

## ADB Economics Working Paper Series



### An Analysis of Revisions to Annual GDP Estimates of Six ADB Regional Members

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Benson Sim, Modesta de Castro, and Melissa Pascua  
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## **Contents**

Abstract	v
I. Introduction	1
II. Why do Revisions Take Place?	3
III. Revisions and Data Quality	4
IV. Description of Key Indicators for Asia and the Pacific	5
V. Definitions of Revisions Indicators	7
VI. Analysis of Results	11
VII. Data Limitations and Caveats	16
VIII. Conclusion	18
Selected References	20



## **Abstract**

This paper analyzes the histories of revisions of official annual real gross domestic product (GDP) growth rates for six regional members of the Asian Development Bank (ADB)—People’s Republic of China; India; Indonesia; Republic of Korea; Taipei,China; and Thailand—for the period 1990–2004 as computed from successive editions of ADB’s flagship annual statistical publication, *Key Indicators for Asia and the Pacific*. A number of revisions indicators for each economy are computed. The results show that first published estimates of annual real GDP growth rates in all the six economies are revised upward 3 years later and in the latest period. Most of the six economies also experienced positive revisions to estimates of annual real GDP growth rates in the first, second, third, and latest years after their initial release. Revisions to first published estimates of annual real GDP growth rates a year later tend to be mostly small, although there are some outliers. In all the six economies, the size of the mean absolute revisions to the first published estimates of annual real GDP growth rates is nontrivial. All the six economies also have rather low relative mean absolute revisions to initial estimates of annual real GDP growth rates published a year later, implying that the first published estimates are generally robust for the purpose of assessing the current performance of these economies. The mean squared revisions for most of the six economies tend to be rather low. This implies that there may not be much volatility in the revisions to initial estimates of annual real GDP growth rates in these economies. Mean revisions in the first, second, third, and latest years in Indonesia are statistically significant, while the People’s Republic of China and Taipei,China have mean revisions that are statistically significant for the latest period.



# I. Introduction

Gross domestic product (GDP) is one of the key economic statistics produced by a country and provides a comprehensive and thorough overview of the state of its economy. Due to its public good characteristics, it is not possible for a private sector entity to compile and disseminate GDP data. Rather, the task of compiling and disseminating GDP estimates is performed by government agencies, very often a single one. In most countries, this important role is performed by the national statistical office (NSO), while in others, it is undertaken by other government agencies such as the central bank. Releases of GDP data of a country are closely watched, monitored, and analyzed by policymakers, researchers, forecasters, economists, and academia. These releases are also widely reported and commented upon in the media. It is common knowledge that GDP estimates are often subject to subsequent revisions after their debut or initial release. This results in several vintages of an observation for a specified time period. As an example, a country may release GDP for 2000 in 2001, and then update the estimate in 2002. More often than not, this process can result in substantial revisions to the initial estimates. A natural question that arises is how reliable the initial estimates are compared to the subsequent, presumably more accurate ones.

This paper analyzes the histories of revisions of official annual real or constant price GDP growth rates for six regional members of the Asian Development Bank (ADB), namely, People's Republic of China (PRC); India; Indonesia; Republic of Korea (henceforth Korea); Taipei, China; and Thailand—for the period 1990–2004.<sup>1</sup> In particular, it examines the magnitude and direction of revisions to initial estimates of annual real GDP growth rates as computed from successive editions of the ADB's flagship statistical publication, *Key Indicators for Asia and the Pacific* (KI).<sup>2</sup> This approach is commonly described as revisions analysis and constitutes one way to establish the reliability of the first estimates of constant price GDP growth rates by comparing them with subsequent estimates. As GDP estimates are also used by forecasters and economists in econometric models, the results of revisions analysis will enable them to assess the impact that revised data may have on their models. In addition, the compilation of GDP estimates is not an end in itself. In many countries, GDP estimates are also used as inputs to compile

<sup>1</sup> According to ADB (2009), these six economies had a combined share of 84.2% in the aggregate GDP measured at purchasing power parity of developing member countries in the Asia and Pacific region in 2008. They also had the six largest GDP among these economies in that year. GDP measured at purchasing power parity rather than at market exchange rates is used to rank the economies and compute the shares as it corrects for differences in price levels across economies.

<sup>2</sup> Growth rates are used to ensure that the official estimates of GDP are comparable across all time periods, regardless of differences in the size of the economy.

other economic statistics such as per capita real GDP as well as labor and total factor productivity growth. Thus, performing revisions analysis of GDP estimates will help shed light on the underlying reasons for the revisions to those economic statistics that are computed using GDP data as one of the inputs. Moreover, revisions analysis can be used as a tool by producers of official statistics such as GDP to gain a better understanding of the statistical compilation process so that problems can be identified and improvements can be made. Indeed, this is one reason behind the International Monetary Fund's (IMF) Special Data Dissemination Standards' advice to countries to perform revisions analysis and to develop a revisions policy that is both transparent and consistent across the range of economic statistics compiled.

The approach used in the study broadly mirrors those in studies described in Ahmad, Bournot, and Koechlin (2004); Di Fonzo (2005); McKenzie (2007); and OECD (1979) for member countries of the Organisation for Economic Cooperation and Development (OECD) with one key exception. The cited studies used quarterly constant price GDP growth rates mainly from the OECD's Main Economic Indicators Original Release Data and Revisions Database and back issues of the *Main Economic Indicators* publication for analysis. In our case, we were unable to obtain data on the various vintages of constant price quarterly GDP data for some economies. Thus, we could only resort to using the annual constant price GDP estimates from the various editions of the KI. A number of studies of this genre have also made use of annual GDP and other data (see Bjerke 1974; Fixler and Grimm 2002, 2005, and 2008; Gleiser and Schavey 1974; Grimm and Parker 1998; Symons 2001).

The paper is organized as follows. We first discuss the various reasons for revisions to official economic statistics such as GDP in Section II. Next, in Section III, we discuss these revisions in the context of data quality. This is followed by a description of the contents of the KI and its data collection process in Section IV. The terminology for measuring revisions and the definitions of the revisions indicators that are used in many studies of this genre are presented in Section V. The key results in Section VI show that first published estimates of annual real GDP growth rates in the KI in all the six economies are revised upward 3 years later and in the latest period. Most of the six economies also experienced positive revisions to estimates of annual real GDP growth rates in the first, second, third, and latest years after their initial release in the KI. The distribution of revisions to first published estimates of annual real GDP growth rates 1 year later shows that most revisions tend to be rather small in nature, although there are some outliers. In all six economies, the size of the mean absolute revisions to the first published estimates of annual real GDP growth rates is nontrivial. In the case of PRC; Indonesia; Korea; and Taipei, China, these revisions tend to become bigger in the first, second, third, and latest years after their first release in the KI. After adjusting for each economy's annual real GDP growth rates, the relative mean absolute revisions for the PRC are found to be visibly much lower than those in the other economies. All the six economies also have rather low relative mean absolute revisions to initial estimates of

annual real GDP growth rates that are published a year later, while the mean squared revisions for most of the six economies tend to be rather low. There is a clear tendency for the initial estimates of annual real GDP growth rates to be revised upward in the case of India, Indonesia, Korea, and Thailand 1–3 years later and in the latest period. This is particularly so for Indonesia. Most of the initial estimates of real GDP growth rates for the PRC and Taipei,China have also been revised upward for the latest period. Consequently, Indonesia is the only economy where the mean revisions for all the four time periods are statistically significant, while the PRC and Taipei,China have statistically significant mean revisions for the latest period. Section VII describes the data limitations and caveats of the study, while Section VIII concludes.

## II. Why do Revisions Take Place?

There are a number of reasons why first official estimates of economic statistics such as GDP are subsequently revised. One, GDP is an indicator capturing the productive activities of an entire economy over an accounting period, so it is inevitable that the compilation of GDP is no simple and straightforward task. Compilation involves getting hard data from a myriad of sources such as surveys and administrative data for all the sectors of the economy. However, more often than not, the hard data needed to compile GDP may only become available after considerable time lags. Due to the need to release economic statistics as early as possible, compiling agencies may thus first compile and disseminate estimates of GDP using incomplete data sources. In many instances, imputation methods such as interpolation may be used in the absence of hard data in the preparation of the first estimates. In subsequent periods, as more hard data from surveys, tax returns, and other sources become available, the initial estimates are revised. Further, compiling agencies may introduce new surveys, enhance existing survey forms, or exploit previously unused administrative data sources after the release of the initial estimates. Incorporating such data into economic statistics such as GDP will result in their initial estimates being revised.

Two, compiling agencies may improve the methodology they use to compile economic statistics such as GDP after releasing the initial estimates. As an example, they may make use of the supply and use tables to compile balanced estimates of GDP. Also, constant price estimates of GDP may be rebased after the initial estimates have been released. In other instances, compiling agencies may even switch to compiling GDP estimates using annually chain-linked volume indexes, or to using hedonic or quality-adjusted price indexes as deflators for information and communication technology products. Such methodological improvements will inevitably result in revisions to the initial estimates of GDP and their real growth rates.

Three, a common source of revisions reflects changes in definitions and concepts. For instance, in the case of GDP, compiling agencies may adopt the recommendation of

the United Nations System of National Accounts 1993 (SNA93) to capitalize business purchases of computer software and databases that are meant to be used for more than one accounting period.<sup>3</sup> They may also allocate the interest margin or financial intermediate services indirectly measured into the various final demand components of GDP. Such changes tend to have an effect on the previously computed levels and growth rates of GDP.

Last but not least, the complex and intricate nature inherent in compiling estimates of economic statistics such as GDP plus the immense pressure on compiling agencies to disseminate them to the public in a timely manner means that it may not be possible to discount the occurrence of human computational errors and mistakes during the production of the estimates. Errors may also occur in the source data. If these errors are discovered after the release of the initial estimates and corrected, subsequent releases of the estimates will be different from the initial ones.

### **III. Revisions and Data Quality**

As mentioned above, revisions to GDP estimates take place for a number of reasons. Given the inevitable nature of revisions, data users would invariably have an interest in the quality of these estimates. On their part, compiling agencies would have to ensure that the disseminated data is of reasonably high quality. As described in Carson (2000) and Carson and Laliberté (2002), data quality has a number of dimensions. The key ones include accuracy, reliability, and timeliness, which are also captured in the dimensions and elements of the IMF's Data Quality Assessment Framework.

As defined in Carson and Laliberté (2002), accuracy refers to the closeness between the estimated value and the unknown true value that the statistics were intended to measure. An assessment of the accuracy of an estimate involves evaluating the error associated with it. However, in practice, it is not possible to assess the accuracy of GDP estimates using a single statistic since it requires an assessment of many potential sources of errors across datasets. Reliability refers to the closeness of the initial estimates to subsequent estimates. This can be measured by comparing estimates over time. However, it should be noted that estimates that are not revised are not necessarily the most reliable because the lack of revisions could reflect the fact that no better information is available to revise a first estimate computed using partial and unreliable data. Timeliness, which is defined in Carson (2000) as the lag between the end of the reference period and the initial publication of statistics for that period, is of equal importance as compiling agencies will

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<sup>3</sup> SNA93 is a framework that prescribes international statistical standards for the measurement of various economic series. The framework was published jointly by the United Nations, Commission of the European Communities, IMF, Organisation for Economic Co-operation and Development, and World Bank. More information on the SNA93 can be obtained from <http://unstats.un.org/unsd/sna1993/introduction.asp>.

need to ensure that data such as GDP estimates are disseminated to policymakers and data users as soon as possible after the end of the period to which they refer for analysis and decision making.

However, there is a possibility of a trade-off between accuracy/reliability and timeliness. The most accurate and reliable statistics of, say, GDP, will only be available after all available data sources have been used for its compilation. This will only happen after some time after the release of the initial estimates. The time lag can be 2–3 years after the reference period, or even longer. This will be of limited use to policymakers. On the other hand, GDP estimates produced and released days after the end of the reference period may not be useful to policymakers if they need to be substantially revised later on. Thus, compiling agencies will need to develop data dissemination policies that strike the best balance between these competing dimensions.

## **IV. Description of Key Indicators for Asia and the Pacific**

Complete data archives containing all historical data vintages of the variables in question are needed before a proper and thorough revisions analysis exercise can be undertaken. The process of gathering old data to assemble the information set for a study of this nature is not smooth sailing if one does not have ready access to successive editions of a specific publication containing long time-series data on the economic variables to be analyzed. A specific publication is needed to enable the systematic archiving of all vintages of the data. In our case, the task of assembling the historical vintages of annual GDP for the six economies was eased to a large extent by the availability of successive editions of the KI, which contain time-series estimates of annual real GDP for these six economies.

The KI is the flagship annual statistical publication of the ADB. It features the most current annual economic, financial, social, and environmental data on ADB's 48 regional members and has been published since the late 1960s. Since 2001, it has also featured a special chapter focusing on a topic of current policy or measurement interest. To date, 40 volumes of the publication have been produced. As described below, the data collection process for the KI typically begins in March or April each year, while the publication is usually released in August of the same year.

The KI is available in printed format as well as on CD-ROM and the Internet. The printed publication presents data on the Millennium Development Goals (MDGs) and regional tables, besides the special chapter. In addition, brief commentaries on achievements of the MDGs and economic, financial, social, and environmental developments in the regional members have been included beginning with the 2008 edition of the KI. The regional tables are compiled from a set of country tables and other international data

sources and contain indicators unrelated to the MDGs. The web-based and CD-ROM versions of the publication contain the special chapter, MDGs and regional tables, commentaries, as well as country tables. The country tables contain time series data for various indicators grouped under the following topics:

- (i) Population
- (ii) Labor force
- (iii) National accounts (including GDP)
- (iv) Production indexes
- (v) Energy
- (vi) Price indexes
- (vii) Money and banking
- (viii) Government finance
- (ix) External trade
- (x) Balance of payments
- (xi) International reserves
- (xii) Exchange rates
- (xiii) External indebtedness

As each edition of the KI provides a snapshot of the time-series data for the various indicators (including GDP), these snapshots, in principle, provide a consistent and comprehensive information set of GDP estimates that can be used for the purpose of this study.

Depending on the indicator in question, data for the KI are obtained from the appropriate government offices in the regional members and other statistical partners such as international, private, and nongovernment organizations. Data obtained from government agencies typically comprise statistics on population, labor force, national accounts, production indexes, energy, price indexes, money and banking, government finance, external trade, and balance of payments. Meanwhile, data obtained from international organizations, private, and nongovernmental organizations typically consist of statistics on international reserves; exchange rates; external indebtedness; MDGs; as well as poverty, social, financial, infrastructure, governance, and environment indicators. In the case of government agencies in the regional members, questionnaires to get updated data are sent to them around March or April of every year. These government agencies would usually reply with the updated data in May or June. In some instances, updated data are also gathered from the official websites of the appropriate government agencies of the regional members. In the case of other statistical partners such as international, private, and nongovernmental organizations, data are typically downloaded from their online databases or from other media such as CD-ROMs. In all instances, the updated data collected from the various data sources are carefully validated before they are published in the KI in August.

In the specific case of GDP (or most other economic statistics for that matter), the role of compiling and disseminating these statistics is performed by the government sector

due to the fact that their measurement has public good characteristics. Thus, it is not possible for a private sector entity to undertake the role of compiling and disseminating GDP data. In most countries, this important role is performed by the NSO, while in others, it is undertaken by other government agencies such as the central bank. As can be seen in Table 1, with the exception of Korea and Thailand, this is the case for the most of the six economies in our study. In the case of Korea, the Bank of Korea is the agency responsible for compiling GDP, while in the case of Thailand, the National Economic and Social Development Board is the agency responsible for performing this role. These six agencies are sent questionnaires to provide updated GDP and other data during the KI data collection exercise each year.

**Table 1: Agency Responsible for Compiling GDP in the Six Major Economies**

<b>Economy</b>	<b>Responsible Agency</b>
China, People's Republic of	National Bureau of Statistics
India	Central Statistical Organization
Indonesia	Central Bureau of Statistics
Korea, Republic of	Bank of Korea
Taipei, China	Directorate General of Budget, Accounting and Statistics
Thailand	National Economic and Social Development Board

## V. Definitions of Revisions Indicators

Revisions analysis provides a measure of the quality of a statistic or indicator in terms of its reliability. However, it should be noted that revisions do not imply that one statistic is more or less accurate than another. On the contrary, a statistic that is not revised may well be less accurate than one that has undergone revisions because the source data for the former may present formidable measurement challenges.

A typical way to assess the reliability of a parameter of interest is to construct confidence intervals for it. However, in the case of economic statistics like GDP, it is not possible to do so because the data are compiled using eclectic sources, including random and nonrandom surveys, administrative records, and extrapolated and interpolated estimates. Consequently, the best and, perhaps, only way to evaluate the reliability of early estimates of such statistics is to compare them with later estimates. Following previous studies in the literature, we define revision as the difference between a later (or more recent) estimate and an earlier estimate. This is usually expressed as later less preliminary (i.e.,  $L - P$ ). In our study, this would refer to annual real or constant price estimates of GDP growth rates. As the real GDP growth rate for a particular reference period can have different values over time depending on its vintage, the symbol  $L$  in the expression  $L - P$  will have a different value depending on the time interval from the first published data ( $P$ ). Thus, it can refer to estimates of annual real GDP growth rates published 1–3 years after their first appearance in the KI. For the purpose of our study,

we will use the time period notations  $t + 1$ ,  $t + 2$ , and  $t + 3$  to refer to the size of the revisions between the estimates of annual real GDP growth rates that appear in the KI 1, 2, and 3 years after their debut in the publication and the debut or initial estimates in the KI. In addition, we will use the time period notation “latest” to refer to the size of the revisions between the estimates of annual real GDP growth rates that appear in the latest edition of the KI and the debut estimates in the publication. It is preferable to denote the most recent estimate as “latest” rather than “final” as there is always a possibility that an estimate may be revised due to methodological improvements or rebasing long after it is released. In other words, in the case of economic statistics like GDP, it may be prudent to avoid classifying estimates as final.

The following main summary indicators are computed in many revisions analysis studies:

Mean revision

$$\bar{R} = \frac{1}{n} \sum_{t=1}^n (L_t - P_t) = \frac{1}{n} \sum_{t=1}^n R_t$$

where  $L_t$  is the later estimate and  $P_t$  is the preliminary estimate for each reference period,  $R_t = L_t - P_t$  is the revision, and  $n$  is the number of observations. The key interest of this indicator is in its sign. A positive sign implies, on average, an underestimation of the first releases of annual real GDP growth rates. Conversely, a negative sign indicates an overestimation. Large revisions of opposite signs offset each other so that the signs’ usefulness may be limited to determining the average direction of revisions. This indicator is sometimes referred to as “average bias”.

Relative mean revision

$$RR = \frac{\sum_{t=1}^n (L_t - P_t)}{\sum_{t=1}^n L_t} = \frac{\sum_{t=1}^n R_t}{\sum_{t=1}^n L_t}$$

This indicator normalizes the mean revision indicator using the latest annual real GDP growth rates. Hence, it can account for the possibility of larger errors during high-growth periods so that better comparisons across time periods and between high-growth and low-growth countries can be made.

Mean absolute revision

$$MAR = \frac{1}{n} \sum_{t=1}^n |L_t - P_t| = \frac{1}{n} \sum_{t=1}^n |R_t|$$

This indicator may be more useful than the mean revision to assess the size of revisions because it eliminates the compensating effects on the indicator arising from positive and negative revisions. However, because it is expressed in absolute percentage terms, it can provide an indication of the average size of revisions, but not the directional bias, if any.

Relative mean absolute revision

$$RMAR = \frac{\sum_{t=1}^n |L_t - P_t|}{\sum_{t=1}^n |L_t|} = \frac{\sum_{t=1}^n |R_t|}{\sum_{t=1}^n |L_t|}$$

This indicator corrects the mean absolute revision for the size of growth, and thus takes into consideration the fact that revisions may be expected to be larger in time periods of high real GDP growth than in periods of low growth.

Mean squared revision

$$MSR = \frac{1}{n} \sum_{t=1}^n (L_t - P_t)^2 = \frac{1}{n} \sum_{t=1}^n R_t^2$$

The mean squared revision is a summary measure of the variance of revisions based on a symmetric and quadratic loss function. It has some useful properties as described in Di Fonzo (2005). It can be decomposed to quantify the effects due to the systematic differences between the preliminary and latest estimates, the extent of the proportional changes between these estimates, and a disturbance term.

This study focuses on annual real GDP growth rates. Thus, the values of  $L$ ,  $P$ , and  $R$  in the above formulae refer to annual real GDP growth rates for the six economies as published in successive editions of the KI.

As explained in Branchi et al. (2007), the above summary indicators cover most of the following three aspects of revisions that are generally distinguished: (i) stability, i.e., whether the revisions were low or high; (ii) bias, i.e., whether the revisions were mostly in the same direction; and (iii) volatility, i.e., whether there were many changes between the first and the latest estimate. They also stress that there is no such thing as an “ideal indicator”. Rather, as all indicators provide summary information on a specific aspect of the frequency distribution, they should be analyzed jointly, and not separately.

It is not sufficient to conclude from the mere observation of a positive or negative mean revision that there is a systematic or predictable bias in the estimates of real GDP growth

rates. Random adjustments to the first estimates of real GDP growth rates are the norm rather than the exception. As a result, the computed mean revision over any given time period is likely to be nonzero. However, for a systematic relationship between the initial and later estimates to be present, the expected mean revision needs to be nonzero. This means that the observed mean revision needs to be statistically different from zero. The typical approach to test the hypothesis that a parameter of interest is zero against the alternative that it is nonzero is to use the standard  $t$ -statistic. However, as explained in Di Fonzo (2005), the standard  $t$ -test assumes that the revisions are independent of each other. This is not necessarily true for time series data such as GDP as revisions made for one period may be associated with revisions made to previous periods. Hence, to test for the statistical significance of the mean revision, we will use a simple and robust approach based on the heteroskedasticity and autocorrelation consistent solution proposed by Newey and West (1987) to obtain a robust estimate of the variance of the mean revision, which takes into consideration any serial correlations of the data series. This is used in the  $t$ -test to determine whether the mean revision is nonzero. If the  $t$ -test shows that a mean revision is statistically different from zero, the conclusion is that the initial estimates are consistently too low or too high so that they have a tendency to be revised upward or downward later on. Mathematically, the variance of the mean revision can be expressed as

$$\text{Var}(\bar{R}) = \frac{1}{n(n-1)} \left( \sum_{t=1}^n \hat{\varepsilon}_t^2 + \frac{4}{3} \sum_{t=2}^n \hat{\varepsilon}_t \hat{\varepsilon}_{t-1} + \frac{2}{3} \sum_{t=3}^n \hat{\varepsilon}_t \hat{\varepsilon}_{t-2} \right)$$

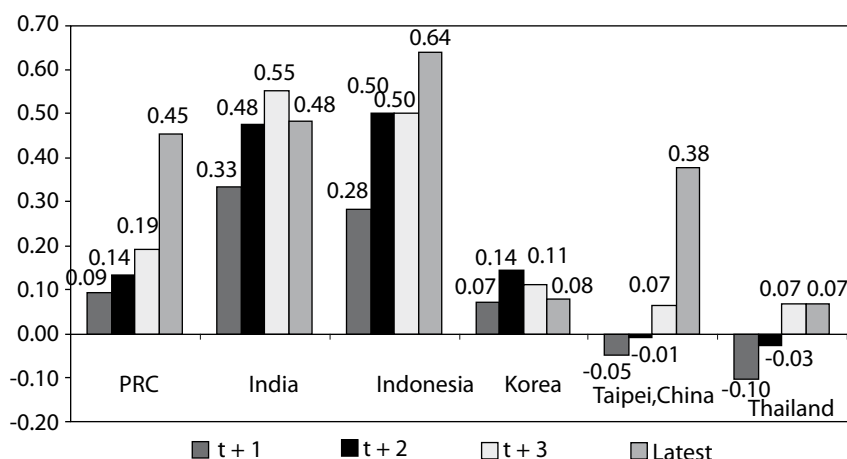
where  $\hat{\varepsilon}_t = R_t - \bar{R}$ .

The OECD has made available on its Main Economic Indicators Original Release Data and Revisions Database (see <http://stats.oecd.org/mei/default.asp?rev=1>) Excel spreadsheets with preprogrammed formulae to enable data users to perform revisions analysis on a number of key economic variables. We made use of these spreadsheets to compute the various summary indicators and  $t$ -statistics for the six economies using their annual constant price GDP growth rates for the years 1990–2004 as published in successive editions of the KI. Thus, this would result in 15 years of annual real GDP growth rates for the years 1990–2004 for analysis. However, since the spreadsheets are meant to be used in conjunction with monthly and quarterly data series, some modifications had to be made to them before they could be used for our study.

## VI. Analysis of Results

Figure 1 shows the mean revisions by economy for the  $t + 1$ ,  $t + 2$ ,  $t + 3$  and latest periods for 1990–2004. What is interesting is that in all the six economies, the revisions for the  $t + 3$  and latest periods are all positive, implying that annual real GDP growth rates have been revised upward after the first release. In addition, except for Taipei,China and Thailand, the other economies have positive revisions throughout. Further, the PRC and Indonesia tend to have progressively upward revisions. On the other hand, Taipei,China and Thailand have downward revisions for the  $t + 1$  and  $t + 2$  periods and upward revisions after that.

**Figure 1: Mean Revisions to First Published Annual Real GDP Growth Rates, 1990–2004 (percentage points)**



The distribution of the revisions for the estimates of annual real GDP growth rates for the  $t + 1$  period in all the six economies is shown in Figure 2. As can be observed, the revisions tend to be frequently concentrated around the 0.01–0.20 and –0.19–0.00 percentage point ranges. This suggests that in most economies, revisions tend to be relatively small in nature. Nevertheless, rather extreme outliers of less than –0.39 and greater than 0.8 percentage points can be observed. These revisions are for India, Korea, and Thailand.

**Figure 2: Distribution of Revisions to First Published Annual Real GDP Growth Rates One Year Later, 1990–2004**

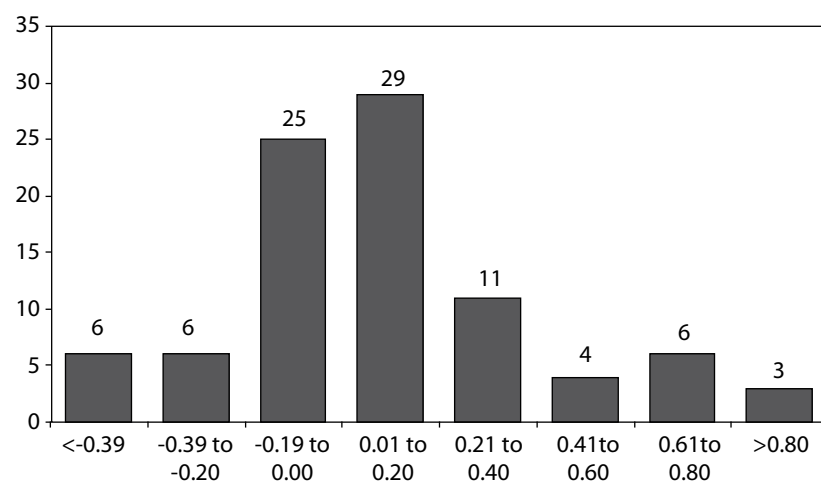


Figure 3 shows the mean absolute revisions for the six economies in the study. As mentioned earlier, mean absolute revisions are better than the mean revisions to assess the extent of revisions because they avoid the compensating effects arising from positive and negative revisions. For all the economies, the size of the mean absolute revisions to the first published estimates of annual real GDP growth rates is nontrivial. The size of the revisions in the case of India tends to be larger than those in the other economies. In addition, the revisions to the first published estimates tend to become larger over time in the case of PRC; Indonesia; Korea; and Taipei, China. This suggests that in general, subsequent revisions to estimates do not offset previous revisions. Also, the size of the mean absolute revisions appears to be dispersed across the economies, although a ranking of the economies according to the size of the revisions will depend on the revisions period in question.

**Figure 3: Mean Absolute Revisions to First Published Annual Real GDP Growth Rates, 1990–2004 (percentage points)**

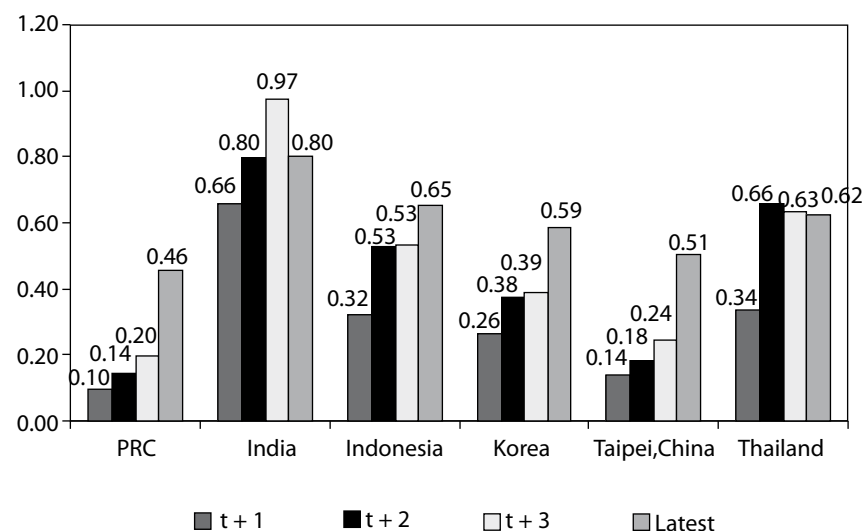
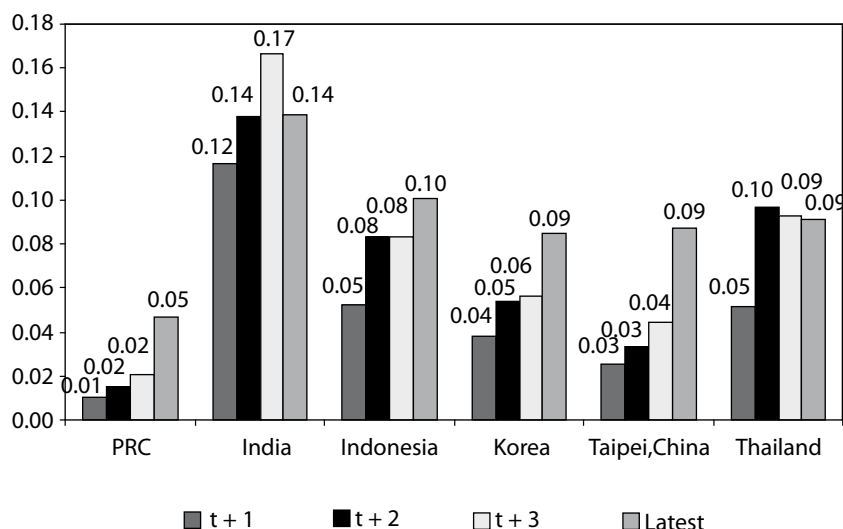


Figure 4, which is a replication of Figure 3, shows the relative mean absolute revisions by economy. The relative mean absolute revision may be more appropriate for comparing the magnitude of revisions across countries as it adjusts the mean absolute revisions for the average absolute size of the relevant growth rate over the analysis period.

**Figure 4: Relative Mean Absolute Revisions to First Published Annual Real GDP Growth Rates, 1990–2004 (percentage points)**



One rather visible result from Figure 4 is that the relative mean absolute revisions for the PRC are now noticeably much lower compared to the revisions for the other five economies. This could be due to the much higher annual real GDP growth rates enjoyed by the PRC compared to the other economies during the study period.

Relative mean absolute revisions can also be used to provide a measure of the robustness for first published estimates of different growth rates since according to McKenzie (2007), they can be interpreted as the expected proportion of the first published estimates that are likely to be revised within a certain period (e.g., 1 year). For example, if an economy has, say, a relative mean absolute revision of 0.5 for the  $t + 1$  period, it means that on average, the initial estimates of annual real GDP growth rates will be revised by more than half within 1 year. As can be observed from Figure 4, all the six economies in the study have rather low relative mean absolute revisions for the  $t + 1$  period. This suggests that the first published estimates of annual real GDP growth rates may be adequately robust for the purpose of assessing the current performance of these economies.

The mean squared revisions for all the six economies are shown in Figure 5. Higher values for mean squared revisions tend to imply greater volatility. In general, most of the economies have rather low values of below 1 for the mean squared revisions throughout.

This suggests that in general, there is not much volatility in the revisions across all the four time periods. However, mean squared revisions tend to increase as time progresses for the PRC; Indonesia; Korea; and Taipei,China.

**Figure 5: Mean Squared Revisions to First Published Annual Real GDP Growth Rates, 1990–2004 (percentage points)**

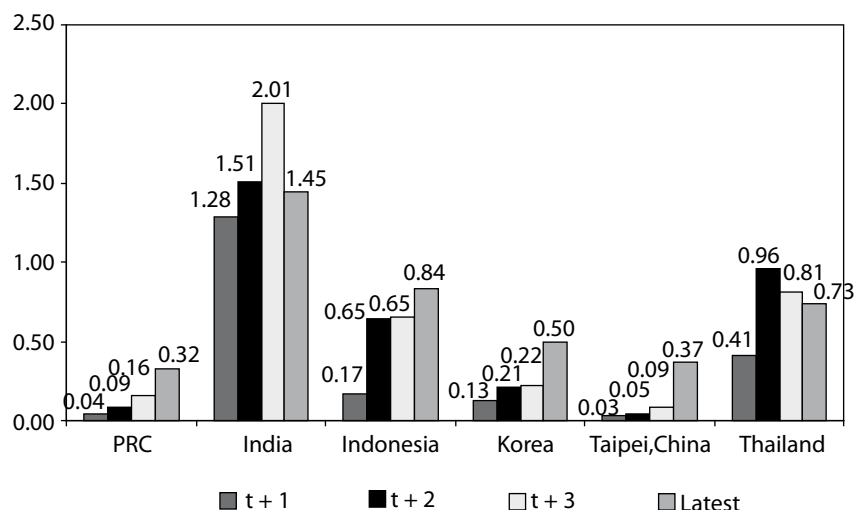


Table 2 shows the  $t$ -statistics for the mean revisions of annual real GDP growth rates for the  $t + 1$ ,  $t + 2$ ,  $t + 3$ , and latest periods for the six economies in the study. The asterisks in the table indicate whether the mean revisions are statistically different from zero. Also, the proportion of time that the initial estimates of annual real GDP growth rates are revised upward is provided in the table. To reinforce the analysis in Figure 1, there is a clear tendency for the initial estimates of annual real GDP growth rates to be revised upward across all the four time periods in the case of India, Korea, Thailand, and especially Indonesia. In the case of Indonesia, for the latest period, 93.33% of the initial estimates of annual real GDP growth rates have been revised upward. Most of the initial estimates of real GDP growth rates for the PRC and Taipei,China have also been revised upward for the latest period. Consequently, Indonesia is the only economy where the  $t$ -statistics for the mean revisions across all the four time periods are significant, while the PRC and Taipei,China have significant  $t$ -statistics for the mean revisions for the latest period. This is different from the ideal situation where revisions should be random so that they are equally likely to be positive or negative and centered around zero. There may thus be a need for those economies where mean revisions are significantly different from zero on a consistent basis to review the compilation methods for early estimates of GDP and see if any improvements are needed.

**Table 2: t-statistics for Mean Revisions to Annual Real GDP Growth Rates and Proportion of Time Initial Estimates of Annual Real GDP Growth Rates are Revised Upward**

<b>Economy</b>	<b>t+1</b>	<b>t+2</b>	<b>t+3</b>	<b>latest, L</b>
PRC	1.41	1.36	1.42	3.48***
India	1.06	1.31	1.23	1.54
Indonesia	4.02***	2.71**	2.70**	2.60**
Korea	0.65	0.91	0.70	0.31
Taipei,China	-0.83	-0.11	0.79	2.38**
Thailand	-0.55	-0.08	0.23	0.24

<b>Economy</b>	<b>%(t+1)&gt;P</b>	<b>%(t+2)&gt;P</b>	<b>%(t+3)&gt;P</b>	<b>%L&gt;P</b>
PRC	46.67	46.67	46.67	86.67
India	53.33	60.00	60.00	73.33
Indonesia	86.67	86.67	86.67	93.33
Korea	73.33	73.33	66.67	53.33
Taipei,China	33.33	40.00	53.33	73.33
Thailand	73.33	80.00	80.00	80.00

\*\* significant at 5 percent level, \*\*\* significant at 1 percent level.

To sum up, annual real GDP growth rates in all the six economies are revised upward in the  $t + 3$  and latest periods. Most of the six economies also experienced positive revisions to initial estimates of annual real GDP growth rates in the  $t + 1$ ,  $t + 2$ ,  $t + 3$ , and latest periods. The distribution of revisions for the  $t + 1$  period shows that most revisions tend to be rather small in nature, although there are some outliers. In all the six economies, the extent of the mean absolute revisions to the first published estimates of annual real GDP growth rates is nontrivial. These revisions tend to become larger over time in the case of PRC; Indonesia; Korea; and Taipei,China. After adjusting for each economy's annual real GDP growth rates, the relative mean absolute revisions for the PRC are found to be visibly much lower than those in the other economies. All the six economies also have relatively low mean absolute revisions for the  $t + 1$  period, implying that the first published estimates of annual real GDP growth rates are generally robust for the purpose of assessing the current performance of these economies. The mean squared revisions for most of the six economies tend to be rather low. This implies that there may not be much volatility in the revisions to annual real GDP growth rates across all the four time periods in these economies. There is a clear tendency for the initial estimates of annual real GDP growth rates to be revised upward in the case of India, Korea, Thailand, and especially Indonesia in the four time periods. Most of the initial estimates of real GDP growth rates for the PRC and Taipei,China have also been revised upward for the latest period. Consequently, Indonesia is the only economy where the  $t$ -statistics for the mean revisions across all the four time periods are significant, while the PRC and Taipei,China have significant  $t$ -statistics for the mean revisions for the latest period. The casual observer may thus be tempted to adjust the first estimates of annual real GDP growth rates of these economies (especially Indonesia) upward to correct for their understatement. However, it is not advisable to make such adjustments because, as will

be explained below, revisions to GDP estimates can arise from a combination of routine and one-off revisions. If the observed revisions are mainly caused by one-off revisions such as definitional and methodological changes, they will not serve as a good guide to future revisions, so adjustments to correct for perceived bias should be avoided. However, it is very difficult to assemble accurate information on the timing and impact of all past definitional and methodological changes, so probably the best course of action is for compiling agencies (especially those whose mean revisions are statistically different from zero consistently) to review the compilation methods for the first estimates of annual real GDP growth rates so that improvements can be made.

## VII. Data Limitations and Caveats

Performing revisions analysis requires complete data archives containing all historical data vintages of the variable in question. The process of gathering old data to assemble the data archives for a study of this nature is not as easy as one would imagine if one does not have ready access to successive editions of a specific publication containing long time-series data on the economic variables to be analyzed. In our case, the task of assembling the historical vintages of annual real GDP growth rates for the six economies has been made less difficult and tedious by the availability of successive editions of the KI, which contain time-series estimates of GDP for the economies in question. Nevertheless, the results of the study should be interpreted with the following data limitations and caveats in mind.

As mentioned earlier, ADB typically writes to the respective agencies in its regional members to provide data for the KI in March or April of each year. These agencies would usually provide ADB the data in May or June, and these data would be the latest they have at that point in time. After careful validation, these estimates (including those for GDP) are then published in KI in August. In the case of GDP, the estimates for the latest reference year are taken to be the initial or first estimates. However, it is possible that the GDP estimates for the latest reference year as published in the KI may not be the initial official ones as published by the regional members. This could be because regional members may release preliminary estimates of GDP in the first quarter of the year, which are then revised 1–2 months later. This means that by the time they receive the data request in March or April, the latest estimates they have available would be the second set of estimates rather than the preliminary ones. The second set of estimates would be provided to ADB, as it is the standard practice for compiling agencies to provide the latest vintage of data in response to data requests, which would then be reflected in the KI. In addition, due to various reasons such as resource constraints, there is a likelihood that regional members may not report all revisions to earlier years when providing the GDP data to ADB every year. Thus, the computation of the various revisions indicators may be affected to some extent, so some care would need to be exercised when interpreting the results of the study.

The study covers annual constant price estimates of GDP growth rates from 1990 to 2004, so that each economy will have only 15 observations of annual real GDP growth rates for analysis. The relatively low number of observations is necessitated by the fact that in the most recent editions of the KI, regional members have been requested to provide revised levels of data series back to 1989. Thus, it is not possible to include the period before this year in the study so that more observations can be made available for analysis. Consequently, this may weaken the results. Naturally, one way to increase the number of observations is to make use of quarterly data for the sample period. Unfortunately, unlike many other studies in the literature, there does not seem to be a single data source in the public domain that can be used to assemble the complete data archives for all the vintages of quarterly GDP for the economies in our study. Thus, rather than crying over spilled milk, it may be better to focus on making improvements in the future. One obvious way is to ensure that regional members continue to provide revised levels of data series such as GDP back to 1989 in future data collection exercises for the KI. This would increase the number of observations of annual real GDP growth rates in future studies on this subject.

As indicated before, GDP estimates can be revised due to a combination of routine revisions such as incorporation of more updated data sources and one-off revisions such as changes in definitions and methodologies. In the case of the latter, it is important to note that the sample period in our study overlapped with the time when many of the six economies were implementing the various recommendations of SNA93. Ideally, any revisions analysis should make a distinction between routine revisions to the first estimates and one-off revisions such as those due to the implementation of SNA93. However, it is a nontrivial exercise to fully separate the effects of the various types of revisions as it would require a thorough assessment of the data sources, detailed production processes, and revisions policies in each economy. Such additional metadata are, unfortunately, rather difficult to assemble as they require a relatively large amount of resources, which were not available in the case of our study.

There could also be instances where a compiling agency makes exceptional changes to its system of compiling GDP estimates, and the revisions for some of the reference years do not make their first appearance in the KI immediately, but only some time later. An example is the PRC, which formally switched from using the Soviet-type Material Product System to the United Nations System of National Accounts (SNA) to compile its GDP in 1993. As described in Xu (2009), which provides a thorough and systematic account of the establishment, reform, and development of national accounts of the PRC, the coverage of national output in the Material Product System only includes five material production sectors, namely, agriculture; industry; construction; transport, post and telecommunications; and commerce (including catering services) and excludes nonmaterial service sectors such as finance and insurance, real estate, and education. These excluded sectors are in the production boundary in the SNA. After the formal adoption of the SNA in 1993, the new time series estimates of GDP were reported in

the KI only from the 1998 edition. This means that estimates of annual real GDP growth rates for the earlier reference years in our analysis period only made their debut in the 1998 edition of the KI. The estimates for the earlier reference years might not be the actual initial estimates as released by the PRC statistical authorities much earlier. In other words, they might have undergone some revisions before they were provided to ADB, so the interpretation of the revisions analysis for PRC needs to be done with this caveat in mind. Nevertheless, this is mitigated by the fact that the initial estimates for the latter reference years in the analysis period published in the KI are likely to be close to the initial ones released by the PRC statistical authorities.

## VIII. Conclusion

This study has used successive editions of ADB's annual flagship statistical publication, the *Key Indicators for Asia and the Pacific*, to perform a revisions analysis of annual real GDP growth rates in six ADB regional members for the 1990–2004 period. Standard revisions indicators found in many studies of this genre were computed for analysis. The computation of the statistics for the various revisions indicators was facilitated to a rather large extent by the availability of Excel spreadsheets with preprogrammed formulae on the Main Economic Indicators Original Release Data and Revisions Database webpage on the OECD's website.

The key results show that first published estimates of annual real GDP growth rates in the KI in all the six economies are revised upward 3 years later and in the latest period. Most of the six economies also recorded positive revisions to initial estimates of annual real GDP growth rates 1, 2, and 3 years later and in the latest period. The distribution of revisions to first published estimates of annual real GDP growth rates 1 year later reveals that most revisions tend to be rather small in nature, although there are some outliers. In all the six economies, the extent of the mean absolute revisions to the first published estimates of annual real GDP growth rates is nontrivial. These revisions tend to increase in the first, second, third, and latest years in the case of PRC; Indonesia; Korea; and Taipei,China. After adjusting for each economy's annual real GDP growth rates, the relative mean absolute revisions for the PRC are found to be perceptibly much lower than those in the other economies. All the six economies also have rather low relative mean absolute revisions to initial estimates of annual real GDP growth rates published 1 year later. This suggests that the first published estimates are generally robust for the purpose of assessing the current performance of these economies. The mean squared revisions for most of the six economies tend to be rather low. This implies that there may not be much volatility in the revisions to annual real GDP growth rates in these economies. There is a clear tendency for the estimates of annual real GDP growth rates for India, Korea, Thailand, and especially Indonesia to be revised upward in the first, second, third, and latest years after their initial release. Most of the initial

estimates of real GDP growth rates for the PRC and Taipei,China have also been revised upward for the latest period. Consequently, Indonesia is the only economy where mean revisions across all the four time periods are statistically significant, while the PRC and Taipei,China have mean revisions that are statistically significant for the latest period. This is different from the ideal situation where revisions should be random so that they are equally likely to be positive or negative and centered around zero. There may be a need for those economies where the mean revisions are consistently statistically different from zero to review the compilation methods for the first estimates of annual real GDP growth rates so that improvements can be made. However, it is not advisable to adjust upward the first estimates of annual real GDP growth rates of those economies and correct for understatement where the mean revisions are statistically significant because of the difficulty in determining the extent of the revisions caused by routine revisions and one-off revisions. The latter will not serve as a good guide to future revisions.

In general, the revisions made by the six economies to their annual real GDP growth rates should also not be taken to mean that the first published estimates of these statistics are mostly unreliable. Rather, the six economies have a long experience in the compilation of GDP and have reasonably good sets of basic data, so these revisions can generally be interpreted as reflecting the initial uncertainty associated with their first estimates. Indeed, small and infrequent revisions should generally be treated with caution as they may indicate that the national accounts of an economy are obtained from a weak and partial set of basic statistics with hardly any updated information.

Although the study has some caveats such as the relatively low number of observations that could weaken the results, it nevertheless illustrates the potential benefits of performing revisions analysis. Hence, for the benefit of data users, it may be useful for compiling agencies to provide sufficient background information on the nature of the revisions that they have done to past data when disseminating economic statistics such as GDP as this would facilitate and improve the analysis and use of the statistics.

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## **About the Paper**

Benson Sim, Modesta de Castro, and Melissa Pascua examine the magnitude and direction of revisions to initial estimates of annual real gross domestic product growth rates for six regional members of the Asian Development Bank (ADB), namely, People's Republic of China; India; Indonesia; Republic of Korea; Taipei, China; and Thailand, as computed from successive editions of ADB's flagship annual statistical publication, *Key Indicators for Asia and the Pacific*.

## **About the Asian Development Bank**

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries substantially reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two thirds of the world's poor: 1.8 billion people who live on less than \$2 a day, with 903 million struggling on less than \$1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

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