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DOES PPP-ADJUSTED DATA EXAGGERATE THE RELATIVE *SIZE* OF POOR ECONOMIES?

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Abstract

The concept of purchasing-power parity has been invaluable for making international comparisons of living standards. But the growing practice of using adjusted real income data designed to measure relative living standards for estimating the relative productive potential or "economic size" of countries may be quite misleading. In particular, the data now usually employed may greatly exaggerate the economic size of poor countries. Instead we propose a definition of relative economic size measured by valuing total output at the equilibrium prices that would prevail in an hypothetical world of frictionless economic integration. This gives very different answers.

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DOES PPP-ADJUSTED DATA EXAGGERATE THE RELATIVE *SIZE* OF POOR ECONOMIES?

I. Introduction

This paper addresses the recent vogue in using PPP-adjusted GDP data as a comparative measure of the economic *size* of nations. The concept of economic size of nations is less well-defined than *per capita* income or wealth, for which a well-developed literature exists. To the extent that size connotes an aggregate measure of productive capacity, as distinct from the product of population with average living standards, it is not clear that the same PPP-adjustments are immediately applicable.

The hazards of converting output figures at market exchange rates have been acknowledged for decades; the results obtained can be most misleading. Development of systematic purchasing-power adjusted output data, especially the Penn World Tables from the International Comparison Project (ICP) (Summers and Heston, 1988, 1991), has accordingly opened the door to a wealth of cross-country applications. The usual adjustments involve replacing actual goods prices by standard prices, which are output-weighted averages of national prices. The adjusted figures for per capita output or consumption are a big improvement when it comes to comparing living standards, and this paper in no way attempts to question their use in that context.

In practice, the standard prices employed are closer to the relative price structure that exists now in the rich countries. In rich countries, goods and services for which productivity differentials are not very great have relatively high prices, essentially because the opportunity cost of factors used in their production is so high. That is why the usual PPP-adjusted figures greatly increase the relative economic size of poor countries.

But is this a good basis for measuring the relative productive capacity or economic size of different countries? We propose an alternative definition whereby a country's relative economic size is measured by its output valued at the prices that would prevail in a frictionless global equilibrium. In such a state, relatively low-skill or unproductive factors of production, at present resident in poor countries, would be employed in producing those goods and services for which productivity differentials are slight. This would depress the price of these goods.

Specifically, we ask what the PPP-adjustments would be if calculated at a price set approximating what might prevail if all existing policy and technological barriers to international price equalization were removed at current productivity levels. Pursuing this thought experiment, it is clear that, in such a scenario, both production patterns and relative prices would alter. Valuing actual or potential output (or factors of production) at these notional equilibrium prices can produce quite different figures for relative economic size. In particular, the relative size of poor countries on this definition may well be much smaller *on average* than that implied by conventional PPP-adjustment. Indeed, as a group, the relative size of the poor countries may be little larger than is implied by the unadjusted GNP figures.

Two caveats: First, the thought experiment does not pretend to be a forecast: over time, human and physical capital formation will change the productive capacity of poor countries. Second, in case of any misunderstanding, it should be clear that this is not an argument for reverting to the use of market exchange rates which of course remain quite misleading for country-by-country comparisons.

The empirical facts

One of the big messages of the usual PPP-adjusted data is an apparent shrinkage of the gap between rich and poor countries. For example, without PPP-adjustment, per capita output in Portugal is 104 times that in its former colony Mozambique, but using PPP-adjusted figures the multiple falls to 14. Likewise, arbitrarily selecting

other ex-colonial pairings, per capita output gap between the UK and Bangladesh shrinks from a multiple of 83 to a multiple of 13; that between France and Côte d'Ivoire shrinks from 130 to 27; that between the Netherlands and Indonesia from 25 to 5.

Table 1: *Shrinkage Factors: Selected Country Pairs*

		Ratio of per capita GNPs		Shrinkage factor
		at market prices	at PPPs	
Portugal	Mozambique	104	14	7.4
United Kingdom	Bangladesh	83	13	6.4
Netherlands	Indonesia	130	27	4.8
France	Côte d'Ivoire	25	5	5.0
Slovenia	Mauritius	2.2	0.5	4.4
Mali	Uganda	1.3	0.4	3.2
Switzerland	Kuwait	2	1	2.0

Another consequence of this shrinkage is a re-ranking of countries by total economic size, as has recently been highlighted by the International Monetary Fund's *World Economic Outlook* and in many recent issues of *The Economist*. This applies especially to the populous countries of Asia. At PPPs, China's total GNP is larger than that of Japan - making it the second largest economy in the world on this reckoning, whereas at market exchange rates it slips to seventh place just ahead of Canada. At PPPs, India's GNP matches that of France instead of being smaller than Australia's as it is if the comparison is made at market exchange rates.

Especially when expressed in terms of total economic size and re-ranking, the PPP figures suggest a much smaller degree of world economic dominance of the industrial, or advanced, countries. If recent growth rate differentials are maintained,

the leading world economies will be passed out before long, and the economic centre of gravity will decisively move southward and eastward. According to IMF (1997) forecasts based on PPPs, total real output of China will surpass that of both the EU and the USA by about 2007.

The shrinkage factor (or what is sometimes called the ratio of national price levels) is typically larger the wider the initial output gap. Figure 1 shows the shrinkage factor relative to the US for each of 114 countries.[1] An upward-sloping trend (long known as the Samuelson-Balassa relationship) is evident: using the World Bank's definitions, for low-income countries the mean shrinkage factor is about 4.1, for lower (upper) middle-income countries it is about 2.6 (1.9); for high-income countries it just under 1.1 (Table 2)

Table 2: *Shrinkage Factor by Range of Income*

Country income group	GNP per capita (nominal $, mean)	Shrinkage Factor Relative to US* (unweighted mean)
Low-income	430	4.1
Lower-middle-income	1670	2.6
Upper-middle-income	4260	1.9
High-income	24930	1.1

*Ratio of PPP-adjusted to unadjusted per capita GNP, index US=100.

The statistical regularity underlying these large differences is clear: poor countries produce relatively more of goods that have a relatively low valuation at home. Two

[1]These are based on the World Bank Atlas approach which smooths the nominal figures over a three years average. Note that 38 of the 114 of the PPP-adjustments shown in Figure 1 are fitted values from a regression relationship, estimated from the ICP data on the remaining 76 countries, where the PPP adjustment is a function of secondary school enrolment and of the "Atlas-based" smoothed but unadjusted per capita GDP (cfAhmad, 1992).

alternative theories explain why this should be so. The approach of Harrod (1933), Balassa (1964), and Samuelson (1964, 1974) is to suppose that countries have different production functions, with poor countries being less productive for both traded and non-traded goods, but with the productivity gap wider for traded goods. While trade will tend to bring the prices of the former to equality internationally, that is not true for non-traded goods, which will tend to have lower prices in the country where productivity is lower. The alternative approach of Kravis and Lipsey (1983) and Bhagwati (1984) envisages a common production function, but factor immobility implying that goods intensive in the plentiful factor will have a lower relative price.[2]

Note that shrinkage factors can vary considerably, even between countries at similar levels of income. The ratio of Slovenia's per capita output to that of Mauritius shrinks from 2.2 to 0.5; the Mali/Uganda ratio shrinks from 1.3 to 0.4; and the two-to-one advantage apparently held by Switzerland over Kuwait shrinks to nothing after the PPP adjustment. This dimension of PPP adjustment is not disputed by the present paper: we are only concerned with the systematic variation of shrinkage with level of income.

Potential productivity and the "world equilibrium" price set

But are the poor countries really as productive in aggregate as the PPP adjustments seem to imply? After all, studies of particular sectors consistently point to huge gaps in manufacturing productivity (e.g. China's manufacturing productivity only 6 per cent of that in the US, Timmer, 1999). Productivity gaps in non-traded goods and services are usually measured to be lower but with little confidence.

The usual PPP adjustments are based on valuing national output at standard price vectors that are essentially output-weighted averages of national price levels. Such a

[2]Both of these models assume common tastes: differential tastes would tend to run in the opposite direction, local preferences driving up the prices of specific non-traded goods. See also Asea and Mendoza (1994), Rogoff (1996).

procedure can be justified when the questions of interest relate to welfare. But it is not at all obvious that the same standard price vectors are the most relevant for answering questions about size. Instead, consider the world price vector that would emerge if the barriers that cause international price differences were removed. We argue first that, if one were to evaluate national outputs at that price vector, one would probably obtain sharply different results, with lower shrinkage factors. Furthermore, that price vector is arguably more relevant for judging underlying or potential productive capacity, not least becauseglobalization and technology changes makes future convergence towards that price vector plausible.

Section 2 provides a brief review of the standard price approach to international comparisons, and suggests how an application of the logic of the economic index can help in selecting a "world equilibrium" standard price vector differing from the usual weighted averages. Section 3 presents a simple model of productivity differences. The model is used to compute several alternative "world equilibrium" standard price vectors appropriate to comparisons of productive capacity and shows how heavily dependent the shrinkage factors can be on the choice of standard price vector. Section 4 assesses how realistic the model is, by reference to recent empirical work on international productivity differences. Section 5 contains concluding remarks.

II. Standard Price Indexes

The index number problem

International comparisons of output call for the use of index number theory to deal with the fact that relative prices and the composition of output differ from country to country.[3] There are several established ways of using price and output data for constructing international comparisons of aggregate GDP, but we will focus here on the approach which allows us to make our main points in the simplest possible way, namely, the use of a set or vector of standard international prices to value the product groups.[4] This approach also happens to be the most widely used in practice.[5]

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[3]An authoritative discussion is Kravis et al. (1982). The typical PPP adjustments begin with the collection of prices in the different countries for precisely specified final products, representative of product groups into which expenditure on GNP is subdivided. There is a lively debate on alternatives, especially for the purpose of sectoral productivity comparisons. Thus, in their study of manufacturing productivity, Van Ark and Pilat (1993) employ unit values instead of the specification pricing technique of the ICP. Another point of disagreement is whether productivity and productive capacity are best measured by reference to gross output or net output (net of depreciation) (Hulten, 1992). Van Ark and Pilat (1993) favour net output, a decision which, along with the use of unit values, is criticized by Jorgenson (1993). Bernard and Jones (1997) make sectoral productivity comparisons using the usual standard-price PPP adjustment.

[4]Factor prices could also be used as an alternative to output prices, but involve greater practical difficulties in achieving quality equivalence. Comparing skill levels of labour inputs, for example, is notoriously difficult, and even the best attempts to do this by using information such as number of years' schooling are inevitably very imperfect (Barro and Lee, 1993). This may not matter so much if "years of schooling" is being used as an explanatory variable in a growth regression (e.g., among many others, Mankiw, Romer and Weil, 1992); it matters more when it is being used to compare skill-corrected wage rates across countries. Any measure of capital stocks raises well-known and difficult questions; adding the dimension of international comparison only adds to a severe problem. As a result, there is probably much less agreement on the degree to which relative factor prices differ across countries than there is for the relative prices of different types of output.

[5]Though there are other methods in use for adjusting GNP ratios: Diewert (1990) and Hill (1997) provide lucid surveys. In terms of Hill's taxonomy the standard price methods to which we chiefly refer here are his "average price symmetric star" methods. The most prominent competitor to these in practice are the "mean asymmetric star" methods, involving an averaging over the different ratios produced by each pair of national prices; of these the so-called EKS method is most widely used.

But what standard price vector should be used, and how much does it matter? Hill (1997) lists eight different formulas that have been proposed in the literature for generating the standard price vector. Each of these formulas is based on some kind of averaging of the price vectors prevailing in the different countries. They differ as to functional form of the averaging and as to the use of output weights in the averaging. Loosely speaking, the closer the standard price vector is to rich country prices the larger the shrinkage factor (a consequence of the well-known Gerschenkron effect). Thus the weights used in the averaging can matter in a systematic way.

Geary-Khamis prices

The most widely used procedure for choosing standard prices was introduced by Geary (1958) and elaborated by Khamis (1972). The Geary-Khamis procedure generates currency conversion factors (PPPs) as well as a standard set of international prices (one of Hill's eight). These satisfy two criteria. First, the international price for each good is a weighted average of national prices (converted at the PPPs), with the weights corresponding to output shares. Second, the value of GDP for each country computed at national prices and converted at the PPPs equals the value of GDP computed at international prices.

Because of the dependence on output shares, a small poor country contributes little to the formation of the Geary-Khamis prices; this tends to yield a relatively high shrinkage factor for small poor countries, as a result of the Gerschenkron effect. Does the dependence of shrinkage on size reflect an underlying reality, or is it an arbitrary artefact of the averaging procedure? Concerns of this type have kept alive the long-running debate over alternative averaging procedures, including the use of price averages which are not weighted by volumes. The choice between such alternatives has generally been couched in terms of an axiomatic approach to index numbers in which aggregation and symmetry criteria are to the fore. There has been a tension in this literature between the search for "representativeness" and the need to avoid undue influence of "tiny countries". Can economic equilibrium concepts

provide some additional guidance in helping to match the choice of standard price vector more closely with the economic issues being addressed?

Economic indexes

As an alternative to applying the standard prices to *actual* quantities, the so-called economic indexes use *imputed* quantities purporting to represent the quantities that take account of the demand or supply response that would be entailed by a change from actual prices to the standard price vector. In order to calculate economic indexes, however, there is the major drawback that, in addition to actual price and quantity information, it is in general necessary to have some estimate of the demand or supply elasticities in order to take account of the responses. In other words one needs to have some estimate of the parameters of utility or production functions in the different countries. Nevertheless, the economic index approach in an instructive one. Furthermore, even if the parameters of the utility or production functions are not fully known, some usable results can be obtained for economic indexes.[6]

World equilibrium prices

A line of thinking analogous to that which leads to the economic index suggests an alternative approach to choosing standard prices that relates more closely to the economic issues being addressed. Thus, instead of simply employing one of the available averages of actual prices as a standard price vector, one could in principle compute the price vector that would prevail in the equilibrium of some hypothetical economic configuration.

Specifically, in order to get a standard price set that is informative in the context of measuring aggregate productive potential, imagine a world economy endowed with

[6]For example, Dowrick and Quiggin (1997), show that quite a narrow range (about +/- 15 per cent) bounds the value of a true cost-of-living index based on arbitraryhomothetic preferences. For productivity comparisons (though not in a standard-price context) Caves et al. (1982) show that, if the production function is translog, under mild restrictions, the ratio of (Malmquist) indices can be calculated from price and output data alone.

existing resources, but in which all barriers to trade had been removed, and in which a single price prevailed for each good. This hypothetical "world equilibrium" price vector is an interesting one to use as a standard price for the international comparisons. Alternatively, we could imagine a world in which factors were free to migrate. This too would produce an equilibrium goods-price vector which can in principle be used as a standard price.

Since barriers to goods or factor movements are thought to be at the root of international prices differences, and as these barriers are gradually being eroded by policy and technological developments, use of one or other of these "world equilibrium" price vectors can throw relevant new light on the comparative aggregate productive potential of different economies.

If it could be argued that moving from the usual approach to a world equilibrium price vector made but little difference, that itself would be an important source of comfort.[7] But the remainder of this paper shows that the effect might be very large indeed, with the world equilibrium likely to be much closer to poor country prices than to rich country prices.[8]

[7]For example, it turns out that, in a model without production, and for a class of homothetic utility functions, the market-clearing prices that would result from equal distribution of world welfare are generated by the Geary procedure (Neary, 1996).

[8]The historical problem of measuring the productive capacity of the formerly planned economies illustrates the value of using world equilibrium prices as a reference. Protection through policy-created barriers masked the productivity gaps of transition economies for decades. Some (though not all) of the output collapse in these countries can best be interpreted as a reflection of their lower productivity when measured at actual world prices.

III. Computing world equilibrium prices

A model of international labour productivity differences in traded goods

We consider a multi-country two-good model designed to capture in a simple way the Balassa-Samuelson idea that high productivity is harder to achieve on average in the production of non-traded goods, while retaining an internationally common production function as in the Kravis-Lipsey-Bhagwati approach. Thus, suppose that there are just two goods: good T, which is always traded, is produced by capital and skilled labour; good N is produced by capital and unskilled labour only. Secondly, let us suppose that labour in country i is endowed with a skill level l_i which thus enters as a multiplicative factor in the production of T but does not contribute to production of N.

$$y_{iT} = f(K_{iT}, l_i L_{iT})$$
$$y_{iN} = g(K_{iN}, L_{iN})$$

Finally let capital be internationally and intersectorally mobile, let both of the production functions be constant returns to scale and well-behaved, and take the price of T to be unity everywhere.

These are conditions under which the non-substitution theorem applies: knowledge of the international rental rate of return on capital (together with the production technology) is enough to determine wages and outputs. Except to the extent that it affects the international rental rate on capital, domestic demand has no influence on the equilibrium relative price of N or on the wage rate. The logic of this familiar argument[9] is as follows: international mobility of capital implies that the world rental of capital determines the ratio of capital to labour efficiency units used in the T sector; this in turn determines the wage rate of labour efficiency units. Using T as numeraire, the relative price of N and the capital-to-labour ratio in the N sector are both determined by the conditions that the marginal products of labour and capital

[9]This all assumes that the country is producing traded goods as well as non-traded. For a recent textbook treatment, see Obstfeld and Rogoff (1996).

equate the wage and rental rates already determined in the *T* sector.

The qualitative features of the equilibrium of this model can be described in words. Consider first the situation where labour is internationally immobile and where, because of some policy or technological barrier, good *N* is non-tradable. In terms of labour efficiency units the wage is the same in all countries; thus the ratio of wage rates per worker is proportionate to the ratio of efficiencies. In other words the wage rate for labour of skill level $l=1$ is common internationally. The wage rate *per person* is higher in richer (high-efficiency) economies, as it is effectively determined by labour's opportunity cost in the *T* sector; as a result, the price of *N* will also be higher in rich countries - though increasing less than in proportion to wages.

So we have some of the high-skilled labour in the rich countries producing *N* even though this does not actually use their skills. It would be cheaper to replace these high-skill workers in the production of *N* with low-skilled labour, but this is not possible because of labour immobility and the fact that this good is non-traded.

In this model, the ratio between *per capita* labour income in two countries *A* (think of America) and *B* (think of Bangladesh), measured in terms of *T*, is proportional to the ratio of skill levels l_A / l_B. But it is important to recognize that in real terms the difference is smaller because of the relatively high price of *N* in *A* (Figure 2). As to the question of relative productive capacity or potential in the two countries, at one level (and ignoring capital[10] for a moment), the true productivity ratio of labour is l_A / l_B, and should not be subject to any shrinkage.[11]

[10]As for capital, we have made no statement about its ownership. In theory workers could have an equal share of ownership in the world capital stock. In practice history will likely dictate that capital ownership is lower in poor countries, thus reinforcing the point being made here.

[11]Note that, considering skill-adjusted wages and the return on capital, factor-price equalization prevails, at least when measured in terms of the traded good as numeraire. It is instructive to realize that this implies that a GNP comparison based on market exchange rates is in this case a standard (factor) price index. Of course it represents only one of many possible standard price indexes, but the fact remains that if factor price equalization prevails, the

So much for the base case; now consider what would happen if some of the barriers to economic integration were removed whether through factor mobility, policy or technological change. The resulting redistribution of labour resources, or unification of the market for good *N*, will result in a new set of production patterns and market-clearing prices.

World equilibrium prices with integrated goods markets

The consequences of making good *N* tradable are dramatic. The relative price of the two goods becomes common worldwide reflecting the law of one price. Because of its lower skill requirements, production of *N* shifts to the poorer countries, while the richer countries specialize in the skill-based good *T*. Specifically there is a particular value l^* of the skill parameter which divides the countries. Those with a higher skill level produce only the skill-based good *T*, while those with a lower skill level produce only *N*.

It is easy to show that the *per person* wage rate in the high-skill countries remains proportionate to the skill parameter, as it was in the base case of non-tradability of *N*. But, because of the specialization, factor price equalization does not apply as between the high skill and low skill countries. In the latter, because the skills are not being used, the *per person* wage rate is fixed at the rate applying in the borderline country with skill level l^*.

If the rental rate on capital is the same as in the base case, then we can plot the *per person* real wage in this unified goods market case as in Figure 2. For low skill levels this is constant, but above l^* it increases in proportion to the skill parameter l. The effect of unifying the world market for *N* is thus to compress international real wage differentials for low skill levels, while expanding them for high skill levels.

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unadjusted GNP ratios are one of the many valid PPP indices.

The real wage ratio between a high skill country and any country that is not too far below the borderline skill level will be higher at these price levels than in the base case.

If few countries have skill levels far below the borderline skill level, then comparisons based on this hypothetical world equilibrium price set will tend to imply less shrinkage than conventional comparisons based on the usual price averages. In practice, the distribution of skills or productivity is, on most measures, positively skewed. This creates a presumption that there will be fewer countries with a skill level far below the borderline value than there are countries far above it.

Of course, the identity of the borderline country, and thus the equilibrium prices in an unified market, depends on demand patterns. The prices of N will be lower than before in rich countries: how far will this induce increased demand in rich countries? At one extreme we could imagine that N was an inferior good and with little elasticity of substitution. This would result in low demand and a low equilibrium price. On the other hand, if N was a luxury good and with high substitutability between the two goods, the world demand for N would be strong, requiring the output of many countries, and thus resulting in a high equilibrium price in the unified market.

Calibrated simulations

The qualitative features of the equilibrium described above do not tell us whether the world equilibrium prices would be closer to rich country or poor country prices. For that we need some quantification. To this end we calibrated the model and conducted simulations for a multi-country world. The results are shown in Figures 3 and 4 which assume a Cobb-Douglas production technology and different demand structures. We modelled 50 countries, assigning values of the skill parameter l to each in such a way as to result in a distribution of skills corresponding to the actual

world distribution of countries by average per capita GNP.[12] The market-clearing relative price in each country, the Geary-Khamis standard price and the world skill-adjusted wage rate are first calculated before unification of the goods market. The world market price, and the *per person* wage rate in the borderline country are then calculated on the assumption of goods market unification. The resulting shrinkage factors are plotted against the skill level in panel *a*; and the Lorenz curves of actual *per capita* GNP calculated on the basis first of the Geary-Khamis prices and then of the world equilibrium prices are plotted in panel *b*.

The price and income elasticities of demand for good *N* are both zero in Figure 3. As each person consumes the same quantity of that good, this yields a low world equilibrium price, low shrinkage factors at that price and a more unequal distribution of *per capita* GNP. In contrast, Figure 4 is based on each country acting as if they all had identical Cobb-Douglas utility functions (constant value share) giving much higher price and income elasticity of demand for good *N* and a much higher world equilibrium price. Even with Cobb-Douglas demand the world equilibrium standard prices yield lower shrinkage factors than the Geary-Khamis prices and a more unequal distribution of *per capita* GNP.[13] In both cases, the relative size of poor countries is much smaller when evaluated at world equilibrium prices than at Geary-Khamis prices.

The full "economic index" corresponding to each of these cases was also calculated (i.e. using the imputed production quantities as well as the imputed world equilibrium

[12]The flat segments in the plots correspond to the average levels of productivity of India and China, which are assigned to a sufficient number of hypothetical countries in the simulation to match India and China's relative size in the actual world population.

[13]The essential parameters for the simulations shown are as follows: both production functions have a capital share parameter of 0.4; the required minimum consumption of good *N* in the zero demand elasticity case is fixed to be just within the production capacity of the poorest country and the Cobb-Douglas case is calibrated to deliver the same share of good *N* consumption for the richest country as in the zero demand elasticity case.

prices). If plotted on figures 3 and 4, the economic index would in each case be quite close to the plot shown for actual quantities evaluated at world equilibrium prices.

Standard prices based on modelling equilibrium with labour mobility

As a further example, we assume once again the low-skill good N is non-traded, but ask what happens if labour is fully mobile, and redistributes itself efficiently across countries. Both goods are produced in all countries. Once again the lower-skill workers end-up producing the low-skill good. The same borderline value of l^* divides those who are employed in the traded goods sector from the others, and the world equilibrium price is as in the unified goods market case.

IV. Discussion: Modelling Productivity Differences

The model of the previous section provides two main reasons why conventional shrinkage factors may exaggerate the relative productive capacity of poor countries. First, skill differentials that are manifest mainly in the production of traded goods may be concealed by PPP-adjusted comparisons. Second, the world equilibrium relative prices that would prevail if goods or factor markets were unified might well be closer to those now prevailing in poor countries; if so, such a unification would result in wider gaps between per capita GNP than is indicated by conventional PPP adjustments.

International productivity differences by sector

An essential assumption of our model are that labour productivity differences between rich and poor countries manifest themselves most strongly in the traded goods sector. Because manufacturing output is more heavily traded than that of services,[14] our assumption is buttressed by evidence that productivity differences are larger on average in manufacturing. Indeed, detailed comparisons of manufacturing productivity covering both rich and poor countries (Maddison and van Ark, 1989, Pilat and Rao, 1996, Timmer, 1999) reveal that there are very substantial productivity differences between manufacturing in rich and poor countries.[15,16] This is true not only for labour productivity, but for total factor productivity, taking into account the amount of capital employed also.[17] Data for services are not so readily available or reliable for a wide range of rich and poor countries (but see Mulder,

[14]Though growing rapidly, traded services still represent a fairly small proportion of world trade, and likely are disproportionately representative of those service sectors in which rapid technological progress and high skill requirements are the norm.

[15]Indeed, they show that the shrinkage factor implied by the sectoral PPP for manufacturing is comparatively small. Convergence among industrial countries in sectoral productivity in manufacturing is documented by Dollar andWolff (1988), cf. OECD (1996).

[16] For productivity comparisons in agriculture, see Prasada Rao, 1993

[17]For reflections on the problems raised in trying to distinguish between capital accumulation and productivity growth see Rodrik (1997) and Young (1995).

1999 for Brazil and Mexico). However, even if the quality of services in poor countries tends to be overstated, there is little reason to dispute the proposition that, as Bhagwati (1984) put it so long ago, it is services that are relatively cheap in developing countries, and by extension that productivity in services is not so different as between rich and poor countries.

Why are international productivity differences in services relatively low?

The factors that inhibit poor countries from reaching rich country productivity in manufacturing are increasingly being sought under the heading of political, historical and geographical infrastructures (cf. for example, Easterly and Levine, 1997, Hall and Jones, 1997a and b, Landes, 1990). It is hard to imagine why the service sector would not be faced with the same social infrastructure. If so, then -- measurement issues aside -- the fact that measured productivity differences are less in the service sector suggests not so much (*pace* Yotopolous, 1995) that the developing countries have somehow climbed higher on the productivity ladder in services but that, in aggregate, the ladder is not as steep in services.[18] And that fits the assumption of our model that the potential for productivity is more limited in non-traded goods

Do marginal labour productivities differ?

Finally, our model attaches the international productivity differences to one factor, labour, though similar results would be obtained provided at least part of the productivity differences are of the labour-augmenting type. That this is a reasonable assumption is supported by, for example, the work of Hall and Jones, already mentioned above, which does indicate that both the accumulation of capital and the productivity of factors of production in place are influenced by the social infrastructure factors. Analysis of the wage experience of immigrants to the United States (e.g. Borjas, 1987) can also throw light on this question, though it is necessary to take account of the fact that immigrants may not be a representative sample of the

[18]Nevertheless, it may be necessary to take account of the consideration that some of the social infrastructure advantages of the host country may be inherited by the migrant.

source country labour force, and that their labour market experience after reaching the host country will be influenced by transitional adjustment factors as well as by post-migration human capital accumulation by them.

V. Concluding remarks

When commentators rank countries in terms of overall economic size they are often implicitly appealing to some notion of potential economic production. Here use of PPP-adjusted data may mislead. Although PPP adjustments provide a major improvement over the use of unadjusted data in comparing living standards across countries, they can present an overly rosy picture if interpreted as indicative of the relative productive capacity of nations. Not only will catch-up rates tend to be slower for PPP-adjusted than for unadjusted per capita output, but future developments in migration and technology may reveal that the handicaps suffered by poor countries are deep-seated and perhaps better reflected in present productivity differentials in traded-good production than in their apparently better performance on average in service sector productivity. Greater globalization may see relative prices move closer to values now prevailing in poor countries.

We have presented a calibrated multi-country model which supports this line of reasoning, embodying the fact that international productivity differences are stronger in traded goods. Although it is a two good model, it provides insights into equilibrium price and output behaviour which can be applied to a multi-good world. It suggests that, although the purchasing power of wages in poor countries is now typically much higher than implied by market exchange rates, much of this advantage could be eroded by reductions in the barriers to trade or migration, thereby revealing the underlying gaps in productivity. Key to this line of reasoning is that the price of non-traded goods and of labour of different skills may be highly sensitive to structural change. A calculation of production potential that neglects this sensitivity misses much of the story.

The model does not represent a worst case: the situation could be even less advantageous to developing countries that are unable to overcome the factors that at present hold them back. Indeed, to the extent that information and communications technologies increase not only the tradability of services but also the potential productivity in their production, the underlying skills and infrastructure deficiencies of the poorer countries could manifest themselves in a widening of real income differentials, as this hitherto protected segment, representing a growing share of GDP, becomes subject to competition from low-cost imports.

The issues raised are conceptual ones, but will also benefit from further attention being given to international empirical comparisons of productivity and factor quality at the sectoral level.

The argument of this paper does not rely on the law of one price actually prevailing in the future. This and other simple assumptions made in order to obtain the precise and perhaps over-dramatic conclusions of the simple model presented should not distract from the essential point being made: the common price structure inherent in conventional PPP calculations - weighted as they are by current production, and thus tending on average to rich-country prices - may be very far from that to which globalization is bringing the world economy, when the relative population may become more important.

The fact that the cost of a shoe-shine in New York may represent a couple of days' wages for a labourer in Dhaka does not only point to a failure of the law of one price, but also to important differences in actual and potential productivity between these two cities. The gap in average living standards is surely smaller than the gap in productivity in any metric relevant to a comparison of the overall economic size of these two cities.

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Figure 1: *Shrinkage factors*

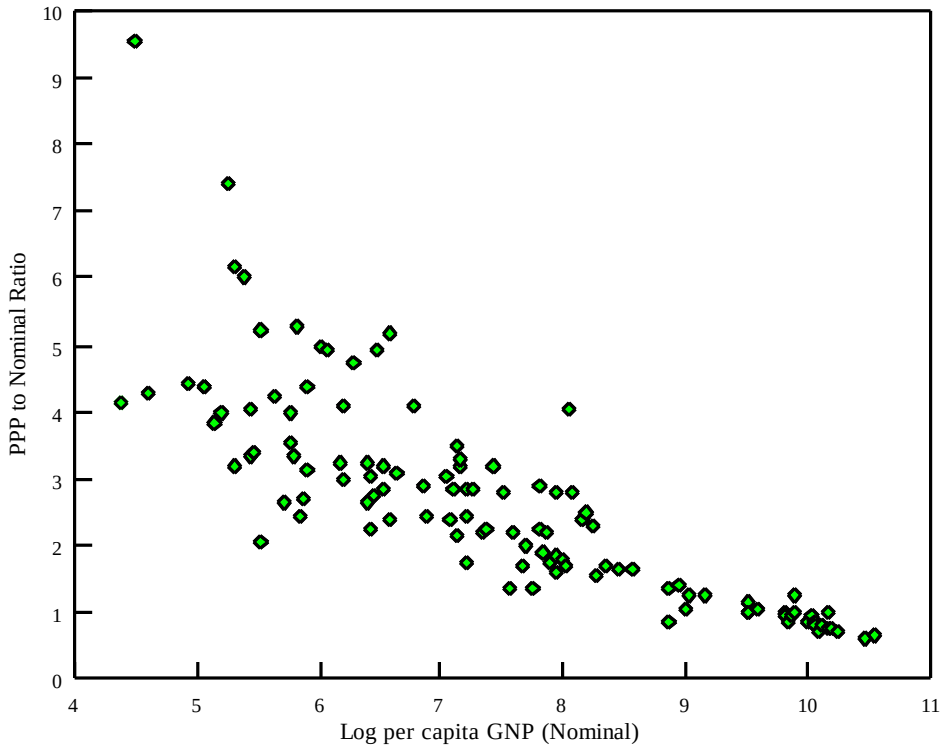

Figure 2: *Real wage at different productivities*

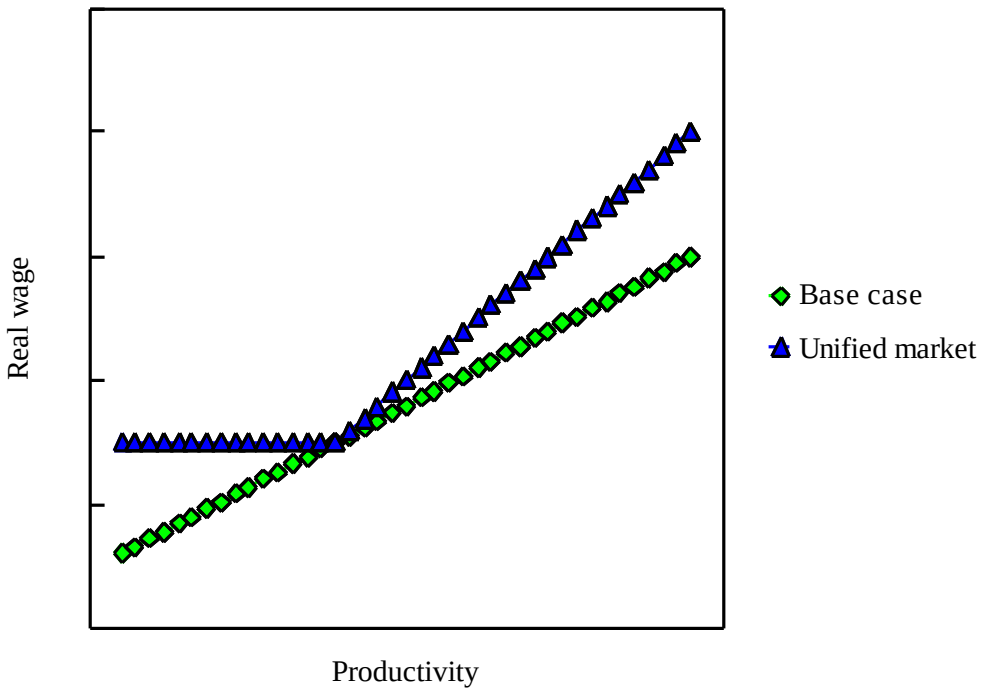

Figure 3: *Shrinkage Factors and Lorenz Curves at Different Standard Prices*

a: Shrinkage Factors

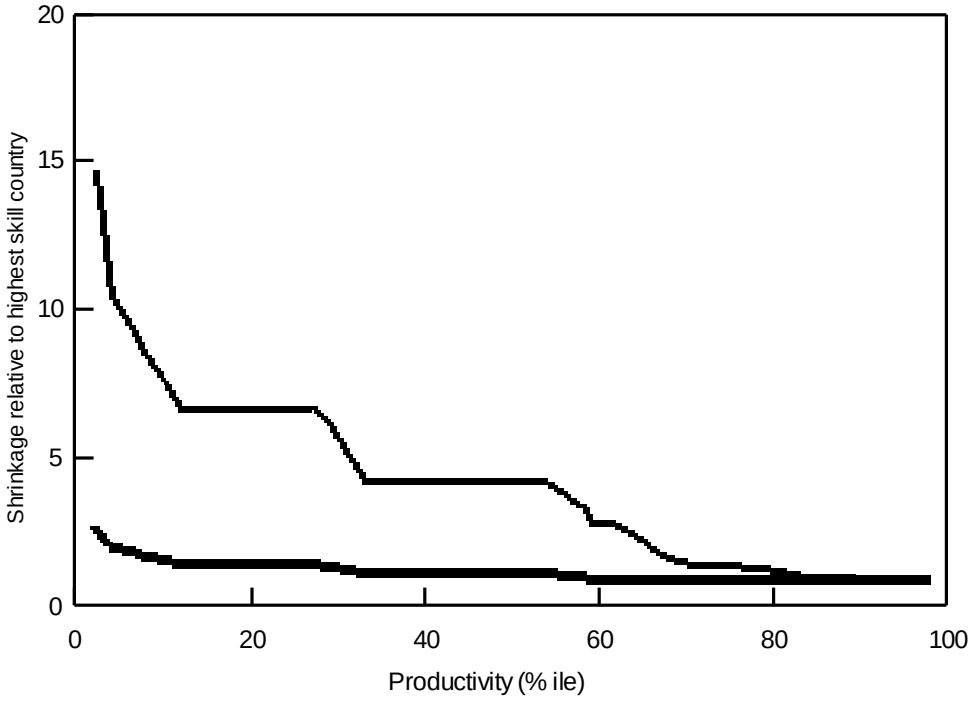

Figure 4: *Shrinkage Factors and Lorenz Curves at Different Standard Prices*

a: Shrinkage Factors