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Abstract

GDP in *constant* prices of ASEAN countries suffers from substitution *bias* by ignoring relative price changes and makes GDP growth and shares *dependent* on the base year. These analytical deficiencies led the US since the mid-1990s to convert GDP from constant to *chained* prices. Thus, cross-country comparisons in constant prices are analytically shaky even with the same base year. Therefore, this paper implements US GDP in chained prices in Indonesia, Malaysia, Philippines, and Thailand to alleviate substitution bias and prevent base-year dependence of GDP growth and shares for valid cross-country comparisons.

Converting UN GDP data from constant 1990 prices to chained prices affected Malaysia and the Philippines more than Indonesia and Thailand. Shares of GDP *level* during 2002-06 show Malaysia's industry sector expanded (43.6 to 47.6 percent) while its service sector shrunk (49.1 to 43.7 percent). In the Philippines, the agriculture sector shrunk (19.2 to 14.7 percent) while the service sector expanded (48.6 to 53.6 percent). Shares of GDP *growth* during 2002-06 show the industry sector drove Thailand's GDP growth, contributing around 54 percent, while the service sector drove GDP growth in Indonesia, Malaysia, and in the Philippines, contributing around 49, 49, and 60 percent, respectively, before and after conversion.

Keywords: Real GDP; Constant prices; Chained prices; Fisher index
JEL classification: C43

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1. Introduction

The index formulas underlying GDP in constant prices of ASEAN countries are the fixed-base Laspeyres quantity index and the fixed-base Paasche price index that are well-known to be problematic.[1] Specifically, the problem stems from the fact that a change in the base year *alone* of either index leads inevitably to a change in the GDP growth rate. The change in the growth rate in this case is *anomalous* (i.e., no real or physical basis) because it happens without a change in the volume of production.[2] Moreover, because the GDP growth rate and shares of components are tied together, there are also anomalous changes in shares in constant prices. Furthermore, because GDP in constant prices in effect ignores changes in relative prices over time, shares in constant prices do not embody the real effects of relative price changes and, hence, these shares portray a distorted picture of economic transformation in terms of shifts in the economy's sectoral composition. Thus, GDP in constant prices is questionable as basis for valuation of the economy's production and analysis of its growth performance.

The analytic implication of the above anomalies for cross-country comparisons of GDP growth and sectoral composition in constant prices is that the comparisons are invalid unless the base years are the same. But because a change in the base year alone results in the above anomalies, changing the base year to a common one across countries would still render the comparisons analytically shaky. In sum, the framework of GDP in constant prices needs an alternative that avoids the above anomalous results so that cross-country comparisons of GDP growth and sectoral composition would stand on more solid analytic grounds.

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[1] As shown later in this paper, GDP in constant prices can be computed either by the *inflation* (multiplication) method employing the fixed-base Laspeyres quantity index or by the *deflation* (division) method employing the fixed-base Paasche price index.

[2] Changing the base year of GDP in constant prices could lead to *legitimate* changes in GDP growth rates and shares of components when rebasing involves further adjustments to base year prices necessitated by a number of factors, for example, accounting for the disappearance of old commodities or appearance of new ones. But it follows that these legitimate changes are necessarily combined with the above anomalous changes.

The above problems with GDP in constant prices have long been known but the desirability of conversion, though established in principle, depended on the actual severity of the problems in practice. In the case of the US, for example, the onset of the information technology revolution in the late 1980s induced a switch to GDP in chained dollars because constant dollar pricing would have incorrectly measured the impacts of information technology in the national income and product accounts. To illustrate the severity of the problem in hindsight, Whelan (2002) estimated for example that the 1998 growth rate of US GDP in constant dollars was 4.5 percent using 1995 prices (i.e., 1995 is the base year) but will rise to 6.5 percent using 1990 prices, then to 18.8 percent in 1980 prices, and stunningly to 37.4 percent in 1970 prices. This implies that in measuring US GDP in constant dollars, older fixed base years would tend to overestimate the importance of information technology products especially because their prices have dramatically fallen in more recent years. Hence, beginning in the mid-1990s, the US converted GDP to chained dollars (Landefeld and Parker, 1997; Seskin and Parker, 1998; Moulton and Seskin, 1999).[3]

In light of US experience and in view of the desirable theoretical properties of the underlying GDP indexes, the framework of US GDP in chained prices (dollars) is proposed by this paper for adoption to convert GDP of ASEAN countries to chained prices. Moreover, the US framework is free of the above anomalies of GDP in constant prices so that cross-country GDP growth and sectoral comparisons would be analytically sensible. Furthermore, Dumagan's (2008b) implementation of the US framework to convert Philippine GDP from constant to chained prices needed data only on GDP components in current prices and in constant prices─which are available for all ASEAN countries─and, thus, demonstrated that

[3] About the earliest appearance of US GDP in chained dollars may be found in the official publication of the US Bureau of Economic Analysis, *Survey of Current Business*, November/December 1995. As noted earlier, the conversion of US GDP from constant to chained dollars is consistent with the recommendations in the UN SNA 1993 to implement chained volume measures.

the above cross-country comparisons would also be empirically feasible.[4] Hence, beyond its immediate purpose of enabling analytically solid and sensible cross-country GDP growth and sectoral composition comparisons, it is hoped that this paper's conversion of GDP in ASEAN countries to chained prices would hasten the long-delayed ASEAN implementation of the UN *System of National Accounts 1993* (SNA 1993).[5]

Nonetheless, conversion to chained prices does not imply abandoning components in constant prices. The focus on growth of quantities requires "physical" quantities that are difficult to define across product categories above the commodity level. However, components in constant prices fill the need for absent or unavailable physical quantities because these components grow at the same rate as their counterpart physical quantities. For this reason, compilation of components in constant prices needs to be continued because these components are necessary *data inputs* for calculating GDP in chained prices. But this paper objects to the present practice of measuring real GDP simply as the sum of components in constant prices because this GDP could yield anomalous results and, thus, is questionable as basis for valuation of the economy's production and analysis of its growth performance.

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[4] Except for the empirical applications and conclusions specific to Indonesia, Philippines, Malaysia, and Thailand using UN data, the analytical framework of this paper and most of the prose are identical to those in the author's (Dumagan, 2008b) earlier paper converting Philippine GDP from constant to chained prices using data from the NSCB.

[5] The recommendation in SNA 1993 for adoption of chained volume measures (CVM) in national income accounts amounts in principle to conversion of GDP from *constant* prices to *chained* prices. To this day, however, ASEAN countries still measure GDP in constant prices while some countries in Asia, North America, and Europe have converted GDP to chained prices. Examples are the US (1996), Australia (1998), Denmark (1999), Canada (2001), United Kingdom (2003), Japan (2004), and Hong Kong (2007). However, the index formulas underlying CVM are not uniform. For instance, the US (Landefeld and Parker, 1997; Seskin and Parker, 1998; Moulton and Seskin, 1999) and Canada (Chevalier, 2003) have implemented the chained Fisher index while Australia (Aspden, 2000) and the United Kingdom (Robjohns, 2007) have implemented the chained Laspeyres index. In the case of Japan (Maruyama, 2005), annually chain-linked Laspeyres volume index and quarterly chain-linked Fisher volume index measures have been implemented. Hong Kong (Census and Statistics Department, 2007) has adopted *annually re-weighted chain linking approach* but the underlying index formula is not specified. More recently, most Member States of the European Union (2007) have made a changeover to CVM in their quarterly and annual national accounts.

Virola (2008), the current Secretary General of the National Statistical Coordination (NSCB) of the Philippines, noted that no developing country has so far implemented CVM but stated that the Philippines started "migration" to the 1993 SNA by "pilot adoption" in 1997 through technical assistance by the Asian Development Bank and the Philippine-Australian Government Facility Project, 2001-2003. Among the specific activities of NSCB under the 1993 SNA implementation plan is "exploring the use of CVM" that sad to say has so far not culminated in CVM implementation in official practice. So, the exploration continues and it is hoped that this paper will be part of NSCB's exploration. Indeed, the time has for seriously considering CVM adoption (Valdepeñas, 2008).

However, the focus of this paper is mainly on the effects of GDP conversion to chained prices on the *growth rate* of overall GDP and *real shares* of components as these are the analytical aspects where, in the view of this paper, conversion is most beneficial for the purposes of analyzing and understanding the economy's growth performance and (sectoral) transformation. The application is also limited to Indonesia, Malaysia, Philippines, and Thailand as these four countries should suffice for purposes of illustration, given this paper's space limitations.

The rest of this paper is organized as follows. Section 2 presents an index number framework that reveals analytically the problems of GDP in constant prices and shows their solutions by conversion to chained prices. The analysis shows that GDP in constant prices is objectionable for the *failure* of the underlying fixed-base quantity and price indexes to perform their purpose, which is to completely separate quantity and price changes. Thus, this paper recommends GDP in chained prices precisely for the success of the underlying quantity and price indexes in performing this purpose. Section 3 utilizes GDP data in current prices and constant 1990 prices of Indonesia, Malaysia, Philippines, and Thailand from the UN to empirically illustrate the above problems and their solutions. The illustrations serve to concretize the economic rationality, feasibility, and ease of converting GDP to chained prices. Moreover, by alleviating if not eliminating the effects of substitution bias on real shares, chained prices paint a more illuminating picture of each country's sectoral transformation hitherto hidden by constant 1990 prices. Section 4 concludes this paper.

2. A Sketch of an Index Number Framework for GDP

Both the problems of GDP in constant prices and their solutions by GDP conversion to chained prices may be explained by examination of the index number formulas underlying these measures of GDP.

GDP in constant prices may be computed either by multiplication (*inflation*) of a fixed-base Laspeyres quantity index by GDP in the base year or by division (*deflation*) of GDP in current prices by a fixed-base Paasche price index (Balk, 2004a). Either way, the result is the same. These two methods are described below.

2.1 *GDP in Constant Prices from a Fixed-Base Laspeyres Quantity Index*

In concept, a quantity index permits comparison of any two quantity bundles each comprising *N* goods, allowing for the possibility that one bundle has more of some goods and less of the others than the other bundle. To be able to say that one bundle is larger or smaller than the other, each bundle needs to be collapsed into a single value. This is usually done by multiplying each quantity by the corresponding price and then summing them up and this sum is the single value desired. If the prices and quantities are of the same year, the results are like GDP in current prices that incorporate both "changes in prices" and "changes in quantities." However, a quantity index is intended to capture only changes in quantities and, therefore, changes in prices should be netted out. The usual way to do this is to value the quantity bundles being compared by the *same* prices. In this case, the values reflect only "changes in quantities" and these values are used to construct the quantity index.

By formula, a quantity index is a ratio of the value of the "newer" quantity bundle to the value of the "older" bundle where the values are obtained using the same prices. The Laspeyres quantity index with a fixed base year is a special case where any bundle is compared to the bundle of the base year and the *fixed* base year holds prices *constant*. For example, let there be three years: the base year b and two other adjoining years s and t, $t = s + 1$, and $i = 1, 2, \cdots, N$ commodities. In the base year, prices are p_{ib} and quantities are q_{ib}. The quantities in years s and t are q_{is} and q_{it}. In this case, the fixed-base Laspeyres (denoted by the superscript *L*) quantity indexes are, by definition,

$$Q_{bb}^{L} = \frac{\sum_i^N p_{ib} q_{ib}}{\sum_i^N p_{ib} q_{ib}} = 1 \quad ; \quad Q_{bt}^{L} = \frac{\sum_i^N p_{ib} q_{it}}{\sum_i^N p_{ib} q_{ib}} \quad ; \quad Q_{bs}^{L} = \frac{\sum_i^N p_{ib} q_{is}}{\sum_i^N p_{ib} q_{ib}} . \qquad (1)$$

Notice from (1) that the index in the base year equals 1, i.e., $Q_{bb}^{L} = 1$, because this compares the base year bundle to itself. In other years, the index may differ from 1. Suppose that $Q_{bt}^{L} = 1.05$. Since the valuations are in year b prices, this means that the "overall" quantity in year t (numerator), which is $\sum_i^N p_{ib} q_{it}$, is 105 percent of the overall quantity in year b (denominator), which is $\sum_i^N p_{ib} q_{ib}$. Thus, if the prices and quantities encompass all final goods and services in the economy, then the overall quantity in year t becomes the economy's GDP in constant prices, denoted below by Y_t^L, that can be obtained by multiplying together Q_{bt}^{L} and $\sum_i^N p_{ib} q_{ib}$.

To generalize the preceding discussion, let,

$Y_t^L =$ Year t GDP in constant year b prices ;

Q_{bt}^{L}= Laspeyres GDP quantity index linking year t to a fixed base year b ;

$\sum_i^N p_{ib} q_{ib} =$ GDP in the base year b .

Combining the above with (1), it follows that for any year t or s,

$$Y_t^L = Q_{bt}^{L} \times \sum_i^N p_{ib} q_{ib} = \sum_i^N p_{ib} q_{it} \quad ; \quad Y_s^L = Q_{bs}^{L} \times \sum_i^N p_{ib} q_{ib} = \sum_i^N p_{ib} q_{is} . \qquad (2)$$

The result in (2) shows that GDP in constant prices may be obtained by multiplying (inflating) the relative change in overall quantities, as measured by the fixed-base Laspeyres quantity index, by the base year GDP acting as the scalar.

An appealing property of (2) in practice is that the procedure can be *replicated* to any arbitrary number of subaggregates (e.g., industries or sectors) and still obtain the same aggregate GDP. Suffice it for illustration that there are two mutually exclusive subgroups *X* and *Z*. In this case, GDP in the base year and GDP in constant prices in year t are split into,

$$\sum_i^N p_{ib} q_{ib} = \sum_{x \in X} p_{xb} q_{xb} + \sum_{z \in Z} p_{zb} q_{zb} \; ; \qquad (3)$$

$$\sum_{i}^{N} p_{ib} q_{it} = \sum_{x \in X} p_{xb} q_{xt} + \sum_{z \in Z} p_{zb} q_{zt} \ . \qquad (4)$$

The corresponding fixed-base subgroup Laspeyres quantity indexes are, by definition,

$$Q_{bt}^{LX} = \frac{\sum_{x \in X} p_{xb} q_{xt}}{\sum_{x \in X} p_{xb} q_{xb}} \quad ; \quad Q_{bt}^{LZ} = \frac{\sum_{z \in Z} p_{zb} q_{zt}}{\sum_{z \in Z} p_{zb} q_{zb}} \ . \qquad (5)$$

Applying the procedure in (2) to (3), (4), and (5) yields,

$$Y_t^L = Q_{bt}^{LX} \times \sum_{x \in X} p_{xb} q_{xb} + Q_{bt}^{LZ} \times \sum_{z \in Z} p_{zb} q_{zb} = \sum_{i}^{N} p_{ib} q_{it} \ . \qquad (6)$$

The result in (6) illustrates the *additivity* property of constant price components from the fact that the above Laspeyres quantity index is consistent in aggregation.[6]

2.2 *GDP in Constant Prices from a Fixed-Base Paasche Price Index*

GDP in current prices is given by prices and quantities in the same year, e.g., t or s,

$$\sum_{i}^{N} p_{it} q_{it} \quad ; \quad \sum_{i}^{N} p_{is} q_{is} \ . \qquad (7)$$

GDP in constant prices may also be obtained by dividing or deflating (7) by a Paasche (denoted by the superscript *P*) price index with a fixed base. This index is, by definition,

$$P_{bt}^{P} = \frac{\sum_{i}^{N} p_{it} q_{it}}{\sum_{i}^{N} p_{ib} q_{it}} \quad ; \quad P_{bs}^{P} = \frac{\sum_{i}^{N} p_{is} q_{is}}{\sum_{i}^{N} p_{ib} q_{is}} \ . \qquad (8)$$

Dividing (7) by (8) correspondingly yields exactly the same GDP in constant prices in (2),[7]

$$Y_t^L = \frac{\sum_{i}^{N} p_{it} q_{it}}{P_{bt}^{P}} = \sum_{i}^{N} p_{ib} q_{it} \quad ; \quad Y_s^L = \frac{\sum_{i}^{N} p_{is} q_{is}}{P_{bs}^{P}} = \sum_{i}^{N} p_{ib} q_{is} \ . \qquad (9)$$

Like the fixed-base Laspeyres quantity index, the fixed-base Paasche price index is also consistent in aggregation. This means that (7) can be split into subgroups similar to (3) and

[6] The term "consistent in aggregation" is due to Vartia (1976). An underlying index has this property if the value being calculated (e.g., GDP) in say, two stages as in the above example, necessarily equals the value calculated in a single stage, as shown by (6). The number of stages could be any arbitrary number greater or equal to two. By this definition, Diewert (1978) showed that the Fisher index presented later in this paper is only "approximately" consistent in aggregation.

[7] For example, in the Philippines, the NSCB follows the deflation method in computing GDP in constant prices (Domingo, 1992; Virola, *et. al.*, 2001).

the corresponding subgroup deflators similar to (5) can be constructed from (8). In this case, summing up the deflated subgroups yields exactly the same GDP in constant prices in (6).[8]

2.3 *Effects of Changing the Base year on GDP in Constant Prices*

A change in the base year will change the level of GDP in constant prices in (2) or (9) because the scalar value of base year GDP will change. But whatever its scalar value, base year GDP cancels out of growth rate and shares calculations. Therefore, the GDP growth rate and shares of components are expected *not* to change with the base year because the base year is chosen simply to determine the unit of valuation.

But contrary to expectations, it is possible for the GDP growth rate and shares of components in constant prices to change when a different fixed base year is chosen. To see these changes analytically, consider the GDP growth rate from year *s* to *t* in (2) or (9) and its decomposition into the growth contributions of components given by,

$$\frac{Y_t^L}{Y_s^L} - 1 = \frac{\sum_i^N p_{ib} q_{it}}{\sum_i^N p_{ib} q_{is}} - 1 = \sum\nolimits_i^N g_{it}^L \quad ; \quad g_{it}^L = \left(\frac{p_{ib} q_{is}}{\sum_i^N p_{ib} q_{is}}\right)\left(\frac{q_{it}}{q_{is}} - 1\right). \tag{10}$$

In (10), g_{it}^L is the growth contribution of component *i*.

If the base year is changed from *b* to *c*, the growth rate in (10) will change if the prices in years *b* and *c* are not proportional to each other. That is,

$$\frac{\sum_i^N p_{ib} q_{it}}{\sum_i^N p_{ib} q_{is}} - 1 \neq \frac{\sum_i^N p_{ic} q_{it}}{\sum_i^N p_{ic} q_{is}} - 1 \quad , \quad \text{if} \quad \frac{p_{ib}}{p_{ic}} \neq k \, , \ \text{all } i \, . \tag{11}$$

Since the price proportionality condition is surely violated in reality, the change in the growth rate in (11) is inevitable.

To understand the problem implied by the inequalities in (11), consider again (9). Because the quantity bundles in years *s* and *t* are valued in the same base year prices p_{ib}, the

[8] This property of consistency in aggregation permits additivity of GDP components in constant prices obtained by "double deflation," which is implemented when feasible to compute real gross value added of industries which equals output deflated by its own deflator less the inputs deflated by their own deflators.

relative change in GDP in constant prices, the ratio of Y_t^L to Y_s^L in (9), supposedly measures aggregate "volume" or overall "quantity" changes *net* of price effects. However, the inequalities in (11) imply that the value of this ratio changes when new base year prices p_{ic} are used. This change is anomalous because all along the quantity bundles in years *s* and *t* are the *same* as before. The implication is that the relative change of GDP in constant prices does not completely net out price effects and, hence, is a dubious measure of aggregate volume or overall quantity changes.

Moreover, the change in the growth rate in (11) necessarily implies that the shares of components in constant prices will change, which is also anomalous for the same reason. This follows because (11) yields,

$$\sum_i^N \left(\frac{p_{ib}q_{is}}{\sum_i^N p_{ib}q_{is}}\right)\frac{q_{it}}{q_{is}} \neq \sum_i^N \left(\frac{p_{ic}q_{is}}{\sum_i^N p_{ic}q_{is}}\right)\frac{q_{it}}{q_{is}} . \tag{12}$$

In turn, the above inequality implies that,

$$\frac{p_{ib}q_{is}}{\sum_i^N p_{ib}q_{is}} \neq \frac{p_{ic}q_{is}}{\sum_i^N p_{ic}q_{is}} \quad \text{for some } i . \tag{13}$$

The inequality in (13) means that a change in the fixed base year from *b* to *c* will change a component's share in the same year *s* if in (11) the price ratio k does not hold for all i. As a result, this component's growth contribution in (10) will also change.

The above anomalies of changing growth rates and shares in constant prices can be avoided by conversion of GDP to chained prices as shown in the following analysis.

2.4 *GDP in Chained Prices from a Chain-Type Fisher Quantity Index*

In a chain index framework, a chain-type index J_t is linked to a quantity index that uses prices and quantities in the adjoining periods *s* and *t* by,

$$J_t = J_s \times Q_{st}^F \quad ; \quad J_b = 1 \quad , \quad b = \text{base year} . \tag{14}$$

Since s follows t, i.e., $t = s + 1$, J_t in (14) is devised where $J_b = 1$ because Q_{st}^F may not equal the conventional value of 1 in the base year b. In the US GDP chain index framework—proposed by this paper for implementation to ASEAN GDP—Q_{st}^F is the Fisher (1922) quantity index, denoted by the superscript F, defined below. This index has well-known desirable theoretical properties and is widely used in practice.[9]

In similar fashion to the case of constant prices in (2), the *level* of GDP in chained prices, denoted below by Y_t^F, equals the chain-type index in (14) multiplied by GDP in the base year,

$$Y_t^F = J_t \times \sum_i^N p_{ib} q_{ib} = J_s \times Q_{st}^F \times \sum_i^N p_{ib} q_{ib} \quad ; \quad J_b = 1. \tag{15}$$

By definition, Q_{st}^F is the geometric mean of the Laspeyres quantity index (Q_{st}^L) and the Paasche quantity index (Q_{st}^P),

$$Q_{st}^F = (Q_{st}^L \times Q_{st}^P)^{\frac{1}{2}} \quad ; \quad Q_{st}^L = \frac{\sum_i^N p_{is} q_{it}}{\sum_i^N p_{is} q_{is}} \quad ; \quad Q_{st}^P = \frac{\sum_i^N p_{it} q_{it}}{\sum_i^N p_{it} q_{is}}. \tag{16}$$

Notice that the Laspeyres quantity index values the quantity bundles in years s and t using the prices of the "older" bundle in s while the Paasche quantity index values these bundles using the prices of the "newer" bundle in t. These quantity indexes use as weights the prices from year to year so that prices are "chained" and, thus, (15) measures GDP in chained prices.

2.5 *Effects of Changing the Base year on GDP in Chained Prices*

In concept, GDP in chained prices is also an aggregate "volume" or overall "quantity" measure denominated in base year prices. The relative change or the ratio of this GDP between any two years should only measure "volume" or "quantity" changes because the base year GDP cancels out of the ratio. This may be seen by expanding (14). This yields,

[9] The indexes underlying the US chained dollar framework are the superlative Fisher price and quantity indexes. Diewert (1976, 1978) defined an index as "superlative" if it is *exact* for an aggregator function (e.g., a utility or production function) that is *flexible*, i.e., capable of providing a second-order differential approximation to an arbitrary twice differentiable linearly homogeneous function. The Fisher index is the exact index for the homogeneous form of the flexible quadratic aggregator function.

$$J_2 = J_1 \times Q_{12}^F \quad ; \quad J_3 = J_2 \times Q_{23}^F = J_1 \times Q_{12}^F \times Q_{23}^F \,. \tag{17}$$

Moreover, (15) implies,

$$\frac{Y_2^F}{Y_1^F} = \frac{J_2}{J_1} = Q_{12}^F \quad ; \quad \frac{Y_3^F}{Y_1^F} = \frac{J_3}{J_1} = Q_{12}^F \times Q_{23}^F \,. \tag{18}$$

Combining (17) and (18) yields the general result that,

$$\frac{Y_T^F}{Y_1^F} = \frac{J_T}{J_1} = Q_{12}^F \times Q_{23}^F \times \cdots \times Q_{(T-1)T}^F \,. \tag{19}$$

These show that the relative change from year 1 to any year forward up to *T* in (19) equals the products of the year to year Fisher quantity indexes starting from year 1 to *T*.

That the ratios in (18) and (19) are *unaffected* by a change in the base year, it is sufficient to show that the Fisher quantity index in (16) is free of base year prices earlier denoted by p_{ib} or p_{ic} . This is shown below.

2.6 *Data for GDP in Chained Prices*

The data for computing GDP in chained prices are the same as those for computing the Fisher index in (16). For this purpose, data on components of GDP in current prices and in constant prices for years *s* and *t* are necessary and sufficient. These data are given by,

$$(p_{is}q_{is}\,, p_{it}q_{it}) \quad ; \quad (p_{ib}q_{is}\,, p_{ib}q_{it}) \,. \tag{20}$$

The computation requires the first set of data in current prices in (20). It also requires the cross-products of prices and quantities from different years, $(p_{is}q_{it}\,, p_{it}q_{is})$, that can be obtained from (20) by,

$$\frac{p_{is}q_{is}}{p_{ib}q_{is}} = \frac{p_{is}}{p_{ib}} \quad ; \quad \frac{p_{is}}{p_{ib}} \times p_{ib}q_{it} = p_{is}q_{it} \quad ; \quad \frac{p_{it}q_{it}}{p_{ib}q_{it}} = \frac{p_{it}}{p_{ib}} \quad ; \quad \frac{p_{it}}{p_{ib}} \times p_{ib}q_{is} = p_{it}q_{is} \,. \tag{21}$$

Moreover, these data yield the price and quantity ratios that are also needed later,

$$\frac{p_{it}q_{it}}{p_{ib}q_{it}} \Big/ \frac{p_{is}q_{is}}{p_{ib}q_{is}} = \frac{p_{it}}{p_{is}} \quad ; \quad \frac{p_{ib}q_{it}}{p_{ib}q_{is}} = \frac{q_{it}}{q_{is}} \,. \tag{22}$$

The results in (21) and (22) show that base year prices cancel out in computing the Fisher quantity index so that this index does not change with the base year. Therefore, the relative change of GDP in chained prices in (18) equals the "unchanged" Fisher quantity index and, thus, implies that this relative change measures only "quantity" changes.

2.7 *Additive Formulas for GDP in Chained Prices*

The formula for calculating the overall *level* of GDP in chained prices was earlier given by (15). To facilitate the implementation of this formula in more detail—in terms of determining component contributions to the level and growth rate of GDP in chained prices as well as the real shares of components that satisfy additivity—it would be useful to employ the *additive* decomposition of the Fisher quantity index (van IJzeren, 1952; Dumagan, 2002; Balk, 2004b).

The additive decomposition of the Fisher quantity index involves also the Fisher price index (P_{st}^F), the geometric mean of the Laspeyres (P_{st}^L), and Paasche (P_{st}^P) price indexes. These are,

$$P_{st}^F = (P_{st}^L \times P_{st}^P)^{\frac{1}{2}} \quad ; \quad P_{st}^L = \frac{\sum_i^N q_{is} p_{it}}{\sum_i^N q_{is} p_{is}} \quad ; \quad P_{st}^P = \frac{\sum_i^N q_{it} p_{it}}{\sum_i^N q_{it} p_{is}} \, . \tag{23}$$

Dumagan (2002) showed, using (16) and (23), that the additive decomposition of the Fisher index is,[10]

$$Q_{st}^F = (Q_{st}^L \times Q_{st}^P)^{\frac{1}{2}} = \sum_i^N w_{is}^F \left(\frac{q_{it}}{q_{is}} \right) \; ; \; w_{is}^F = \left(\frac{P_{st}^F}{P_{st}^L + P_{st}^F} \right) w_{is}^L + \left(\frac{P_{st}^L}{P_{st}^L + P_{st}^F} \right) w_{is}^P \, . \tag{24}$$

$$w_{is}^L = \frac{p_{is} q_{is}}{\sum_i p_{is} q_{is}} \quad ; \quad w_{is}^P = \frac{p_{it} q_{is}}{\sum_i p_{it} q_{is}} \quad ; \quad \sum_i^N w_{is}^F = \sum_i^N w_{is}^L = \sum_i^N w_{is}^P = 1 \, . \tag{25}$$

From (15), (16), (24) and (25), the growth rate of GDP in chained prices becomes a sum,

[10] Balk (2004b) surveyed the *additive* and *multiplicative* decompositions of the Fisher index. He pointed out that van IJzeren (1952) was the first to derive a satisfactory additive decomposition, "unfortunately in an article in a rather obscure publication series of what is now called Statistics Netherlands." Thus, Balk noted that van IJzeren's decomposition escaped wider attention in the statistical community, leading to independent rediscoveries by Dumagan (2002) and by Reinsdorf, Diewert, and Ehemann (2002).

$$\frac{Y_t^F}{Y_s^F} - 1 = Q_{st}^F - 1 = \sum_i^N g_{it}^F \quad ; \quad g_{it}^F = w_{is}^F \left(\frac{q_{it}}{q_{is}} - 1\right). \tag{26}$$

In (26), g_{it}^F is the additive growth contribution of component i. Moreover, (26) implies that the level of GDP in chained prices also becomes a sum,

$$Y_t^F = \sum_i^N y_{it}^F \quad ; \quad y_{it}^F = Y_s^F w_{is}^F \left(\frac{q_{it}}{q_{is}}\right). \tag{27}$$

In (27, y_{it}^F is the additive level contribution of component i. Hence, the real shares sum to 1 (or 100 percent) and each share is given by,

$$\frac{y_{it}^F}{Y_t^F} = \frac{Y_s^F}{Y_t^F} w_{is}^F \left(\frac{q_{it}}{q_{is}}\right) = \frac{w_{is}^F}{Q_{st}^F} \left(\frac{q_{it}}{q_{is}}\right) \quad ; \quad \sum_i^N \frac{y_{it}^F}{Y_t^F} = 1. \tag{28}$$

It is important to note that the constant base year prices cancel out in all calculations of (23) to (28). Therefore, the growth rate, growth contributions, and shares of components of GDP in chained prices do not change with the base year.

It may be noted that the basic formulas for US GDP in chained dollars are the same as (14), (15), and (16) (Landefeld and Parker, 1997; Seskin and Parker, 1998; Moulton and Seskin, 1999).[11] Moreover, the decomposition formula of US GDP growth into the contributions of components is the same as (26) as shown by Dumagan (2000, 2002).

However, the US decomposition of the level of GDP in chained prices and calculation of real shares do not follow the additive procedures in (27) and (28) and, hence, lead to *non-additivity* (Ehemann, Katz, and Moulton, 2002; Whelan, 2002). To resolve this non-additivity problem─which is common to chain linking procedures─Dumagan (2008a) derived and proposed (27) and (28) above for the case of GDP based on the chain-type Fisher index.

[11] While the additive decomposition of the Fisher index has been applied to the national income accounts of the US (see the above references) and to those of the Philippines in this paper, the multiplicative decomposition of this index has been applied to total factor productivity analysis, for example, in US agriculture (Dumagan and Ball, 2008).

2.8 *Framework for Separating Quantity Changes from Price Changes*

The analysis so far examined mainly the *quantity* side of GDP because of the focus on the relative change (growth) of real GDP. However, there is the *price* side to consider in the overall framework of analyzing the relative change of GDP in current prices.

The relative change of GDP in current prices is measured by the "value index" (V_{st}), the ratio of GDP in current prices in the adjoining years s and t,

$$V_{st} = \frac{\sum_i^N p_{it} q_{it}}{\sum_i^N p_{is} q_{is}} \,. \tag{29}$$

By definition, the value index in (29) combines the effects of quantity changes and price changes and, thus, presents the problem of separating these combined effects. In this case, the role of the quantity index is to capture only the quantity changes while that of the price index is to capture only the price changes. It may now be shown that the fixed-base Laspeyres quantity and Paasche price indexes both fail to perform these roles while the chain type Fisher quantity and Fisher price indexes both succeed.

The fixed-base Laspeyres quantity index in (1) and fixed-base Paasche price index in (8) are dual to each other from the fact that the value index in (29) can be expressed as,

$$\frac{\sum_i^N p_{it} q_{it}}{\sum_i^N p_{is} q_{is}} = \frac{Q_{bt}^L}{Q_{bs}^L} \times \frac{P_{bt}^P}{P_{bs}^P} \,. \tag{30}$$

To show once again the inherent anomalies in the indexes in right-hand side of (30), consider that the base year dependence of the relative change of GDP in constant prices shown analytically in sections 2.1 to 2.3 necessarily implies that,

$$\frac{\sum_i^N p_{it} q_{it}}{\sum_i^N p_{is} q_{is}} = \frac{Q_{bt}^L}{Q_{bs}^L} \times \frac{P_{bt}^P}{P_{bs}^P} = \frac{Q_{ct}^L}{Q_{cs}^L} \times \frac{P_{ct}^P}{P_{cs}^P}, \qquad b \neq c \,. \tag{31}$$

Mathematically, the decompositions in the right-hand side of (31) are *exact* but *not unique* because it depends on the base year. By implication, the fixed-base Laspeyres quantity index fails to capture only quantity changes while the fixed-base Paasche price index fails to capture only price changes. For these reasons, GDP in constant prices is a questionable measure of the economy's volume of production.

In contrast, given the same relative change in GDP in current prices in the left-hand side of (30) or (31), the base year invariance of the chain type Fisher quantity and price indexes shown in sections 2.5 and 2.6 necessarily implies that,

$$\frac{\sum_i^N p_{it}q_{it}}{\sum_i^N p_{is}q_{is}} = Q_{st}^F \times P_{st}^F \text{, for any base year .} \qquad (32)$$

It may be noted that the equality in (32) is the Fisher (1922) "factor reversal" property.[12]

Mathematically, the decomposition in (32) is *exact* and *unique.*[13] By implication, the chain type Fisher quantity index captures only quantity changes while the Fisher price index captures only price changes. For these reasons, this paper recommends employing these indexes in GDP conversion from constant to chained prices.

3. Empirical Results

In light of (20), (21), and (22), data on GDP in current prices and in constant 1990 prices for Indonesia, Philippines, Malaysia, and Thailand from the UN are necessary and sufficient to compute GDP in chained prices. GDP data in current prices (Table 1) in constant 1990 prices (Table 2) for Indonesia are used as a starting illustration but salient empirical results are presented later for all four countries.

Each entry in Table 1 is interpreted as $p_{it}q_{it}$ while each one in Table 2 is interpreted as $p_{ib}q_{it}$ where $b = 1990$.

[12] The term "factor reversal" in the context of the equality in (31) comes from the fact that, by definition, the Fisher price index can be obtained from the Fisher quantity index, vice versa, by *reversing* the roles of prices and quantities. In addition, the Fisher index has the "time reversal" property which means that the quantity (price) index with time moving from s to t is the *reciprocal* of the quantity (price) index with time moving in reverse from t to s. According to Fisher (1922), the factor reversal and time reversal properties make an index "ideal." For this reason, the Fisher index is sometimes called the Fisher ideal index.

[13] For a numerical example of value index decomposition for the Philippines showing non-uniqueness of (31) but uniqueness of (32), see Dumagan (2008b), p. 22.

Table 1. Gross Domestic Product (GDP) in Current Prices

	2002	2003	2004	2005	2006
		(Million US Dollars)			
Indonesia	204,606	246,618	267,849	295,199	383,077
Agriculture, hunting, forestry, fishing	30,242	35,651	37,091	37,668	52,437
Mining and Utilities	18,936	21,769	24,408	31,951	36,725
Manufacturing	56,190	66,330	71,559	78,927	102,599
Construction	11,870	14,613	16,003	17,872	22,926
Wholesale, retail trade, restaurants and hotels	33,528	39,069	41,321	44,302	59,092
Transport, storage and communication	10,522	13,864	15,918	18,647	22,833
Other Activities	43,318	55,322	61,549	65,832	86,465

Source: United Nations Statistics Division (www.unstats.un.org). GDP data from 1985 to 2006 were used in all calculations but due to space limitations the results before 2002 were omitted in all tables in this paper. However, all the results are available from the author upon request.

Table 2. GDP in Constant 1990 Prices

	2002	2003	2004	2005	2006
		(Million US Dollars)			
Indonesia	214,272	224,147	235,139	247,935	262,074
Agriculture, hunting, forestry, fishing	29,461	30,577	31,574	32,359	35,050
Mining and Utilities	19,647	19,156	17,915	18,116	20,506
Manufacturing	60,977	64,229	68,328	71,490	75,606
Construction	10,795	11,453	12,311	13,215	13,693
Wholesale, retail trade, restaurants and hotels	36,145	38,114	40,281	43,742	45,231
Transport, storage and communication	13,950	15,651	17,745	20,047	19,754
Other Activities	43,297	44,967	46,985	48,966	52,234

Source: United Nations Statistics Division (www.unstats.un.org).

Tables 1 and 2 yield in Table 3 the ratios for each industry of $p_{it}q_{it}$ to $p_{ib}q_{it}$ or the implicit deflators $p_{it}q_{it}/p_{ib}q_{it} = p_{it}/\ p_{ib}$, i.e., current prices relative to 1990 prices.

Table 3. Current Prices Relative to 1990 Prices

	2002	2003	2004	2005	2006	Average
	(Ratios: Entries in Table 1 Divided by Entries in Table 2)					
Indonesia	0.95	1.10	1.14	1.19	1.46	1.17
Agriculture, hunting, forestry, fishing	1.03	1.17	1.17	1.16	1.50	1.21
Mining and Utilities	0.96	1.14	1.36	1.76	1.79	1.40
Manufacturing	0.92	1.03	1.05	1.10	1.36	1.09
Construction	1.10	1.28	1.30	1.35	1.67	1.34
Wholesale, retail trade, restaurants and hotels	0.93	1.03	1.03	1.01	1.31	1.06
Transport, storage and communication	0.75	0.89	0.90	0.93	1.16	0.92
Other Activities	1.00	1.23	1.31	1.34	1.66	1.31

Source: Tables 1 and 2.

There are two ways of rebasing with the same results. One corresponds to the inflation method and the other to the deflation method of computing GDP in constant prices.

The inflation method works as follows. Select a column in Table 3 for a given year, for example, $t = 2004$. The column entries are ratios, i.e., prices in 2004 over the prices in 1990. Therefore, in using this column to multiply all the columns in Table 2, the 1990 prices cancel out and the latter columns are now valued in 2004 prices. Hence, summing up the results in each column yields GDP in constant 2004 prices for each year.

To illustrate the deflation method of rebasing, let the new base year be also 2004. In this case, divide each column of relative prices in Table 3 by those in 2004. Hence, the old 1990 base prices cancel out and the results in each column are now "current prices over 2004 prices," thus, yielding a column of "1" in 2004 because the base year price deflator equals 1. By dividing or deflating the GDP in current prices in Table 1 by these new set of deflators the current prices cancel out and each quantity is now multiplied by 2004 prices. Therefore, the sum of each column (year) yields GDP in constant 2004 prices each year. By similar procedure, GDP in constant prices can be computed for other base years shown in Table 4.

Table 4. GDP in Constant Prices

	2002	2003	2004	2005	2006
Indonesia			(Million US Dollars)		
Constant 1990 Prices	214,272.0	224,147.0	235,139.0	247,935.0	262,074.0
Constant 1995 Prices	262,507.8	274,838.9	288,692.1	304,346.4	321,602.2
Constant 2000 Prices	186,520.6	194,530.9	203,240.3	213,708.9	226,622.2
Constant 2005 Prices	258,659.2	269,394.1	280,907.3	295,199.0	313,366.5

Source: Tables 1, 2, and 3.

It can be checked that the price proportionality condition for rebasing not to change the GDP growth rates in constant prices is violated in Table 3. As a result, the rebased GDP in Table 4 have changing growth rates in the same year depending on the base year, as shown in Table 5. Hence, growth rate "cheating" is possible, for example, by choosing base year 1995 to obtain the highest growth rate of 5.04 percent in 2004 or base year 2005 to obtain the highest growth rate of 6.15 percent in 2006.

Table 5. Growth of GDP in Constant Prices

	2002	2003	2004	2005	2006
Indonesia			(Percent)		
Constant 1990 Prices	4.31	4.61	4.90	5.44	5.70
Constant 1995 Prices	4.36	4.70	5.04	5.42	5.67
Constant 2000 Prices	4.13	4.29	4.48	5.15	6.04
Constant 2005 Prices	4.06	4.15	4.27	5.09	6.15

Source: Table 4.

Table 6 shows one of the major results of chained prices that the Fisher quantity index (Q_{st}^F) does not change with the base year. However, there are different values of the chain type index (J_t) for different base years ($J_b = 1,\ b = 1990, 1995, 2000, 2005$).

Table 6. Fisher and Chain Type GDP Quantity Indexes

	2002	2003	2004	2005	2006
Indonesia					
Fisher Quantity Index	1.0420	1.0447	1.0463	1.0514	1.0608
Chain Type Quantity Index					
base year = 1990	1.6020	1.6736	1.7511	1.8411	1.9530
base year = 1995	1.1121	1.1618	1.2156	1.2780	1.3557
base year = 2000	1.0772	1.1254	1.1775	1.2380	1.3132
base year = 2005	0.8702	0.9090	0.9511	1.0000	1.0608

Source: Tables 1, 2, and 3 and equations (14) and (16).

Given the Fisher quantity index, the chain type indexes are calculated forward and backward starting from the base year value of 1 by a recursive procedure,

$$\text{Starting from } J_b = 1, \qquad J_t = J_s Q_{st}^F \ \text{ if } \ t > b \quad \text{or} \quad J_s = \frac{J_t}{Q_{st}^F} \ \text{ if } \ s < b\,.$$

This implies that the chain type indexes are proportional to each other and their proportional value is the Fisher quantity index. For example, in Table 6, the ratio of the value of a chain type index in 2005 to its value in 2004 equals the value of the Fisher quantity index in 2005.

$$\frac{J_t}{J_s} = Q_{st}^F = 1.0514 = \frac{1.8411}{1.7511} = \frac{1.2780}{1.2156} = \frac{1.2380}{1.1775} = \frac{1.0000}{0.9511}.$$

This proportionality necessarily implies that the growth rate of chain type indexes and, hence, the growth rate of GDP in chained prices do not change with a change in the base year.

By multiplying the alternative values of the chain type quantity index in Table 6 for different base years by the corresponding scalar value of GDP in the base year ($\sum_i^N p_{ib} q_{ib}$), the GDP in chained prices are obtained and presented in Table 7.

Table 7. GDP in Chained Prices

	2002	2003	2004	2005	2006
Indonesia			(Million US Dollars)		
Chained 1990 Prices	213,649.3	223,198.7	233,532.6	245,529.8	260,459.9
Chained 1995 Prices	262,133.0	273,849.5	286,528.5	301,248.2	319,566.4
Chained 2000 Prices	186,648.5	194,991.1	204,019.0	214,500.0	227,543.3
Chained 2005 Prices	256,869.3	268,350.4	280,774.8	295,199.0	313,149.4

Source: Tables 1, 2, and 3 and equations (14), (15), and (16).

Table 8 shows that the growth rate of GDP in chained prices remains the same whatever is the base year. Thus, changing the growth rate through base year manipulations is not possible in this case.

Table 8. Growth of GDP in Chained Prices

	2002	2003	2004	2005	2006
Indonesia			(Percent)		
Chained 1990 Prices	4.20	4.47	4.63	5.14	6.08
Chained 1995 Prices	4.20	4.47	4.63	5.14	6.08
Chained 2000 Prices	4.20	4.47	4.63	5.14	6.08
Chained 2005 Prices	4.20	4.47	4.63	5.14	6.08

Source: Table 7.

The base-year dependence of the growth rate of GDP in constant prices in Table 5 makes growth decomposition misleading. However, for comparison with the case of chained prices in Table 10, Table 9 shows the decomposition of GDP growth in constant 1990 prices.

Table 9. Contributions to Growth of GDP in Constant 1990 Prices

Indonesia	2002	2003	2004	2005	2006	Average 2002-06	Share
			(Percentage Points)				(Percent)
Agriculture Sector	**0.48**	**0.52**	**0.44**	**0.33**	**1.09**	**0.57**	**11.47**
Agriculture, hunting, forestry, fishing	0.48	0.52	0.44	0.33	1.09	0.57	
Industry Sector	**1.82**	**1.60**	**1.66**	**1.81**	**2.82**	**1.94**	**38.86**
Mining and Utilities	0.05	-0.23	-0.55	0.09	0.96	0.06	
Manufacturing	1.49	1.52	1.83	1.34	1.66	1.57	
Construction	0.27	0.31	0.38	0.38	0.19	0.31	
Services Sector	**2.01**	**2.49**	**2.80**	**3.29**	**1.80**	**2.48**	**49.68**
Wholesale, retail trade, restaurants and hotels	0.72	0.92	0.97	1.47	0.60	0.94	
Transport, storage and communication	0.53	0.79	0.93	0.98	-0.12	0.62	
Other Activities	0.77	0.78	0.90	0.84	1.32	0.92	
Sum = GDP growth rate (Table 5)	**4.31**	**4.61**	**4.90**	**5.44**	**5.70**	**4.99**	**100.00**

Source: Table 2 and equation (10).

Table 10. Contributions to Growth of GDP in Chained Prices

Indonesia	2002	2003	2004	2005	2006	Average 2002-06	Share
			(Percentage Points)				(Percent)
Agriculture Sector	**0.51**	**0.56**	**0.46**	**0.33**	**1.09**	**0.59**	**12.03**
Agriculture, hunting, forestry, fishing	0.51	0.56	0.46	0.33	1.09	0.59	
Industry Sector	**1.81**	**1.56**	**1.52**	**1.79**	**3.07**	**1.95**	**39.80**
Mining and Utilities	0.06	-0.23	-0.62	0.11	1.31	0.13	
Manufacturing	1.45	1.44	1.70	1.24	1.54	1.47	
Construction	0.31	0.35	0.44	0.44	0.22	0.35	
Services Sector	**1.88**	**2.35**	**2.65**	**3.01**	**1.92**	**2.36**	**48.17**
Wholesale, retail trade, restaurants and hotels	0.68	0.87	0.88	1.29	0.52	**0.85**	
Transport, storage and communication	0.39	0.63	0.74	0.77	-0.09	**0.49**	
Other Activities	0.81	0.84	1.02	0.96	1.49	**1.02**	
Sum = GDP growth rate (Table 8)	**4.20**	**4.47**	**4.63**	**5.14**	**6.08**	**4.90**	**100.00**

Source: Tables 1, 2, and 3 and equation (26).

In comparing the 2002-2006 average shares of contributions to GDP growth, Tables 9 and 10 show that agriculture contributed 11.47 percent in constant 1990 prices but a larger 12.03 percent in chained prices; industry, 38.86 percent (constant 1990) but a larger 39.80 percent (chained); and services, 49.68 percent (constant 1990) but a smaller 48.17 percent (chained). Because the above changes are quite slight, these results show that chained prices still indicate as much as constant 1990 prices the relative importance of services compared to agriculture and industry as the driver of Indonesia's GDP growth.

Table 5 showed that GDP growth in constant prices in the same year changes with the base year. Hence, an industry's share of GDP in constant prices in the same year also changes. But an industry's share of GDP in chained prices in the same year remains the same whatever is the base year. Table 11 shows, for example, that the 2006 share of *manufacturing* steadily fell from 28.85 percent in constant 1990 prices to 26.64 percent in constant 2005 prices while it remained 26.71 percent in chained prices. In contrast, the 2006 share of *construction* steadily rose from 5.22 percent in constant 1990 prices to 5.91 percent in constant 2005 prices while it remained 5.95 percent in chained prices.

Table 11. Shares in 2006 GDP in Constant and Chained Prices

	Shares in 2006 GDP in Constant Prices for Different Base Years				Shares in 2006 GDP in Chained Prices , Any Base Year
	1990	1995	2000	2005	
Indonesia		(Percent)			(Percent)
Agriculture, hunting, forestry, fishing	13.37	14.57	14.44	13.02	13.35
Mining and Utilities	7.82	6.63	9.69	11.54	10.56
Manufacturing	28.85	28.69	27.25	26.64	26.71
Construction	5.22	5.32	5.61	5.91	5.95
Wholesale, retail trade, restaurants and hotels	17.26	15.81	15.95	14.62	15.02
Transport, storage and communication	7.54	7.84	5.65	5.86	5.91
Other Activities	19.93	21.14	21.41	22.41	22.49
Sum	100.00	100.00	100.00	100.00	100.00

Source: Tables 1, 2, and 3, expression (13) and equations (27) and (28).

The explanation for the steady fall of manufacturing but steady rise of construction in Table 11 may be seen in Table 3. Note in the latter table that during 2002-06, the overall (i.e., economy-wide) average of prices relative to 1990 prices was 1.17. That is, during this period, overall prices rose on average 17 percent above 1990 prices. However, in manufacturing, prices relative to 1990 prices was on average 1.09 or rose 9 percent, which was *slower* than the economy-wide 17 percent rise in prices. In contrast, in construction, prices relative to 1990 prices was on average 1.34 or rose 34 percent, which was *faster* than the economy-wide rise in prices. This implies that, between manufacturing and construction, relative prices rose in favor of the latter. This explains why as the *fixed-base* year is changed by changing the *constant* prices from the prices in 1990 to those in 1995, 2000, and 2005 to measure shares in 2006 GDP in constant prices, the shares of manufacturing fell while those of construction rose as shown in Table 11.

Viewed from the *production* side of GDP, the rise of relative prices above in favor of construction against manufacturing implies a supply *substitution* towards more construction (i.e., rising share) but less manufacturing (i.e., falling share). However, this substitution effect from relative price changes would *not* be measured if prices are constant. For this reason, GDP in constant prices has substitution *bias*. But because GDP in chained prices allows for relative price effects, substitution bias would be alleviated if not eliminated. By implication, shares in constant prices are misleading indicators of relative importance of an industry in the economy precisely because they ignore the real effects overtime of changes in relative prices. To the extent that these real effects are incorporated by shares in chained prices, these shares are superior indicators of the growing or declining importance of an industry in the economy.

The analysis up to this point focused only on Indonesia to allow more details on the effects of converting GDP from constant to chained prices. It is clear by now that the conversion to chained prices avoids the anomalies from the base-year dependence of the growth and shares of GDP in constant prices.

At this juncture, the focus shifts to comparisons of GDP growth rates and shares in constant and chained prices between Indonesia, Malaysia, Philippines, and Thailand. Table 12 shows that during 2002-06, Indonesia had the lowest while Malaysia had the highest average GDP growth either in constant 1990 prices or in chained prices.[14] However, average GDP growth slowed in chained prices compared to growth in constant 1990 prices for

[14] The percent GDP growth in constant 1990 prices and in chained prices by country in Table 12 are broken out into percentage point contributions by sector for each country in Table 14.

Indonesia, Malaysia, and Thailand but became faster for the Philippines.[15] The explanation for this Philippine exception may be seen in Tables 13 and 14.

Table 12. GDP Growth in Constant 1990 Prices and in Chained Prices

	2002	2003	2004 (Percent)	2005	2006	Average 2002-06 (Percent)
Indonesia						
Constant 1990 prices	4.31	4.61	4.90	5.44	5.70	**4.99**
Chained prices	4.20	4.47	4.63	5.14	6.08	**4.90**
Malaysia						
Constant 1990 prices	5.26	5.67	7.32	5.15	6.05	**5.89**
Chained prices	5.15	5.74	7.29	4.91	5.78	**5.77**
Philippines						
Constant 1990 prices	4.45	4.93	6.18	4.97	5.37	**5.18**
Chained prices	4.42	5.05	6.29	5.21	5.43	**5.28**
Thailand						
Constant 1990 prices	5.32	7.14	6.28	4.49	4.99	**5.64**
Chained prices	5.28	7.08	6.27	4.44	4.95	**5.60**

Source: Tables 1, 2, 3 and equations (10) and (26).

Table 13 shows that based on average contribution to GDP *level* (i.e., the usual share of GDP) during 2002-06, agriculture is the smallest sector in all four countries and the Philippines has the largest agriculture sector measured either in constant 1990 prices (19.15 percent) or chained prices (14.66 percent), even though Philippine agriculture shrunk by over 4 percentage points after GDP conversion from constant to chained prices. Also, among the four countries, the Philippines has the largest service sector in constant 1990 prices (48.64 percent) and more so in chained prices (53.57 percent) because it was only in the Philippines that this sector enlarged in chained prices. Malaysia has the largest industry sector among the four countries in constant 1990 prices (43.59 percent) and more so in chained prices (47.57 percent) because Malaysian industry had the largest increase in GDP share after conversion.

Table 13 shows that GDP conversion from constant to chained prices could change the picture of economic transformation in terms of shifting sectoral composition. Malaysia is a

[15] This comparison between constant 1990 prices and chained prices across the above four countries is warranted by the fact that 1990 is the common base year of the original UN data on GDP in constant prices for these countries. For example, see Table 2 for Indonesia.

case in point. During 2002-06, the average GDP level share in constant 1990 prices of industry (43.59 percent) was *smaller* than the share of services (49.13 percent). In contrast, the share in chained prices of industry (47.57 percent) became *larger* than the share of services (43.74 percent). That is, in Malaysia, the service sector is the largest measured in constant 1990 prices but the industry sector is the largest measured in chained prices (given that agriculture is the smallest sector by either measure).

Table 13. Sector Contributions to GDP Level in Constant 1990 Prices and in Chained Prices

	2002	2003	2004 (Percent)	2005	2006	Average GDP Level Share 2002-06 (Percent)
Agriculture Sector						
Indonesia						
Constant 1990 prices	13.75	13.64	13.43	13.05	13.37	**13.45**
Chained prices	14.62	14.57	14.05	13.13	13.35	**13.94**
Malaysia						
Constant 1990 prices	7.45	7.45	7.28	7.09	7.12	**7.28**
Chained prices	8.21	8.97	9.05	8.62	8.59	**8.69**
Philippines						
Constant 1990 prices	19.71	19.48	19.32	18.74	18.51	**19.15**
Chained prices	15.08	14.78	14.79	14.47	14.18	**14.66**
Thailand						
Constant 1990 prices	10.55	11.10	10.19	9.44	9.39	**10.13**
Chained prices	9.08	10.17	9.93	9.87	10.40	**9.89**
Industry Sector						
Indonesia						
Constant 1990 prices	42.66	42.31	41.91	41.47	41.90	**42.05**
Chained prices	43.38	41.93	41.55	42.52	43.22	**42.52**
Malaysia						
Constant 1990 prices	43.20	43.78	44.08	43.60	43.29	**43.59**
Chained prices	45.39	46.13	47.64	48.96	49.74	**47.57**
Philippines						
Constant 1990 prices	32.78	32.48	32.02	31.97	31.81	**32.21**
Chained prices	31.64	31.71	31.54	31.88	32.07	**31.77**
Thailand						
Constant 1990 prices	41.55	42.47	43.10	43.49	43.85	**42.89**
Chained prices	42.65	43.52	43.85	43.96	44.55	**43.71**
Service Sector						
Indonesia						
Constant 1990 prices	43.59	44.05	44.66	45.48	44.73	**44.50**
Chained prices	42.00	43.50	44.40	44.35	43.42	**43.54**
Malaysia						
Constant 1990 prices	49.35	48.77	48.64	49.30	49.59	**49.13**
Chained prices	46.39	44.89	43.31	42.43	41.66	**43.74**
Philippines						
Constant 1990 prices	47.51	48.04	48.67	49.29	49.68	**48.64**
Chained prices	53.28	53.50	53.67	53.65	53.75	**53.57**
Thailand						
Constant 1990 prices	47.90	46.43	46.71	47.07	46.76	**46.97**
Chained prices	48.26	46.31	46.22	46.16	45.05	**46.40**

Source: Tables 1, 2, and 3; expression (13) and equations (27) and (28).

Recall from Table 12 that only the Philippine GDP growth rose in chained prices. This appears understandable—given that the Philippine service sector is the largest in Table 13—because Table 14 shows it is only in the Philippines where the growth contribution of services (as a share of GDP growth) rose after GDP conversion to chained prices, by over 4 percentage points (58.24 percent to 62.63) during 2002-06.

Table 14. Sector Contributions to GDP Growth in Constant 1990 Prices and in Chained Prices

	2002	2003	2004	2005	2006	Average 2002-06 (Pct. Pt.)	Average GDP Growth Share 2002-06 (Percent)
		(Percentage Points, Pct. Pt.)					
Agriculture Sector							
Indonesia							
Constant 1990 prices	0.48	0.52	0.44	0.33	1.09	**0.57**	**11.47**
Chained prices	0.51	0.56	0.46	0.33	1.09	**0.59**	**12.03**
Malaysia							
Constant 1990 prices	0.21	0.42	0.36	0.18	0.45	**0.32**	**5.51**
Chained prices	0.23	0.50	0.45	0.22	0.55	**0.39**	**6.75**
Philippines							
Constant 1990 prices	0.78	0.74	1.03	0.35	0.76	**0.73**	**14.15**
Chained prices	0.60	0.56	0.79	0.27	0.58	**0.56**	**10.63**
Thailand							
Constant 1990 prices	0.07	1.34	-0.27	-0.33	0.42	**0.25**	**4.38**
Chained prices	0.06	1.23	-0.26	-0.34	0.46	**0.23**	**4.10**
Industry Sector							
Indonesia							
Constant 1990 prices	1.82	1.60	1.66	1.81	2.82	**1.94**	**38.86**
Chained prices	1.81	1.56	1.52	1.79	3.07	**1.95**	**39.80**
Malaysia							
Constant 1990 prices	1.86	3.07	3.53	1.76	2.31	**2.50**	**42.53**
Chained prices	1.94	3.23	3.78	1.93	2.49	**2.67**	**46.32**
Philippines							
Constant 1990 prices	1.25	1.30	1.52	1.55	1.55	**1.43**	**27.61**
Chained prices	1.20	1.26	1.50	1.54	1.56	**1.41**	**26.73**
Thailand							
Constant 1990 prices	2.91	3.95	3.34	2.34	2.55	**3.02**	**53.45**
Chained prices	2.98	4.04	3.39	2.37	2.58	**3.07**	**54.82**
Service Sector							
Indonesia							
Constant 1990 prices	2.01	2.49	2.80	3.29	1.80	**2.48**	**49.68**
Chained prices	1.88	2.35	2.65	3.01	1.92	**2.36**	**48.17**
Malaysia							
Constant 1990 prices	3.19	2.19	3.43	3.20	3.29	**3.06**	**51.97**
Chained prices	2.98	2.00	3.06	2.76	2.74	**2.71**	**46.93**
Philippines							
Constant 1990 prices	2.42	2.90	3.64	3.07	3.06	**3.02**	**58.24**
Chained prices	2.62	3.23	4.00	3.39	3.28	**3.31**	**62.63**
Thailand							
Constant 1990 prices	2.34	1.85	3.21	2.47	2.03	**2.38**	**42.17**
Chained prices	2.24	1.81	3.14	2.41	1.91	**2.30**	**41.08**

Source: Tables 1, 2, 3, 12 and equations (10) and (26).

Just as Table 13 showed that the agriculture sector has the smallest average GDP *level* shares during 2002-06 in all four countries (measured either in constant 1990 prices or chained prices), the same thing is true for this sector in having the smallest average GDP *growth* shares in Table 14 (by either measure). This means that the *growth-driving* sector in all four countries is not agriculture.

Table 14 shows that in Thailand, the average GDP growth shares of the industry sector are greater than those of the service sector by over 11 percentage points (measured in constant 1990 prices or in chained prices), implying that Thailand's GDP growth is driven by industry. In contrast, the GDP growth shares of the service sector are larger than those of the industry sector in Indonesia, Malaysia, and in the Philippines. That is, in these three countries, GDP growth is driven by the service sector, most especially in the Philippines where this sector contributed around 50 percent to GDP level (Table 13) and around 60 percent to GDP growth (Table 14) during 2002-06.[16]

4. Conclusion

Real GDP may be valued either in constant prices or in chained prices. Unfortunately, a change in the base year alone of GDP in constant prices leads inevitably to anomalous changes in the growth rate and shares of components because the condition for them to remain the same─which is the proportionality of prices between the two base years─is surely violated in practice. The above changes are anomalous because they may happen without a change in the volume of production. In contrast, the growth rate and shares of GDP in chained prices do not change with a change in the base year alone. That is, the anomalous changes from GDP in constant prices will be avoided by conversion to chained prices.

This paper showed that the fixed-base Laspeyres quantity and Paasche price indexes─that underlie GDP in constant prices─fail to perform their purposes, which are for the quantity index to capture only quantity changes and for the price index to capture only

[16] Intal (2008) indicated that the service sector is where the Philippines appears to have comparative advantage over other countries in the region.

price changes. Thus, this paper recommends implementing the framework of US GDP in chained prices precisely for the success of the underlying chain type Fisher quantity and price indexes in performing the above purposes.

The feasibility and ease of implementation of the US framework were illustrated using UN data on GDP in current prices and in constant 1990 prices for four ASEAN countries: Indonesia, Philippines, Malaysia, and Thailand. However, implementation still requires GDP components in constant prices and these components together with those in current prices are sufficient data inputs to compute GDP in chained prices. What this paper objects to is the present practice of measuring real GDP simply as the sum of components in constant prices because this GDP could yield anomalous results and, thus, is questionable as basis for valuation of the economy's production and analysis of its growth performance.

The illustrative conversion to chained prices of GDP in Indonesia showed that the results are not only free of the anomalies of GDP in constant prices but also allow for the effects of relative price changes over time to alleviate substitution bias and to portray a more realistic picture of the economy's sectoral transformation. The results for all four countries show that in Thailand, the average GDP growth shares of the industry sector are greater than those of the service sector (measured in constant 1990 prices or in chained prices), implying that Thailand's GDP growth is driven by industry. In contrast, the GDP growth shares of the service sector are larger than those of the industry sector in Indonesia, Malaysia, and in the Philippines. That is, in these three countries, GDP growth is driven by the service sector, most especially in the Philippines where this sector contributed over 50 percent to GDP level and over 60 percent to GDP growth during 2002-06.

Therefore, to establish on more analytically solid and realistic footings the measurement of GDP and the analysis of GDP growth and sectoral composition in Indonesia, Malaysia, Philippines, Thailand, and in other countries as well, this paper concludes that their GDP in constant prices should be converted to GDP in chained prices.

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