Part 4

Technical notes

GDP growth and inflation forecasting performance of *Asian Development Outlook*

Asian Development Outlook (ADO) has been the flagship publication of the Asian Development Bank (ADB) since 1989. Issued twice a year since 1999—both in April, the "main" *ADO,* and in September,[1] the *ADO Update*—the publication contains country economic data and analysis, and projections of key macroeconomic variables. It provides important context for ADB's policy dialogue with its member countries and other stakeholders, and guides ADB management in its views on important development and economic issues.

Since its inception, the April issue of *ADO* has provided current- and next-year forecasts for a range of macroeconomic aggregates; the September release also does this, and analyzes the performance of each developing member country (DMC) during the first half of the year.

This second evaluation of the forecasting performance of *ADO* for real gross domestic product (GDP) growth and inflation—the first was in *ADO 2006 Update*—provides an update. It expands coverage from nine to 14 DMCs, enabling analysis not only across DMCs but also across three subregions (East Asia, South Asia, and Southeast Asia). Additional sample points are added for 2006.

Measuring forecasting quality

This evaluation again centers on the forecasting errors of real GDP growth and inflation. Current- and next-year forecasts for 14 DMCs, from 1990 to 2006, are considered. (The 14 DMCs are Bangladesh; People's Republic of China [PRC]; Hong Kong, China; India; Indonesia; Republic of Korea; Malaysia; Pakistan; Philippines; Singapore; Sri Lanka; Taipei,China; Thailand; and Viet Nam.) Forecasts released in April and in September are also compared with each other. The forecast errors are benchmarked against Consensus Economics forecasts for the period 2000–2006 (i.e., after the Asian financial crisis that began in 1997).

As a measure of the accuracy of forecasts, the size of the forecast error—the difference between the actual value and the forecast for a given year—is used. As both April and September releases of *ADO* are used in this investigation, two sets of current- and next-year forecasts are shown. For example, the April current-year forecast error in GDP growth in 2006 is the difference between actual growth in 2006 and the forecast made in *ADO 2006*; the September current-year forecast error is the difference between actual growth in 2006 and the forecast made in *ADO 2006 Update.*

Similarly, the April next-year forecast error is the difference between actual growth in 2006 and the forecast made in *ADO 2005*; the September next-year forecast error is the difference between actual growth in

2006 and the forecast made in *ADO 2005 Update*. *Positive forecast errors* indicate underprediction and *negative forecast errors* indicate overprediction.

The current-year forecasts provided in September should be considered only partial forecasts as they already draw on some information on outcomes. Self-evidently, more information for a given calendar year is available in September than in April that year: first-half GDP estimates and up to 7 months of inflation data are available for most DMCs.

Three measures of accuracy and bias are considered in this investigation: mean absolute error (MAE), root-mean-square error (RMSE), and fraction of positive errors (FPE). Mean error, a common measure of forecast accuracy and bias, is not used in this evaluation as it is sensitive to the sign of the error: positive and negative values cancel and give misleading results. It is for this reason that MAE and RMSE are used, which cumulate errors irrespective of their arithmetic sign. Low values for these two measures indicate greater accuracy. Of the two, the RMSE gives greater weight to large forecast errors.

With regard to FPE, a result higher than 0.50 indicates a general tendency for the forecasts to underpredict actual values; conversely, a figure lower than 0.50 indicates a tendency to overpredict. Additional tests are applied to detect whether there is a systematic bias in the sign of the forecasting error and to assess the forecasts' ability to predict changes in direction.

Ideally, exposure to more information should result in a smaller forecast error, i.e., greater accuracy. This suggests that the current-year forecast error ought to be smaller than that for the next year. Similarly, September current- and next-year forecast errors should be smaller than April errors (since by that time more information is available). In addition, a shorter forecast horizon (and therefore less uncertainty) should not only result in greater accuracy on average but also less variance in the prediction. This suggests that the variance of the current-year forecast error should be lower than that for the next year. Similarly, for both the current- and next-year forecasts, the variance of the September forecast errors should be smaller than April's.

Forecasting record of April issue of *ADO*

Tables 4.1.1 and 4.1.2 report summary statistics for the forecast errors for both current- and next-year forecasts for GDP growth and inflation for each of 14 DMCs, grouped by subregion. The MAE, RMSE, FPE, and standard deviation are shown.

GDP growth

Current-year forecasts. For GDP growth, the mean of the current-year forecast error (i.e., the bias averaged across time and across DMCs) in absolute terms is 1.6 percentage points. Singapore posted the largest absolute forecast error, at 2.5 percentage points, followed by Hong Kong, China and Malaysia, at 2.2 percentage points. Although Singapore showed the highest MAE, Malaysia had the highest RMSE, indicating a greater number of large forecast errors. Indeed, the current-year forecast errors

4.1.1 Descriptive statistics for forecast errors of GDP growth, April issue of *ADO*, 1990–2006

	Mean absolute error (percentage points)	Root-mean-square error (percentage points)	Fraction of positive errors	Standard deviation (percentage points)
Current-year forecast	**1.55**	**2.24**	**0.63***	**2.38**
East Asia	**1.74**	**2.60**	**0.59***	**2.62**
China, People's Rep. of	1.88	2.37	0.88*	1.75
Hong Kong, China	2.18	3.35	0.59	3.42
Korea, Rep. of	1.85	2.71	0.47	2.76
Taipei,China	1.06	1.96	0.41	1.94
South Asia	**1.08**	**1.43**	**0.57***	**1.51**
Bangladesh	0.51	0.65	0.53	0.67
India	1.33	1.64	0.65	1.69
Pakistan	1.15	1.53	0.59	1.55
Sri Lanka	1.34	1.89	0.53	1.95
Southeast Asia	**1.74**	**2.53**	**0.70***	**2.67**
Indonesia	1.58	2.79	0.76*	2.88
Malaysia	2.18	3.39	0.76*	3.49
Philippines	1.05	1.38	0.53	1.32
Singapore	2.47	3.16	0.71*	3.11
Thailand	2.06	3.05	0.65	3.11
Viet Nam	1.09	1.44	0.76*	1.39
Next-year forecast	**2.11**	**3.19**	**0.51**	**3.45**
East Asia	**2.30**	**3.39**	**0.53**	**3.50**
China, People's Rep. of	2.48	3.24	0.82*	2.77
Hong Kong, China	2.69	3.87	0.47	3.98
Korea, Rep. of	2.79	4.19	0.47	4.31
Taipei,China	1.23	2.25	0.35	2.15
South Asia	**1.39**	**1.81**	**0.40**	**1.85**
Bangladesh	0.71	0.84	0.29	0.77
India	1.51	1.81	0.59	1.87
Pakistan	1.94	2.39	0.24	2.19
Sri Lanka	1.39	2.20	0.47	2.21
Southeast Asia	**2.47**	**3.98**	**0.58***	**4.18**
Indonesia	2.51	5.37	0.65	5.51
Malaysia	2.77	4.60	0.65	4.74
Philippines	1.74	2.78	0.35	2.47
Singapore	3.41	4.19	0.59	4.31
Thailand	2.97	5.11	0.59	5.15
Viet Nam	1.46	1.86	0.65	1.91

Note: For fraction of positive errors, * indicates statistical significance at the 10% level, based on the sign test. The sign test can be used to examine if one random variable in a pair (X, Y) tends to be larger than the other variable. In this study, the two random variables are the forecast and actual outcome. The null hypothesis is that the forecast is more likely to overpredict actual growth.

Source: Staff calculations.

for Malaysia displayed the highest variability, with a standard deviation of 3.5 percentage points. By subregion, South Asia posted the lowest MAE.

A particularly high FPE (more than 70%) is observed for PRC, Indonesia, Malaysia, Singapore, and Viet Nam. The preponderance of DMCs with an FPE above 0.50 suggests a tendency for GDP forecasts in April's *ADO* to underpredict current-year GDP growth. This is supported by the sign test, which rejects the null hypothesis of likely overprediction.

Only the Republic of Korea and Taipei,China have FPEs lower than 0.50. For the former, the MAE was affected when growth was greatly overpredicted for 1998, a year in which the economy experienced a

4.1.2 Descriptive statistics for forecast errors of inflation, April issue of *ADO*, 1990–2006

	Mean absolute error (percentage points)	Root-mean-square error (percentage points)	Fraction of positive errors	Standard deviation (percentage points)
Current-year forecast	**2.20**	**3.30**	**0.35***	**4.31**
East Asia	1.78	2.27	0.28*	2.54
China, People's Rep. of	3.22	4.44	0.29*	4.53
Hong Kong, China	1.66	1.88	0.24*	1.79
Korea, Rep. of	1.06	1.33	0.29*	1.28
Taipei,China	1.17	1.41	0.29*	1.29
South Asia	**2.26**	**2.91**	**0.43**	**3.10**
Bangladesh	2.13	2.84	0.35	2.80
India	2.11	2.64	0.53	2.72
Pakistan	1.52	1.72	0.35	1.74
Sri Lanka	3.27	4.45	0.47	4.47
Southeast Asia	**2.44**	**4.26**	**0.35***	**5.74**
Indonesia	3.80	9.56	0.59	9.37
Malaysia	0.69	0.86	0.24*	0.67
Philippines	1.36	1.85	0.29	1.67
Singapore	0.83	1.15	0.06*	0.87
Thailand	1.35	2.05	0.47	1.96
Viet Nam	6.85	10.07	0.44	9.54
Next-year forecast	**3.27**	**4.89**	**0.46**	**6.48**
East Asia	**2.69**	**3.55**	**0.35***	**3.99**
China, People's Rep. of	5.14	6.63	0.29*	6.77
Hong Kong, China	2.66	3.74	0.29*	3.53
Korea, Rep. of	1.55	2.29	0.47	2.36
Taipei,China	1.41	1.56	0.35	1.39
South Asia	**2.96**	**3.91**	**0.55**	**3.96**
Bangladesh	3.47	4.30	0.53	4.33
India	2.50	3.18	0.53	3.23
Pakistan	2.71	3.27	0.53	3.36
Sri Lanka	3.18	4.87	0.63	4.59
Southeast Asia	**3.88**	**6.43**	**0.47**	**8.78**
Indonesia	5.88	12.81	0.82	12.26
Malaysia	1.14	1.27	0.24*	1.10
Philippines	2.57	3.27	0.53	3.37
Singapore	1.23	1.56	0.24*	1.29
Thailand	2.06	2.81	0.53	2.84
Viet Nam	10.78	16.86	0.44	16.59

Note: See note to Table 4.1.1. For the sign test, the null hypothesis is that the forecast is more likely to underpredict actual inflation.

Source: Staff calculations.

severe contraction in the Asian financial crisis. For the latter, GDP growth was greatly overpredicted in 2001, but the economy contracted because of an export slump in the information and communication technology sector.

Note that the general trend of underpredicting GDP growth remains even if the crisis years are deleted from the evaluation and the resulting negative bias for these years is removed from the forecasts. Without the crisis years, the FPE increases to 0.67, from 0.63.

Next-year forecasts. The MAE and the RMSE are, as might be expected, larger for next- than current-year forecasts. MAEs range from 0.71 to 3.41 percentage points, with Singapore again posting the highest

MAE. But Indonesia has the highest RMSE, and consequently the highest standard deviation.

The PRC has a preponderance of positive errors for next-year forecasts: GDP forecasts are underpredicted 82% of the time. In contrast, FPEs are very low for Pakistan (0.24), Bangladesh (0.29), Taipei,China (0.35), and Philippines (0.35). (But there is a strong tendency to underpredict GDP growth for both current- and next-year forecasts for PRC, India, Indonesia, Malaysia, Singapore, Thailand, and Viet Nam.)

As next-year forecasts are more susceptible to unexpected economic developments, they are made with less certainty and confidence than current-year forecasts; consequently, errors are more volatile. The standard deviations (many of them above 2 percentage points) of next-year forecast errors are greater than those of the current year. The increase of the spread in errors between the current- and next-year forecasts for many economies also appears quite large. As an example, the standard deviation of the forecast errors in Indonesia and the Philippines almost doubles.

Inflation

Current-year forecasts. During the early part of the 1990s, more than half the 14 DMCs under consideration experienced double-digit inflation: PRC; Hong Kong, China; India; Indonesia, Pakistan; Philippines; Sri Lanka; and Viet Nam. Viet Nam and Indonesia recorded the two highest inflation rates: 83% for the former in 1991 and 58.5% for the latter in 1998.

In a separate calculation (the results of which are not shown in a table), for Viet Nam, current-year inflation estimates were, on average, above outcomes by almost 5 percentage points. This is largely explained by the gross overestimation of inflation in 2 years, 1990 and 1991—improved supply conditions in 1991 helped lower inflation in that year. Indonesia's current-year inflation forecasts, on the other hand, were underpredicted on average by 3 percentage points—largely driven by the failure to predict the sharp increase in prices during the Asian financial crisis and in 2005 when fuel subsidies were unexpectedly cut. In terms of the more robust measures of MAE and RMSE, it is still these two DMCs that top the list: Viet Nam's forecasts are more than three times as high as the overall MAE and RMSE of, respectively, 2.2 and 3.3 percentage points, and Indonesia's are two to three times as high.

Viewed as a whole, more than 60% of the DMCs' forecast errors are negative, suggesting a general tendency of current-year forecasts of April's *ADO* to overpredict inflation. Again this is supported by the sign test, which rejects the null hypothesis that the forecasts are more likely to underpredict inflation. The FPEs are generally low, ranging from 0.06 to 0.59, and only India and Indonesia have an FPE of more than 0.50.

The same general trend again holds even if the crisis years are removed from the analysis: the forecasts are still overestimated more than 60% of the time but the MAE, RMSE, and standard deviation are smaller.

Next-year forecasts. The same overprediction tendency is seen for next-year forecasts: April's *ADO* overestimates inflation 54% of the time on average. In addition, the MAE, RMSE, and standard deviation of next-year forecasts are higher than current-year forecasts.

April versus September forecasts

Table 4.1.3 shows, for 12 DMCs, the MAE, FPE, and standard deviation of forecast errors for GDP growth and inflation for both April and September forecasts for GDP growth and inflation. (Bangladesh and Pakistan are not included as the current fiscal year for these DMCs is ended by the time the September issue of *ADO*, the *ADO Update*, is released. The "current-year forecasts" for GDP growth and inflation published in *ADO Update* for these two DMCs are already actual growth and inflation figures.)

GDP growth

September MAEs of both current- and next-year forecast errors are overall lower than April forecast errors. This general picture also holds at a subregional level. However, slight increases of MAE in September are observed for Indonesia (current-year forecasts); and for India; Philippines; Taipei,China; and Viet Nam (next-year forecasts).

Current-year GDP growth forecasts in all DMCs except the PRC and Viet Nam have smaller variances for September forecast errors. Furthermore, the reduction in the variance between April and September is quite large. For example, the standard deviation of the current-year forecast error in Sri Lanka falls from 2.67 percentage points in April to 0.31 percentage points in September, representing an 88% reduction. Overall, the standard deviation of current-year forecast errors decreases by 60%.

The same general pattern exists for the next-year forecast errors, but it is less pronounced. For the entire sample, the September forecast has a smaller standard deviation, declining by 11% relative to April. Again, Sri Lanka posted the highest reduction in the dispersion of its forecasts, the September standard deviation being 75% lower than that of April. The larger reduction in the spread of errors in the current-year forecasts suggests that information gathered between April and September benefits the current-year forecasts more than the next-year forecasts.

As a whole, the FPE increases from April to September. This is true for both current- and next-year forecasts. Although GDP growth forecasts are generally underpredicted (as shown by an FPE above 0.50, regardless of whether current- or next-year, and date of reporting), this underprediction becomes more pronounced when figures for the first half of the year are known. No obvious explanation exists for this.

Inflation

MAEs for the September release of inflation forecasts are smaller than in the April release. This is true irrespective of subregion and whether a current- or next-year forecast. Of the 12 DMCs evaluated, only India posted a slight increase in the September MAE of its next-year forecasts.

In general, additional information gathered between April and September helps the accuracy of the forecasts. The improvement, as measured by the reduction in MAE, is more pronounced in current- than next-year forecasts. A larger reduction of the MAE is observed for inflation forecasts than GDP growth forecasts. This may be because GDP is harder to predict, as it is determined by a host of factors and is a lower frequency variable than inflation.

4.1.3 Descriptive statistics for forecast errors, April and September issues of *ADO*, 2000–2006

	Mean absolute error (percentage points)		Standard deviation (percentage points)		Fraction of positive errors	
	April	Sep	April	Sep	April	Sep
			GDP growth			
Current-year forecast	**1.39**	**0.75**	**1.99**	**0.80**	**0.71**	**0.78**
East Asia	**1.51**	**0.81**	**2.16**	**0.77**	**0.64**	**0.82**
China, People's Rep. of	1.71	1.14	0.57	0.66	1.00	1.00
Hong Kong, China	2.19	1.03	2.62	0.66	0.71	1.00
Korea, Rep. of	0.73	0.63	1.03	0.73	0.43	0.71
Taipei,China	1.43	0.46	2.84	0.60	0.43	0.57
South Asia	**1.59**	**1.14**	**2.23**	**1.23**	**0.71**	**0.86**
India	1.51	1.30	1.92	1.62	0.57	0.71
Sri Lanka	1.66	0.92	2.67	0.31	0.86	1.00
Southeast Asia	**1.25**	**0.72**	**1.81**	**0.69**	**0.76**	**0.83**
Indonesia	0.69	0.71	0.72	0.69	0.86	0.86
Malaysia	1.56	0.60	2.34	0.64	0.71	0.71
Philippines	0.61	0.43	0.73	0.52	0.86	0.71
Singapore	2.73	1.24	3.61	1.05	0.57	0.86
Thailand	1.26	0.71	1.60	0.54	0.57	0.86
Viet Nam	0.63	0.61	0.30	0.45	1.00	1.00
Next-year forecast	**2.05**	**1.76**	**2.84**	**2.52**	**0.58**	**0.64**
East Asia	**2.47**	**2.33**	**3.22**	**3.30**	**0.54**	**0.64**
China, People's Rep. of	2.07	2.00	0.42	0.44	1.00	1.00
Hong Kong, China	3.96	3.53	4.66	5.11	0.57	0.57
Korea, Rep. of	1.83	1.76	2.47	2.26	0.29	0.57
Taipei,China	2.01	2.03	3.25	3.48	0.29	0.43
South Asia	**1.69**	**1.46**	**2.57**	**1.76**	**0.50**	**0.59**
India	1.79	2.07	2.18	2.30	0.57	0.57
Sri Lanka	1.60	0.60	3.00	0.76	0.43	0.60
Southeast Asia	**1.89**	**1.72**	**2.70**	**2.46**	**0.64**	**0.67**
Indonesia	1.17	0.69	1.38	0.77	0.57	0.71
Malaysia	2.41	2.41	3.63	3.58	0.43	0.71
Philippines	0.73	0.93	1.22	1.35	0.71	0.43
Singapore	4.43	3.91	5.21	4.59	0.57	0.71
Thailand	1.81	1.53	2.25	2.12	0.57	0.43
Viet Nam	0.76	0.87	0.44	0.39	1.00	1.00
			Inflation			
Current-year forecast	**1.35**	**0.63**	**1.95**	**1.01**	**0.35**	**0.27**
East Asia	**1.11**	**0.41**	**1.05**	**0.47**	**0.21**	**0.21**
China, People's Rep. of	1.24	0.53	1.14	0.60	0.29	0.29
Hong Kong, China	1.59	0.40	0.97	0.41	0.00	0.14
Korea, Rep. of	0.67	0.24	0.76	0.26	0.29	0.14
Taipei,China	0.94	0.46	0.96	0.61	0.29	0.29
South Asia	**1.89**	**1.03**	**2.81**	**1.53**	**0.57**	**0.44**
India	1.01	0.79	1.37	1.12	0.57	0.29
Sri Lanka	2.77	1.38	3.77	1.86	0.57	0.60
Southeast Asia	**1.34**	**0.80**	**1.94**	**1.23**	**0.36**	**0.26**
Indonesia	1.66	1.41	2.37	1.97	0.29	0.57
Malaysia	0.70	0.36	0.79	0.23	0.29	0.00
Philippines	1.39	0.89	1.49	1.10	0.29	0.29
Singapore	0.51	0.24	0.50	0.20	0.14	0.14
Thailand	0.74	0.39	0.88	0.53	0.57	0.43
Viet Nam	3.03	1.50	3.91	1.90	0.57	0.14
Next-year forecast	**2.25**	**1.83**	**3.13**	**2.42**	**0.45**	**0.44**
East Asia	**1.91**	**1.40**	**2.28**	**1.56**	**0.32**	**0.25**
China, People's Rep. of	1.87	1.63	2.01	1.70	0.14	0.14
Hong Kong, China	3.13	2.14	2.99	1.67	0.29	0.00
Korea, Rep. of	0.89	0.67	1.30	0.88	0.57	0.43
Taipei,China	1.74	1.17	1.85	1.27	0.29	0.43
South Asia	**2.34**	**2.03**	**3.53**	**2.49**	**0.71**	**0.69**
India	1.09	1.66	1.42	1.89	0.57	0.57
Sri Lanka	3.60	2.56	4.51	3.11	0.86	0.80
Southeast Asia	**2.45**	**2.04**	**3.28**	**2.75**	**0.45**	**0.50**
Indonesia	4.84	3.83	4.91	4.06	0.71	0.86
Malaysia	1.44	1.11	1.43	1.17	0.29	0.29
Philippines	1.93	1.59	2.41	1.87	0.57	0.43
Singapore	0.84	0.73	1.03	0.65	0.29	0.29
Thailand	1.77	1.54	2.07	1.79	0.43	0.57
Viet Nam	3.87	3.46	4.97	4.46	0.43	0.57

Source: Staff calculations.

Further, all the standard deviations of April current-year forecast errors are higher than September's. For September revisions to the current-year estimate, the standard deviations fall by 48%. Next-year forecast errors also see a reduction.

In terms of FPE, for both April and September, the majority of forecast errors are negative, i.e., they display a tendency for inflation forecasts to be too high. This proportion is about 65–73% for current-year forecasts, and about 55% for next-year forecasts.

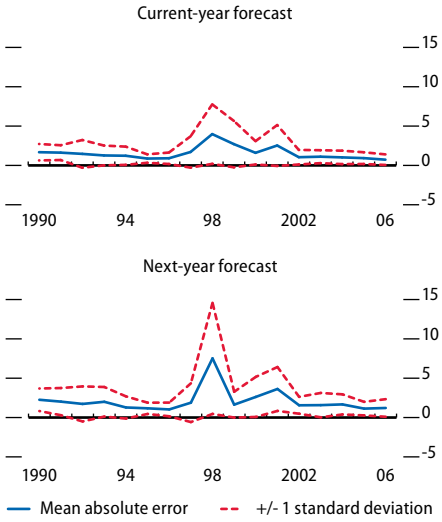
Accuracy of forecasting over time

GDP growth

Figure 4.1.1 plots the MAE of GDP growth forecasts over time. The MAE was estimated through a simple cross-sectional average of all DMCs' absolute forecast errors for each year. To ensure a similar number of DMCs across the years, only the forecasts in the April *ADO* were considered. The solid line refers to the MAE and the dashed lines to values of the absolute prediction error at less than and at more than one sample standard deviation, estimated for each year. A smaller gap between the solid line and dashed lines indicates more tightly distributed forecast errors.

Forecast accuracy for GDP growth appears to have gradually improved over time (if one ignores the sharp rise in forecast errors in the crisis years). Not only are forecast errors declining, but they have also been characterized by lower variance in recent years.

4.1.1 Mean absolute error of GDP growth forecasts, April issue of *ADO* (percentage points)



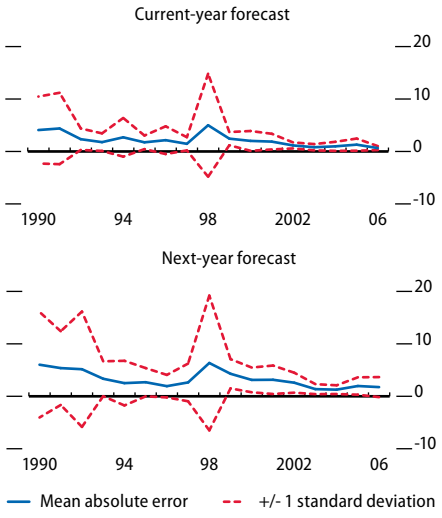
Source: Staff calculations.

Click here for figure data

Inflation

A similar exercise was undertaken for inflation. As shown in Figure 4.1.2, MAEs of current- and next-year forecasts have declined in recent years. This would indicate greater forecast accuracy after the crisis years, and even better than the quality of forecasts prior to the crisis. The trend of the RMSE also improves (Figure 4.1.3). For inflation, a large part of the improvement in overall forecast accuracy is due to the substantial decrease in the forecast errors for Bangladesh, PRC, Indonesia, Sri Lanka, and Viet Nam.

4.1.2 Mean absolute error of inflation forecasts, April issue of *ADO* (percentage points)



Source: Staff calculations.

Click here for figure data

Improved forecast accuracy

The progress in forecast quality is attributable not only to learning effects but also to the gradual stability seen in the overall macroeconomic environment, and access to higher-quality data. Recent years in developing Asia have been characterized by stable growth, as well as lower average inflation. Improvements in national statistical systems in several DMCs have also increased timely access to more reliable macroeconomic data.

Growth and turning points

Earlier sections assessed the quality of forecasting by the *size* of prediction errors. This section assesses quality in terms of the accuracy of prediction about the *direction of change*. In the case of growth,

a good forecast should be able to discriminate between a positive change in growth (or acceleration) and a negative change in growth (or deceleration). This test is relevant as some short- to medium-term business decisions are influenced by expectations of whether the immediate macroeconomic outlook is better or worse than current conditions.

Pooling data across years and DMCs reveals that the April issue of *ADO* has correctly predicted the direction of current-year GDP growth forecasts for about 70% of the time since 1990; for next-year forecasts, the corresponding figure is 64%. These statements are true even if the crisis years are excluded from the evaluation. Accuracy of directional forecast tends to be negatively associated with the pace of growth (Figure 4.1.4).

The strength of a forecast to discriminate between an acceleration and a deceleration may also be measured by applying the Hansen-Kuiper's discriminant score (HK), defined here as: HK = A(g) – FA(g), where A(g) is the proportion of accelerations (including no change in growth) that have been correctly forecast to occur, while FA(g) is the proportion of decelerations that have been falsely forecast. It ranges between "-1" and "1." A score of 1 indicates perfect forecasting, while "-1" means that all forecasts are incorrect. Referring to Table 4.1.4, A(g) is computed as $A_R/(A_R+A_W)$ while FA(g) is estimated as $D_W/(D_W+D_R)$.

4.1.4 Contingency table for actual and predicted outcomes

		Actual	
		Acceleration	Deceleration
Predicted	Acceleration	A_R	D_W
	Deceleration	A_W	D_R

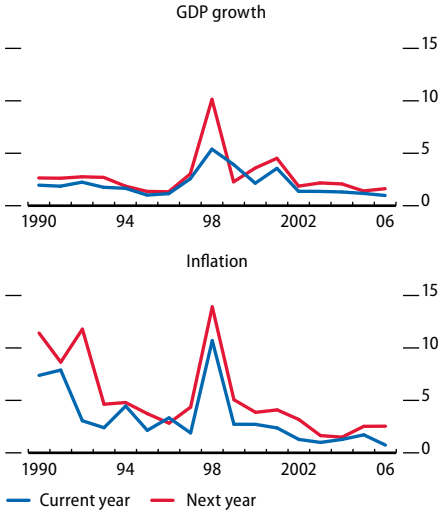
The HK has a desirable property: forecasts that uniformly predict only a single outcome, say a good event, will score zero, provided that there is at least one bad event. Thus, a forecast that predicts acceleration throughout will have an A(g) equal to 1, but also an FA(g) equal to 1, and thus an HK that is equal to 0. However, if events of only one kind occur and they are correctly predicted, the HK score will be 1. Results are shown in Table 4.1.5. Not surprisingly, current-year forecasts perform better on the HK test than next-year forecasts. Except for South Asia (i.e., India and Sri Lanka), September forecasts do better than those in April. Generally, predictions are best for East Asia. Although the accuracy of the

4.1.5 Hansen-Kuiper's discriminant score, GDP growth, April and September issues of *ADO*

	All	East Asia	South Asia	Southeast Asia
April issue				
Current year: 1990–2006, 2000–2006	0.45, 0.48	0.59, 0.60	0.50, 0.25	0.34, 0.47
Next year: 1990–2006, 2000–2006	0.28, 0.27	0.32, 0.27	0.34, 0.25	0.22, 0.26
September issue				
Current year: 2000–2006	0.63	0.72	0.38	0.64
Next year: 2000–2006	0.28	0.30	0.13	0.32

Source: Staff calculations.

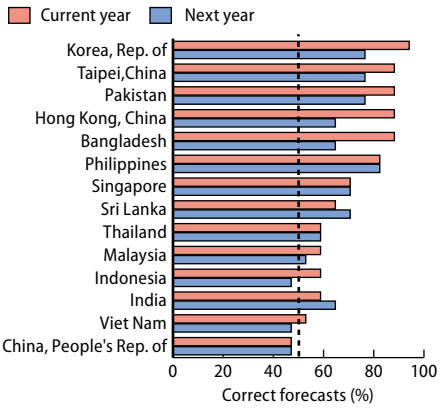
4.1.3 Root-mean-square error of GDP growth and inflation forecasts, April issue of *ADO* (percentage points)



Source: Staff calculations.

Click here for figure data

4.1.4 Accuracy of direction of GDP growth, April issue of *ADO* (percentage points), 1990–2006



Source: Staff calculations.

Click here for figure data

direction for predicted GDP growth is relatively weak for the PRC, it is quite good for Hong Kong, China; Republic of Korea; and Taipei,China.

Using a contingency table, tests of association between predicted and actual growth can be conducted. Table 4.1.6 reports two types of measures—the Pearson chi-square test and phi coefficient—applied on GDP growth current- and next-year forecasts over the period 1990–2006. Results of the chi-square test reject the null hypothesis of no association between predicted and actual growth. To examine the type and degree of association, the phi coefficient is used here. It is a special case of the correlation coefficient applied to binary variables, ranging from +1 (positive association) to -1 (negative association). The phi coefficients again show a stronger positive correlation between forecast and actual growth in current- than next-year forecasts.

The current-year phi coefficient (not shown) for East Asia, at 0.60, is also higher than those for South Asia (0.50) and Southeast Asia (0.35), suggesting better forecast quality in East Asia (at least on this measure).

4.1.6 Tests of association, GDP growth, April issue of *ADO*, 1990–2006

		Actual					
		Current-year			Next-year		
		Accel.	Decel.	Total	Accel.	Decel.	Total
Predicted	Acceleration	82	50	132	86	46	132
	Deceleration	18	88	106	39	67	106
	Total	100	138	238	125	113	238
	Pearson chi-square			49.17			18.96
	P-value for Pearson chi-square			0.00			0.00
	Phi coefficient			0.45			0.28

Source: Staff calculations.

ADO and Consensus Economics forecasts

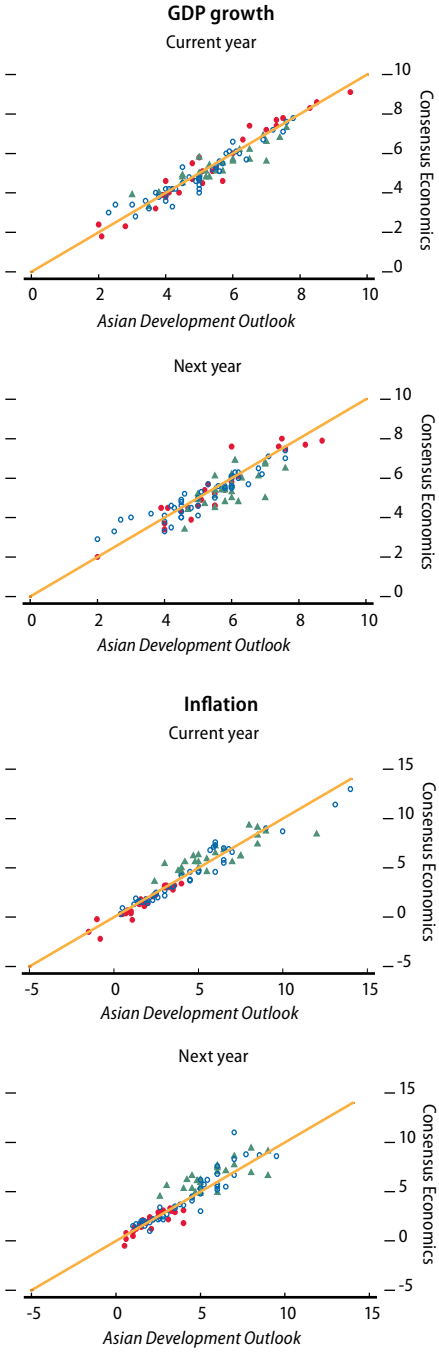
A comparison of the April issue of *ADO* and Consensus Economics forecast errors suggests that *ADO* has a better track record on growth (especially in South Asia) but Consensus Economics performs slightly better on inflation (particularly East Asia and Southeast Asia; Table 4.1.7). However, there is little statistical significance in these differences, and it is not possible to trace directly the reasons for them. Consensus Economics forecasts seem to fare better for DMCs with deeper financial markets and for monetary rather than real variables.

The apparent lack of significant differences between *ADO* and Consensus Economics forecasts may be observed from Figure 4.1.5. Most of the scatter points lie very close to the 45° line, showing a fairly high level of correlation between the two sets of forecasts. This is most evident in current-year GDP forecasts.

Conclusions

Even with the expanded dataset (from nine to 14 DMCs) and use of additional statistical tests, findings similar to those in *ADO 2006 Update*

4.1.5 April *ADO* and Consensus Economics forecasts (%), 2000–2006



Sources: Consensus Economics Inc., *Asia Pacific Consensus Forecasts*, various years; staff calculations.

Click here for figure data

4.1.7 Average differences between April *ADO* and Consensus Economics forecasts (percentage points), 2000–2006

Indicator	All		East Asia		South Asia		Southeast Asia	
Growth								
Average difference in mean absolute errors								
Current year: F_{ADO} - $F_{Consensus}$	-0.05	(-0.74)	0.12	(0.76)	-0.25	(-3.29)***	-0.01	(-0.17)
Next year: F_{ADO} - $F_{Consensus}$	-0.00	(-0.00)	0.16	(1.41)	-0.14	(-1.30)	0.00	(0.03)
Inflation								
Average difference in mean absolute errors								
Current year: F_{ADO} - $F_{Consensus}$	0.07	(0.95)	0.27	(3.08)***	-0.43	(-3.04)**	0.26	(2.64)**
Next year: F_{ADO} - $F_{Consensus}$	0.02	(0.17)	0.23	(1.85)*	-0.17	(-0.70)	0.03	(0.20)

Note: ***, **, and * indicate that the average differences are significant at 1%, 5%, and 10%, respectively. A negative coefficient means that the *ADO* forecast has a lower mean absolute error than the Consensus Economics forecast. Values in parentheses are t-statistics.

Source: Staff calculations.

emerge. First, there is a tendency for *ADO* to underpredict growth and overpredict inflation. Second, forecast accuracy has improved over time.

Other points are salient. *ADO* has a fairly high level of accuracy, not only in terms of predicting the magnitude of change, but also in terms of forecasting the direction of change. Still, forecast accuracy tends to vary across DMCs as well as subregions. Accuracy has also been—and is likely to remain—susceptible to shocks.

Endnote

1 The main *ADO* appears in March or April, and the *Update* in August or September. For the sake of simplicity, April and September are used.

Estimating subregional and regional growth for developing Asia

In estimating subregional (e.g., East Asia) and regional (i.e., developing Asia) gross domestic product (GDP) growth, it is necessary to use weights to properly account for the contribution of countries to overall regional performance. In this aggregation, country income measured in domestic currency must be converted to common units. A choice has to be made whether to use market exchange rates; some kind of adjusted exchange rate, e.g., the World Bank Atlas method; or purchasing power parity (PPP) rates.

In its early publications, *Asian Development Outlook* derived its subregional and regional averages using current US dollar exchange rates. But after the financial crisis in 1997–98 as devaluations of currencies continued, *ADO* shifted to the Atlas method to smoothen the abrupt changes associated with the rapid movement of Asian currencies.

This technical note explains the two most frequently used weighting systems in cross-country comparisons of economic size and growth—the World Bank Atlas method and the PPP approach—and illustrates how their use can influence the calculation of averages. These measures are usually applied to the gross national income (GNI) of economies, so that the rankings or the relative economic size of economies reflect all facets of income earned domestically and abroad.

World Bank Atlas method

While using current market exchange rates is straightforward, it is an unsatisfactory solution for international comparisons because of possible volatility of market exchange rates and cross-country inflation rates. For instance, their use will depress estimates of those economies experiencing large depreciations even though domestic purchasing power may change by much less. The Atlas method reduces these fluctuations and modulates impacts on estimates of economic size and growth. The World Bank's official estimates of countries' relative economic sizes are based on GNI, which is converted to US dollars, using the Atlas method.

The Atlas conversion factor (ACF) is the average of a country's exchange rate for a given year and its exchange rates for the 2 preceding years, adjusted for the difference between the rate of inflation in the country and the G5 economies.[1] A country's inflation rate is measured by the change in its GDP deflator, while that for the G5, also called "international" inflation, is measured by the change in their special drawing rights (SDR) deflators.

The SDR deflator is calculated as the weighted average of the G5 economies' GDP deflators in SDR units. Country deflators are first expressed in SDR units with each country's SDR weight used for

aggregation. The SDR deflator is then converted to US dollars using the $/SDR Atlas conversion factor (the simple average of the actual $/SDR exchange rate for year *t*, and the inflation-adjusted $/SDR exchange rates for years *t-1* and *t-2*).

The ACF is then applied to a country's GNI to get the GNI in US dollars. The ACF, e^*, for year *t* is calculated as follows:

$$e_t^* = \frac{1}{3}\left[e_{t-2}\left(\frac{p_t}{p_{t-2}} / \frac{p_t^{S\$}}{p_{t-2}^{S\$}} \right) + e_{t-1}\left(\frac{p_t}{p_{t-1}} / \frac{p_t^{S\$}}{p_{t-1}^{S\$}} \right) + e_t \right]$$

where, e_t = annual exchange rate or domestic currency per dollar, p_t = the GDP deflator, and $p_t^{S\$}$ = the SDR deflator in dollars.

This formula implies that if domestic and international price deflators move in perfect synchronization, the Atlas deflator is just the unweighted average of the current and past 2 years' exchange rates. However, if domestic inflation is faster than international inflation over comparable periods, the weighted average of the historical market exchange rates is raised to reflect the fact that there has been an erosion of domestic purchasing power relative to the international benchmark. A higher ACF reduces a country's GNI in US dollars; a lower ACF, reflecting higher international inflation or an appreciation of the domestic currency relative to the dollar, increases it.

Taking the ratio of a country's GNI in US dollars to total regional GNI gives the country's weight, w_i. The weighted GDP growth for the region or subregion is then computed using the following formula:

$$g_j = \sum_{i \in j} g_i \left[\frac{w_i}{\sum_{k \in j} w_k} \right]$$

where, g_i = growth rate of country *i*, *k* = subregion, and *j* = region.
The World Bank publishes Atlas-based GNI data on a regular basis. For most countries, the GNI data can be downloaded from the *World Development Indicators* online database.

Purchasing power parity method

An alternative approach in converting income from national currencies into a common currency is the PPP method. This is useful for aggregating real expenditures into regional and subregional totals because it eliminates the relative price distortions between traded and nontraded goods inherent in conversions using market exchange rates.
PPP is defined as the number of units of a country's currency that is required to buy the same amount of goods and services in another country. PPPs are expressed in terms of a "numeraire" currency, usually US dollars and presented either in terms of values expressed in the common currency or as an index with the common currency equal to 100. The choice of a numeraire currency does not affect the relative parities of volume and prices across economies.

PPP numbers are not available on a yearly basis, because special

and benchmark International Comparison Program price surveys are only conducted at about 3- to 5-year intervals, depending on the region. PPP estimates for nonbenchmark years are therefore extrapolated or estimated, based on the latest benchmark year.

As with Atlas-based GNI data, the World Bank publishes PPP-based GNI estimates through the *World Development Indicators* online database.

Comparing economic size and regional growth estimates

Atlas- and PPP-converted GNIs provide better estimates of economic size and computations of growth than do market exchange rates because of the volatility inherent in exchange rates and the changes in the relative price levels between countries. The Atlas method damps variability caused by fluctuations in exchange rates, while the PPP method eliminates the effects of differences and changes in relative price levels. Though better conversion factors than simple market exchange rates, they are not perfect.

For the Atlas method, results may still be distorted if exchange rates change rapidly. The PPP method, on the other hand, is based on surveys, hence subject to sampling errors and estimation problems, particularly on services that may have a large nonmarket component. PPP estimates for nonbenchmark years use the nearest sample period, and so may not be reflective of the actual PPP for the year. For countries not covered in PPP surveys, estimates are imputed using statistical models, and as such are prone to error.

The GNI of developing countries measured in PPP terms will generally exceed their GNI measured using the Atlas method, reflecting productivity differentials between high- and low-income countries. In a high-productivity country, high wages lead to high prices of services and other nontraded goods, whereas in a low-productivity country, low wages produce low prices. The low prices of nontraded goods in developing countries boost GNI in PPP terms, but not using the Atlas conversion factors.

4.2.1 Top 10 economies based on GNI shares (% of total regional GNI), 2006

PPP method		Atlas method	
China, People's Rep. of	50.6	China, People's Rep. of	43.6
India	21.4	India	15.3
Korea, Rep. of	6.1	Korea, Rep. of	14.7
Indonesia	4.7	Indonesia	5.4
Thailand	3.1	Hong Kong, China	3.7
Philippines	2.6	Thailand	3.4
Pakistan	2.1	Malaysia	2.4
Bangladesh	1.8	Singapore	2.3
Malaysia	1.5	Philippines	2.1
Viet Nam	1.4	Pakistan	2.1
Total	95.3	Total	95.0

Note: PPP estimates exclude Afghanistan; Bhutan; Cook Islands; Maldives; Marshall Islands; Palau; Taipei,China; Timor-Leste; and Tuvalu. Atlas estimates here exclude Taipei,China.

Sources: World Bank, *World Development Indicators* online database; *Asian Development Outlook* database.

Economic size

Comparing GNI data based on the Atlas and PPP methods confirms the difference in rankings. Table 4.2.1 shows the top 10 economies in terms of size (excluding Taipei,China), for each method. The People's Republic of China (PRC), India, Republic of Korea (Korea), and Indonesia are in the top four spots for both approaches, but rankings for Hong Kong, China; Philippines; and Thailand are more sensitive. Other country differences are also apparent.

Subregional and regional growth

These variations in weights result in different estimates of GDP growth for regional and subregional aggregates (Table 4.2.2). Growth estimates are higher under PPP because the PRC and India have higher PPP shares than Atlas shares and their growth rates are among the fastest in the region (Figure 4.2.1). Estimated regional growth in 2006, excluding Taipei,China, was 9.4% in PPP terms compared with only 8.5% using the Atlas method. (This difference is not sensitive to the inclusion of Taipei,China in the Atlas calculations.)

At the subregional level, the most significant differences are for East Asia. This is because of the larger weight given to rapidly growing PRC and a reduction in the weight for Korea, where growth is moderate.

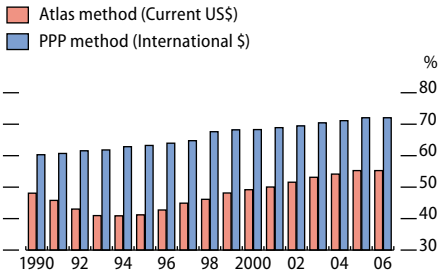
4.2.2 Subregional and regional GDP growth (%)

	2002	2003	2004	2005	2006
Atlas method (current $)					
Central Asia	8.7	9.4	9.8	11.1	12.4
East Asia	7.5	7.3	8.4	8.3	9.0
South Asia	3.7	7.8	7.4	8.7	8.8
Southeast Asia	4.8	5.3	6.4	5.6	6.0
The Pacific	0.4	1.8	3.6	2.6	2.6
Developing Asia	6.4	7.1	7.9	8.0	8.5
PPP method (current international $)					
Central Asia	8.6	9.1	9.6	11.3	12.7
East Asia	8.6	9.0	9.5	9.7	10.4
South Asia	3.7	7.9	7.4	8.7	8.9
Southeast Asia	4.9	5.6	6.3	5.6	5.9
The Pacific	0.7	0.7	3.2	2.7	2.2
Developing Asia	6.7	8.2	8.4	8.9	9.4

Note: PPP estimates exclude Afghanistan; Bhutan; Cook Islands; Maldives; Marshall Islands; Palau; Taipei,China; Timor-Leste; and Tuvalu. Atlas estimates here include Taipei,China.

Sources: World Bank, *World Development Indicators* online database; *Asian Development Outlook* database.

4.2.1 Shares of PRC and India to total GNI



Source: World Bank, *World Development Indicators* online database.

Click here for figure data

Conclusions

The differences between the Atlas and PPP methods influence estimates of economic size and calculations of subregional and regional growth. The Atlas method smoothens fluctuations in income caused by changes in exchange rates, while the PPP method eliminates the effects of differences and changes in the relative price levels of goods and services.

In these growth computations, *ADO* uses Atlas-based GNI weights because the factors used in the calculation of country GNIs are more

timely, continuous, and less subject to statistical problems in aggregation procedures. With the PRC and India dominating overall GNI shares in PPP terms, the estimated growth for the region would be higher with the PPP than Atlas method.

Endnote

1 Since 2001, the G5 economies have comprised the euro zone (superseding two previous members, France and Germany), Japan, United Kingdom, and United States.

References

Asian Development Bank. 2007. "Purchasing Power Parity Preliminary Report." Economics and Research Department. A report prepared for the 2005 International Comparison Program in Asia and the Pacific. Available: http://www.adb.org/Documents/Reports/ICP-Purchasing-Power-Parity/Main-Report.pdf.

Asian Development Bank (various years). *Asian Development Outlook*. Manila.

World Bank. International Comparisons of Income website. Available http://go.worldbank.org/W51XUJ1QX0.

———International Comparison Program. Available: http://go.worldbank.org/MW520NNFK0