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MACRO-ECONOMIC MEASURES FOR A GLOBALIZED WORLD: GLOBAL GROWTH AND INFLATION

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This paper offers a framework for measuring global growth and inflation, built on standard index number theory, national accounts principles, and the concepts and methods for international macro-economic comparisons. Our approach provides a sound basis for purchasing power parity (PPP)- and exchange rate (XR)-based global growth and inflation measures. The Sato–Vartia index number system advocated here offers very similar results to a Fisher system but has the added advantage of allowing a complete decomposition with PPP or XR effects. For illustrative purposes, we present estimates of global growth and inflation for 141 countries over the years 2005 and 2011. The contribution of movements in XRs and PPPs to global inflation are presented. The aggregation properties of the method are also discussed.

Keywords: International Comparison, World Growth, World Inflation, Exchange Rate, Purchasing Power Parity, Index Number Theory

1. INTRODUCTION

World economic growth and inflation are terms used in the popular press and by various international organizations. Regular estimates of both are compiled and disseminated by these organizations. The *World Economic Outlook*, a flagship publication of the International Monetary Fund (IMF), publishes estimates of global growth and inflation regularly. The 2018 issue reports a global growth of 3.8% in 2017 and a projected growth of 3.9% in 2018. Similar estimates for the whole world or for various country groups are published by the World Bank, Eurostat, and the Organisation for Economic Co-operation and Development (OECD). The United Nations' *World Economic Situation and Prospects*, 2018, reports: "In 2017, global growth is estimated to have reached 3.0% when calculated at market exchange rates (XRs), or 3.6% when adjusted for purchasing

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power parities (PPPs)." The global inflation rate for 2017 was estimated to be 2.6%. It is amply clear from these publications that growth of the world economy and concomitant global inflation are significant economic data.

This is corroborated by private institutions. For example, Price Waterhouse Coopers in its *Global Economy Watch* 2016 reported over 2016 a global growth of 3.0% in PPP terms and 2.9% in market XR terms. Global inflation was reported to be 2.6% and 1.9% in PPP and XR terms, respectively. Similarly, in November 2016, IECONOMICS reported the Euro area inflation to be 2%. Morgan Stanley in its *Global Outlook 2017: Higher Growth, Bigger Risks* reported a projected global growth of 3.4% for 2017. Such published figures on global growth and inflation get factored into the decision-making by both private and public entities.

The regular and high profile publication of statistics on world growth performance and global inflation should generally imply that such statistics are based on a clear and well-founded theoretical framework. However, from a careful search through these publications, it is difficult to find formal definitions of global growth and global inflation. Global growth estimates are often presented with the labels "in PPP terms" or "at market exchange rates", and global inflation is commonly computed as a simple or weighted average of inflation rates of a number of countries. Ward's (2001) overview of the conceptual issues concerning global inflation and its relationship with international price levels and purchasing power parities (PPPs) is still actual. Specifically, Ward emphasized that the measurement of global growth and inflation are complementary targets, and his paper is interesting as it provides a brief inventory of approaches existing at that time.

In addition to the index-number-based measures of global inflation published by international agencies, a number of works in the literature have estimated global inflation econometrically. Cicarelli and Mojon (2010) first proposed a measure based on a static principal components analysis.[1] This approach has been followed by Mumtaz and Surico (2012) who used a dynamic factor model. Indicators of inflation are constructed by mapping Consumer Price Index (CPI) inflation of each country onto a world factor. The resulting indicator of global inflation is a weighted average of CPI inflations with weights determined by their factor loadings. A similar method was used by Monacelli and Sala (2009), who developed the indicators using a cross section of 948 CPI products in four OECD countries. Huber et al. (2019) construct measures of global growth and inflation as weighted cross-sectional averages with weights obtained from a connectivity matrix, commonly used in spatial econometrics. However, these statistical approaches are not based on national accounting principles and are not designed to disentangle movements in the global economy into inflation and growth components.

The present paper makes several important steps forward in this significant area.

- First and foremost, the paper provides, to the best of our knowledge for the first time, a conceptual framework for the compilation of global measures of growth and inflation. An important feature of this framework is that it is built on the principle that any discussion of global growth or inflation must begin with a notion of the size of the global economy observed at different points of time. Here we draw on the developments with respect to international macro-economic measures compiled and published regularly by the World Bank.

- Second, our approach is based on the standard macro-economic measurement principles of the System of National Accounts (SNA) of the United Nations, adopted by national statistical offices in their regular compilation of national accounts.
- Third, in developing our measures, we do not assume that countries as such are decision-making entities equipped with well-defined preferences, production functions, or expenditure functions.[2] Instead, we only assume that all (or a sample of) the economic transactions of their inhabitants (economic agents such as households, firms, government institutions) are recorded such that sufficiently reliable annual national accounts (according to SNA regulations) are published and the index number toolbox can be used for analytic purposes. Similar to the conventional national-level gross domestic product (GDP) in current prices, we begin with a measure of global GDP as a function of the current prices of goods and services.
- Fourth, if the "world" is made up of a single country then our global measures of growth and inflation reduce to the standard growth rate based on constant price GDP and the GDP deflator. Thus, our approach is consistent with country-level practices in measuring growth and inflation.
- Fifth, we show that global inflation estimates from international organizations such as the IMF and the United Nations are based on inadequate formulae which fail to appropriately account for movements in PPPs or XRs over time.
- Sixth, we discuss the aggregation properties of our method with respect to two dimensions, namely the grouping of countries, and the components of GDP (private household consumption, investment, government consumption, exports, and imports).
- Finally, we illustrate our method by employing data from the regular releases of international macro-economic comparisons across the world by the World Bank.[3]

The paper is organized as follows. Section 1 briefly recalls the basic accounting framework. Section 2 presents the basic concepts for international comparison and the definition of world economy: nominal GDP, real GDP, XRs, PPPs, and price levels. Section 3 goes into the heart of the issue: how to decompose the development of nominal or real-world GDP over time into the components global inflation and growth. Two techniques from the index number toolbox are provided and their analytical differences discussed. Section 4 considers aggregation issues. We present two sets of structurally similar measures to complement those for GDP level. The first refers to regional growth and inflation. These are measures for groups of countries where we present a relation of consistency in aggregation. The second set is for GDP components. Given enough data, one also wants component-wise comparisons. The obvious requirement then is that these are consistent with the overall comparison. Section 5 presents empirical results based on data for internationally comparable macro-aggregates of 141 countries from the ICP of the World Bank. The final section concludes by summarizing the main contributions of the paper.

2. THE BASIC FRAMEWORK

International economic comparisons of countries (or regions) are conceptually based on considering each country as an aggregate, consolidated production unit. The accounting relation of each country for each time period (conventionally assumed to be a year) is then given by[4]

$$C_K + C_L + M_{EMS} + \Pi = R, \tag{1}$$

where C_K denotes capital input cost, C_L denotes labor input cost, M_{EMS} denotes the cost of imported intermediate commodities (energy, materials, and services), R denotes the revenue obtained from all the goods and services produced, and Π is a remainder term which may or may not be equal to 0, dependent on the way capital input cost has been calculated (see Balk (2010) and Jorgenson and Schreyer (2013) for explanation). It is good to note here that by intermediate commodities are understood all those commodities that need further processing before becoming available for final demand. As Kohli and Natal (2014) observe, also "almost all so-called 'finished' products must transit through the domestic production sector and go through a number of changes—such as unloading, transporting, storing, assembling, testing, cleaning, financing, insuring, marketing, wholesaling and retailing—before reaching final demand." Put otherwise, imported intermediate commodities comprise all those commodities to which value is added through the domestic production process.

There are, however, imports that don't need domestic value added to them, such as imported services. Let the import cost of those commodities be denoted by M_F, and let total import cost then be defined as $M \equiv M_{EMS} + M_F$.

The fundamental supply–demand equality, firmly entrenched in the National Accounts, is given by

$$M_F + R = E + I + G + X, \tag{2}$$

where, respectively, E is the value of private household consumption, I is the value of investment, G is the value of government consumption, and X is the value of exports. The sum of the first three terms, $E + I + G$, is called domestic absorption.

Using the definition of total import cost M, equation (2) can be rewritten as

$$M + R - M_{EMS} = E + I + G + X. \tag{3}$$

For each production unit, revenue minus intermediate input cost is called value added, which at the country level is called GDP:

$$GDP \equiv R - M_{EMS}. \tag{4}$$

Since value added is additive, *GDP* is the sum of value added of all the individual production units operating within the borders of the country, which is useful for a variety of analytical questions. Inserting the GDP definition (4) in the supply–demand equation (3) we get the familiar result[5]

$$M + GDP = E + I + G + X. \qquad (5)$$

Now suppose for a moment that there is a single world currency and that there are no import–export tax distortions, so that import prices paid are equal to export prices received, then total import cost $\sum M$ would be equal to total export revenue $\sum X$, where the sum is taken over all the countries. Then, consequently, total (or world) GDP would be equal to total (or world) domestic absorption,

$$\sum GDP = \sum (E + I + G). \qquad (6)$$

Relative GDP, that is the ratio of a country's GDP to world GDP, could then be considered as an important indicator of a country's welfare.

Unfortunately, even if there were a single world currency, the comparison of GDPs between countries is hindered by the fact that for the same commodities different prices are charged in different countries. Thus, before comparing GDPs, any price effects must be removed.

Summarizing, the international comparison of GDPs (or their components) is plagued by currency differences and price differences.

3. CONCEPTS FOR INTERNATIONAL COMPARISON

Let[6] countries be labeled $1, ..., M$. How do we compare the GDP of country j, GDP_j, expressed in its own currency, to the GDP of country k, GDP_k, also expressed in its own currency? The first instrument that comes to mind is a set of (market) XR_j $(j = 1, ..., M)$, where a certain arbitrary country has been selected as reference. Thus, for this country, the XR equals 1 by definition. XRs are transitive—that is, no arbitrage assumed—so that XR_k/XR_j is the XR of country k's currency relative to country j's currency, that is, the number of k currency units that can be obtained for 1 j currency unit. Of course, when countries use the same currency, as in case of the Euro area, they have the same XR.

In the international comparison literature, the term nominal GDP represents GDP after conversion by means of XRs. Thus, *nominal* GDP of country j is defined as

$$NGDP_j \equiv GDP_j/XR_j \; (j = 1, ..., M). \qquad (7)$$

Since all these nominal GDP's are expressed in the same currency (namely, that of the reference country), they can be added. Thus, total nominal GDP is

$$NGDP \equiv \sum_{j=1}^{M} NGDP_j = \sum_{j=1}^{M} \frac{GDP_j}{XR_j}. \qquad (8)$$

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Notice that the magnitude of (total) nominal GDP depends on the reference country selected for the XRs. However, as one easily checks, the share of country j in total nominal GDP, $NGDP_j/NGDP$ ($j = 1, ..., M$), does not depend on which reference country has been chosen.

The second instrument that can be used to make country-specific GDP magnitudes comparable is a set of *purchasing power parities* PPP_j ($j = 1, ..., M$). In general, the PPP of country j represents the number of currency j units required to purchase a basket of goods and services for which one unit of an actual or artificial reference country currency is required. For instance, if the PPP of Indian rupee is 2.50 relative to the Hong Kong dollar, it means that what can be purchased with one dollar in Hong Kong requires 2.50 rupees in India.

Countries can have the same currency, such as the countries of the Euro area, yet the purchasing power of this currency in the different countries does not need to be equal. Thus, PPPs are like spatial price indices. Unlike spatial price indices, PPPs carry a dimension: currency j units per reference currency unit. PPPs serve the dual purpose of currency conversion and accounting for price-level differences across countries. Deaton and Heston (2010) provide an overview of the concept of PPPs and international real income comparisons. Methods for computing PPPs, given prices and quantities of all the countries involved, are surveyed by Balk (2008), (2009), Diewert (2013), and Rao (2013). It is important to notice that each PPP_j is a function of all the underlying prices and quantities of all the M countries. The PPPs are determined up to a positive scalar and are transitive; however, they are not directly comparable across time periods.

PPPs can be used to convert country-specific GDPs into comparable constructs, basically in the same way as XRs were employed. Thus, in the international comparison literature this is referred to as *real* GDP of country j and defined as[7]

$$RGDP_j \equiv GDP_j/PPP_j \; (j = 1, ..., M). \tag{9}$$

Real GDP is comparable over countries and can thus be added. Total real GDP is

$$RGDP \equiv \sum_{j=1}^{M} RGDP_j = \sum_{j=1}^{M} \frac{GDP_j}{PPP_j}. \tag{10}$$

Notice that the magnitude of (total) real GDP is determined up to a positive scalar. However, as one easily checks, the share of country j in total real GDP, $RGDP_j/RGDP$ ($j = 1, ..., M$), does not depend on a reference country. Real GDP *per capita*, often used as a measure of welfare, is also determined up to a positive scalar.

We note here that the PPPs are compiled from price data collected by countries participating in an international comparison project, along with National Accounts weights for aggregating those data; see Rao (2013) for details on the 2011 round of the ICP. The fact that such PPPs refer to a particular year, a so-called benchmark year, implies that (total) real GDP magnitudes also refer to a particular year and therefore are not comparable over time. We return to this issue in the next section.

We now have two sets of instruments, XRs and PPPs. Recall that the XRs are based on a certain reference country and that the PPPs are determined up to a positive scalar. Let the PPPs be rescaled so that they are based on the same reference country as the XRs. Then the price-level index (PLI) of country j is defined as

$$PLI_j \equiv PPP_j/XR_j \; (j = 1, ..., M). \tag{11}$$

The name comes from the fact that a PLI is seen as a measure of the price level of a country relative to the level at which its currency can be converted by the XR. For example, consider the case of Australia versus the United States. At some date, the XR was 0.97 AUD per 1 USD. At the same time, a BigMac costed in these countries 2.75 AUD and 2.25 USD, respectively. Then the BigMac-based PPP for Australia relative to the United States was 2.75/2.25 = 1.22. The PLI was then 1.22/0.97 = 1.26.

Using definitions (7) and (9), it appears that

$$PLI_j = NGDP_j/RGDP_j \; (j = 1, ..., M), \tag{12}$$

that is, a price-level index is nominal GDP divided by real GDP. This provides another interpretation of the concept. Empirically, it appears that over countries the price-level index is positively correlated with nominal or real GDP *per capita*. See Inklaar and Timmer (2014) for a recent study of this phenomenon.

Since PPPs and XRs are transitive, the PLIs are also transitive. The PLI of the reference country is by definition equal to 1. Moving to another reference country leads to different PLIs. Since both PPPs and XRs are determined up to a positive scalar, the same holds for the PLIs.

A convenient normalization[8] is to adjust the set of PPPs by a common positive scalar μ such that total real GDP, based on the adjusted PPPs, is equal to total nominal GDP, based on the given XRs:

$$\sum_{j=1}^{M} \frac{GDP_j}{PPP_j/\mu} = \sum_{j=1}^{M} \frac{GDP_j}{XR_j}. \tag{13}$$

Rewriting expression (13), using the PLI definition of expression (11), the nominal GDP definition of expression (7), and the real GDP definition of expression (9), leads to

$$1 = \frac{\sum_{j=1}^{M} \frac{PLI_j}{\mu} RGDP_j}{\sum_{j=1}^{M} RGDP_j} = \frac{\sum_{j=1}^{M} NGDP_j}{\sum_{j=1}^{M} NGDP_j \left(\frac{PLI_j}{\mu}\right)^{-1}}, \tag{14}$$

that is, the real-GDP-weighted arithmetic mean and the nominal-GDP-weighted harmonic mean of adjusted PLIs are both equal to 1. Notice that the weights are adjustment-invariant.

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To the best of our knowledge, the foregoing, and in particular expressions (8), (10), and (13), represents current Eurostat practice in compiling National Accounts for the EU and Euro regions (without consolidation of flows between member states). As there does not exist a single source to refer to, we must rely on the meta-data accompanying the website tables. The PPPs are calculated according to the Gini-Eltetö-Köves-Szulc (GEKS) method. For a description of this method, the reader is referred to one of the surveys quoted above.

4. MEASUREMENT OF GLOBAL INFLATION AND GROWTH

In this section, we explore systematically the concepts of global inflation and growth and their connection with XRs and PPPs as discussed in the previous section. We begin with the notion of inflation and growth at the national level.

The introduction of the temporal dimension means that we need a superscript denoting time periods (years). Thus, let GDP_j^s and GDP_j^t represent GDP of country j in periods s and t, respectively (where without loss of generality, it can be assumed that s precedes t). Even though both aggregates are expressed in the currency unit of country j, a direct comparison is considered less useful since the effects of price and quantity change between periods s and t are intertwined. Welfare change is usually defined as the quantity part of nominal GDP change.

To measure this, National Accounts expresses GDP "at constant prices" together with its implicit price deflator (= nominal GDP divided by constant-price GDP). Notice that, for any country, there is some reference year for which the implicit price deflator exhibits the value 1. Using these data, each country's GDP ratio, for any pair of years, can be decomposed as the product of a price index (= ratio of deflators) and a quantity index (= ratio of constant-price GDPs),

$$\frac{GDP_j^t}{GDP_j^s} = P_{GDP}^j(t,s)Q_{GDP}^j(t,s)\ (j=1,...,M). \tag{15}$$

The price indices measure inflation and the quantity indices measure growth at the country level. The functional forms may or may not be the same for the various countries. Whether the indices are direct or chained is immaterial to the argument in this paper. All we ask of the two indices is that together they exhaust any temporal GDP ratio.

Basically, we want to mimick this construction at the global level, thereby using the two comparison concepts discussed in the previous section.

4.1. Using XRs

We start with *total nominal GDP* as defined by expression (8), repeated here with a time superscript as

$$NGDP^t \equiv \sum_{j=1}^{M} NGDP_j^t = \sum_{j=1}^{M} \frac{GDP_j^t}{XR_j^t}. \tag{16}$$

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How can we now decompose a ratio $NGDP^t/NGDP^s$ in price and quantity components? Here is the first attempt:

$$\frac{NGDP^t}{NGDP^s} = \frac{\sum_{j=1}^{M} P^j_{GDP}(t,s)\left(XR^s_j/XR^t_j\right) Q^j_{GDP}(t,s) NGDP^s_j}{\sum_{j=1}^{M} NGDP^s_j} = \frac{\sum_{j=1}^{M} NGDP^s_j Q^j_{GDP}(t,s)}{NGDP^s} \times \frac{NGDP^t}{\sum_{j=1}^{M} NGDP^t_j \left(P^j_{GDP}(t,s)\frac{XR^s_j}{XR^t_j}\right)^{-1}}. \tag{17}$$

The first equality is obtained using the definition of *NGDP* in expression (8) as well as equation (15). This equality makes clear that in the movement from $NGDP^s$ to $NGDP^t$ three components are involved: price change, XR change, and quantity change. The second equality is obtained by applying the familiar Laspeyres–Paasche decomposition to two components: the combination of price and XR change, and quantity change. Thus, the first factor at the right-hand side is a Laspeyres quantity index, that is, a weighted arithmetic mean of country-specific quantity indices where the weights are period s nominal GDP shares.[9] The second factor is a Paasche index of price-over-XR; it is a weighted harmonic mean, but now the weights are period t nominal GDP shares.

We can also apply the Paasche–Laspeyres decomposition. Then we obtain

$$\frac{NGDP^t}{NGDP^s} = \frac{\sum_{j=1}^{M} NGDP^s_j \left(P^j_{GDP}(t,s)\frac{XR^s_j}{XR^t_j}\right)}{NGDP^s} \times \frac{NGDP^t}{\sum_{j=1}^{M} NGDP^t_j \left(Q^j_{GDP}(t,s)\right)^{-1}}. \tag{18}$$

The first factor at the right-hand side is now a Laspeyres index of price-over-XR. The second factor is a Paasche quantity index, that is, a harmonic mean of country-specific quantity indices where the weights are period t nominal GDP shares.

These two decompositions are clearly asymmetric.[10] A symmetric decomposition is obtained by taking geometric means of the two price and quantity indices in the previous equations, so that

$$\frac{NGDP^t}{NGDP^s} = \left(\frac{\sum_{j=1}^{M} NGDP^s_j \left(P^j_{GDP}(t,s)\frac{XR^s_j}{XR^t_j}\right)}{NGDP^s} \frac{NGDP^t}{\sum_{j=1}^{M} NGDP^t_j \left(P^j_{GDP}(t,s)\frac{XR^s_j}{XR^t_j}\right)^{-1}}\right)^{1/2}$$

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$$\times \left(\frac{\sum_{j=1}^{M} NGDP_j^s Q_{GDP}^j(t,s)}{NGDP^s} \frac{NGDP^t}{\sum_{j=1}^{M} NGDP_j^t \left(Q_{GDP}^j(t,s)\right)^{-1}} \right)^{1/2}$$
$$\equiv (P/XR)_{GDP}^F(t,s;XR) \times Q_{GDP}^F(t,s;XR). \tag{19}$$

Thus, we have a decomposition in a Fisher price-over-XR index and a Fisher quantity index. The inclusion of *XR* as conditioning variable in the two functions expresses the fact that the weights used are *nominal* GDP shares. Basically, expression (19) is our reconstruction of the first approach of Diewert and Fox (2017, expressions (6) and (7)). Notice that for $M = 1$ expression (19) reduces to expression (15).

Recall that by construction, the ratio $NGDP^t/NGDP^s$ depends on the reference country for the XRs (which is supposed to be the same for both periods s and t). The quantity index, $Q_{GDP}^F(t,s;XR)$ is invariant to the choice of the reference country, since this choice does not influence the nominal GDP shares. The price-over-XR index, $(P/XR)_{GDP}^F(t,s;XR)$, however, is not invariant, due to the occurrence of the XR component. The effect of this lack of invariance is demonstrated in Table 1 of Diewert and Fox (2017).

An invariant price index could be defined as

$$P_{GDP}^F(t,s;XR) \equiv \tag{20}$$
$$\left(\frac{\sum_{j=1}^{M} NGDP_j^s P_{GDP}^j(t,s)}{NGDP^s} \frac{NGDP^t}{\sum_{j=1}^{M} NGDP_j^t \left(P_{GDP}^j(t,s)\right)^{-1}} \right)^{1/2}.$$

The disadvantage then is that

$$P_{GDP}^F(t,s;XR) \times Q_{GDP}^F(t,s;XR) \neq NGDP^t/NGDP^s, \tag{21}$$

that is, price index and quantity index do not deliver a complete decomposition of the nominal GDP ratio.

Though the Fisher-type decomposition, expression (19), is useful, it appears to be impossible to disentangle the separate contributions of domestic inflation, $P_{GDP}^j(t,s)$ $(j = 1, ..., M)$, and XR behavior, XR_j^t/XR_j^s $(j = 1, ..., M)$. An alternative approach, however, enables us to explicitly break up the total *NGDP* ratio in *three* components. Using the logarithmic mean, it appears that

$$\frac{NGDP^t}{NGDP^s} = \exp\left\{ \sum_{j=1}^{M} \Phi^{jts} \ln\left(\frac{NGDP_j^t}{NGDP_j^s} \right) \right\}, \tag{22}$$

where the weights, adding up to 1, are defined by

$$\Phi^{jts} \equiv \frac{LM\left(\frac{NGDP_j^t}{NGDP^t}, \frac{NGDP_j^s}{NGDP^s}\right)}{\sum_{j=1}^{M} LM\left(\frac{NGDP_j^t}{NGDP^t}, \frac{NGDP_j^s}{NGDP^s}\right)} \ (j = 1, ..., M),$$

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and the function $LM(.,.)$ is the logarithmic mean.[11] Expression (22) says that the total nominal GDP ratio is a weighted geometric mean of country-specific nominal GDP ratios, the weights being (normalized) logarithmic means of nominal GDP shares in the two periods compared. Of course, when the temporal distance between the periods s and t is large, then expression (22) may be replaced by a product of consecutive period ratios (and direct indices by chained indices); but this is immaterial to the argument developed here.

The definition of $NGDP_j$ in expression (7) and the GDP decomposition in equation (15) are then used to obtain the three-factor decomposition

$$\frac{NGDP^t}{NGDP^s} = \exp\left\{\sum_{j=1}^{M} \Phi^{jts} \ln P^j_{GDP}(t,s)\right\} \times \exp\left\{\sum_{j=1}^{M} \Phi^{jts} \ln\left(\frac{XR^s_j}{XR^t_j}\right)\right\} \times \exp\left\{\sum_{j=1}^{M} \Phi^{jts} \ln Q^j_{GDP}(t,s)\right\}. \tag{23}$$

The three indices at the right-hand side are three-factor versions of the Sato–Vartia index. A Sato–Vartia index resembles a Törnqvist index, except that arithmetic mean shares are replaced by logarithmic mean shares, which must be normalized.[12] Notice that for $M = 1$ expression (23) reduces to expression (15).

Combining the first two right-hand side terms, XR-based global inflation is defined as

$$(P/XR)^{SV}_{GDP}(t,s;XR) \equiv \exp\left\{\sum_{j=1}^{M} \Phi^{jts} \ln\left(P^j_{GDP}(t,s)\frac{XR^s_j}{XR^t_j}\right)\right\}, \tag{24}$$

and XR-based global growth (quantity change) as the remainder,

$$Q^{SV}_{GDP}(t,s;XR) \equiv \exp\left\{\sum_{j=1}^{M} \Phi^{jts} \ln Q^j_{GDP}(t,s)\right\}. \tag{25}$$

The pair of indices defined here corresponds to the pair in expression (19), but the Sato–Vartia indices have a much simpler functional form than the Fisher indices. Moreover, the Sato–Vartia structure in expression (23) enables us to isolate the XR component from the price component in a straightforward way.[13]

One look at the definitions makes clear that the quantity index in expression (25) is invariant to the choice of the reference country for the XRs, since this choice does not influence the nominal GDP shares. The price-over-XR index in expression (24), however, is not invariant, due to the occurrence of the XR component. An invariant price index could be defined as

$$P^{SV}_{GDP}(t,s;XR) \equiv \exp\left\{\sum_{j=1}^{M} \Phi^{jts} \ln P^j_{GDP}(t,s)\right\}, \tag{26}$$

However, as is evident from expression (23), we then obtain

$$P^{SV}_{GDP}(t,s;XR) \times Q^{SV}_{GDP}(t,s;XR) \neq NGDP^t/NGDP^s, \tag{27}$$

that is, price index and quantity index do not deliver a complete decomposition of the nominal GDP ratio.

4.2. Using PPPs

Instead of total nominal GDP, the second approach considers *total real GDP* as defined by expression (10), repeated here with a time superscript as

$$RGDP^t \equiv \sum_{j=1}^{M} RGDP^t_j = \sum_{j=1}^{M} \frac{GDP^t_j}{PPP^t_j}. \tag{28}$$

Like before, a ratio $RGDP^t/RGDP^s$ can be symmetrically decomposed as a pair of Fisher indices,

$$\begin{aligned} \frac{RGDP^t}{RGDP^s} &= \\ &\left(\frac{\sum_{j=1}^{M} RGDP^s_j \left(P^j_{GDP}(t,s) \frac{PPP^s_j}{PPP^t_j} \right)}{RGDP^s} \frac{RGDP^t}{\sum_{j=1}^{M} RGDP^t_j \left(P^j_{GDP}(t,s) \frac{PPP^s_j}{PPP^t_j} \right)^{-1}} \right)^{1/2} \\ &\times \left(\frac{\sum_{j=1}^{M} RGDP^s_j Q^j_{GDP}(t,s)}{RGDP^s} \frac{RGDP^t}{\sum_{j=1}^{M} RGDP^t_j \left(Q^j_{GDP}(t,s) \right)^{-1}} \right)^{1/2} \\ &\equiv (P/PPP)^F_{GDP}(t,s;PPP) \times Q^F_{GDP}(t,s;PPP). \end{aligned} \tag{29}$$

The first index measures price-over-PPP change from period s to period t, and the second index measures quantity change. In both cases, the weights are *real* GDP shares, which is why PPP occurs as conditioning variable. The quantity index $Q^F_{GDP}(t,s;PPP)$ corresponds to the index advised by Diewert and Fox (2017, expression (16)).[14] However, as global inflation index Diewert and Fox (2017, expression (18)) suggested

$$\begin{aligned} P^F_{GDP}(t,s;PPP) &\equiv \\ &\left(\frac{\sum_{j=1}^{M} RGDP^s_j P^j_{GDP}(t,s)}{RGDP^s} \frac{RGDP^t}{\sum_{j=1}^{M} RGDP^t_j \left(P^j_{GDP}(t,s) \right)^{-1}} \right)^{1/2}. \end{aligned} \tag{30}$$

The advantage of this pair of indices is that both are invariant to the choice of the reference country for the PPPs. The disadvantage is that generally it will be the case that

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$$P^F_{GDP}(t,s;PPP) \times Q^F_{GDP}(t,s;PPP) \neq RGDP^t/RGDP^s, \tag{31}$$

that is, price index and quantity index do not deliver a complete decomposition of the real GDP ratio.[15]

Similar to expression (22) we have

$$\frac{RGDP^t}{RGDP^s} = \exp\left\{\sum_{j=1}^{M} \Psi^{jts} \ln\left(\frac{RGDP_j^t}{RGDP_j^s}\right)\right\}, \tag{32}$$

where the weights, adding up to 1, are defined by

$$\Psi^{jts} \equiv \frac{LM\left(\frac{RGDP_j^t}{RGDP^t}, \frac{RGDP_j^s}{RGDP^s}\right)}{\sum_{j=1}^{M} LM\left(\frac{RGDP_j^t}{RGDP^t}, \frac{RGDP_j^s}{RGDP^s}\right)} \; (j=1,...,M).$$

Notice the subtle difference with the earlier expression (22). The total real GDP ratio is a weighted geometric mean of country-specific real GDP ratios, the weights being (normalized) logarithmic means of real GDP shares in the two periods compared.

We now combine the definition of $RGDP_j$ in expression (9) with equation (15). This leads to the three-factor decomposition

$$\frac{RGDP^t}{RGDP^s} = \exp\left\{\sum_{j=1}^{M} \Psi^{jts} \ln P^j_{GDP}(t,s)\right\} \times \tag{33}$$
$$\exp\left\{\sum_{j=1}^{M} \Psi^{jts} \ln\left(\frac{PPP_j^s}{PPP_j^t}\right)\right\} \times \exp\left\{\sum_{j=1}^{M} \Psi^{jts} \ln Q^j_{GDP}(t,s)\right\}.$$

Combining the first two right-hand side terms, PPP-based global inflation is defined by

$$(P/PPP)^{SV}_{GDP}(t,s;PPP) \equiv \exp\left\{\sum_{j=1}^{M} \Psi^{jts} \ln\left(P^j_{GDP}(t,s)\frac{PPP_j^s}{PPP_j^t}\right)\right\}, \tag{34}$$

and PPP-based global growth (quantity change) is defined as the remainder,

$$Q^{SV}_{GDP}(t,s;PPP) \equiv \exp\left\{\sum_{j=1}^{M} \Psi^{jts} \ln Q^j_{GDP}(t,s)\right\}. \tag{35}$$

This quantity index is invariant to the choice of the reference country for the PPPs, since only real GDP shares enter the formula. However, the price index $(P/PPP)^{SV}_{GDP}(t,s;PPP)$ is not invariant, since the PPPs play an explicit role. An invariant price index could be defined as

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$$P_{GDP}^{SV}(t,s;PPP) \equiv \exp\left\{\sum_{j=1}^{M} \Psi^{jts} \ln P_{GDP}^{j}(t,s)\right\}, \tag{36}$$

but then we would have

$$P_{GDP}^{SV}(t,s;PPP) \times Q_{GDP}^{SV}(t,s;PPP) \neq RGDP^{t}/RGDP^{s}, \tag{37}$$

that is, price index and quantity index do not deliver a complete decomposition of the real GDP ratio.

4.3. Relations

It is important to notice that if the normalization defined by expression (13) is imposed on the data, then $NGDP^t/NGDP^s = RGDP^t/RGDP^s$. Then expressions (19), (23), (29), and (33) all provide decompositions of the same ratio.

It is interesting to relate expressions (34) to (24), and (35) to (25). Straightforward manipulation, using the price-level index definition (11), yields the following expressions:

$$\frac{(P/PPP)_{GDP}^{SV}(t,s;PPP)}{(P/XR)_{GDP}^{SV}(t,s;XR)} = \exp\left\{\sum_{j=1}^{M}(\Psi^{jts} - \Phi^{jts}) \ln\left(P_{GDP}^{j}(t,s)\frac{XR_j^s}{XR_j^t}\right)\right\} \times \exp\left\{\sum_{j=1}^{M} \Psi^{jts} \ln\left(\frac{PLI_j^s}{PLI_j^t}\right)\right\} \tag{38}$$

and

$$\frac{Q_{GDP}^{SV}(t,s;PPP)}{Q_{GDP}^{SV}(t,s;XR)} = \exp\left\{\sum_{j=1}^{M}(\Psi^{jts} - \Phi^{jts}) \ln\left(Q_{GDP}^{j}(t,s)\right)\right\}. \tag{39}$$

What we see here is that the right-hand side of expression (38) consists of two terms. The first is an exponentiated covariance, between real and nominal share differences and price-over-XR index numbers[16]; the second term is the inverse of mean price-level index change. Expression (39) is also an exponentiated covariance, but now between real and nominal share differences and country-specific quantity change. An important research question is: what causes these covariances to be unequal to zero?

Unlike XRs, PPPs are usually not available every year, but are compiled infrequently at so-called benchmark years. PPPs for non-benchmark years are then conveniently estimated by extrapolation. This has a peculiar consequence, as will be demonstrated now.

When the period t PPPs are obtained by extrapolating the period s PPPs, that is, when $PPP_j^t = PPP_j^s P_{GDP}^{j}(t,s)/P_{GDP}^{j'}(t,s)$ where j' is the numeraire for the PPPs, then global inflation according to expression (34) reduces to

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$$(P/PPP)^{SV}_{GDP}(t, s; PPP) \equiv \exp\left\{\sum_{j=1}^{M} \Psi^{jts} \ln P^{j'}_{GDP}(t, s)\right\} = P^{j'}_{GDP}(t, s), \qquad \mathbf{(40)}$$

since $\sum_{j=1}^{M} \Psi^{jts} = 1$. Now there are M choices for the numeraire j', so it makes sense to define mean global inflation as the unweighted geometric mean

$$\bar{P}_{GDP}(t, s) \equiv \prod_{j'=1}^{M} P^{j'}_{GDP}(t, s)^{1/M}. \qquad \mathbf{(41)}$$

As one sees, the economic size of the countries does not play any role here.[17]

4.4. An Intermediate Conclusion

This section made clear that decompositions of total nominal GDP change and total real GDP change are structurally similar. The magnitude of nominal GDP change and real GDP change depends on the numeraire country of the XRs and the PPPs, respectively. In both cases, the quantity component (measuring global growth) appears to be invariant. The price-over-XR and the price-over-PPP components (measuring global inflation), respectively, are not invariant. Invariant inflation components can be defined at the cost of loosening completeness of decomposition. Using Sato–Vartia instead of Fisher's indices has the advantage that three-factor decompositions can be generated easily.

5. AGGREGATION ISSUES

5.1. The Contribution of (Groups of) Countries

In the previous section, we considered the measurement of inflation and growth for an entire set of countries. Though interesting as such, one is usually also interested in the contribution of single countries or groups of countries to global inflation and growth. It is particularly here that we see the advantage of Sato–Vartia indices over Fisher indices. One example is sufficient to demonstrate this.

Consider the XR-based global quantity index as defined by expression (25). The logarithmic version reads

$$\ln Q^{SV}_{GDP}(t, s; XR) = \sum_{j=1}^{M} \Phi^{jts} \ln Q^{j}_{GDP}(t, s). \qquad \mathbf{(42)}$$

Now recall that the logarithm of an index number (in the neighbourhood of 1) can be interpreted as a percentage. Then expression (42) says that the (additive) contribution of country j to global growth is given by the percentage growth experienced by the country itself times its nominal GDP share Φ^{jts} ($j = 1, ..., M$).

Next, let the entire set of countries be split into, say, two disjunct subsets A and B, that is, $A \cup B = \{1, ..., M\}$ and $A \cap B = \emptyset$. Then expression (42) can be decomposed as

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$$\begin{aligned}
&\ln Q^{SV}_{GDP}(t,s;XR) \\
&= \sum_{j\in A} \Phi^{jts} \ln Q^{j}_{GDP}(t,s) + \sum_{j\in B} \Phi^{jts} \ln Q^{j}_{GDP}(t,s) \\
&= \Phi^{Ats} \sum_{j\in A} \Phi^{jAts} \ln Q^{j}_{GDP}(t,s) + \Phi^{Bts} \sum_{j\in B} \Phi^{jBts} \ln Q^{j}_{GDP}(t,s),
\end{aligned} \tag{43}$$

where $\Phi^{Ats} \equiv \sum_{j\in A} \Phi^{jts}$, $\Phi^{Bts} \equiv \sum_{j\in B} \Phi^{jts}$, $\Phi^{jAts} \equiv \Phi^{jts}/\Phi^{Ats}$ $(j \in A)$, and $\Phi^{jBts} \equiv \Phi^{jts}/\Phi^{Bts}$ $(j \in B)$. Notice that the weights Φ^{jAts} and Φ^{jBts} add up to 1.

Now expression (43) says that the (additive) contribution of country set A to world growth is given by the mean percentage growth experienced by the set A itself times its nominal GDP share Φ^{Ats}. Notice, however, that the mean growth of A, $\sum_{j\in A} \Phi^{jAts} \ln Q^{j}_{GDP}(t,s)$, is not equal to the logarithm of the Sato–Vartia quantity index of the set A, since Sato–Vartia indices are not consistent-in-aggregation (see Balk (2008), 108–113).

The difference is subtle and the effect therefore might not be great. By substituting the definition of Φ^{jts} into the definition of Φ^{jAts}, we see that

$$\Phi^{jAts} = \frac{LM\left(\frac{NGDP^{t}_{j}}{NGDP^{t}}, \frac{NGDP^{s}_{j}}{NGDP^{s}}\right)}{\sum_{j\in A} LM\left(\frac{NGDP^{t}_{j}}{NGDP^{t}}, \frac{NGDP^{s}_{j}}{NGDP^{s}}\right)} \; (j \in A).$$

Recall that $NGDP^{\tau} = \sum_{j=1}^{M} NGDP^{\tau}_{j}$ $(\tau = s,t)$. The Sato–Vartia weights for the elements of subset A, however, would be given by

$$\tilde{\Phi}^{jAts} = \frac{LM\left(\frac{NGDP^{t}_{j}}{NGDP^{t}_{A}}, \frac{NGDP^{s}_{j}}{NGDP^{s}_{A}}\right)}{\sum_{j\in A} LM\left(\frac{NGDP^{t}_{j}}{NGDP^{t}_{A}}, \frac{NGDP^{s}_{j}}{NGDP^{s}_{A}}\right)} \; (j \in A),$$

where $NGDP^{\tau}_{A} = \sum_{j\in A} NGDP^{\tau}_{j}$ $(\tau = s,t)$. The logarithm of the Sato–Vartia quantity index of the set A is then given by $\sum_{j\in A} \tilde{\Phi}^{jAts} \ln Q^{j}_{GDP}(t,s)$.

Similar definitions of course hold for country set B. The effect of the inconsistency-in-aggregation is then given by observing that

$$\ln Q^{SV}_{GDP}(t,s;XR) \neq \Phi^{Ats} \sum_{j\in A} \tilde{\Phi}^{jAts} \ln Q^{j}_{GDP}(t,s) + \Phi^{Bts} \sum_{j\in B} \tilde{\Phi}^{jBts} \ln Q^{j}_{GDP}(t,s). \tag{44}$$

Using the linear homogeneity of the logarithmic mean, one easily checks that $\tilde{\Phi}^{jAts} = \Phi^{jAts}$ $(j \in A)$ and $\tilde{\Phi}^{jBts} = \Phi^{jBts}$ $(j \in B)$ if the shares $NGDP^{\tau}_{A}/NGDP^{\tau}$ and $NGDP^{\tau}_{B}/NGDP^{\tau}$ are constant through time $(\tau = s,t)$. Over small time spans this condition is almost always nearly fulfilled, which implies that the difference between the two sides of expression (44) is very small. This will be confirmed by the case discussed below.

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5.2. Nominal GDP Components

Rewriting expression (5), adding time and country labels, we obtain

$$GDP_j^t = E_j^t + I_j^t + G_j^t + X_j^t - M_j^t \; (j = 1, ..., M). \tag{45}$$

This equation suggests that GDP consists of five "components", four of which are positive (namely, private household consumption, investment, government consumption, exports) and one is negative (imports). As a partial remedy for this negativity one frequently considers net exports, $X_j^t - M_j^t$, as the fourth component. The sign of this construct, however, is uncertain.

We are here interested in a decomposition of nominal GDP change into contributions of the various components. From expression (45), it is clear that

$$NGDP_j^t = (E_j^t + I_j^t + G_j^t + X_j^t - M_j^t)/XR_j^t \; (j = 1, ..., M). \tag{46}$$

For splitting the ratio $NGDP_j^t/NGDP_j^s$, we generalize the procedure of Balk (2010, Appendix B). By repeatedly using the logarithmic mean, we obtain

$$\begin{aligned} \ln \frac{NGDP_j^t}{NGDP_j^s} &= \ln \frac{XR_j^s}{XR_j^t} + \ln \frac{E_j^t + I_j^t + G_j^t + X_j^t - M_j^t}{E_j^s + I_j^s + G_j^s + X_j^s - M_j^s} \qquad (47) \\ = \ln \frac{XR_j^s}{XR_j^t} &+ \theta_E^{jts} \ln(E_j^t/E_j^s) + \theta_I^{jts} \ln(I_j^t/I_j^s) + \theta_G^{jts} \ln(G_j^t/G_j^s) + \theta_X^{jts} \ln(X_j^t/X_j^s) \\ &- \theta_M^{jts} \ln(M_j^t/M_j^s), \end{aligned}$$

where $\theta_V^{jts} \equiv LM(V_j^t, V_j^s)/LM(GDP_j^t, GDP_j^s)$ $(V = E, I, G, X, M)$ are the mean shares of the five components in GDP of country j. This interpretation rests on the fact that $LM(V_j^t, V_j^s)$ is the (logarithmic) mean value of a component while $LM(GDP_j^t, GDP_j^s)$ is the (logarithmic) mean value of GDP, both means being taken over the periods s and t. Notice that $\theta_E^{jts} + \theta_I^{jts} + \theta_G^{jts} + \theta_X^{jts} - \theta_M^{jts} \neq 1$, since the logarithmic mean $LM(., 1)$ is concave. For all practical purposes, however, the difference is negligible.

Next, it is assumed that there exist price and quantity indices such that each component value ratio can be split as follows:

$$E_j^t/E_j^s = P_E^j(t, s) Q_E^j(t, s) \; (j = 1, ..., M) \tag{48}$$

$$I_j^t/I_j^s = P_I^j(t, s) Q_I^j(t, s) \; (j = 1, ..., M) \tag{49}$$

$$G_j^t/G_j^s = P_G^j(t, s) Q_G^j(t, s) \; (j = 1, ..., M) \tag{50}$$

$$X_j^t/X_j^s = P_X^j(t, s) Q_X^j(t, s) \; (j = 1, ..., M) \tag{51}$$

$$M_j^t/M_j^s = P_M^j(t, s) Q_M^j(t, s) \; (j = 1, ..., M). \tag{52}$$

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Substituting now these expressions into expression (47) and rearranging a little bit delivers

$$\ln \frac{NGDP_j^t}{NGDP_j^s} = \ln \left(\frac{XR_j^s}{XR_j^t} \frac{P_E^j(t,s)^{\theta_E^{jts}} P_I^j(t,s)^{\theta_I^{jts}} P_G^j(t,s)^{\theta_G^{jts}} P_X^j(t,s)^{\theta_X^{jts}}}{P_M^j(t,s)^{\theta_M^{jts}}} \right) \tag{53}$$

$$+ \ln \left(\frac{Q_E^j(t,s)^{\theta_E^{jts}} Q_I^j(t,s)^{\theta_I^{jts}} Q_G^j(t,s)^{\theta_G^{jts}} Q_X^j(t,s)^{\theta_X^{jts}}}{Q_M^j(t,s)^{\theta_M^{jts}}} \right).$$

The final step is to substitute expression (53) into expression (22). The result is

$$\ln \frac{NGDP^t}{NGDP^s} = \tag{54}$$

$$\sum_{j=1}^{M} \Phi^{jts} \ln \left(\frac{XR_j^s}{XR_j^t} \right)$$

$$+ \sum_{j=1}^{M} \sum_{V=E,I,G,X} \Phi^{jts} \theta_V^{jts} \ln P_V^j(t,s) - \sum_{j=1}^{M} \Phi^{jts} \theta_M^{jts} \ln P_M^j(t,s)$$

$$+ \sum_{j=1}^{M} \sum_{V=E,I,G,X} \Phi^{jts} \theta_V^{jts} \ln Q_V^j(t,s) - \sum_{j=1}^{M} \Phi^{jts} \theta_M^{jts} \ln Q_M^j(t,s).$$

As we see, for each GDP component, there is a price index and a quantity index. In addition to these 10 components, there is the contribution of the XRs. Recall that this part is numeraire-dependent.

5.3. Real GDP Components

Unlike XRs, PPPs depend on prices and quantities of all the underlying commodities. This implies that in principle each GDP component has its own set of PPPs. We assume that the reference country is the same for all these sets. Using the component PPPs, real GDP is assumed to be equal to

$$RGDP_j^{*t} \equiv \frac{GDP_j^t}{PPP_j^{*t}} \tag{55}$$

$$= \frac{E_j^t}{PPP_{Ej}^t} + \frac{I_j^t}{PPP_{Ij}^t} + \frac{G_j^t}{PPP_{Gj}^t} + \frac{X_j^t}{PPP_{Xj}^t} - \frac{M_j^t}{PPP_{Mj}^t} \; (j = 1, ..., M),$$

where PPP_j^{*t} is the GDP-level PPP and $PPP_{Ej}^t, ..., PPP_{Mj}^t$ denote the component-specific PPPs. Equation (55) defines the GDP-level PPP as a (generalized) harmonic mean of the component PPPs. An asterisk is added to emphasize that PPP_j^{*t} is not necessarily equal to the GDP-level PPP_j^t introduced earlier.

It is convenient to write equation (55) as

$$RGDP_j^{*t} = RE_j^t + RI_j^t + RG_j^t + RX_j^t - RM_j^t \; (j = 1, ..., M), \tag{56}$$

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where real values are defined as $RV_j^t \equiv V_j^t / PPP_{Vj}^t$ $(V = E, I, G, X, M)$. The task at hand is to decompose the ratio $RGDP_j^{*t}/RGDP_j^{*s}$. We basically follow the procedure of the previous section. Thus,

$$\begin{aligned} &\ln \frac{RGDP_j^{*t}}{RGDP_j^{*s}} \\ &\quad = \vartheta_E^{jts} \ln(RE_j^t/RE_j^s) + \vartheta_I^{jts} \ln(RI_j^t/RI_j^s) + \vartheta_G^{jts} \ln(RG_j^t/RG_j^s) \\ &\qquad + \vartheta_X^{jts} \ln(RX_j^t/RX_j^s) - \vartheta_M^{jts} \ln(RM_j^t/RM_j^s), \end{aligned} \tag{57}$$

where $\vartheta_V^{jts} \equiv LM(RV_j^t, RV_j^s)/LM(RGDP_j^{*t}, RGDP_j^{*s})$ $(V = E, I, G, X, M)$ are the mean shares of the five components in real GDP of country j. Notice that $\vartheta_E^{jts} + \vartheta_I^{jts} + \vartheta_G^{jts} + \vartheta_X^{jts} - \vartheta_M^{jts} \neq 1$ since the logarithmic mean $LM(., 1)$ is concave.

Employing relations (48)–(52), we conclude that each term at the right-hand side of expression (57) can be decomposed as

$$\begin{aligned} \frac{RV_j^t}{RV_j^s} &= \frac{V_j^t}{V_j^s} \frac{PPP_{Vj}^s}{PPP_{Vj}^t} \\ &= P_V^j(t,s) Q_V^j(t,s) \frac{PPP_{Vj}^s}{PPP_{Vj}^t} \ (j = 1, ..., M;\ V = E, I, G, X, M). \end{aligned} \tag{58}$$

Substituting then decompositions (58) into expression (57), and the result into expression (32) (after $RGDP$ has been replaced by $RGDP^*$ and Ψ by Ψ^*), and doing some rearrangement delivers as final result

$$\begin{aligned} &\ln \frac{RGDP^{*t}}{RGDP^{*s}} = \\ &\sum_{j=1}^{M} \sum_{V=E,I,G,X,M} \Psi^{*jts} \vartheta_V^{jts} \ln \left(\frac{PPP_{Vj}^s}{PPP_{Vj}^t} \right) \\ &+ \sum_{j=1}^{M} \sum_{V=E,I,G,X} \Psi^{*jts} \vartheta_V^{jts} \ln P_V^j(t,s) - \sum_{j=1}^{M} \Psi^{*jts} \vartheta_M^{jts} \ln P_M^j(t,s) \\ &+ \sum_{j=1}^{M} \sum_{V=E,I,G,X} \Psi^{*jts} \vartheta_V^{jts} \ln Q_V^j(t,s) - \sum_{j=1}^{M} \Psi^{*jts} \vartheta_M^{jts} \ln Q_M^j(t,s). \end{aligned} \tag{59}$$

As we see, for each GDP component, there is a price index and a quantity index. In addition to these 10 components, there is the contribution of the component PPPs. Recall that this part, which can also be split into five components, is numeraire-dependent.

Notice that expression (59) has the same structure as expression (54), except the first term at the right-hand side.

5.4. Real GDP Components; An Alternative Approach

The negativeness of one of its "components" remains an embarrassing feature of the conventional GDP decomposition in expression (45). Thus, let us return to the economically more meaningful supply–demand equality (5). Its real counterpart reads

$$RM_j^t + RGDP_j^{*t} = RE_j^t + RI_j^t + RG_j^t + RX_j^t \; (j = 1, ..., M), \tag{60}$$

where the various definitions were provided in the previous subsection. The left-hand side of this expression denotes real supply, $RS_j^t \equiv RM_j^t + RGDP_j^{*t}$, and the right-hand side denotes real demand, $RD_j^t \equiv RE_j^t + RI_j^t + RG_j^t + RX_j^t$ $(j = 1, ..., M)$. All the components are now positive.

Consider first the logarithmic change of real supply. Applying the logarithmic mean twice delivers

$$\ln \frac{RS_j^t}{RS_j^s} = \psi_M^{jts} \ln(RM_j^t/RM_j^s) + \psi_{GDP}^{jts} \ln(RGDP_j^{*t}/RGDP_j^{*s}), \tag{61}$$

with $\psi_M^{jts} \equiv LM(RM_j^t, RM_j^s)/LM(RS_j^t, RS_j^s)$ and $\psi_{GDP}^{jts} \equiv LM(RGDP_j^{*t}, RGDP_j^{*s})/LM(RS_j^t, RS_j^s)$ being the mean shares of real imports and real GDP in real supply.

Similarly, for the logarithmic change of real demand, we obtain

$$\ln \frac{RD_j^t}{RD_j^s} = \sum_{V=E,I,G,X} \psi_V^{jts} \ln(RV_j^t/RV_j^s), \tag{62}$$

with $\psi_V^{jts} \equiv LM(RV_j^t, RV_j^s)/LM(RD_j^t, RD_j^s)$ $(V = E, I, G, X)$ being the mean shares of the four components of real demand of country j.

If at each time period real supply equals real demand, then the right-hand side of equation (61) equals the right-hand side of equation (62). Backing out the real GDP change term yields

$$\psi_{GDP}^{jts} \ln \frac{RGDP_j^{*t}}{RGDP_j^{*s}} = \sum_{V=E,I,G,X} \psi_V^{jts} \ln(RV_j^t/RV_j^s) - \psi_M^{jts} \ln(RM_j^t/RM_j^s), \tag{63}$$

or

$$\ln \frac{RGDP_j^{*t}}{RGDP_j^{*s}} = \sum_{V=E,I,G,X} \frac{\psi_V^{jts}}{\psi_{GDP}^{jts}} \ln(RV_j^t/RV_j^s) - \frac{\psi_M^{jts}}{\psi_{GDP}^{jts}} \ln(RM_j^t/RM_j^s). \tag{64}$$

By substituting the various definitions and using the identity of real demand and real supply, one immediately obtains that

$$\frac{\psi_V^{jts}}{\psi_{GDP}^{jts}} = \vartheta_V^{jts} \; (V = E, I, G, X) \tag{65}$$

$$\frac{\psi_M^{jts}}{\psi_{GDP}^{jts}} = \vartheta_M^{jts}, \tag{66}$$

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so that expression (64) is identical to expression (57). Basically, it is the additivity of (real) values which underlies this result.

6. ESTIMATES OF REGIONAL AND GLOBAL GROWTH AND INFLATION

In this section, we report calculations of regional and global price change and economic growth over the period 2005–2011.[18] The period chosen is largely determined by the data available from the ICP at the World Bank. ICP conducts international comparisons periodically, and the last two rounds of the ICP were in the benchmark years 2005 and 2011. The results from the 2017 round are expected to be released in 2019. The ICP is a worldwide statistical program to collect comparative price and national accounts and compile estimates of PPPs of currencies and real expenditures for the whole range of final goods and services that comprise GDP including consumer goods and services, government services and capital goods (see http://icp.worldbank.org for extensive details). Results from the 2005 and 2011 ICP are available, respectively, from World Bank (2008) and (2015). The methodology and the conceptual framework that underpins the ICP are described in Rao (2013).

The 2005 ICP covered 146 economies, whereas the 2011 ICP had an increased coverage of 177 economies. In implementing the measures of regional and global inflation and economic growth proposed in this paper, we focus on 141 countries that are common to both rounds of ICP.[19] As a result, our world estimates refer to these 141 economies and the regional groupings used here coincide with those used in the ICP. The regions used are: Asia and the Pacific; Africa; CIS; Eurostat-OECD; Latin America; West Asia and the singleton countries Iran and Georgia. Egypt and Sudan participated in both Africa and the West Asian region but for the purpose of our computations, we have included them in Africa. Similarly, the Russian Federation is included in the Eurostat-OECD region and not in the CIS region. Readers must exercise caution in interpreting results for the Asia-Pacific region as countries like Australia, Japan, South Korea, and New Zealand are included in the Eurostat-OECD region. The Caribbean and Pacific Islands did not participate in 2005 and thus we are unable to provide estimates for these regions.

PPPs for private household consumption (E), government consumption (G), and gross capital formation (I) are used in the computations. For exports (X) and imports (M), XRs are used to convert currency-specific expenditures into real values, that is, $PPP_{Vj} = XR_j$ for $V = X, M$. The PPP at GDP level used in the calculations is that implied by equation (55) (thus, PPP^*). The value data in domestic currency on E, I, G, X, and M, their respective deflators, and the GDP deflator were sourced from the UN database. GDP for each country has been computed using expression (45). This ensures consistency across all the computations, whether they are at the level of GDP or components thereof. Finally, *XRs* are sourced from the International Financial Statistics (IFS) of the IMF. All the data used in

TABLE 1. XR-based regional and global growth and inflation, 2005–2011

ICP region	$\frac{NGDP^{2011}}{NGDP^{2005}} = \frac{RGDP^{2011}}{RGDP^{2005}}$	XR-based decomposition			
		Price change (Fisher)[1]	Growth (Fisher)	Price change (SV)[2]	Growth (SV)
Asia and the Pacific	2.4571	1.5696	1.5655	1.5691	1.5659
Africa	2.3873	1.7972	1.3284	1.7972	1.3284
CIS	2.4351	1.9570	1.2443	1.9571	1.2442
Eurostat-OECD	1.2881	1.2107	1.0639	1.2107	1.0639
Latin America	2.5821	1.9736	1.3083	1.9738	1.3082
Iran	2.6458	2.1138	1.2517	2.1138	1.2517
West Asia	2.2883	1.5730	1.4548	1.5729	1.4548
Georgia	2.2907	1.6377	1.3988	1.6377	1.3988
World	1.6495	1.3946	1.1828	1.3946	1.1828

Notes: [1]Equation (19).[2]Equation (24).
Source: World Bank (ICP), UN Database, IMF(IFS).
All data presented in Appendix Tables A1 (for 2005) and A2–A3 (for 2011).

TABLE 2. PPP-based regional and global growth and inflation, 2005–2011

ICP region	$\frac{NGDP^{2011}}{NGDP^{2005}} = \frac{RGDP^{2011}}{RGDP^{2005}}$	PPP-based decomposition			
		Price change (Fisher)[1]	Growth (Fisher)	Price change (SV)[2]	Growth (SV)
Asia and the Pacific	2.4571	1.5618	1.5732	1.5614	1.5736
Africa	2.3873	1.7956	1.3295	1.7957	1.3294
CIS	2.4351	1.9583	1.2435	1.9585	1.2433
Eurostat-OECD	1.2881	1.2025	1.0712	1.2025	1.0712
Latin America	2.5821	1.9617	1.3163	1.9617	1.3163
Iran	2.6458	2.1138	1.2517	2.1138	1.2517
West Asia	2.2883	1.5795	1.4487	1.5800	1.4483
Georgia	2.2907	1.6377	1.3988	1.6377	1.3988
World	1.6495	1.3152	1.2542	1.3156	1.2538

Notes: [1]Equation (29). [1]Equation (34).
Source: World Bank (ICP), UN Database, IMF(IFS).
All data presented in Appendix Tables A1 (for 2005) and A2–A3 (for 2011).

this paper are presented in Appendix Tables A1–A3. Notice that for 2005, all the deflators are equal to 1.

Table 1 provides the regional and global inflation estimates using equations (19) and (24), which are XR-based. The PPP-based counterparts in Table 2 are obtained using equations (29) and (34), respectively. The PPPs are normalized according to expression (13), so that the weighted mean price levels equal 1 for

TABLE 3. Components of global inflation, 2005–2011

	XR-based (equation (23))		PPP-based (equation (33))	
ICP region	Domestic price	XR	Domestic price	PPP
Asia and the Pacific	1.3936	1.1259	1.4371	1.0865
Africa	1.9626	0.9157	1.9658	0.9135
CIS	2.1325	0.9177	2.1549	0.9089
Eurostat-OECD	1.1101	1.0906	1.1249	1.0690
Latin America	1.6760	1.1777	1.6927	1.1589
Iran	2.5035	0.8444	2.5035	0.8444
West Asia	1.5581	1.0095	1.6190	0.9760
Georgia	1.5237	1.0748	1.5237	1.0748
World	1.3204	1.0561	1.4595	0.9014

each region and the world. Recall that then $NGDP^t/NGDP^s = RGDP^t/RGDP^s$. The regional and global growth estimates are obtained by dividing this ratio by the corresponding inflation estimate.

The computations show that our Sato–Vartia index numbers are almost identical to the Fisher index numbers. However, the advantage of Sato–Vartia indices is that they enable straightforward decompositions, such as separating the XR component from the price component of the movement in total nominal GDP between two time periods. For all regions but one (West Asia), inflation is computed to be higher using XRs than PPPs. This then leads to lower growth figures based on XRs than based on PPPs. Going from 2005 to 2011, the XR-based growth percentage for the aggregate (141 countries) is found to be 18%, while the PPP-based growth appears to be 25%. Using PPP based indices, the fastest growing region was Asia and the Pacific (57%), while the slowest growing region was Eurostat-OECD (7%). Based on XRs, the Asia-Pacific growth was also 57% but the Eurostat-OECD growth was only 6%.

Table 3 shows a further decomposition of global inflation into the portion due to the movement in domestic prices and that due to changes in XRs or PPPs. Here, we use the decompositions in equations (23) and (33) where three components are identified, namely, the change due to the movement in domestic prices, the change due to the movement in XRs or PPPs, and the change due to global growth. The movement in domestic prices is a weighted mean of the domestic GDP deflators. The weights can be XR-based as in equation (23), or PPP-based as in equation (33). The results show that the domestic price changes are measured as higher when using PPP-based weights. The proportion of the change due to non-domestic factors appears to be higher when weights are based on XRs.

We believe that the set of PPP-based measures corresponds to what Ward (2001) envisaged, whereby the Sato–Vartia indices possess the virtue of simple decomposability. The pairs formed by the last column of Tables 1 and 2 (Growth) and the second and fourth columns of Table 3 (Domestic Price Change),

TABLE 4. The magnitude of inconsistency-in-aggregation

	$C1^1$	$C1^2$	$C2^1$	$C2^2$	$C3^1$	$C3^2$
Asia and the Pacific	0.4485	0.4534	0.0554	0.0879	0.0552	0.0879
Africa	0.2839	0.2848	0.0529	0.0792	0.0529	0.0792
CIS	0.2185	0.2178	0.0051	0.0082	0.0051	0.0082
Eurostat-OECD	0.0620	0.0688	0.0378	0.0285	0.0378	0.0286
Latin America	0.2686	0.2748	0.0098	0.0116	0.0098	0.0116
Iran	0.2245	0.2245	0.0010	0.0021	0.0010	0.0021
West Asia	0.3749	0.3704	0.0059	0.0086	0.0058	0.0086
Georgia	0.3356	0.3356	0.0000	0.0001	0.0000	0.0001
World	0.1679	0.2262	0.1679	0.2262	0.1677	0.2262

Notes:
$C1 = \sum_{j \in A} \tilde{\Phi}^{jA} \ln Q^j_{GDP}(2011, 2005)$ with $\tilde{\Phi}^{jA}$ defined below equation (43).
$C2 = \Phi^A \sum_{j \in A} \Phi^{jA} \ln Q^j_{GDP}(2011, 2005)$ with Φ^{jA} defined below equation (43).
$C3 = \Phi^A \sum_{j \in A} \tilde{\Phi}^{jA} \ln Q^j_{GDP}(2011, 2005) =$ RHS of equation (44).
[1]Weights are XR-based. [2]Weights are PPP-based.

respectively, are symmetric, but do not exhaust the world nominal/real GDP development. The gap is closed by the third and last columns of Table 3 (XR and PPP, respectively).

Table 4 illustrates the decomposition discussed in Section 5.1. The logarithms of Sato–Vartia quantity index numbers, which can be interpreted as percentage changes, for the whole world as well as the various regions are given in columns $C1$. Exponentiating the numbers of the $C1$ columns produces the two columns labeled "Growth (SV)" in Tables 1 and 2. The $C2$ columns then provide the decomposition of the logged world index numbers, in the bottom row, according to the right-hand side of equation (43). Logged index numbers according to the right-hand side of expression (44) are given in columns $C3$. The bottom row is the sum of the group contributions. The difference with the bottom row of columns $C2$ is the effect of the *in*consistency-in-aggregation of the Sato–Vartia indices. For all practical purposes this effect appears to be negligible.

Table 5 illustrates the decompositions discussed in Sections 5.2 and 5.3. We again recall that due to the normalization, the ratios of real and nominal GDP are identical. The world movement in prices as well as quantities from 2005 to 2011 appears lower for E, I, and G when using XR-based weights than using PPP-based weights. The reverse is true for exports and imports. The effect of XRs or PPP movements in the overall change of nominal or real GDP between the two periods appears to be 5% or minus 10%, respectively. The PPPs for each component are different and thus it is possible to also see the contribution of component wise PPP changes according to the first term at the right-hand side of equation (59). For E and G, the contributions appear to be negative, but for I, X, and M positive.

TABLE 5. Components of global GDP inflation and growth, 2005–2011

	XR-based[1]			PPP-based[2]		
Component	XR change	Price change	Quantity change	PPP change	Price change	Quantity change
Total	1.0561			0.8966		
Private consumption (E)		1.1121	1.1381	0.9536	1.1337	1.1764
Investment (I)		1.0630	1.0535	1.0124	1.0726	1.0727
Government consumption (G)		1.0566	1.0391	0.9276	1.1124	1.0751
Exports (X)		1.0506	1.0664	1.0133	1.0352	1.0461
Imports (M)		1.0467	1.0665	1.0121	1.0325	1.0463

$$\frac{NGDP^{2011}}{NGDP^{2005}} = \frac{RGDP^{*2011}}{RGDP^{*2005}} = 1.6495$$

Notes: [1] Antilogs of terms of equation (54). [2] Antilogs of terms of equation (59).

7. CONCLUSION

The main objective of this paper is to provide a conceptual framework for the compilation of highly visible and sought-after global macro-economic measures for global growth and inflation. Such measures are currently compiled using market XRs or PPPs of currencies as regularly compiled by the World Bank. We first established the need to anchor these measures on well-established concepts and measures of the size of the global economy.

The global growth and inflation measures proposed here are based on the standard index number approach used by national statistical agencies in their regular compilation of growth and GDP deflators. We derived two symmetric formulas for the calculation of regional and global growth and inflation; one based on the Fisher index and another based on the Sato–Vartia index. We rely thereby on the very simple assumptions that all (or a sample of) the economic transactions of inhabitants (economic agents such as households, firms, government institutions) are recorded such that sufficiently reliable annual national accounts (according to the UN SNA principles) are published and the index number toolbox can be used for analytical purposes. Of the two alternatives proposed, we recommend the use of Sato–Vartia indices as these allow us to split global inflation movements into two effects, change in domestic prices (inflation at national level) and change in the relative worth of currencies (XRs or PPPs). The fact that percentages of overall global growth and inflation based on Sato–Vartia and Fisher index number formulas are numerically close strengthens the argument in favour of Sato–Vartia index. We also pointed out that the current practice of international organizations leads to incomplete measures of global inflation and, thereby, results in an inconsistency between observed changes in the size of the global economy and the published global growth and inflation percentages. The measures we propose here are fully consistent with national practices in the sense that when our method is employed for a single country, the resulting measures of growth and inflation are identical to what the national accounts would show.

Our application used data for 141 countries coming from the last two rounds of the ICP, 2005 and 2011. Between these years, the XR-based growth of the aggregate (141 countries) is found to be 18%, while the PPP-based growth is 25%. Using PPP-based measures, the fastest growing region was Asia and the Pacific (57%), while the slowest growing region was Eurostat-OECD (7%). Global inflation movements are due to changes in domestic prices as well as changes in the relative worth of currencies. When using XR-based weights to compute movements, the domestic price change components are smaller for all regions than they are when using PPP-based weights. We also showed the importance of using appropriately derived weights when measuring regional growth, and the effect of the *in*consistency-in-aggregation of the Sato–Vartia indices, which we found to be negligible.

Finally, using PPP-based measures, the quantity growth in household consumption expenditures is 18% and the price change is 13%. Price changes for government consumption and investment components are 11% and 7%, respectively, and around 3% for exports and imports. Quantity growth has been around 7% for government consumption and investment. The PPP change has contributed negatively to the overall change in real GDP between 2005 and 2010 (by about 10%).

NOTES

1. This study was replicated by Gillitzer and McCarthy (2019).
2. This kind of assumptions was used by Majumder et al. (2015), for example.
3. The World Bank has taken the lead as the global coordinator of work on international comparisons of prices and GDP across countries. This work is conducted under the auspices of the International Comparison Program (ICP) of the United Nations and overseen by the United Nations Statistical Commission.
4. For a broader framework, including the industry dimension, see Samuels and Strassner (2019).
5. This is the equation that underpins the ICP (World Bank (2008) and (2015)). The focus on the expenditure side is a choice based on practical considerations, especially the possibility of collecting prices of goods and services purchased by consumers. International comparisons based on the production side of GDP were a part of the International Comparisons of Output and Productivity (ICOP) project at the University of Groningen, started under the stewardship of Angus Maddison. Comparisons from the production side for EU and World KLEMS projects are obtained using a mixture of comparisons from the expenditure and output side; see Inklaar and Timmer (2014) for details.
6. This section draws on Rao and Balk (2013).
7. We use the same nomenclature as the ICP but deviate from the notation used in recent versions of the Penn World Table (Feenstra et al. (2015)).
8. This normalization was also suggested by Reich (2013).
9. According to Diewert and Fox (2017, 2018) this would be the official OECD measure for overall OECD growth. However, it appears that the OECD uses *real* GDP shares; see footnote 14.

10. A Laspeyres price or quantity index uses the period s perspective, and a Paasche price or quantity index uses the period t perspective.

11. For any two strictly positive real numbers a and b, their logarithmic mean is defined by $LM(a,b) = (a-b)/\ln(a/b)$ if $a \neq b$ and $LM(a,a) = a$. The properties of this mean are discussed in Balk (2008, 134–136). See Balk (2008, 85) for the derivation of expression (22).

12. Two-factor Sato–Vartia indices were almost simultaneously developed by Sato (1976) and Vartia (1976). The indices satisfy all the relevant requirements (axioms, tests), except global monotonicity. As shown in Balk (2002/2003), (2008), however, this defect only materializes in extreme situations. Three- or multi-factor versions are due to Balk (2002/2003). Sato–Vartia indices were introduced in international trade studies by Feenstra (1994).

13. The decomposition proposed here is also simpler than the three-way decomposition suggested by Reich (2013).

14. The Laspeyres part of this quantity index is how the OECD (2011) currently computes global growth.

15. Curiously, the preference of Diewert and Fox (2017) depends on comparing the invariant index $P^F_{GDP}(t,s;PPP)$ to the variant index $(P/XR)^F_{GDP}(t,s;XR)$, a clear case of comparing an apple to an orange.

16. Recall that $\sum_{j=1}^{M}(\Psi^{jts} - \Phi^{jts}) = 0$.

17. This result was also derived by Rao and Rambaldi (2013) as the closed-form GEKS solution from which a full panel of space-time consistent PPPs can be computed satisfying fixity of PPPs in a given year.

18. There are methodological differences between the 2005 and 2011 rounds, and data related issues concerning 2005. These concerns were discussed in some detail by Deaton and Aten (2017), Inklaar and Rao (2017), and Feenstra et al. (2013). We have opted to use, for our illustration, the published World Bank data without any adjustments.

19. Annual PPP estimates are available from projects such as the Penn World Tables (Feenstra et al. (2015)) and UQICD (Rao et al., (2017)), which use the ICP data since its inception in 1970 and produce annual extrapolated series for countries, even if they have not consistently participated in the ICP.

REFERENCES

Balk, B. M. (2002/2003) Ideal indices and indicators for two or more factors. *Journal of Economic and Social Measurement* 28, 203–217.

Balk, B. M. (2008) *Price and Quantity Index Numbers: Models for Measuring Aggregate Change and Difference.* New York: Cambridge University Press.

Balk, B. M. (2009) Aggregation methods in international comparisons: An evaluation. In: D. S. P. Rao (ed.), *Purchasing Power Parities: Recent Advances in Methods and Applications*. Cheltenham UK, Northampton MA: Edward Elgar.

Balk, B. M. (2010) An assumption-free framework for measuring productivity change. *The Review of Income and Wealth* 56, S224–S256.

Cicarelli, M. and B. Mojon (2010) Global inflation. *The Review of Economics and Statistics* 92, 524–535.

Deaton, A. and B. Aten (2017) Trying to understand the PPPs in ICP 2011: Why are the results so different? *American Economic Journal: Macroeconomics* 9, 243–264.

Deaton, A. and A. Heston (2010) Understanding PPPs and PPP-based national accounts. *American Economic Journal: Macroeconomics* 2, 1–35.

Diewert, W. E. (2013) Methods of aggregation above the basic heading level within regions. In: World Bank (ed.), *Measuring the Real Size of the World Economy*, Chapter 6, pp. 169–196. Available at: https://elibrary.worldbank.org/doi/10.1596/9780821397282_CH06.

Diewert, W. E. and K. J. Fox (2017) Output growth and inflation across space and time. *Eurona* 1, 7–40. Addendum in *Eurona* (2018) 2, 71–80.

Feenstra, R. C. (1994) New product varieties and the measurement of international prices. *The American Economic Review* 84, 157–177.

Feenstra, R. C., R. Inklaar and M. P. Timmer (2015) The next generation of the Penn World Table. *The American Economic Review* 105, 3150–3182. Available at: www.ggdc.net/pwt.

Feenstra, R. C., H. Ma, J. P. Neary and D. S. P. Rao (2013) Who Shrunk China? Puzzles in measurement of Real GDP. *Economic Journal* 123, 1100–1129.

Gillitzer, C. and M. McCarthy (2019) Does global inflation help forecasting inflation in industrialized countries? *Journal of Applied Econometrics* 34, 850–857.

Huber, F., M. Fischer and P. Piribauer (2019) The role of US-based FDI flows for global output dynamics. *Macroeconomic Dynamics* 23, 943–973.

Inklaar, R. and D. S. P. Rao (2017) Cross-country income levels over time: Did the developing world suddenly become much richer? *American Economic Journal: Macroeconomics* 9, 265–290.

Inklaar, R. and M. P. Timmer (2014) The relative price of services. *The Review of Income and Wealth* 60, 727–746.

Jorgenson, D. W. and P. Schreyer (2013) Industry-level productivity measurement and the 2008 system of national accounts. *The Review of Income and Wealth* 59, 185–211.

Kohli, U. and J.-M. Natal (2014) The real exchange rate and the structure of aggregate production. *Journal of Productivity Analysis* 42, 1–13.

Majumder, A., R. Ray and K. Sinha (2015) Spatial comparisons of prices and expenditure in a heterogeneous country: Methodology with application to India. *Macroeconomic Dynamics* 19, 931–989.

Monacelli, T. and L. Sala (2009) The international dimension of inflation: Evidence from disaggregated consumer price data. *Journal of Money, Credit and Banking* 41, 101–120.

Mumtaz, H. and P. Surico (2012) Evolving international inflation dynamics: World and country-specific factors. *Journal of the European Economic Association* 10, 716–734.

OECD (2011) Aggregation Methods. Available at: http://www.oecd.org/economy/outlook/aggregationmethods.htm (Accessed on November 22, 2019).

Rao, D. S. P. (2013) The framework of the international comparison program. In: World Bank (ed.), *Measuring the Real Size of the World Economy*, Chapter 1, pp. 13–45. Available at: https://elibrary.worldbank.org/doi/10.1596/9780821397282_CH01.

Rao, D. S. P. (2018) Macro-economic Measures for a Globalised World: Global Growth and Inflation. Working Papers: No. 2018-11, Center for Economic Institutions, Hitotsubashi University.

Rao, D. S. P. and B. M. Balk (2013) Concepts and terminology for international comparisons of prices and real incomes. Paper presented at the Ottawa Group Meeting on Price Statistics, Copenhagen, 1–2 May 2013. Available at: www.ottawagroup.org.

Rao, D. S. P and A. N. Rambaldi (2013) A state-space and constrained GEKS approach to the construction of panels of real incomes at current and constant prices. Paper presented at the Princeton Conference on ICP/PPP, 23–24 May 2013. Available at: www.irs.princeton.edu/events/international-comparisons-conference-pppicp.

Rao, D. S. P., A. N. Rambaldi and B. M. Balk (2015) On Measuring Regional or Global Growth and Inflation. Discussion Papers: No. 552, School of Economics, The University of Queensland.

Rao, D. S. P., A. N. Rambaldi, K. R. Ganegodage, L. T. Huynh and H. E. Doran (2017) UQICD v2.1.2 – User Guide. Discussion Papers: No. 534, School of Economics, The University of Queensland.

Reich, U.-P. (2013) PPPs for SDRs? Some theoretical observations on how to normalise, capture the dynamics, and extend the application of, global purchasing power parities. *Journal of Economic and Social Measurement* 38, 171–185.

Samuels, J. D. and E. H. Strassner (2019) Toward a global integrated industry-level production account: A proposal. *International Productivity Monitor* 36, 7–33.

Sato, K. (1976) The ideal log-change index number. *The Review of Economics and Statistics* 58, 223–228.

https://doi.org/10.1017/S1365100520000152 Published online by Cambridge University Press

Vartia, Y. O. (1976) Ideal log-change index numbers. *The Scandinavian Journal of Statistics* 3, 121–126.

Ward, M. (2001) International price levels and global inflation. *Statistical Journal of the United Nations Economic Commission for Europe (continued as Statistical Journal of the IAOS)* 18, 65–75.

World Bank (2008) Global Purchasing Power Parities and Real Expenditures 2005. International Comparison Program. The World Bank, Washington DC. Available at: http://documents.worldbank.org/curated/en/842221468166145357/pdf/451960REPLACEM0me0box0info00PUBLIC0.pdf.

World Bank (2013) Measuring the Real Size of the World Economy: The Framework, Methodology, and Results of the International Comparison Program ICP. Washington, DC: World Bank. doi:10.1596/978-0-8213-9728-2. License: Creative Commons Attribution CC BY 3.0. Available at: http://pubdocs.worldbank.org/en/927971487091799574/ICPBook-eBook-FINAL.pdf.

World Bank (2015) Purchasing Power Parities and Real Expenditures of World Economies: Summary of Results and Findings of the 2011 International Comparison Program. Washington DC: The World Bank. Available at: http://pubdocs.worldbank.org/en/150971487105181565/Summary-of-Results-and-Findings-of-the-2011-International-Comparison-Program.pdf.

A: APPENDIX

Table A1. Data 2005

WB code	IFS code	Cons exp	Govt exp	Investment	Exports	Imports	*XR*	PPP_{GDP}	PPP_E	PPP_G	PPP_I
USA	111	8.79E+12	1.98E+12	2.98E+12	1.31E+12	2.03E+12	1	1	1	1	1
GBR	112	8.25E+11	2.68E+11	2.14E+11	3.42E+11	3.76E+11	0.55	0.64	0.63	0.59	0.71
AUT	122	1.35E+11	4.51E+10	5.39E+10	1.23E+11	1.15E+11	0.8	0.88	0.86	0.85	0.97
BEL	124	1.56E+11	6.88E+10	6.27E+10	2.29E+11	2.18E+11	0.8	0.92	0.89	1.04	0.9
DNK	128	7.45E+11	4.03E+11	3.04E+11	7.52E+11	6.64E+11	6	8.41	8.75	8.56	8.42
FRA	132	9.78E+11	4.08E+11	3.33E+11	4.67E+11	4.75E+11	0.8	0.94	0.89	1.03	0.99
DEU	134	1.31E+12	4.17E+11	3.85E+11	8.68E+11	7.52E+11	0.8	0.89	0.88	0.91	0.95
ITA	136	8.48E+11	2.89E+11	3.03E+11	3.67E+11	3.69E+11	0.8	0.88	0.88	0.95	0.83
LUX	137	1.07E+10	5.00E+09	6.64E+09	4.83E+10	4.03E+10	0.8	0.91	0.93	1.13	0.91
NLD	138	2.50E+11	1.22E+11	9.71E+10	3.59E+11	3.15E+11	0.8	0.9	0.86	0.94	1.04
NOR	142	8.35E+11	3.86E+11	3.76E+11	8.64E+11	5.45E+11	6.44	8.6	9.41	8.99	9.03
SWE	144	1.34E+12	7.25E+11	4.96E+11	1.33E+12	1.13E+12	7.47	8.97	9.16	8.25	10.66
CHE	146	2.87E+11	5.56E+10	1.05E+11	2.74E+11	2.37E+11	1.25	1.72	1.8	1.76	1.74
CAN	156	7.60E+11	2.70E+11	3.11E+11	5.21E+11	4.66E+11	1.21	1.21	1.21	1.19	1.23
JPN	158	2.91E+14	9.25E+13	1.13E+14	7.21E+13	6.50E+13	110.22	128.5	129.16	119.67	136.36
FIN	172	8.11E+10	3.55E+10	3.16E+10	6.62E+10	5.98E+10	0.8	0.97	1.02	0.92	0.95
GRC	174	1.35E+11	3.49E+10	4.00E+10	4.25E+10	5.89E+10	0.8	0.68	0.7	0.57	0.77
ISL	176	6.10E+11	2.53E+11	2.90E+11	3.22E+11	4.47E+11	62.98	95.05	98.05	86.25	79.6
IRL	178	7.40E+10	2.65E+10	4.37E+10	1.33E+11	1.13E+11	0.8	1.02	1.04	0.97	1.14
MLT	181	3.12E+09	9.41E+08	1.06E+09	5.37E+09	5.50E+09	0.81	0.36	0.58	0.19	0.28
PRT	182	9.98E+10	3.26E+10	3.56E+10	4.24E+10	5.69E+10	0.8	0.69	0.72	0.63	0.71
ESP	184	5.25E+11	1.63E+11	2.67E+11	2.30E+11	2.76E+11	0.8	0.76	0.74	0.69	0.88

Table A1. Continued

WB code	IFS code	Cons exp	Govt exp	Investment	Exports	Imports	*XR*	PPP_{GDP}	PPP_E	PPP_G	PPP_I
TUR	186	4.65E+11	7.65E+10	1.36E+11	1.42E+11	1.65E+11	1.34	0.83	0.87	0.5	1.12
AUS	193	5.62E+11	1.72E+11	2.77E+11	1.96E+11	2.14E+11	1.31	1.39	1.37	1.31	1.47
NZL	196	9.64E+10	2.91E+10	3.86E+10	4.61E+10	4.84E+10	1.42	1.51	1.49	1.26	1.83
ZAF	199	9.91E+11	3.06E+11	2.64E+11	4.34E+11	4.38E+11	6.36	3.54	4	2.25	4.62
ARG	213	3.26E+11	6.34E+10	1.14E+11	1.35E+11	1.03E+11	2.9	1.28	1.21	0.92	1.66
BOL	218	5.11E+10	1.23E+10	1.00E+10	2.74E+10	2.47E+10	8.07	1.97	2.11	1.09	3.48
BRA	223	1.29E+12	4.28E+11	3.42E+11	3.25E+11	2.47E+11	2.43	1.28	1.37	0.91	1.54
CHL	228	4.06E+13	7.32E+12	1.48E+13	2.77E+13	2.19E+13	559.77	346.29	345.67	257.6	355.26
COL	233	2.25E+14	5.34E+13	6.69E+13	5.73E+13	6.39E+13	2320.83	1015.24	1064.66	716.09	1323.09
ECU	248	2.84E+10	4.45E+09	8.48E+09	1.15E+10	1.18E+10	1	0.4	0.43	0.25	0.46
MEX	273	6.39E+12	1.01E+12	2.01E+12	2.51E+12	2.64E+12	10.9	6.9	6.85	4.7	9.62
PRY	288	3.37E+13	5.01E+12	8.96E+12	3.14E+13	2.48E+13	6177.96	2108.7	1844.71	1410.75	3151.33
PER	293	1.73E+11	2.63E+10	4.80E+10	6.73E+10	5.14E+10	3.3	1.52	1.46	1.21	1.69
URY	298	2.95E+11	4.65E+10	7.03E+10	1.29E+11	1.21E+11	24.48	13.02	13.47	8.98	14.51
VEN	299	1.42E+11	3.36E+10	6.17E+10	1.21E+11	6.22E+10	2.11	1.22	1.11	0.65	1.79
BHR	419	2.39E+09	8.44E+08	1.54E+09	5.04E+09	3.87E+09	0.38	0.2	0.25	0.11	0.17
CYP	423	8.68E+09	2.41E+09	2.60E+09	8.25E+09	8.33E+09	0.79	0.42	0.43	0.4	0.42
IRN	429	7.87E+14	2.63E+14	4.75E+14	6.13E+14	4.41E+14	8963.96	2447.47	2386.28	1214.84	3715.29
IRQ	433	2.76E+13	1.47E+13	1.02E+13	4.00E+13	4.51E+13	1472	353.84	553.84	241.26	385.15
ISR	436	3.37E+11	1.55E+11	9.62E+10	2.58E+11	2.61E+11	4.49	3.6	3.74	3.27	3.75
JOR	439	7.84E+09	1.74E+09	2.73E+09	4.70E+09	8.41E+09	0.71	0.27	0.42	0.18	0.33
KWT	443	7.59E+09	3.71E+09	3.45E+09	1.51E+10	6.67E+09	0.29	0.23	0.26	0.17	0.15
LBN	446	2.78E+13	4.97E+12	7.28E+12	1.21E+13	1.82E+13	1507.5	714.58	961.55	448.25	632.39
OMN	449	3.63E+09	2.48E+09	2.75E+09	6.96E+09	3.71E+09	0.38	0.22	0.26	0.15	0.18
QAT	453	2.59E+10	2.32E+10	5.19E+10	1.05E+11	4.81E+10	3.64	2.65	3.27	1.89	2.17

TABLE A1. Continued

WB code	IFS code	Cons exp	Govt exp	Investment	Exports	Imports	XR	PPP_{GDP}	PPP_E	PPP_G	PPP_I
SAU	456	3.24E+11	2.63E+11	2.38E+11	7.02E+11	3.07E+11	3.75	2.43	2.7	1.79	1.82
SYR	463	9.93E+11	2.07E+11	3.47E+11	6.18E+11	5.89E+11	53.05	17.7	20.18	9.29	20.38
EGY	469	3.98E+11	6.07E+10	9.24E+10	1.71E+11	1.79E+11	5.78	1.44	1.65	0.63	2.32
BGD	513	3.10E+12	2.28E+11	1.12E+12	6.15E+11	8.54E+11	64.33	21.33	22.06	14.12	25.25
BTN	514	1.46E+10	7.91E+09	1.93E+10	1.38E+10	2.33E+10	44.1	8.8	15.56	6.78	10.82
BRN	516	3.56E+09	2.92E+09	1.80E+09	1.11E+10	4.33E+09	1.66	0.82	0.89	0.39	0.62
KHM	522	2.17E+13	1.49E+12	4.86E+12	1.65E+13	1.87E+13	4092.5	1042.2	1268.19	552.45	881.92
LKA	524	1.69E+12	3.21E+11	5.73E+11	7.93E+11	1.01E+12	100.5	28.83	34.16	14.75	44.17
HKG	532	8.12E+11	1.31E+11	3.02E+11	2.51E+12	2.33E+12	7.78	5.75	6.39	3.45	5.1
IND	534	2.15E+13	4.02E+12	1.16E+13	7.12E+12	8.13E+12	44.1	13.66	13.58	9.35	17.74
IDN	536	1.79E+15	2.25E+14	6.56E+14	9.45E+14	8.30E+14	9704.74	3821.68	3649.45	2513.16	4783.4
KOR	542	4.65E+14	1.20E+14	2.50E+14	3.39E+14	3.16E+14	1024.12	779.97	808.78	675	770
LAO	544	2.02E+13	2.38E+12	9.93E+12	7.47E+12	1.13E+13	10655.17	2186.61	2962.4	1290.48	2060.11
MAC	546	2.94E+10	9.58E+09	2.43E+10	8.94E+10	5.89E+10	8.01	4.61	5.22	2.27	3.63
MYS	548	2.40E+11	6.24E+10	1.21E+11	6.14E+11	4.94E+11	3.79	1.71	1.83	0.75	1.68
MDV	556	6.16E+09	3.27E+09	4.81E+09	9.88E+09	1.06E+10	12.8	5.64	7.98	2.88	8.85
NPL	558	4.69E+11	5.25E+10	1.18E+11	8.60E+10	1.74E+11	71.37	19.77	22.8	13.54	25.15
PAK	564	5.58E+12	5.30E+11	1.06E+12	1.02E+12	1.27E+12	59.51	17.19	17.79	10.14	25.99
PHL	566	4.26E+12	5.13E+11	1.13E+12	2.62E+12	2.93E+12	55.09	19.79	21.11	12.9	24.22
SGP	576	8.38E+10	2.19E+10	4.41E+10	4.79E+11	4.18E+11	1.66	1.14	1.29	0.58	0.95
THA	578	4.24E+12	1.04E+12	2.11E+12	5.21E+12	5.29E+12	40.22	14.72	15.38	10.63	16.89
VNM	582	5.99E+14	5.00E+13	2.86E+14	5.82E+14	6.17E+14	15858.92	4358.87	4846.15	1675.85	5178.42
DJI	611	9.83E+10	3.17E+10	2.08E+10	5.59E+10	8.08E+10	177.72	55.86	83.92	36.56	58.36
AGO	614	8.86E+11	7.97E+11	2.38E+11	2.46E+12	1.53E+12	87.16	35.6	44.09	19.21	30.66
BWA	616	1.93E+10	9.85E+09	1.29E+10	2.69E+10	1.81E+10	5.11	2.52	3	1.36	2.69

TABLE A1. Continued

WB code	IFS code	Cons exp	Govt exp	Investment	Exports	Imports	*XR*	PPP_{GDP}	PPP_E	PPP_G	PPP_I
BDI	618	1.09E+12	1.70E+11	2.22E+11	7.50E+10	3.49E+11	1081.58	264.35	364.55	120.32	528.38
CMR	622	6.30E+12	8.72E+11	1.55E+12	1.79E+12	1.88E+12	527.47	239.58	246.02	127.15	414.74
CPV	624	6.40E+10	1.83E+10	3.34E+10	2.80E+10	5.26E+10	88.67	46.41	68.76	29.95	47.82
CAF	626	6.27E+11	7.42E+10	6.96E+10	1.07E+11	1.67E+11	527.47	234.36	256.84	133.37	467.6
TCD	628	7.70E+11	6.52E+11	6.28E+11	1.69E+12	7.91E+11	527.47	342.79	233.9	338.8	373.56
COG	634	8.77E+11	3.25E+11	7.75E+11	2.54E+12	1.32E+12	527.47	352.55	293.88	124.69	665.15
ZAR	636	2.37E+12	7.25E+11	6.80E+11	1.30E+12	1.67E+12	473.91	154.09	262.47	66.88	224.16
BEN	638	1.77E+12	2.76E+11	4.45E+11	4.96E+11	6.56E+11	527.47	197.45	230.18	96.53	285.42
GNQ	642	2.89E+11	1.19E+11	8.24E+11	3.75E+12	1.18E+12	527.47	345.07	284.35	123.87	197.74
ETH	644	8.14E+10	1.40E+10	2.74E+10	1.61E+10	3.78E+10	8.67	1.98	2.3	1.27	3.82
GAB	646	1.57E+12	6.33E+11	9.87E+11	3.03E+12	1.21E+12	527.47	293.25	355.26	101.05	334.1
GMB	648	1.65E+10	1.26E+09	5.25E+09	1.22E+09	6.36E+09	28.58	7.28	8.66	3.08	16.52
GHA	652	1.35E+10	1.54E+09	3.22E+09	3.56E+09	6.02E+09	0.91	0.34	0.38	0.2	0.53
GNB	654	2.72E+11	4.60E+10	1.87E+10	5.00E+10	7.79E+10	527.47	178.99	235.58	82.58	280.97
GIN	656	7.00E+12	1.02E+12	2.96E+12	3.44E+12	3.77E+12	3644.33	1111.96	1222.7	419.71	1960.34
CIV	662	6.43E+12	9.52E+11	8.26E+11	4.50E+12	3.89E+12	527.47	284.58	276.06	179.8	665.41
KEN	664	1.07E+12	2.46E+11	2.65E+11	3.85E+11	5.13E+11	75.55	26.6	28.55	18.05	50.89
LSO	666	9.54E+09	3.19E+09	1.84E+09	4.25E+09	1.05E+10	6.36	1.88	2.93	1.73	5.97
LBR	668	5.26E+08	6.78E+07	1.00E+08	1.45E+08	4.64E+08	1	0.27	0.49	0.21	0.34
MDG	674	8.70E+12	9.04E+11	2.24E+12	2.85E+12	4.60E+12	2003.03	577.4	632.29	334.45	1183.61
MWI	676	3.84E+11	5.50E+10	6.16E+10	7.30E+10	1.70E+11	118.42	32.87	47.34	16.8	36.06
MLI	678	1.99E+12	4.90E+11	4.47E+11	7.24E+11	9.53E+11	527.47	193.02	240.47	98.04	391.57
MRT	682	3.77E+11	1.46E+11	3.42E+11	1.78E+11	4.78E+11	265.53	70.2	103.73	45.1	148.39
MUS	684	1.30E+11	2.78E+10	4.11E+10	1.13E+11	1.23E+11	29.5	13.23	14.62	7.38	20.96
MAR	686	3.03E+11	1.02E+11	1.45E+11	1.71E+11	2.00E+11	8.87	4.7	4.97	3.61	5.81

TABLE A1. Continued

WB code	IFS code	Cons exp	Govt exp	Investment	Exports	Imports	XR	PPP_{GDP}	PPP_E	PPP_G	PPP_I
MOZ	688	1.26E+11	1.97E+10	2.84E+10	5.38E+10	7.78E+10	23.06	9.2	9.71	6.58	20.68
NER	692	1.31E+12	2.80E+11	3.85E+11	3.33E+11	5.53E+11	527.47	190.62	224.52	104.26	349.03
NGA	694	1.11E+13	1.00E+12	8.04E+11	4.85E+12	2.75E+12	131.27	60.75	64.38	20.42	83.76
RWA	714	1.15E+12	2.62E+11	2.27E+11	1.71E+11	3.51E+11	557.82	147.24	195.15	73.19	300.58
STP	716	1.24E+12	1.69E+11	3.49E+11	1.69E+11	5.56E+11	10557.97	4156.13	5258.85	1845.67	8925.65
SEN	722	3.58E+12	5.98E+11	1.07E+12	1.24E+12	1.95E+12	527.47	221.41	251.97	135.32	332.14
SLE	724	4.32E+12	4.71E+11	5.19E+11	8.38E+11	1.40E+12	2889.59	943.99	1151.71	418.63	1482.52
NAM	728	2.67E+10	8.91E+09	8.59E+09	1.87E+10	1.86E+10	6.36	3.86	4.42	2.43	4.92
SDN	732	4.35E+10	8.92E+09	1.82E+10	1.24E+10	1.84E+10	2.44	1	1.03	0.59	1.87
SWZ	734	1.21E+10	2.50E+09	2.47E+09	1.43E+10	1.50E+10	6.36	2.95	3.18	1.84	4.97
TZA	738	1.06E+13	2.80E+12	3.94E+12	3.32E+12	4.68E+12	1128.93	342.33	402.01	185.61	612.62
TGO	742	1.10E+12	1.50E+11	1.83E+11	4.42E+11	7.65E+11	527.47	185.27	234.43	104.03	392.07
TUN	744	2.59E+10	7.08E+09	8.98E+09	1.88E+10	1.90E+10	1.3	0.56	0.6	0.36	0.73
UGA	746	1.34E+13	2.44E+12	3.81E+12	3.30E+12	5.23E+12	1780.67	533.9	617.83	266.93	1106.3
BFA	748	2.08E+12	5.70E+11	5.67E+11	2.81E+11	7.43E+11	527.47	157.58	202.4	91.44	307.05
ZMB	754	1.92E+13	5.92E+12	7.18E+12	1.11E+10	1.17E+10	4.46	2	2.34	0.99	3.65
FJI	819	3.76E+09	7.93E+08	9.19E+08	2.57E+09	3.22E+09	1.69	1.14	1.35	0.67	1.4
ARM	911	1.69E+12	2.37E+11	6.68E+11	6.46E+11	9.70E+11	457.69	131.26	177.35	77.26	123.33
AZE	912	5.27E+09	1.31E+09	5.17E+09	7.88E+09	6.62E+09	0.95	0.26	0.32	0.14	0.22
BLR	913	3.38E+13	1.35E+13	1.73E+13	3.89E+13	3.84E+13	2153.82	558.99	771.81	336.22	536.73
ALB	914	6.36E+11	8.85E+10	3.01E+11	1.86E+11	3.87E+11	99.87	44.31	48.41	25.19	75.77
GEO	915	7.78E+09	2.01E+09	3.26E+09	3.92E+09	5.99E+09	1.81	0.49	0.73	0.32	0.51
KAZ	916	3.78E+12	8.54E+11	2.15E+12	4.04E+12	3.38E+12	132.88	46.58	57.07	24.86	39.69
KGZ	917	8.53E+10	1.77E+10	1.64E+10	3.87E+10	5.73E+10	41.01	7.88	11.29	4.92	7.85
BGR	918	3.15E+10	8.33E+09	1.17E+10	2.00E+10	2.69E+10	1.57	0.53	0.6	0.35	0.94

TABLE A1. Continued

WB code	IFS code	Cons exp	Govt exp	Investment	Exports	Imports	XR	PPP_{GDP}	PPP_E	PPP_G	PPP_I
MDA	921	3.52E+10	6.19E+09	9.26E+09	1.93E+10	3.46E+10	12.6	2.7	4.39	1.91	3.05
RUS	922	1.08E+13	3.65E+12	3.90E+12	7.61E+12	4.65E+12	28.28	10.27	12.58	5.48	8.75
TJK	923	5.85E+09	1.05E+09	8.01E+08	3.91E+09	5.25E+09	3.12	0.51	0.73	0.32	0.51
CHN	924	7.30E+12	2.64E+12	7.42E+12	6.86E+12	5.83E+12	8.19	3.08	3.46	1.53	3.7
UKR	926	2.57E+11	8.05E+10	9.71E+10	2.18E+11	2.15E+11	5.12	1.25	1.66	0.73	1.16
CZE	935	1.54E+12	6.67E+11	8.07E+11	2.03E+12	1.95E+12	23.96	10.31	14.27	6.22	9.92
SVK	936	2.83E+10	9.04E+09	1.31E+10	3.63E+10	3.86E+10	1.03	0.39	0.54	0.24	0.38
EST	939	6.21E+09	1.92E+09	3.59E+09	7.42E+09	8.00E+09	0.8	0.36	0.5	0.22	0.35
LVA	941	5.68E+09	1.60E+09	2.79E+09	5.93E+09	7.91E+09	0.56	0.2	0.3	0.13	0.21
HUN	944	1.21E+13	4.98E+12	5.02E+12	1.41E+13	1.46E+13	199.58	122.52	119.54	101.15	177.34
LTU	946	4.70E+10	1.35E+10	1.66E+10	3.91E+10	4.43E+10	2.77	1.07	1.47	0.64	1.02
MNG	948	1.70E+12	3.44E+11	8.51E+11	1.79E+12	1.93E+12	1205.22	334.02	423.37	137.79	463.36
HRV	960	1.61E+11	5.06E+10	6.59E+10	1.06E+11	1.23E+11	5.95	2.82	3.9	1.7	2.71
SVN	961	1.56E+10	5.45E+09	7.30E+09	1.74E+10	1.76E+10	0.8	0.44	0.61	0.26	0.42
MKD	962	2.28E+11	5.44E+10	4.89E+10	1.07E+11	1.57E+11	49.28	13.17	18.92	8.24	13.16
BIH	963	1.67E+10	3.81E+09	4.79E+09	5.58E+09	1.26E+10	1.57	0.45	0.72	0.32	0.5
POL	964	6.23E+11	1.78E+11	1.79E+11	3.44E+11	3.53E+11	3.24	1.79	1.83	1.37	2.41
SRB	965	1.30E+12	3.16E+11	3.20E+11	4.75E+11	8.26E+11	66.72	18.23	26.95	11.74	18.74
ROM	968	2.01E+11	5.02E+10	6.85E+10	9.56E+10	1.25E+11	2.91	1.29	1.43	0.82	2.05

TABLE A2. Data 2011, Part 1

WB code	IFS cde	Cons exp	Govt exp	Investment	Exports	Imports	*XR*	PPP_{GDP}
USA	111	1.07E+13	2.53E+12	2.83E+12	2.11E+12	2.69E+12	1	1
GBR	112	9.92E+11	3.37E+11	2.21E+11	4.99E+11	5.23E+11	0.62	0.7
AUT	122	1.64E+11	5.68E+10	6.61E+10	1.66E+11	1.58E+11	0.72	0.83
BEL	124	1.95E+11	9.03E+10	7.66E+10	3.09E+11	3.07E+11	0.72	0.82
DNK	128	8.75E+11	5.08E+11	3.12E+11	9.71E+11	8.69E+11	5.37	7.43
FRA	132	1.16E+12	4.90E+11	4.01E+11	5.73E+11	6.25E+11	0.72	0.83
DEU	134	1.50E+12	5.00E+11	4.73E+11	1.21E+12	1.08E+12	0.72	0.78
ITA	136	9.68E+11	3.22E+11	3.04E+11	4.42E+11	4.68E+11	0.72	0.77
LUX	137	1.33E+10	6.98E+09	7.75E+09	7.85E+10	6.45E+10	0.72	0.84
NLD	138	2.72E+11	1.67E+11	1.07E+11	4.97E+11	4.42E+11	0.72	0.81
NOR	142	1.13E+12	5.91E+11	5.37E+11	1.15E+12	7.96E+11	5.6	8.51
SWE	144	1.67E+12	9.24E+11	6.51E+11	1.71E+12	1.53E+12	6.49	8.6
CHE	146	3.35E+11	6.45E+10	1.20E+11	4.07E+11	3.54E+11	0.89	1.42
CAN	156	9.80E+11	3.82E+11	4.12E+11	5.41E+11	5.62E+11	0.99	1.23
JPN	158	2.85E+14	9.62E+13	9.69E+13	7.13E+13	7.56E+13	79.81	106.95
FIN	172	1.05E+11	4.62E+10	3.66E+10	7.71E+10	7.88E+10	0.72	0.89
GRC	174	1.56E+11	3.62E+10	3.16E+10	5.29E+10	6.71E+10	0.72	0.7
ISL	176	8.45E+11	4.13E+11	2.29E+11	9.54E+11	8.14E+11	115.95	129.32
IRL	178	7.82E+10	2.99E+10	1.73E+10	1.67E+11	1.32E+11	0.72	0.81
MLT	181	4.03E+09	1.35E+09	9.84E+08	1.09E+10	1.08E+10	0.72	0.55
PRT	182	1.13E+11	3.41E+10	3.08E+10	6.04E+10	6.80E+10	0.72	0.62
ESP	184	6.13E+11	2.22E+11	2.32E+11	3.10E+11	3.12E+11	0.72	0.69
TUR	186	9.24E+11	1.81E+11	2.83E+11	3.11E+11	4.24E+11	1.67	0.97
AUS	193	7.95E+11	2.64E+11	4.11E+11	3.16E+11	3.19E+11	0.97	1.53
NZL	196	1.23E+11	4.15E+10	3.73E+10	6.47E+10	6.15E+10	1.27	1.47

Table A2. Continued

WB code	IFS cde	Cons exp	Govt exp	Investment	Exports	Imports	*XR*	PPP_{GDP}
ZAF	199	1.74E+12	6.35E+11	5.53E+11	9.21E+11	8.95E+11	7.26	4.67
ARG	213	1.04E+12	2.79E+11	4.16E+11	4.10E+11	3.72E+11	4.11	2.06
BOL	218	1.01E+11	2.29E+10	3.15E+10	7.33E+10	6.38E+10	6.94	3.12
BRA	223	2.50E+12	8.57E+11	7.99E+11	4.93E+11	5.23E+11	1.67	1.45
CHL	228	7.44E+13	1.46E+13	2.72E+13	4.62E+13	4.23E+13	483.67	354.4
COL	233	3.81E+14	9.80E+13	1.47E+14	1.16E+14	1.24E+14	1848.14	1173.06
ECU	248	4.87E+10	1.01E+10	2.08E+10	2.47E+10	2.65E+10	1	0.54
MEX	273	9.64E+12	1.69E+12	3.17E+12	4.55E+12	4.73E+12	12.42	7.74
PRY	288	7.97E+13	1.12E+13	1.72E+13	5.54E+13	5.27E+13	4191.42	2324.71
PER	293	2.96E+11	4.58E+10	1.29E+11	1.45E+11	1.21E+11	2.75	1.61
URY	298	6.09E+11	1.18E+11	1.70E+11	2.45E+11	2.50E+11	19.31	15.52
VEN	299	7.49E+11	1.56E+11	2.41E+11	4.06E+11	2.67E+11	4.29	2.79
BHR	419	4.23E+09	1.50E+09	1.71E+09	8.63E+09	5.22E+09	0.38	0.24
CYP	423	1.21E+10	3.59E+09	2.97E+09	9.65E+09	1.03E+10	0.72	0.67
IRN	429	2.59E+15	6.54E+14	1.42E+15	1.64E+15	9.90E+14	10616.31	4710.03
IRQ	433	7.63E+13	4.28E+13	3.68E+13	9.65E+13	6.03E+13	1409.48	524.18
ISR	436	5.11E+11	2.11E+11	1.63E+11	3.28E+11	3.33E+11	3.58	3.86
JOR	439	1.76E+10	3.92E+09	4.43E+09	9.33E+09	1.51E+10	0.71	0.25
KWT	443	1.03E+10	6.63E+09	6.40E+09	3.11E+10	1.10E+10	0.28	0.21
LBN	446	4.82E+13	8.35E+12	1.93E+13	2.23E+13	3.88E+13	1507.5	573.76
OMN	449	8.08E+09	4.63E+09	7.08E+09	1.79E+10	8.99E+09	0.38	0.22
QAT	453	7.99E+10	7.68E+10	1.84E+11	4.43E+11	1.59E+11	3.64	2.64
SAU	456	6.82E+11	4.88E+11	5.69E+11	1.41E+12	7.42E+11	3.75	2.02
SYR	463	1.82E+12	4.39E+11	6.56E+11	8.42E+11	8.47E+11	47.4	16.29
EGY	469	1.04E+12	1.55E+11	2.29E+11	2.82E+11	3.39E+11	5.93	1.57

TABLE A2. Continued

WB code	IFS cde	Cons exp	Govt exp	Investment	Exports	Imports	*XR*	PPP_{GDP}
BGD	513	6.64E+12	4.61E+11	2.51E+12	1.82E+12	2.52E+12	74.15	23.52
BTN	514	3.76E+10	1.70E+10	5.71E+10	3.50E+10	5.99E+10	46.67	14.55
BRN	516	4.09E+09	3.57E+09	2.75E+09	1.67E+10	6.00E+09	1.26	0.91
KHM	522	4.31E+13	3.13E+12	8.32E+12	2.82E+13	3.10E+13	4058.5	1375.51
LKA	524	4.57E+12	9.68E+11	1.77E+12	1.51E+12	2.46E+12	110.57	34.72
HKG	532	1.22E+12	1.68E+11	4.55E+11	4.12E+12	4.04E+12	7.78	5.77
IND	534	5.06E+13	1.04E+13	2.99E+13	2.15E+13	2.72E+13	46.67	14.93
IDN	536	4.05E+15	6.69E+14	2.37E+15	1.96E+15	1.85E+15	8770.43	3720.96
KOR	542	6.55E+14	1.90E+14	3.39E+14	7.43E+14	7.23E+14	1108.29	857.86
LAO	544	3.87E+13	8.17E+12	2.06E+13	1.54E+13	1.73E+13	8030.06	2294.56
MAC	546	6.05E+10	2.09E+10	3.66E+10	3.29E+11	1.57E+11	8.02	6.53
MYS	548	4.18E+11	1.15E+11	1.97E+11	8.10E+11	6.65E+11	3.06	1.62
MDV	556	1.26E+10	7.16E+09	1.09E+10	2.55E+10	2.22E+10	14.6	8.07
NPL	558	1.05E+12	1.31E+11	2.93E+11	1.22E+11	4.50E+11	74.02	21.88
PAK	564	1.48E+13	1.78E+12	2.29E+12	2.55E+12	3.47E+12	86.34	23.95
PHL	566	7.13E+12	9.42E+11	1.82E+12	3.10E+12	3.45E+12	43.31	18.17
SGP	576	1.28E+11	3.40E+10	7.80E+10	6.89E+11	5.98E+11	1.26	1.04
THA	578	5.92E+12	1.78E+12	2.90E+12	7.94E+12	7.75E+12	30.49	12.52
VNM	582	1.84E+15	1.64E+14	7.45E+14	2.21E+15	2.31E+15	20509.75	6886.5
DJI	611	1.88E+11	4.08E+10	3.78E+10	7.29E+10	1.20E+11	177.72	85.22
AGO	614	3.47E+12	2.36E+12	1.50E+12	6.90E+12	4.52E+12	93.93	66.85
BWA	616	4.86E+10	1.94E+10	3.36E+10	4.64E+10	5.24E+10	6.84	3.46
BDI	618	2.65E+12	4.08E+11	6.28E+11	2.97E+11	9.65E+11	1261.07	394.42
CMR	622	9.52E+12	1.46E+12	2.58E+12	2.31E+12	3.32E+12	471.87	224.35
CPV	624	1.03E+11	2.62E+10	6.60E+10	4.66E+10	8.92E+10	79.32	43.1

Table A2. Continued

WB code	IFS cde	Cons exp	Govt exp	Investment	Exports	Imports	*XR*	PPP_{GDP}
CAF	626	9.33E+11	6.47E+10	1.55E+11	1.13E+11	2.44E+11	471.87	251.14
TCD	628	1.35E+12	9.92E+11	1.12E+12	2.48E+12	9.92E+11	471.87	281.95
COG	634	1.56E+12	5.00E+11	2.10E+12	5.93E+12	3.42E+12	471.87	363.92
ZAR	636	1.12E+13	1.95E+12	3.03E+12	9.49E+12	1.08E+13	919.49	506.21
BEN	638	2.64E+12	4.00E+11	7.13E+11	4.91E+11	8.25E+11	471.87	208.36
GNQ	642	5.50E+11	2.85E+11	2.76E+12	7.63E+12	4.00E+12	471.87	356.04
ETH	644	3.98E+11	4.36E+10	1.41E+11	8.60E+10	1.62E+11	16.9	4.91
GAB	646	2.42E+12	1.11E+12	2.82E+12	4.68E+12	2.11E+12	471.87	355.37
GMB	648	2.02E+10	2.84E+09	7.14E+09	5.03E+09	8.64E+09	29.46	9.65
GHA	652	3.68E+10	9.96E+09	1.53E+10	2.64E+10	2.97E+10	1.51	0.68
GNB	654	3.74E+11	5.36E+10	5.79E+10	1.23E+11	1.42E+11	471.87	216.37
GIN	656	2.56E+13	4.75E+12	1.31E+13	1.05E+13	1.72E+13	6658.03	2240.19
CIV	662	7.64E+12	1.58E+12	9.28E+11	6.44E+12	4.47E+12	471.87	247.8
KEN	664	2.35E+12	4.99E+11	6.09E+11	8.06E+11	1.45E+12	88.81	30.98
LSO	666	1.78E+10	6.29E+09	4.86E+09	8.86E+09	1.90E+10	7.26	2.99
LBR	668	1.29E+09	1.47E+08	1.44E+08	4.24E+08	1.43E+09	1	0.3
MDG	674	1.76E+13	2.04E+12	3.53E+12	5.36E+12	8.48E+12	2025.12	651.47
MWI	676	1.07E+12	1.59E+11	6.28E+10	2.55E+11	4.39E+11	156.52	71.15
MLI	678	3.10E+12	8.59E+11	1.11E+12	1.25E+12	1.34E+12	471.87	204.73
MRT	682	8.63E+11	1.89E+11	3.23E+11	8.20E+11	9.15E+11	281.12	108.23
MUS	684	2.37E+11	4.34E+10	7.76E+10	1.73E+11	2.14E+11	28.71	14.87
MAR	686	4.73E+11	1.46E+11	2.46E+11	2.86E+11	3.91E+11	8.09	3.39
MOZ	688	2.93E+11	4.89E+10	6.49E+10	1.13E+11	1.57E+11	29.07	15.32

TABLE A2. Continued

WB code	IFS cde	Cons exp	Govt exp	Investment	Exports	Imports	*XR*	PPP_{GDP}
NER	692	2.24E+12	4.36E+11	1.16E+12	6.32E+11	1.45E+12	471.87	203.63
NGA	694	2.28E+13	4.98E+12	3.91E+12	2.00E+13	1.37E+13	154.74	79.84
RWA	714	3.09E+12	5.69E+11	8.18E+11	5.33E+11	1.14E+12	600.31	246.52
STP	716	5.29E+12	6.57E+11	1.20E+12	4.49E+11	2.92E+12	17622.94	6733.19
SEN	722	5.31E+12	9.60E+11	1.61E+12	1.79E+12	3.04E+12	471.87	220.22
SLE	724	1.12E+13	1.29E+12	5.32E+12	2.08E+12	7.14E+12	4349.16	1395.85
NAM	728	5.59E+10	2.29E+10	1.93E+10	3.74E+10	4.79E+10	7.26	4.22
SDN	732	1.20E+11	6.99E+09	3.22E+10	3.15E+10	2.79E+10	2.67	1.17
SWZ	734	2.49E+10	4.41E+09	2.76E+09	1.92E+10	2.15E+10	7.26	3.78
TZA	738	2.48E+13	6.15E+12	1.35E+13	1.10E+13	1.90E+13	1572.12	488.22
TGO	742	1.47E+12	2.06E+11	3.09E+11	7.13E+11	9.93E+11	471.87	201.76
TUN	744	4.28E+10	1.16E+10	1.40E+10	3.13E+10	3.61E+10	1.41	0.55
UGA	746	3.86E+13	3.89E+12	1.13E+13	1.18E+13	1.96E+13	2522.75	827.91
BFA	748	3.37E+12	8.73E+11	1.12E+12	1.33E+12	1.68E+12	471.87	206.35
ZMB	754	4.47E+13	1.92E+13	2.19E+13	4.32E+10	3.67E+10	4.86	2.35
FJI	819	4.49E+09	9.08E+08	1.11E+09	3.99E+09	4.19E+09	1.79	1.04
ARM	911	3.16E+12	4.88E+11	9.86E+11	8.98E+11	1.79E+12	372.5	156.96
AZE	912	1.94E+10	5.27E+09	1.05E+10	2.94E+10	1.25E+10	0.79	0.42
BLR	913	1.42E+14	4.14E+13	1.13E+14	2.41E+14	2.44E+14	4974.63	1895.04
ALB	914	1.01E+12	1.36E+11	4.37E+11	4.42E+11	7.38E+11	100.89	43.93
GEO	915	1.80E+10	4.43E+09	5.47E+09	8.82E+09	1.33E+10	1.69	0.71
KAZ	916	1.18E+13	2.94E+12	5.77E+12	1.31E+13	7.53E+12	146.62	85.87
KGZ	917	2.39E+11	5.21E+10	6.86E+10	1.56E+11	2.33E+11	46.14	13.37
BGR	918	4.70E+10	1.18E+10	1.62E+10	4.99E+10	4.91E+10	1.41	0.64

TABLE A2. Continued

WB code	IFS cde	Cons exp	Govt exp	Investment	Exports	Imports	*XR*	PPP_{GDP}
MDA	921	7.95E+10	1.66E+10	1.92E+10	3.70E+10	7.07E+10	11.74	3.84
RUS	922	2.74E+13	1.00E+13	1.21E+13	1.69E+13	1.22E+13	29.38	17.11
TJK	923	2.92E+10	4.11E+09	8.60E+09	5.34E+09	2.23E+10	4.61	1.12
CHN	924	1.69E+13	6.32E+12	2.16E+13	1.35E+13	1.23E+13	6.46	3.61
UKR	926	8.76E+11	2.37E+11	2.42E+11	6.67E+11	7.47E+11	7.97	2.93
CZE	935	1.94E+12	7.93E+11	9.26E+11	2.88E+12	2.72E+12	17.7	13.11
SVK	936	3.97E+10	1.24E+10	1.60E+10	5.99E+10	6.05E+10	0.72	0.49
EST	939	8.20E+09	3.12E+09	3.83E+09	1.41E+10	1.35E+10	0.72	0.51
LVA	941	8.87E+09	2.53E+09	3.04E+09	1.17E+10	1.27E+10	0.5	0.33
HUN	944	1.47E+13	5.82E+12	4.95E+12	2.45E+13	2.28E+13	201.06	119.37
LTU	946	6.71E+10	1.99E+10	1.94E+10	8.10E+10	8.37E+10	2.48	1.5
MNG	948	5.58E+12	1.37E+12	5.47E+12	6.91E+12	9.63E+12	1265.52	462.53
HRV	960	1.98E+11	6.53E+10	6.73E+10	1.34E+11	1.36E+11	5.34	3.7
SVN	961	2.08E+10	7.53E+09	6.72E+09	2.60E+10	2.52E+10	0.72	0.61
MKD	962	3.45E+11	8.42E+10	9.47E+10	2.19E+11	3.07E+11	44.23	16.78
BIH	963	2.22E+10	6.02E+09	5.24E+09	8.02E+09	1.43E+10	1.41	0.67
POL	964	9.34E+11	2.75E+11	3.09E+11	6.70E+11	6.98E+11	2.96	1.78
SRB	965	2.47E+12	6.19E+11	5.93E+11	1.16E+12	1.68E+12	73.33	34.25
ROM	968	3.53E+11	8.38E+10	1.45E+11	2.08E+11	2.40E+11	3.05	1.55

TABLE A3. Data 2011, Part 2

WB code	IFS code	PPP_E	PPP_G	PPP_I	Def_{GDP}	Def_E	Def_G	Def_I	Def_X	Def_M
USA	111	1	1	1	1.12	1.13	1.2	1.09	1.17	1.21
GBR	112	0.76	0.59	0.63	1.17	1.2	1.18	1.17	1.27	1.31
AUT	122	0.85	0.82	0.79	1.11	1.13	1.14	1.16	1.12	1.17
BEL	124	0.88	0.83	0.71	1.13	1.14	1.2	1.17	1.13	1.15
DNK	128	8.52	7.23	6.25	1.15	1.13	1.18	1.1	1.11	1.1
FRA	132	0.88	0.75	0.81	1.11	1.1	1.1	1.16	1.09	1.11
DEU	134	0.82	0.66	0.82	1.06	1.11	1.08	1.07	1.05	1.09
ITA	136	0.83	0.7	0.67	1.11	1.13	1.1	1.14	1.12	1.18
LUX	137	0.99	1.06	0.73	1.25	1.14	1.21	1.07	1.26	1.21
NLD	138	0.87	0.76	0.8	1.08	1.09	1.12	1.08	1.14	1.16
NOR	142	9.8	8.97	8.6	1.33	1.13	1.33	1.27	1.39	1.16
SWE	144	9.11	8.04	8.95	1.13	1.11	1.17	1.11	1.09	1.08
CHE	146	1.61	1.53	1.28	1.08	1.06	1.13	1.04	1.13	1.15
CAN	156	1.28	1.14	1.2	1.15	1.09	1.19	1.16	1.1	1.01
JPN	158	116.1	83.69	110.17	0.92	0.94	0.97	0.98	0.87	1.09
FIN	172	0.98	0.78	0.82	1.12	1.15	1.24	1.11	1.05	1.13
GRC	174	0.76	0.51	0.72	1.16	1.2	1.06	1.11	1.21	1.23
ISL	176	138.89	108.34	155.03	1.54	1.57	1.53	1.81	2.15	2.47
IRL	178	0.95	0.78	0.61	0.97	0.99	1.1	0.79	1.03	1.11
MLT	181	0.63	0.38	0.57	1.21	1.14	1.17	1.4	1.21	1.19
PRT	182	0.7	0.5	0.55	1.09	1.11	1.05	1.09	1.13	1.12
ESP	184	0.78	0.59	0.62	1.1	1.14	1.11	1.11	1.15	1.18
TUR	186	1.16	0.55	1.12	1.57	1.61	1.75	1.52	1.76	1.98
AUS	193	1.53	1.31	1.71	1.29	1.18	1.27	1.08	1.33	0.94
NZL	196	1.59	1.11	1.69	1.19	1.16	1.22	1.08	1.23	1.12

TABLE A3. Continued

WB code	IFS code	PPP_E	PPP_G	PPP_I	Def_{GDP}	Def_E	Def_G	Def_I	Def_X	Def_M
ZAF	199	5.07	3.85	4.6	1.53	1.4	1.58	1.48	1.94	1.52
ARG	213	2.68	1.17	1.86	2.3	2.1	2.8	1.96	2.4	1.81
BOL	218	2.91	2.85	3.62	1.64	1.53	1.46	1.58	2.2	1.84
BRA	223	1.66	1.15	1.31	1.51	1.41	1.64	1.39	1.28	0.94
CHL	228	391.64	214.68	373.66	1.39	1.25	1.48	1.19	1.44	1.12
COL	233	1196.95	910.19	1395.26	1.37	1.29	1.37	1.2	1.52	1.05
ECU	248	0.55	0.43	0.61	1.46	1.32	1.52	1.57	1.89	1.55
MEX	273	8.94	3.81	9.26	1.33	1.32	1.44	1.31	1.43	1.37
PRY	288	2309.43	1853.23	2663.07	1.51	1.68	1.5	1.11	1.33	1.41
PER	293	1.57	1.05	1.96	1.26	1.18	1.14	1.11	1.67	1.14
URY	298	16.42	11.98	15.73	1.5	1.36	2	1.45	1.34	1.15
VEN	299	2.92	1.78	2.85	3.57	3.7	3.24	2.62	4.82	2.62
BHR	419	0.22	0.21	0.19	1.36	0.99	1.04	1.04	1.63	1.23
CYP	423	0.71	0.61	0.61	1.18	1.18	1.2	1.1	1.13	1.13
IRN	429	5001.36	1865.57	7137.24	2.5	2.81	2.49	2.3	2.01	1.87
IRQ	433	573.42	276.48	695.06	2.06	2.47	2.47	2.47	2.36	2.36
ISR	436	4.27	3.05	4.03	1.16	1.18	1.15	1.02	0.95	0.99
JOR	439	0.32	0.18	0.37	1.65	1.72	1.59	1.46	1.73	1.81
KWT	443	0.18	0.2	0.15	1.67	1.39	1.15	1.16	1.78	1.24
LBN	446	831.26	362.11	578.07	1.3	1.32	1.23	1.24	1.35	1.42
OMN	449	0.2	0.17	0.17	1.6	1.2	1.33	1.24	2.37	1.46
QAT	453	2.64	3.38	1.74	1.49	1.38	1.37	1.2	1.74	1.22
SAU	456	1.79	1.84	1.54	1.42	1.3	1.3	1.19	1.78	1.24
SYR	463	21.1	9.19	14.68	1.62	1.58	1.15	1.6	1.44	1.6
EGY	469	1.8	0.71	2.69	1.85	1.86	2.11	1.64	1.02	1.1

TABLE A3. Continued

WB code	IFS code	PPP_E	PPP_G	PPP_I	Def_{GDP}	Def_E	Def_G	Def_I	Def_X	Def_M
BGD	513	24.85	15.63	27.33	1.49	1.57	1.39	1.49	1.49	1.73
BTN	514	16.96	9.92	22.24	1.39	1.59	1.46	1.36	1.48	1.48
BRN	516	0.85	0.53	0.84	1.23	0.96	0.9	1.07	1.68	0.96
KHM	522	1527.56	664.85	1546.8	1.37	1.3	1.11	1.1	0.87	0.85
LKA	524	42.22	19.77	51.36	1.81	1.79	1.88	1.88	1.61	1.72
HKG	532	5.75	5.8	5.58	1.08	1.11	1.12	1.17	1.19	1.22
IND	534	14.98	11.97	18.89	1.53	1.47	1.58	1.42	1.57	1.49
IDN	536	4091.94	2377.45	3644.95	1.9	1.73	1.97	2.37	1.34	1.51
KOR	542	912.02	658.01	895.66	1.14	1.18	1.22	1.24	1.25	1.41
LAO	544	2914.85	969.17	2903.76	1.44	1.42	1.79	1.1	1.19	1.04
MAC	546	5.46	4.66	4.97	1.46	1.38	1.4	1.52	1.34	1.26
MYS	548	1.59	1.07	1.59	1.24	1.19	1.22	1.17	1.13	1.07
MDV	556	10.68	4.61	8.73	1.51	1.52	1.5	1.72	1.17	1.13
NPL	558	25.76	19.18	31.79	1.82	1.79	1.78	1.8	1.58	1.59
PAK	564	25.41	16.19	33.69	2.31	2.31	2.06	1.96	2.05	2.58
PHL	566	18.87	15.55	19.2	1.3	1.33	1.31	1.23	0.93	0.99
SGP	576	1.17	0.83	0.81	1.11	1.2	1.16	1.07	1.01	1.02
THA	578	12.84	9.91	13.5	1.25	1.24	1.2	1.24	1.09	1.12
VNM	582	7624.97	2862.69	8252.13	2.11	2.11	2	1.66	2.22	2.19
DJI	611	101.48	69.04	95.41	1.22	1.24	1.09	0.9	0.76	0.74
AGO	614	73.83	50.67	56.98	2.14	1.63	1.69	1.69	2.42	2.04
BWA	616	4.44	2.66	3.28	1.59	1.29	1.68	1.59	1.72	1.75
BDI	618	487.33	221.85	694.1	1.35	1.33	1.17	2.01	1.67	1.27
CMR	622	230.38	171.18	313.99	1.14	1.19	1.17	1.11	1.3	1.13
CPV	624	47.57	33.23	58.74	1.04	1.36	1.11	0.95	1.18	1.21

TABLE A3. Continued

WB code	IFS code	PPP_E	PPP_G	PPP_I	Def_{GDP}	Def_E	Def_G	Def_I	Def_X	Def_M
CAF	626	267.87	166.47	326.11	0.99	1.24	0.93	1.65	0.77	1.32
TCD	628	251.3	169.4	352.97	1.29	1.08	1.49	1.27	1.79	1.25
COG	634	296.5	212.1	389.53	1.59	1.25	1.19	1.06	2.47	1.52
ZAR	636	537.73	359.14	670.56	3.02	3.57	1.51	2.47	7.21	3.71
BEN	638	224.92	133.19	300.06	1.21	1.25	1.16	1.31	0.86	1.1
GNQ	642	321.35	321.05	276.02	1.47	1.62	1.28	1.93	2.06	2.63
ETH	644	5.44	2.91	7.26	2.58	2.54	2.49	2.55	3.98	2.07
GAB	646	359.22	238.63	341.08	1.62	1.06	1.31	1.82	1.67	1.36
GMB	648	10.83	5.19	15.39	1.23	1.25	1.29	1.25	1.25	1.24
GHA	652	0.79	0.46	0.73	3.88	1.97	2.35	2.06	2.37	1.91
GNB	654	248.24	109.97	284.61	1.22	1.07	0.84	1.91	1.07	0.89
GIN	656	2572.34	1155.68	3918.3	2.73	2.8	4.64	2.69	1.87	1.99
CIV	662	235.69	175.33	280.42	1.24	1.23	1.37	1.06	1.3	1.12
KEN	664	35.43	27.22	45.1	1.61	1.66	1.61	1.25	1.66	1.53
LSO	666	3.86	3.16	4.48	1.57	1.41	1.68	1.39	1.51	1.37
LBR	668	0.57	0.35	0.57	1.13	1.17	1.13	1.13	1.33	1.33
MDG	674	704.91	508.98	1057.59	1.69	1.81	2.08	0.99	1.32	1.27
MWI	676	78.02	67.29	94.35	2.16	2.15	1.62	2.25	2.48	2.37
MLI	678	221.87	130.51	280.66	1.33	1.26	1.26	1.63	1.77	1.54
MRT	682	112.81	71.63	172.14	1.54	1.27	1.16	0.95	3.08	1.25
MUS	684	18.29	8.67	16.32	1.35	1.44	1.36	1.37	1.19	1.43
MAR	686	4.19	2.68	3.54	1.13	1.16	1.1	1.16	1.31	1.37
MOZ	688	15.53	16.07	19.63	1.62	1.53	1.42	1.4	1.23	1.27
NER	692	228.75	161.29	284.83	1.28	1.29	1.15	1.39	1.09	1.24
NGA	694	79.53	47.03	92.04	1.75	1.5	1.55	1.52	1.81	2.38

TABLE A3. Continued

WB code	IFS code	PPP_E	PPP_G	PPP_I	Def_{GDP}	Def_E	Def_G	Def_I	Def_X	Def_M
RWA	714	246.83	284.46	373.05	1.65	1.59	1.49	1.5	1.66	1.32
STP	716	10194.79	3535.42	9241.42	2.73	2.63	2.68	2.73	2.45	2.56
SEN	722	246.11	169.61	292.18	1.22	1.19	1.32	1.06	1.21	1.36
SLE	724	1767.19	892.82	2116.6	1.96	1.87	2.14	1.9	2.17	1.74
NAM	728	5.13	3.45	4.11	1.53	1.38	1.64	1.46	1.74	1.39
SDN	732	1.22	0.52	1.26	2.02	2.57	1.22	1.82	1.29	1.65
SWZ	734	4.05	3.46	3.65	1.55	1.58	1.58	1.58	1.58	1.58
TZA	738	585.52	426.83	589.64	1.58	1.59	1.16	1.51	2.25	2.21
TGO	742	232.21	125.02	289.65	1.27	1.19	1.37	0.99	1.03	0.96
TUN	744	0.7	0.34	0.61	1.28	1.27	1.22	1.35	1.41	1.4
UGA	746	946.89	595.23	991.6	1.54	1.73	1.5	1.7	1.75	1.96
BFA	748	222.24	147.86	282.18	1.26	1.13	1.11	1.1	1.44	1.07
ZMB	754	2.51	1.92	2.5	2	1.22	2.03	1.83	3.95	2.12
FJI	819	1.22	0.69	0.96	1.29	1.29	1.29	1.29	1.26	1.26
ARM	911	183.78	75.13	387.11	1.33	1.42	1.68	1.3	1.38	1.63
AZE	912	0.33	0.18	0.79	1.94	1.79	3.17	1.57	1.35	0.98
BLR	913	1832.43	832.92	4012.22	3.05	2.5	3.09	2.46	4.04	3.6
ALB	914	58.17	18.55	57.95	1.19	1.12	1.32	1.1	1.2	1.34
GEO	915	0.84	0.4	1.65	1.52	1.52	1.52	1.52	1.52	1.52
KAZ	916	83.61	35.58	137.12	2.5	1.88	2.38	1.64	3.19	2.09
KGZ	917	17.54	6.82	44.94	2.15	2.11	2.74	2.33	2.67	2.58
BGR	918	0.77	0.31	0.88	1.42	1.3	1.43	1.43	1.64	1.38
MDA	921	5.45	2.11	11.53	1.75	1.74	2.31	1.45	1.31	1.52
RUS	922	16.77	10.62	27.91	2.08	1.69	2.57	1.96	1.9	1.41

TABLE A3. Continued

WB code	IFS code	PPP_E	PPP_G	PPP_I	Def_{GDP}	Def_E	Def_G	Def_I	Def_X	Def_M
TJK	923	1.88	0.48	4.41	2.82	2.39	2.98	8	0.78	2.25
CHN	924	3.7	2.78	3.77	1.38	1.34	1.3	1.39	1.11	1.11
UKR	926	3.31	1.63	6.88	2.67	2.12	2.82	3.05	3.62	2.9
CZE	935	14.9	8.82	14.93	1.06	1.11	1.16	1.02	0.95	0.98
SVK	936	0.57	0.29	0.63	1.08	1.18	1.16	1.02	1.06	1.14
EST	939	0.61	0.31	0.56	1.32	1.31	1.41	1.17	1.27	1.24
LVA	941	0.4	0.19	0.4	1.55	1.44	1.69	1.54	1.42	1.35
HUN	944	137.88	74.2	144.77	1.25	1.31	1.21	1.24	1.12	1.14
LTU	946	1.79	0.89	1.88	1.32	1.35	1.49	1.14	1.32	1.36
MNG	948	590.33	246.95	673.13	2.27	1.67	2.56	2.29	1.9	1.72
HRV	960	4.36	2.52	3.78	1.21	1.23	1.14	1.08	1.23	1.17
SVN	961	0.68	0.48	0.61	1.14	1.17	1.22	1.12	1.12	1.16
MKD	962	22.94	9.23	24.83	1.28	1.21	1.41	1.41	1.35	1.41
BIH	963	0.87	0.46	0.81	1.26	1.18	1.29	1.12	1.29	1.22
POL	964	1.94	1.15	2.42	1.18	1.19	1.25	1.09	1.25	1.25
SRB	965	45.37	19.42	45.49	1.68	1.64	1.63	1.41	1.58	1.51
ROM	968	2	0.77	1.81	1.64	1.41	1.65	1.54	1.55	1.23