base year, a choice which is rather arbitrary and has not theoretical meaning. Equality of terms of trade remains thus undefined, more precisely speaking, it is always assumed implicitly for whichever base year is being nominated.

The paper proposes to resolve this indefiniteness and ambiguity by employing the relatively new statistical tool of purchasing power compilation. Terms of trade are crucially dependent on the rate of foreign exchange, for which exports are traded against imports. The proposition is to call terms of trade equal if the effective real exchange rate derived from the nominal exchange rate by means of purchasing power parities equals one.

A world trade flow table is constructed on that basis, in order to put the compiled equalities and inequalities of trade into a global, coherent perspective.

1. Introduction

At first sight, inequality in exchange seems like an empty concept, because people would not exchange if the process were deemed unequal by one of the two partners involved in it. And, indeed, within the subjective theory of value the concept is non-existing and undefined. Equality and inequality, or equivalence, to be precise, of two economic transactions, can only be ascertained if there is a third party in the game, or an instrument, at least, that is being recognised and acknowledged by both partners of the exchange as describing value in an objective way.

Although refuted and discarded officially, the theory of value as an objective category exists and is alive, albeit underground, and mostly within the accounting discipline (Reich 2001). Input-output tables, as part of national accounting, work with many an assumption that may be interpreted as expressing a theory of objective value, in the way you find it with classical economic authors. Inequality of trade is thus a suitable topic for input-output analysis.

In international trade, in particular, the concept of value as an objective category is visible, because the instrument of its measurement, the national currency, is visible. It forms part of the problem. What is the value of a good selling at two different prices in two different currencies in two different countries?

The paper answers the question by drawing on a relatively new statistical device, namely, the compilation of national purchasing power parities on an international level. Purchasing power parities allow an international comparison of national price levels, and of their inverse, the objective value of a national currency, expressed as volume of domestic products being equivalent to it. The concept of purchasing power parity of different national currencies is regularly applied by international agencies in order to compare gross domestic product between countries in real terms. The paper extends this usage to one of the sub-aggregates of GDP, the foreign trade balance.

The balance of exports and imports is part of the balance of payment and usually analysed within monetary economics. It must financed if it is negative, or, in the opposite case, the surplus must be managed. In this paper we look at the trade balance from the real side of the economy. Exports absorb part of national resources that may be used otherwise for domestic consumption or capital formation. Thus there is an opportunity cost of alternative use to them. Imports, on the other hand, save resources, they represent an opportunity gain. The question is whether the two are equivalent in terms of the resources they put up for their production.

The paper begins by recalling some roots of the concept of inequality in exchange (2.1). Those early attempts were not successful, and one of the reasons for their failure may have been lack of a statistically operational definition. Then, in section 2.2, input-output analysis is introduced. It needs only an elementary exposition for demonstrating the intrinsic connection between the expenditure approach (GDP), and the product approach (value added), as it is being constructed by means of input-output tables. They demonstrate what it means to say that primary factors applied to production are “contained”, or “embodied”, in

the value of final product. Purchasing power parity measurement is introduced, thereafter, in order to make these "contents" internationally comparable. In section 3, a world flow table of international trade of goods is compiled as a first and preliminary application of the concept of a real trade balance, developed in the paper. The difference between a country's nominal trade balance and its real counterpart is interpreted as a measure of inequality of exchange of resources in international trade.

2. The concept of inequality in international trade

2.1 Previous studies: terms of trade and surplus value

When after the second world war the new economic order had been established it was Raùl Prebish (1950) and Paul Singer (1950), who first raised the question of equality within it. In a beautiful analysis of the dynamics of this order, Singer investigates the distribution of gains between industrialised and developing countries. Admitting that within a static view of comparative advantage foreign trade may be spreading benefits fairly evenly over both trading partners, he insists that "it is difficult not to feel that there is more to be said on the subject than most textbooks will admit" (Singer 1950, p. 477). Textbooks have not changed since then in this respect, it seems.

Singer builds his argument on empirical observation of the long term development of terms of trade between the two groups of countries. "It is a historical fact that ever since the seventies the trend of prices has been heavily against sellers of food and raw materials and in favour of the sellers of manufactured articles." (p. 477) Whether or not this observation is true has been part of the extensive discussion that followed, but needs not be reviewed here. At any rate, it may be called a result of the debate that terms of trade are now regularly monitored by international agencies and form part of the data entering into economic policy.

There is another issue concealed in Singer's analysis of which neither he has been aware himself nor the literature thereafter. The terms of trade of a nation are defined as follows:

$$t.o.t = \frac{p_{ex}}{ep_{im}} \qquad (1)$$

p_{ex} are the prices of the country's exports calculated in national currency. p_{im} are the prices of the country's imports, which are calculated in foreign currency, originally. To make them comparable and allow foreign trade to take place foreign exchange markets determine an exchange rate e, which announces the price of foreign currency in domestic currency. Terms of trade depend thus on three variables, the two price systems of the trading agents and the exchange rate ruling between them. Singer deals only with the price systems. Arguing about productivities, technical process, structural innovation etc. he has in mind the national and international markets of products, or, what is often, but wrongly, called the real economy[1]. He works with the assumption, implicitly, of a constant exchange rate, or, stating a more sophisticated an assumption, an exchange rate

[1] The German term "Güterwirtschaft" seems more adequate.

that adjusts automatically to supply and demand created by foreign trade, and it alone.

If this assumption has ever been true, it is not true today when a few percent of the daily turnover of foreign exchange satisfy the needs of foreign trade. It is finance, the capital account, rather than production and income, the current account, that determines these dealings. And because of this third important intervening variable it is necessary to separate the two possible causes of a change in terms of trade from each other: (a) a change in the relative prices of products, which comes about through changes in technology and preferences, (b) a change in the rate of foreign exchange, the causes of which a rooted in financial events and expectations about bonds, shares and other, mostly non-produced assets. The value of money must be included in an analysis of the value of goods and services.

Another point of critique in respect to Singer's analysis is more technical in nature, and also more general. As of now, terms of trade are determined as dynamic variables only, as changes over time. They "improve" or they "deteriorate", but where do they stand? In other words, only the first time derivate of equation one is actually measured in traditional statistics, usually as a change between years. As a result, the question of what are the terms of trade in a given year single year is not answered, neither by present statistics nor theory. It all depends on the chosen base year, and this dependence forms a large uncertainty in judging Singer's theory. The weakness shows in some paradoxes of terminology. It is textbook wisdom to call high terms of trade favourable for a country. But if this is so, why do countries opt for a devaluation of their currency so often, which means that they voluntarily worsen their terms of trade? Are low terms of trade actually better than high ones? And again, if many countries prefer low terms of trade under certain circumstances, why must other countries then be forced to devalue when , for example, they want a credit from the IMF? It is not for doubting these different policies, but for questioning the simplicity of calling high terms of trade "favourable", that we mention these paradoxes. Here again, introducing money and its value as an explicit variable in addition to prices will strengthen and clarify the analysis.

The idea that international trade may not be advantageous to every nation continued to be discussed among development economists when trying to explain the lack of convergence within the new world economic order. Constructing a "model of exchange from Marx's schemes of the general profit rate" Emmanuel (1962) approaches the matter on more conceptual a level than does Singer. The problem he wants to solve consists in the paradox that the law of the market being accepted as the social mechanism of determining equal values between partners, it can hardly produce inequality at the same time. Emmanuel, therefore, defines unequal exchange as an exchange at prices not in accordance with this law. (Emmanuel 1962. pp. 16, 22)[2]

Emmanuel bases his theory on the conceptual distinction of labour values from production prices, discussed and explained in classical value theory and its Marxist specialisation, in particular. In this way his "scheme" does not employ

[2] Emmanuel, arguing within the Marxian theory of value, actually develops a more refined definition, which we need not elaborate here.

empirical data, but works with speculative, though plausible numbers. It is an accounting scheme, not a behavioural model, and in that quality it is independent of behavioural assumptions. Emmanuel isolates two conditions under which the law of the market, and thus equality between partners holds, mobility of capital and mobility of labour. Both conditions are realised within a national economy, more or less, generating a unique rate of interest and a unique wage rate through competition.

Globally, however, the situation is different, capital is mobile, typically, labour is not. Although international movement of capital does encounter certain barriers one may admit that in the very long run equalisation of the profit rate will finally obtain. In contrast, when one examines the possibility of equalisation of wage rates on the international level, it is immediately evident that this condition can in no way be satisfied. "Concerning salaries borders constitute thresholds of absolute discontinuity" (Emmanuel 1962, p. 19, translated by author). In other words, since equivalence of exchange requires not only full competition and absence of barriers on commodity markets, but also on factor markets, and this liberty of factors moving to the best host being asymmetric between factors, it creates asymmetric gains of trade for nations. Low paid worker cannot move to the highly paid jobs. Their low pay yields thus a surplus value which is reaped as a surplus profit by the employing capital. Although written in 1962, the asymmetry of factors Emmanuel observes in their global circulation is probably more pronounced today than at that time. Labour markets are highly segregated nationally, while capital markets form almost the model of a global market.

The theory of unequal exchange advanced by Emmanuel triggered an intensive debate within its community, which we need not retrieve here (see e.g. Amin 1973). The question of why there may reason to look for inequality in international exchange will not be pursued here further on the theoretical level, but by proposing a statistical procedure for measuring it[3]. Emmanuel's exposition is subject to the same critique as the one we raised against Singer. He ignores the existence of the exchange rate intervening into the terms of trade as a third independent variable besides the domestic prices of each trading country. The failure to do so is inherent in all models that work with variables of the real economy alone where the exchange rate is seen as a mere, and constant, numeraire for transforming national values into each other[4]. The simplification is permissible on the assumption that the law of purchasing power parity determines exchange rates. Then relative prices may still differ across countries, but the currencies are exchanged at equal value, meaning that no matter which currency you choose you can by an equivalent amount of goods and services with each. It is a well established fact, however, that exchange rates of currencies are governed

[3] It ought to be mentioned, at least, that Emmanuel rejects all concepts of inequality based on "just" prices, "metacapitalist" or socialist prices, prices related to the "nature" of branches, such as primary vs. secondary production, prices distorted due to politics, or fluctuating prices. "We may (say that) any valid definition of unequal exchange must relate to and be based on the functioning of the capitalist regime itself." (p. 15)

[4] The critique raised above against Singer and Emmanuel concerning the neglect of the exchange rate as an independent variable influencing relative prices also applies to main stream trade theory, that does not even acknowledge the possibility of inequality in trade. It takes, to quote one example, Yarbrough and Yarbrough (2000) almost 500 pages before they feel the need to introduce the exchange rate, and to point out that "a change in the exchange rate, other things equal, changes all foreign prices relative too all domestic prices" (p. 471). All trade theory, including the equalisation theorem of factor rewards has been safely brought home by then, and is never reconsidered thereafter.

by purchasing power parity only partly. Parity of interest is at least as strong a force. Again, if labour were as mobile as capital differences in earnings would even out as fast as they do for capital. But this is not the case so that it is justified to attempt to measure the inequality engendered through the economic asymmetry in factor mobility in factor earnings.

2.2 The new approach: input-output analysis and purchasing power parity

Input-output-analysis has been developed for, and mainly applied to, studying the domestic structure of an economy. National tables of product supply and use, on which the analysis is based, are constructed as parts of the national accounts by national statistical offices. In these accounts the external economy is condensed to a quasi-sector "rest of the world", a term that, in its inappropriateness, mirrors the strongly national point of view under which these statistics are being operated[5].

Nevertheless, it was Leontief, the founding father of input-output analysis, himself who already developed an input-output model of the world economy. But in contrast to his pioneering study of the US-American economy he did not venture into the corresponding statistical endeavour here. The model has been refined in later studies, including theories of interntional trade and linear progamming as constituting elements (Duchin 2005, Stromman and Duchin 2006), where the need is expressed for regionalising flows and prices in a world model, thus determining regional terms of trade. But no attention is paid to the fact that international terms of trade are not determined by national prices alone, ruling on national commodity markets, but by international exchange rates of national currencies as well. The model assumes constant rates of foreign exchange, implicitly.

The omission has been natural, for Leontief, at least, because other options were not available at the time. Meanwhile an important advance has been achieved in statistical methodology. It has become possible to design, construct, and establish a generally valid measure of the external value of a national currency, called purchasing power parity. The project was started at the University of Pennsylvania, supported and distributed by the United Nations and is now in use as a standard measure by the World Bank and other international organisations for comparing national product internationally. As a result, it is now possible to separate the influence of the exchange rate from that of domestic or foreign prices in the analysis of terms of trade, and this is the step we take. We combine input-output accounting with accounting for purchasing power parity. The first one allows expressing the value of final goods and services in terms of industrial value added, and the second allows comparing the value of these factor inputs across borders, independently of the prevailing rates of foreign exchange produced by financial markets.

Let an economic system be described by a technology matrix $\boldsymbol{A}$ and a vector of final products $\boldsymbol{f}$. The vector $\boldsymbol{x}$ of outputs is then given by the Leontief-Inverse

$$\boldsymbol{x} = (\boldsymbol{I} - \boldsymbol{A})^{-1} \boldsymbol{f} \qquad (2)$$

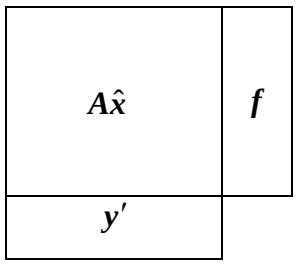
[5] The German reason for this nomenclature was that it was impermissible to classify the German Democratic Republic as foreign. Why all other nations followed this oddity is not known.

Vector $\boldsymbol{f}$ describes the domestic product of the economy in terms of goods and services produced (expenditure approach to GDP). The product approach looks at the value added in each industry, which is defined by

$$\boldsymbol{y}' = \boldsymbol{i}'(\boldsymbol{I} - \boldsymbol{A})^{-1}\hat{\boldsymbol{x}} \tag{3}$$

where $\boldsymbol{y}'$ is the row vector of value added and $\boldsymbol{i}'$ stands for the summation vector. $\hat{\boldsymbol{x}}$ is the diagonal matrix of branch outputs. Value added is usually separated into compensation of employees and operating surplus, the latter assuring the validity of equation 3 as the residual. Value added, as the name says, measures the total input of primary factors of production in a branch[6]. Figure 1 visualises the system.

Figure 1 The data of an elementary input-output system



Consider first a closed economy. Final use consists of two components, final consumption $\boldsymbol{c}_f$ and formation of capital[7] $\boldsymbol{f}_c$, so that

$$\boldsymbol{f} = \boldsymbol{c}_f + \boldsymbol{f}_c\,. \tag{4}$$

Because of the intrinsic linearity of the national accounting system it is possible to map the partition of final use of products into value added of branches, again using the Leontief inverse. This yields two vectors of output $\boldsymbol{x}_{cf}$ and $\boldsymbol{x}_{fc}$ and of value added $\boldsymbol{y}'_{cf}$ and $\boldsymbol{y}'_{cf}$ for each of the two components final consumption and formation of capital,

$$\begin{aligned} \boldsymbol{x}_{cf} &= (\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{c}_f \\ \boldsymbol{x}_{fc} &= (\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{f}_c \end{aligned} \tag{5}$$

and

$$\begin{aligned} \boldsymbol{y}'_{cf} &= \boldsymbol{i}'(\boldsymbol{I} - \boldsymbol{A})\hat{\boldsymbol{x}}_{cf} \\ \boldsymbol{y}'_{fc} &= \boldsymbol{i}'(\boldsymbol{I} - \boldsymbol{A})\hat{\boldsymbol{x}}_{fc}\ . \end{aligned} \tag{6}$$

[6] We neglect the distinction between product and industry, captured in a double set of supply and use tables, and assume a homogeneous branch structure *A*.
[7] We abstract from the distinction between gross and net aggregates.

We then have

$$y'_{cf} + y'_{fc} = y' , \tag{7}$$

and also

$$\begin{aligned} \boldsymbol{y}'_{cf}\boldsymbol{i} &= \boldsymbol{i}'\boldsymbol{f}_{cf} \\ \boldsymbol{y}'_{fc}\boldsymbol{i} &= \boldsymbol{i}'\boldsymbol{f}_{fc} \ , \end{aligned} \tag{8}$$

and a fortiori

$$\boldsymbol{y}'\boldsymbol{i} = \boldsymbol{i}'\boldsymbol{f} \tag{9}$$

Value added equals final product for the total economy[8]. Equation 8 says that the total factor input into a component of final use is exactly equal to the value of that component, and proportional to its share within GDP. Or, putting it differently, the value of the factor input is defined by the value of the corresponding expenditure product. Or, to add a third interpretation, as consumption is the purpose of all production, equations 8 describe the consumption foregone in devoting resources to formation of capital, i.e. the opportunity cost, in terms of consumption, of capital formation.

But equation 9 must also be read with a warning. It expresses equality in quantity, not in quality. Value added is not the same as GDP, although in loose language they are often identified. GDP is an aggregation of final products observed at different markets. Value added is a description of processes in different industries and describes the factors used in that process. It is an accounting construct to equate total size of the two variables, but not a qualitative identity.

Now consider an open economy. The GDP bipartition of equation 4 is then extended to include foreign trade, consisting of a product vector of exports, ***ex***, and of imports, ***im***,

$$\boldsymbol{f} = \boldsymbol{c}_f + \boldsymbol{f}_c + \boldsymbol{ex} - \boldsymbol{im} . \tag{10}$$

Using mapping (5) and (6) in the same way as before we arrive at a four-fold partition of value added,

$$\boldsymbol{y}'_{cf} + \boldsymbol{y}'_{fc} + \boldsymbol{y}'_{ex} - \boldsymbol{y}'_{im} = \boldsymbol{y}' \tag{11}$$

with

$$\begin{aligned} y'_{ex}i &= i'ex \\ \boldsymbol{y}'_{im}\boldsymbol{i} &= \boldsymbol{i}'\boldsymbol{im} \end{aligned} \tag{12}$$

[8] We also ignore product taxes and banking imputation.

The inclusion of foreign trade in domestic product introduces an asymmetry into accounting formulas. Export is counted positive, imports negative. The interpretation must follow this distinction. y'_{ex} measures the value added by domestic factor inputs to the goods and services leaving the economy for other countries. In contrast, $\boldsymbol{y'_{im}}$ measures the value not added by domestic factors, but substituted through production abroad. Equation 11 says nothing about the factor content of these imports. But we may interpret it as expressing the opportunity cost of those imports, namely the factor content of exports which are required to pay for the imports (double factorial terms of trade).

In order to proceed from these basics of accounting for one nation to the concept of a symmetrical picture of international trade we modify our notation slightly. We prefer now to show summation indexes explicitly in the formulas, which makes notation a little clumsier but also more precise. Let f_i^k be the vector of final product i in country k. We partition it into the components of domestic use (final consumption and formation of capital) d_i^k, and flows of foreign trade z_i^{kl} of product i from country k to country l,

$$f_i^k = d_i^k + \sum_l z_i^{kl} - \sum_l z_i^{lk}, \forall i \qquad (13)$$

The second term on the right-hand side of equation 13 sums the exports from country k to all other countries, while the third term sums the imports from them to country k.

Equation 13 is valid under the implicit assumption of a common unit of measurement for all these flows. The assumption is natural and hardly questioned within the realm of a national economy. The national currency, administered by a national central bank is incontestably considered a valid and ubiquitous measure of value, at least for periods of less than a year, transferring the same value from its old to its new owner, independent of the place, the purpose and the individual preferences for which it is transferred. In the international arena, this assumption no longer holds. Omnipotent as a national currency may appear inside its area of circulation, it buys nothing outside, except other currency. Accounting for international trade thus hurts itself at a valuation problem. How may different national products, valued in different national currencies be compared?

The first answer to the problem is usually found by turning to the foreign exchange markets. The rates of exchange created on these markets serve as a useful converter of one currency into another. If e^k is the exchange rate, i.e. the number of units of country k's currency required to buy one unit of some numeraire currency on the foreign exchange market the national accounting balance for GDP in the numeraire currency reads

$$\frac{f_i^k}{e^k} = \frac{d_i^k}{e^k} + \frac{\sum_l z_i^{kl}}{e^k} - \sum_l \frac{z_i^{lk}}{e^l}, \forall i . \qquad (14)$$

The flows produced in country k are converted by that country's exchange rate, and those coming from abroad by the exchange rates of their countries of origin.

Simple as it is, the transformation in nominal terms does not provide a statistically satisfactory way of measuring country performance on an international level. As every tourist knows from experience a currency may provide very different power of purchasing goods and services in different countries, when converted through the foreign exchange markets, depending on the prices ruling in each country. Comparing domestic product between countries in terms of their nominal exchange rates may thus lead to serious distortions. The crucial variable coming in between is the general level of prices ruling in a country. When it is low foreigners are able to buy more at a given exchange rate that if when it is high. In order to measure GDP in real terms we must correct the nominal exchange rates for their differences in price level.

The statistical method for doing so has been developed in analogy to the way the change of the internal price level over time is being monitored. One looks at each product group contained in GDP individually, and by means of appropriately chosen price representatives observes a possible price difference of the representative between countries at given exchange rates. From these data one compiles an aggregate price level for each country. In countries with a high price level a foreign currency unit will buy less when exchanged into domestic currency than in a country with a low price level. Purchasing power parity between currencies is given when these general price levels are equal. Let λ^k be the price level of country k relative to the numeraire country. The transformation of nominal values in equation 14 to real values may then be attained by adjusting the nominal values for their different price levels. One possibility of doing so is expressed by equation 15,

$$\bar{f}_i^k = \frac{f_i^k}{\lambda^k e^k} = \frac{d_i^k}{\lambda^k e^k} + \frac{\sum_l z_i^{kl}}{\lambda^k e^k} - \sum_l \frac{z_i^{lk}}{\lambda^k e^l}, \forall i . \qquad (15)$$

Every transaction concerning country k is deflated by this country's general price level λ^k. This method is reasonable from a national point of view, for the national balance of payment. It creates inconsistencies, however, when you look at it under a global perspective, because the international flows z_i^{kl} are valued in two different ways depending on whether they appear as exports or as imports. As exports from country *k* they are deflated by the price level of the country they originate from, λ^k, as imports to country *l* they are deflated by the deflator λ^l of the receiving country. A consistent valuation has to decide for one of the two.

As explained above, value added equals the value of final product in each country. The same holds for each partition of final product into its different uses (equation 12). Exports are a demand on domestic resources in competition to domestic use, consumption in particular. It is reasonable, therefore, to value international trade flows at their home value, in order to compare the corresponding factor inputs internationally. This leads us directly into conceiving a three-dimensional world trade flow table containing the matrix

$$\mathrm{WFT} = \begin{pmatrix} ..... \\ .....\frac{z_i^{kl}}{\lambda^k e^k}.... \\ ..... \end{pmatrix}, \forall i,k,l\ . \qquad (16)$$

The table shows for each good i from which country it comes and where it goes. It is a theoretical concept, at present. Available data allow only for a two-dimensional table in which the different products are aggregated, and the product dimension disappears. Compilation of such a table is our next task to which we now turn.

3. Statistical realisation: a world trade flow table

3.1 Theory and interpretation

Exports and imports are traditionally compiled by individual countries in their national accounts, and balances of payments. The national trade balances are compared internationally at actual, nominal rates of foreign currency exchange. This is justified in as much, as the concern is national balance in respect to international finance. But if one is interested in an analysis of the relationship between trade and production, searching for a picture of the circulation of goods and services and the employment of factors around the globe, a different kind of representation is appropriate. It is not enough to look at each nation separately, and study its position vis-avis "the rest of the world", but it is occasion to picture the world as one economy within which goods circulate and to apply known accounting rules and axioms to it. This results in what may be called a "world trade flow table".

There is a tradition of thinking along these lines. (Weale 1984), for example, constructs a "world accounting matrix" extending the concept social accounting matrix to studying policies of foreign aid. Vos and de Jong (1995) design and build a "world accounting matrix" (WAM) as a cross-check for the consistency of commoditiy flows, international payments and internal balances across countries for year 1990. Recently, a "world trade model based on comparative advantage with m regions, n goods, and k factors" has been proposed in this journal (Duchin 2005). The model defines an optimal allocation in the Ricardian sense, deriving national sector outputs and international prices from given factor endowments and rewards

Table 1 provides a new example. It has been constructed along the lines of equation 14. Countries have been aggregated into groups, in order to keep the table small. Each row registers the exports $\left(\sum_i \frac{z_i^{kl}}{e^k}\right)$ of one group of countries (row *k)* to the others (columns *l*). Due to country aggregation there are also intra-group exports. By way of logic, the columns of the table represent one group's imports from the others. Measurement is in currency of the numeraire country, conversion at foreign exchange rates. The corresponding table margins show the totals of rows and columns, and their balance, which is compiled in the last row of table 1 yields the trade balance for each group. Contrary to what one would like to cover under the heading of world trade, theoretically, the figures show the trade in goods, only, excluding services, because the corresponding data for services are difficult to obtain. The year 2000 has been selected simply because it is a round number. A long term analysis would require long term data, of course.

Table 1 Nominal World Trade Flow Table: Trade in goods, year 2000
(billion U.S. dollars at actual exchange rates)

group to: from:	I	II	III	IV	V	All exports
I	1498	324	132	187	231	2372
II	304	692	270	192	156	1614
III	149	354	47	53	74	677
IV	233	356	118	0	0	707
V	209	193	103	0	0	505
All imports	2393	1919	670	432	461	5875
All exports	2372	1614	677	707	505	5875
Nominal trade balance	-21	-305	7	275	44	0

Group I: Europe[9]
Group II: Australia, Canada, Japan, New Zealand, United States.
Group III: China, Czech Republic, Hungary, Korean Republic, Mexico, Poland.
Group IV: Developing countries[10]
Group V: Rest of the world

Table 1 is a summary of the detailed compilation explained hereafter. For the moment, we let aside technical matters, in order to explain the concept of the table. The trade balance in nominal terms is slightly negative for group I (Europe), heavily negative for group II comprising the United States, practically neutral for group III with China as the biggest member, heavily positive for group IV, which includes the oil producing countries, and finally slightly positive for the rest of the world. It can be read from the table which group draws finance into the country, offsetting the trade imbalance, and which groups generate the needed finance.

Originally, the data entered into the table have been denominated in their different national currencies. For each currency the law of equivalence holds, internally. A unit of the currency is accepted as transferring the same value, no matter where, by whom, and for what purpose it is paid. Going abroad the national currency looses its validity, and must be exchanged against some other means of payment. The exchange is organized in markets establishing a rate of exchange through supply and demand. One of the forces behind these operation is the power of a currency to purchase goods. The mechanism is conceived as arbitrage. If prices are lower in one country than in another at a given exchange rate product demand will shift to that country, increasing the demand for that country's currency, as well. The currency will appreciate, and the prices for foreigner's will rise until equality in purchasing power has been attained through the exchange market mechanism. The relationship between purchasing power parity and the exchange rate is given by (Kravis and Lipsey 1983, p. 9)

$$PPP^k \div e^k = \lambda^k = \frac{1}{r^k} \qquad (16)$$

The higher the price level λ^k is in a country, the higher is the volume of goods it buys abroad in relation to domestic spending at a given exchange rate e^k, and the higher is its purchasing

[9] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom.
[10] Algeria, Argentina, Bangladesh, Brazil, Chile, Colombia, Egypt, India, Indonesia, Iran, Israel, Malaysia, Nigeria, Pakistan, Peru, Philippines, Romania, Russia, Saudi Arabia, Singapore, South Africa, Thailand, Ukraine, Venezuela, Viet Nam

power parity. If purchasing power parity prevails the price level equals one. As explained above, purchasing power parity is not the only factor governing foreign exchange markets, perhaps not even the dominating one. Other factors are interest rate parity, portfolio composition, expected inflation, or the mere existence of un-traded goods (Krugman and Obstfeld 2000, Kravis and Lipsey 1983). They may outweigh its influence. But the real exchange rate r^k, which is the inverse of the price level λ^k provides, what in domestic economics is compiled by means of the consumer price index in the sense that it measures value of money in terms of the goods and services it buys. Price level, and real exchange rate are defined as dimensionless numbers. They equal one when a country's nominal exchange rate of the numeraire currency equals its purchasing power parity. The details of how to determine a country's purchasing power parity and its relative price level are relegated to the appendix for the interested reader.

Purchasing power studies have become a well-used instrument in analysing the position a country takes within the international trading network, and the fruit it reaps from its comparative advantage within this setting. For Switzerland this analysis has been carried out by (Antille and Fontela 2002), as changes in terms of trade are "the main driving force for the international distribution of incomes of productivity gains" (p. 3). Antille and Fontela analyse how a gain resulting from lowering some particular input coefficient is distributed through the economy to other sectors and to the rest of the world by means of price reactions. Since prices are not governed by cost alone the chain of causation between productivity gain and price decrease is not a simple matter to reconstruct. They find that summing over a period of ten years an amount of 36 billion SF in TFP surplus has been absorbed by Switzerland from the outside world, equivalent to half the imports of year 1988.

Two observations follow. First, the Swiss relationship with the outside world has "drastically changed". A country that has transmitted benefits of its innovative efforts to the world in 1990 is increasingly absorbing world TFP surplus paying relatively little for imports and charging relatively more for exports (Antille and Fontela p. 11). Second, and more important in our context, this change has occurred partly as a continuous appreciation of the Swiss frank in currency markets (variable e in equation 1) and has nothing to do with innovation in production (variable p_{ex} in equation 1). (Antille and Fontela p. 18) The observations highlight the goal we pursue in this paper: isolate the effect of movements of the monetary exchange rate from the effect of productivity change on the value of traded commodities.

While Antille and Fontela analyse the change in the trade of one country with all others (Fujikawa and Milano 2002) compare two countries, China and Japan. Their goal is tracing productivity differences, and their method, input-output analysis. In that they are akin to the study on Switzerland, but the results come out in a different packing. Not gains due to changes of productivity are studied but the distribution of existing comparative advantages. In theory, if the China – Japan study were done for all other countries as well, and carried forward over 10 years, the aggregation for Switzerland should come out at the result of Antille and Fontela. Comparing prices in China and Japan Fujikawa and Milano find that prices in Japan are 3,76 times as high as in China on average, at the given exchange rate. The trade balance being positive for Japan and negative for China in nominal terms it changes sign when converted to real terms. Applying the

interpretation attached to these statistics by Antille and Fontela we can say that Japan absorbs productivity rents from China while building up financial claims against it.

In line with this reasoning table 2 of real values has been constructed from the nominal value table 1 of world trade flows. The exports of goods of each country have been re-valued at real exchange rates of the national currency so that the resulting flows can be compared in terms of volume of products, independent of the valuation through a specific national currency.

Table 2 Real World Trade Flow Table: Trade in goods, year 2000
(billion U.S. dollars at real exchange rates, and normalised to world GNI)

group to: from:	I	II	III	IV	V	All exports
I	1103	234	95	140	174	1746
II	205	515	181	126	100	1127
III	325	722	95	102	162	1406
IV	533	715	261	0	0	1509
V	301	277	148	0	0	726
All imports	2467	2463	780	368	436	6514
All exports	1746	1127	1406	1509	726	6514
Real trade balance	-721	-1336	626	1141	290	0

Table 2 reveals the degree to which the effect of buying cheap and selling dear holds for groups I and II, while groups III, IV, and V sell cheap and buy dear, due to persistent discrepancies between the rates of foreign exchange and their parity of external purchasing power. The almost neutral nominal trade balance of developed economies in Europe (group I) turns negative when converted to real exchange rates, while developing economies (group IV) show a notable surplus. They sell under value, in the sense that market exchange rates of the currencies do not reflect the full input of domestic resources. This is not to say that nominal exchange rates are wrong, and real ones the correct or true exchange rates, in their place. True are the nominal figures, everything else is imputation performed by the accountant. The balance between nominal and real values is a statistical measure. It quantifies the effect of one particular variable, the foreign exchange rate, on the terms at which the wealth of nations is exchanged.

We use the GDP commodity basked for revaluing the trade flows rather than the specific prices indices pertaining to exports and imports respectively, as they are used in terms of trade compilation, ordinarily. This has two reasons. One is practical. Terms of trade are more difficult to access in the detail needed for revaluing every national trade with every other country. The other, better argument is of a theoretical nature. The purpose of the re-calculation is separation of the monetary effect on prices from the market effects of supply and demand, just as in domestic analysis, where a price rise relative to other prices indicates an effect between supply and demand of the good in question, a price rise in line with all other goods has no such significance, but concerns the central bank as a purely monetary phenomenon. Similarly, the rate of foreign exchange is governed by the aggregate purchasing power of currencies, not individual prices, which may differ between nations even if their general price levels are identical.

3.2 Details of compilation

Constructing a detailed world table of international trade flows, simple as it is in theory, is not an easy task, in practice. Data about international trade relationships are far from being complete, so that extrapolations must fill in figures where data are not available. And even where there are data their reliability is difficult to assess due to the need of applying averaged exchange rates of currencies that may be highly volatile. There is the well-known fact that registered world total of exports and of imports do not coincide. More severely, trade flows between nations may differ depending on whether sender or receiver are collecting the data. Thus what is presented here as a world table of trade flows is a first attempt, useful perhaps, for estimating orders of magnitude of revaluation effects, but it is not the final version of a

project. Tables 3 and 4 summarise the findings by comparing real trade balances of trading nations with their nominal trade balances.

The compilation has proceeded as follows. A data set from HWWA has served as the basis, providing figures on exports and imports between 22 OECD countries as well as six non-OECD countries for trade in goods. In addition, 25 other countries are reported by the named nations as either senders or recipients of trade in goods flows. A figure for total trade is also given. These were the raw data for the flow table.

Different compilation problems arose responding to different data situations. For those nations that reported and were reported two figures exist which do not coincide usually, one reason being that exports are reported f.o.b, and imports c.i.f. In the absence of any additional information the average of figures has been entered into the flow table. Some countries in the data set show imports into themselves or exports from themselves, the meaning of which is not clear and could not be explained by the producers of the data on demand. Assuming that it has to do with the difference between general trade and special trade these self-routed flows have been distributed in proportion of the known flows and added to them. This completed the interflow table for the 28 reporting countries. As a result of the averaging the sum of these flows deviated from those reported in the data. Assuming that the total of exports and imports is more reliable than the country repartition, the difference has been distributed proportionately to the trade with those 25 countries that were being reported without reporting themselves. In the absence of any pertinent information no flows were entered for trade between these countries. All the non-accounted trade is thus registered with the residuals of the rest of the world. All in all one may say that under the constraint of given resources internal consistency has been accorded priority over external fidelity in constructing the world table, which must then be read as conveying an idea rather than representing a reliable data set at its present stage.

Once the nominal trade matrix has been established, its transformation into real values is straight forward, applying given purchasing power parities from (World Bank 2002) as explained in the previous section. For each country the row of its exports is multiplied by the corresponding index of purchasing power parity compared to the US-dollar. It is customary to remain at the stage where the currency of one specific country serves as the numeraire. At second thought, however, this practice is neither politically correct, nor theoretically reasonable. It is a fundamental axiom of national accounts that value can be created and "added" only through production. Revaluation is not production. Hence world GNI in real terms must not be larger than it is in nominal terms, this being the actually transacted value figure. Re-normalising the compiled real values in this way makes the US dollar worth 31,315/44,459 = 0.7 international dollars. The full world trade tables of gross flows constructed in this way are too large to be reported here.

Table 3
Trade flows of nations in nominal terms
(trade in goods, year 2000, billion US-dollars at current exchange rates)

Country	GDP	Exports	Imports	Trade Balance	
				absolute	in percent of GNI
Australia	388	64	68	-4	-1
Austria	205	62	67	-5	-3
Belgium	252	185	172	13	5
Canada	650	278	240	38	6
Denmark	172	50	44	5	3
Finland	130	46	34	12	9
France	1.438	296	304	-8	-1
Germany	2.064	550	501	49	2
Greece	126	11	30	-19	-15
Ireland	86	76	51	26	30
Italy	1.163	239	237	2	0
Japan	4.519	479	380	100	2
Netherlands	398	180	175	5	1
New Zealand	50	13	14	-1	-2
Norway	155	60	34	26	16
Portugal	111	24	40	-16	-14
Spain	595	113	153	-40	-7
Sweden	241	87	73	14	6
Switzerland	274	80	83	-2	-1
Turkey	202	28	55	-27	-13
United Kingdom	1.460	285	340	-56	-4
United States	9.602	782	1.218	-436	-5
China	1.063	249	225	24	2
Czech Rep	54	29	32	-3	-6
Hungary	47	28	32	-4	-8
Korea Rep	421	172	160	12	3
Mexico	497	165	171	-6	-1
Poland	162	32	49	-17	-11
Algeria	48	16	8	8	17
Argentina	276	11	12	-1	0
Bangladesh	48	6	3	3	7
Brazil	610	44	36	8	1
Chile	70	16	9	7	10
Colombia	85	11	7	4	5
Egypt	95	5	13	-8	-9
India	455	32	24	9	2
Indonesia	120	54	20	34	29
Iran Islm.R	107	19	9	10	10
Israel	104	28	28	0	0
Malaysia	79	76	37	40	51
Nigeria	33	18	5	13	41
Pakistan	61	7	4	3	4
Peru	53	5	3	2	3
Philippines	79	35	26	9	12

Romania	37	10	10	-1	-2
Russian Fed	241	73	26	47	20
Saudi Arabia	150	59	23	36	24
Singapore	99	59	61	-3	-3
South Africa	129	25	18	7	6
Thailand	122	54	29	24	20
Ukraine	35	7	5	1	4
Venezuela	104	24	10	14	14
Viet Nam	30	11	6	5	17
Rest of the world	1.521	506	462	44	3
Total	31.315	5.875	5.875	0	--

Source: HWWA WORLD MATRIX of Sectoral Economic Data, http://www.hwwa.de/wmatrix, and own calculations.

Table 4
Trade flows of nations in real terms
(trade in goods, year 2000, billion international dollars at purchasing power parities)

Country	GDP	Exports	Imports	Trade Balance	
				Absolute	in percent of GNI
Australia	337	55	84	-29	-9
Austria	151	46	65	-19	-12
Belgium	199	146	174	-28	-14
Canada	589	252	210	42	7
Denmark	102	29	43	-13	-13
Finland	89	31	38	-6	-7
France	1.013	208	299	-91	-9
Germany	1.442	384	556	-172	-12
Greece	125	11	33	-22	-18
Ireland	68	61	43	18	26
Italy	954	196	266	-70	-7
Japan	2.420	257	620	-364	-15
Netherlands	290	131	167	-35	-12
New Zealand	50	13	15	-3	-5
Norway	94	36	33	3	3
Portugal	120	26	38	-12	-10
Spain	535	102	158	-56	-10
Sweden	150	54	66	-11	-7
Switzerland	154	45	75	-29	-19
Turkey	323	44	72	-27	-8
United Kingdom	991	193	343	-150	-15
United States	6.763	551	1.534	-984	-15
China	3.487	818	291	527	15
Czech Rep	100	54	36	18	18
Hungary	85	50	39	11	14
Korea Rep	576	236	210	25	4
Mexico	606	202	143	59	10
Poland	245	48	62	-14	-6
Algeria	108	36	6	30	28
Argentina	314	13	10	3	1
Bangladesh	147	19	3	15	10
Brazil	876	63	29	34	4
Chile	97	22	8	14	15
Colombia	180	24	5	18	10
Egypt	166	8	11	-3	-2
India	1.673	119	20	99	6
Indonesia	420	190	20	171	41
Iran Islm.R	265	47	8	39	15
Israel	85	23	22	0	1
Malaysia	137	133	30	103	75
Nigeria	72	40	5	36	50
Pakistan	181	20	4	16	9
Peru	85	8	3	5	6
Philippines	225	100	21	79	35

Romania	101	26	9	17	16
Russian Fed	821	249	24	225	27
Saudi Arabia	166	66	19	47	28
Singapore	70	42	52	-11	-15
South Africa	276	54	14	39	14
Thailand	270	119	23	96	36
Ukraine	129	25	5	20	16
Venezuela	98	23	8	15	15
Viet Nam	111	41	7	34	31
Rest of the world	2.185	726	436	291	13
Total	31.315	6.515	6.515	0	--

Source: HWWA WORLD MATRIX of Sectoral Economic Data, http://www.hwwa.de/wmatrix, and own calculations.

The detailed tables confirm the impression gained from the aggregate tables 1 and 2. If exports are valued in at real exchange rates the trade balances of OECD countries decrease while those of the others increase. In other words the economic principle of "buy cheap and sell dear" is well observed by the first group, and less so by the second. It is note-worthy, that the detailed exercise here does not lead to essentially different results than communicated in (Reich 2000), in spite of the fact that those figures were derived through crude estimates almost on the back of an envelope. The existing differences in purchasing power parity are by an order of magnitude larger than the measurement uncertainties of statistical procedure.

Looking at specific nations the three biggest traders, US, Japan, and Germany, form an interesting triad. The US trade deficit increases from -4.5 to –14.5 percent of its GNI, importing 984 billion $ of world resources, while exporting only for 436 billion $[11]. Japan, the second largest economy, while appearing as a creditor from its nominal trade balance, +2.2 percent of GNI, also becomes a heavy importer of world resources, -15 percent of GNI, and so does Germany with a move from +2.4 to –11.9 percent of GNI. The three countries together consume a real value of 5116 $billion dollars of world resources more than they employ.

Major net resource exporters are Indonesia, the Russian Federation and above all China with 527 billion dollars producing more than its employs, 15.1 percent of its GNI. The amount supplied to the world by the Russian Federation of 225 billion $ is only half of that, but stands for a quarter of its GNI (27.4 percent). For Indonesia its net real export of 171 billion $ makes up even 40.7 percent of GNI.

There are also countries which take a neutral position in this international economic power game. As defined above, trade is equal when the nominal and real trade balances coincide, because the value of the resources embodied in the products transferred abroad corresponds to the foreign value added in products received received. Examples are Ireland, Argentina, and Israel, the first running a heavy trade surplus (29.8 and 26.1 percent of GNI respectively), the second and third having their trade fully equilibrated (-0.3 and +0.9 percent of GNI respectively for Argentina, and 0.0 and 0.6 percent of GNI for Israel). One may infer that for their currencies foreign exchange value is determined by use for trade only.

4. Conclusion

[11] In this comparison a dollar, whether US or international, represents 1/ 33 billionth of world GNI.

The economic theory of unequal exchange is still at its infant stage. Textbooks ignore it, statistics as well. Concerning the latter, a proposition for improvement has been elaborated in this paper. Exchange is unequal when the intervening currencies are of different purchasing power at home than they are abroad. Input-output analysis shows us the intrinsic connection between a vector of final products, a sub-aggregate of GDP such as exports and the value added by domestic factors of production embodied in it. The foreign exchange rate re values these factor contents according to its own laws. Parity for these values is achieved when the nominal exchange rate coincides with the mutual parity purchasing power. On the basis of this definition, a comprehensive table of international trade flows is able to show the inequality of every country's trade with every other country.

Purchasing power parity of currencies holds at most over the very long run with heavy fluctuations in between. It is a well-known fact that between industrialised and developing countries it does not hold at all. The world trade flow table for goods in year 2000 presented here is not meant as a proof of that statement, of which there is no need. It adds, rather, to this general information the detail at which different inequalities can be shown to exist and measured, even if this exercise has not reached a satisfactory stage of statistical foundation, yet, at this stage.

Input-output analysis is widely used for studying relationships between output prices and input prices, "the terms of trade", of different industries within an economy, including the distribution of productivity spill-over. The paper extends this trail of research into studying trade between different nations, providing information about the distribution of gains between them. It is a widely held blindness to ignore that any gain in terms of trade of one country entails a corresponding a loss for another one, by definition. No production frontier is extended by a change the terms of trade. Terms of trade distribute rather than create gains of trade, and it is for this reason analysis of their equity must find a place in trade statistics as well as theory.

Theoretically, and following Emmanuel, equality in terms of trade may be achieved by increasing labour mobility, and lowering institutional barriers that now prevent labour from moving out of underpaid jobs upstairs (e.g. immigration laws). But this is only a theoretical solution. In practice, a worker will always receive a lower real wage in developing countries than in industrialised ones for the same work (e.g. a university teacher), as Emmanuel observes himself.

The final question is, rather, what use there is for a measure of inequality of exchange for economic policy. The advice to undervalued countries drawn from Singer's analysis was withdrawal from the world market and build-up of import substituting industries. Emmanuel's analysis was interpreted as leading to the same conclusion, although its author did not mean it that way. By now, all schools of thought have learnt to avoid simple answers. Yet, for finishing this paper a provocative statement by Singer may be re-animated: "The industrialised countries have received real repayments from their foreign investments (in many forms).. When on the top of the returns in these … forms they also tried to 'get their money back' they may perhaps have been asking (in the economic, not in the legal sense) for double payment; they may have been trying to get a quart out of a

pint bottle." (Singer 1950, p. 480). Perhaps, a regularly compiled table of world trade flows helps to put into perspective this latent feeling of asymmetry. A devaluation of the national currency may be assessed differently in its economic consequences between countries enjoying a favourable exchange rate, and those which already suffer from an unfavourable one. Equality in trade is a decent goal, it seems, of international economics to go for.

Appendix

The relationship between purchasing power parity and the price relative is given by

$$PPP_i^k = P_i^k e^k \tag{1}$$

where PPP_i^k is the purchasing power parity of country k in product class i, and P_i^k is the price relative of the country in respect to the numeraire country within product class i. From these data, collected for each product class in each country, a system of joint (world) prices π_i and national price levels λ^k is deduced by means of the following revaluation system:

$$\lambda^k = \frac{\sum_i \frac{f_i^k}{e^k}}{\sum_i \pi_i \frac{f_i^k}{PPP_i^k}}, \forall k\,. \tag{2}$$

The general price level is defined as the ration of the nominal value of GDP of a country expressed in a numeraire currency over sum of the volumes valued at a shadow world price π_i which itself is defined as an international (harmonic) average of national prices,

$$\pi_i = \frac{\sum_k \frac{f_i^k}{\lambda^k e^k}}{\sum_k \frac{f_i^k}{PPP_i^k}}, \forall i\,. \tag{3}$$

The two sets of equations for a homogeneous set of linear equations in unknowns π_i and ε^k with

$$\varepsilon^k = \frac{1}{\lambda^k}, \tag{4}$$

namely

$$\pi_i \sum_k \frac{f_i^k}{PPP_i^k} - \sum_k \varepsilon^k \frac{f_i^k}{e^k} = 0, \forall i \qquad \wedge \qquad (5)$$

$$-\sum_i \pi_i \frac{f_i^k}{PPP_i^k} + \varepsilon^k \sum_i \frac{f_i^k}{e^k} = 0, \forall k \qquad (6)$$

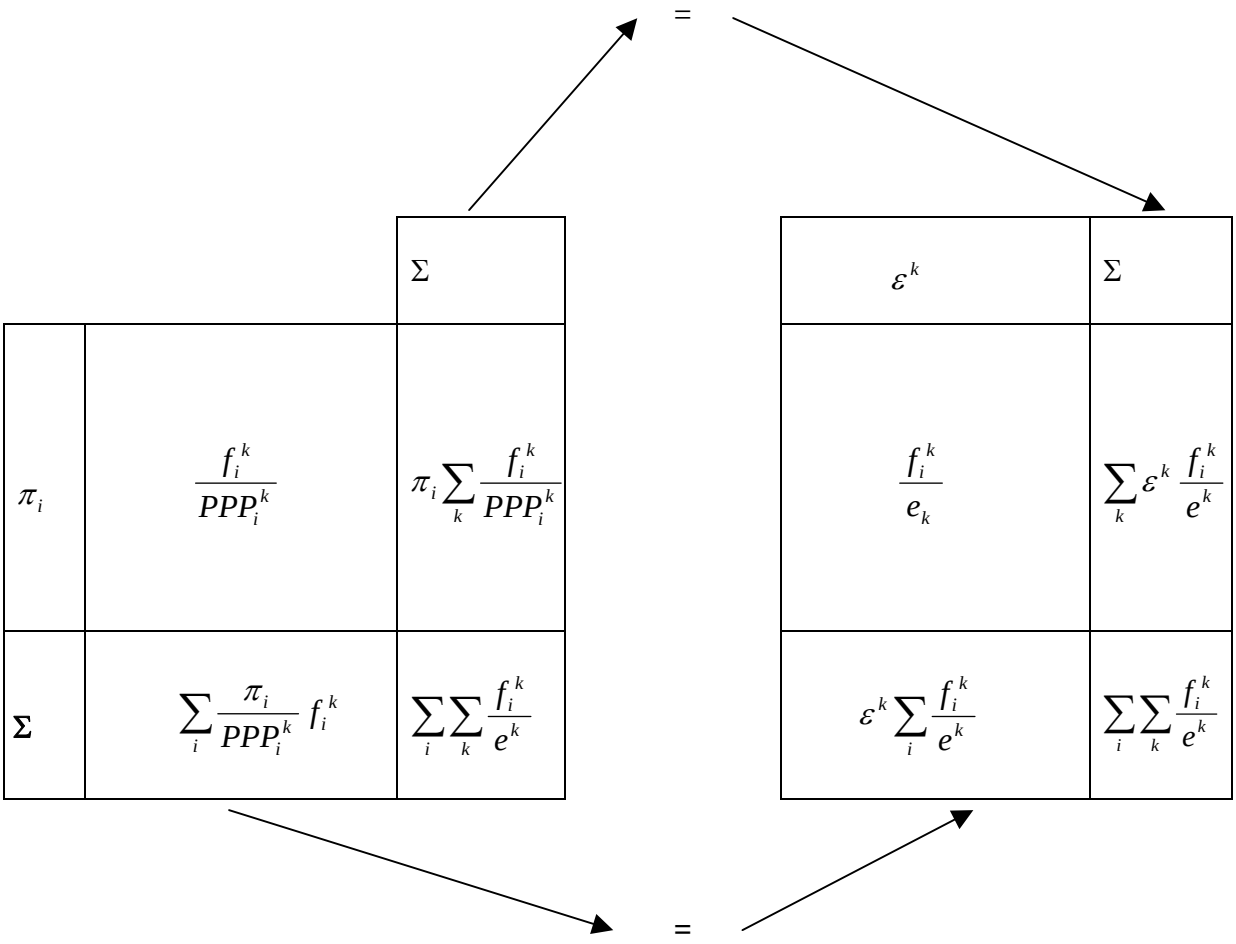
ε^k is the real exchange rate (Kravis and Lipsey 1983, p. 9). You can interpret this accounting system, proposed by Geary and Khamis saying that in the first equation the sum of the volumes (deflated nominal values) multiplied by the world price must equal the total value of the product group in nominal terms valued at real exchange rates for each product group, and, in equation 16, the nominal sum of products (GDP) transformed at its real exchange rate must equal the same GDP valued in world prices for each product group. Both sets of unknowns are dimensionless numbers, the real exchange rate being the inverse of the general price level.

The national accounting balance which has been set up in domestic currency units in equation 8 now reads

$$\varepsilon^k y^k = \sum_i \pi_i \frac{f_i^k}{e^k} \qquad (7)$$

in international currency. Table 2 visualises this compilation.

Table 2 Scheme of purchasing power parity compilation



The arrows indicate equations. Summing over columns *k* yields equality of column sums of volumes (left table) and real values (right table, equation 5). Summing over rows *i* yields row sums (GDP) of countries, where again the sum of volumes (left table) equals the sum of real values (right table, equation 6). Volumes are values at equal prices between countries, and different for each product, real values are values at equal purchasing power of the measurement unit over products, and different for each country. The sum totals of each table are equal and normalised to the transaction value of world GDP (lower right hand corners). The tables construct world prices and national purchasing power as dual variables in a similar way as quantity and price are constructed in the inter-industry table.

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