Cross-Country Comparison of Agricultural Performance Using Different Data Sets

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Abstract: This paper examines the consistency of two series of aggregate output data in comparing the agricultural performance of 60 developing countries. Employing two approaches that take into account the fact that deepening of intermediate goods takes place in agriculture as development proceeds, it is found that, in less than half the country cases tested, the data on gross agricultural output compiled by the US Department of Agriculture and the series on value-added in agriculture produced by the World Bank are consistent with each other and with the expectation of deepening of intermediate goods. The World Bank's aggregates provide the more optimistic reading of performance of the two series, but neither series indicates that a majority of developing countries have performed adequately in terms of the test of agricultural performance suggested by Johnston and Mellor in 1961.

Introduction

Some 30 years ago, in their classic statement on the role of the agricultural sector in economic development, Johnston and Mellor (1961) set forth a simple formula for estimating the growth of domestic demand for agricultural production as development proceeds. Their formula is:

(1) $D^* = P^* + e_y Y^*$

where D^* = the growth rate of domestic demand, P^* = the growth rate of population, e_y = the income-elasticity of demand for agricultural products, and Y^* = the growth rate of per-capita income.[2] Equation (1) provides a means of estimating demand for agricultural production across developing economies and also suggests a test of adequate agricultural performance. If the growth rate of domestic agricultural output (A^*) equals the Johnston-Mellor growth rate of demand (i.e., if $A^* = D^*$), then domestic production growth will be sufficient to leave a country's external agricultural orientation (the degree to which it is a net importer or exporter of agricultural produce) the same. This condition, which is considerably more general than the notion of self-sufficiency,[3] is denoted as Johnston-Mellor adequacy. When the Johnston-Mellor adequacy test is used to examine the agricultural performance of 84 developing economies since 1950, the results suggest that the "typical" country has failed to achieve such adequacy (Wells, 1989).

This finding depends on the accuracy of the measures of aggregate agricultural production by country used for comparison. Such measures of aggregate agricultural output are compiled by several different agencies, including the US Department of Agriculture (USDA), FAO, and, as part of its coverage of national accounts aggregates, the World Bank.

Although the sets of agricultural aggregates provided by these agencies are compiled independently, each depends ultimately on field surveys of crop and livestock activities conducted by agricultural ministries or offices of statistics of the individual developing countries. Each agency adjusts the basic data in different ways to prepare aggregate measures of agricultural output.

Questions regarding the reliability of the different series have been raised for some time and deal with the methods by which aggregates are prepared (Farnsworth, 1961), discrepancies among the major reporting sources (Paulino and Tseng, 1980; and Wells, 1988), and with the interpretation of the tenuous record of Africa's agricultural performance in the past two decades (e.g., World Bank, 1981; and Berry, 1984). Although these problems have led to some caution in the use of the data,[4] there is little alternative for those dealing with the overall record of agricultural growth in developing countries.

Recognizing these problems, the purpose in this paper is to examine the consistency of agricultural production aggregates derived from two major data sources: the USDA series and that produced by the World Bank as part of its comparative survey of national accounting aggregates. To do this, several tests are employed that recognize a fundamental conceptual difference between the two data sources: the World Bank's series records, in constant prices, the value added in the agricultural sector while the USDA series records gross agricultural output; i.e., the total value of agricultural output without deduction from intra- or inter-industry inputs.[5] The tests derive from the differences expected in estimates of both long-run growth and year-to-year fluctuations in series measuring the value added in agriculture as opposed to gross agricultural output.[6]

Deepening of Intermediate Goods and Estimates of Output over Time

The approach used derives from the well-known proposition that, as economic development proceeds, inputs to agriculture from other sectors of the economy (including agriculture) increase as a share of total output. This deepening of the intermediate goods component implies that measures of the growth of value-added in agriculture (V^*) will differ from measures of the growth of gross agricultural output (A^*).

Let V_t = value added in agriculture, in constant prices, in time t; and A_t = the value of gross agricultural output in time t, also at constant prices.[7]

Next let $v_t = V_t/A_t$. The expectation is that v_t declines over time with economic development as the weight of intermediate inputs into agriculture increases. Denoting the exponential growth rate of a variable (estimated over the time series available) with an appended (*), it is therefore concluded that:

(2) $v^* = V^* - A^* < 0$, for all cases of developing economies where $A^* > 0$

A second and more complex test employing the same concept of deepening of intermediate goods can be developed using the same notation as above, and, defining β_t as the share of intermediate inputs in A_t, gives:

(3) $V_t = A_t - \beta_t A_t + \varepsilon_t = (1-\beta_t)A_t + \varepsilon_t$, where ε_t is an error term

Reducing these to indices implies that:

$$(4)\quad V_O\frac{V_t}{V_O} = (1-\beta_t)A_O\frac{A_t}{A_O} + \varepsilon_t$$

$$(5)\quad \frac{V_t}{V_O} = (1-\beta_t)\frac{A_O}{A_O}\frac{A_t}{A_O} + \varepsilon'_t$$

Thus:

$$(6)\quad \frac{V_t}{V_O} = \frac{A_O}{V_O}\frac{A_t}{A_O} - \beta_t\frac{A_O}{V_O}\frac{A_t}{A_O} + \varepsilon'_t$$

Now, let $h(t)$ be some generalized but positive and increasing function of time and reformulate (6) as:

$$(7)\quad \frac{V_t}{V_O} = \gamma\frac{A_t}{A_O} - \eta h(t)\frac{A_t}{A_O} + \varepsilon'_t$$

The expectation is that $\gamma > 1$ and that $\eta < 0$. We are experimenting with different forms of $h(t)$ and here use the value $h(t) = (t^{\lambda} - 1)\lambda$ to estimate Equation (7).

Year-to-Year Fluctuations

The third means of comparing the USDA and World Bank data involves the consistency of year-to-year movements in output in each of the 60-country sample of LDCs. Here, it is assumed that the observed changes in output from one year to the next reflect a predicted component ($d\hat{V}_t$ or $d\hat{A}_t$) arising from returns normally expected to inputs and a variable component δ_t reflecting disturbances in the production function due to weather and other factors.

The expected change in value-added ($d\hat{V}_t$) is related to the expected change in gross agricultural output, $d\hat{A}_t$, by:

(8) $d\hat{V}_t = (1-\beta_t)d\hat{A}_t - d\beta_t\hat{A}_t$

where $d\beta_t > 0$ by deepening of intermediate goods, and the actual change in value-added, dV_t, is given by:

(9) $dV_t = d\hat{V}_t + \delta_t = (1-\beta_t)d\hat{A}_t - d\beta_t\hat{A}_t + \delta_t$

The actual change in gross agricultural output, dA_t, is given by:

(10) $dA_t = d_t + \delta_t > dV_t$, because $d\hat{A}_t > d\hat{V}_t$

Hence, we predict that when $dV_t > 0$, dA_t should also be > 0.

Preliminary Results

Selected results are presented in Tables 1 and 2 and indicate that for most of the countries, the USDA and World Bank data are inconsistent with each other given the postulate of deepening of intermediate goods in agriculture.

In Table 1, "consistent" reflects cases that meet the first and second tests and essentially reflect deepening of intermediate goods taking place. Col. 1 shows the number of country cases where Equation (7) holds at least 80 percent of the time.[8] Employing the 80-percent measure for the third (year-to-year) test, 12 of the sample of 60 pass all three tests of consistency. Four additional countries pass at least one of the long-run consistency tests—i.e., η from Equation (7) is negative and significant or υ^* is negative—as well as the short-run tests, but for at least 44 countries in the sample, the World Bank and USDA estimates exhibit neither long- nor short-run patterns of agricultural growth consistent with being taken from the same data series in a case where deepening of intermediate goods is occurring.

Although the results of the first and second tests are highly correlated—only 4 of the 60 cases show discrepancies between these two tests—the short- and long-run tests act quite independently. About half the countries (25–33) pass the long-run test, and 31 countries pass the short-run test. The long- and short-run results vary by country so that overall only about a quarter of the sample passes both short- and long-run tests that the series are similar.

Table 2 provides an appraisal of the impact of differences in USDA and World Bank measures of agricultural performance by comparing the numbers and proportions of countries that meet various yardsticks of Johnston-Mellor adequacy used in previous study (Wells, 1989).

For the 60-country sample, the level of performance implied by the World Bank series is considerably more optimistic than that implied by the USDA series.[9] A similar result is found in another test of estimated growth rates using the USDA, FAO, and World Bank series for 13 African economies (Wells, 1988).

Table 1—Distribution of 60 Developing Countries

	$dV > 0$ and $dA > 0$		Subtotal
	≥ 80%	< 80%	
Low-income countries:			
$v^* < 0$ and coefficient b:			
Consistent[1]	(a) 4	(b) 5	9
Unclear		(c) 5	5
Not consistent	(d) 3	(e) 4	7
Subtotal	7	14	21
Lower-middle-income countries:			
$v^* < 0$ and coefficient b:			
Consistent	(f) 3	(g) 5	8
Unclear	(h) 2		2
Not consistent	(i) 6	(j) 7	13
Subtotal	11	12	23
Upper-middle-income countries:			
$v^* < 0$ and coefficient b:			
Consistent	(k) 5	(l) 2	7
Unclear	(m) 2		2
Not consistent	(n) 6	(o) 1	7
Subtotal	13	3	16
Combined total:			
$v^* < 0$ and coefficient b:			
Consistent	12	13	25
Unclear	4	4	8
Not consistent	15	12	27
Subtotal	31	29	60

Notes: The two series appear consistent when $v^* < 0$ and η (Equation 7) is significant. If one of these conditions does not hold, the country is coded "unclear," and if neither holds, the country is coded "not consistent." (a) India, Niger, Malawi, and Pakistan; (b) China, Bénin, Burkina Faso, Senegal, Tanzania, and Zaire; (c) Bangladesh, Ethiopia, Sudan, and Uganda; (d) Burundi, Kenya, and Sri Lanka; (e) Myanmar, Ghana, Sierra Leone, and Togo; (f) Jordan, Tunisia, and Zimbabwe; (g) Côte d'Ivoire, Ecuador, El Salvador, Nigeria, and Zambia; (h) Indonesia and Morocco; (i) Egypt, Paraguay, Peru, Philippines, Thailand, and Turkey; (j) Bolivia, Cameroon, Colombia, Costa Rica, Dominican Republic, Jamaica, and Nicaragua; (k) Barbados, Greece, South Korea, Panama, South Africa, and Venezuela; (l) Argentina; (m) Malaysia and Mexico; (n) Algeria, Brazil, Chile, Cyprus, Uruguay, and Yugoslavia; and (o) Trinidad and Tobago.

Table 2—Measures of Agricultural Performance: USDA versus World Bank Data

Per-Capita Growth Rates	Number of Countries		Percent	
	USDA	World Bank	USDA	World Bank
Low-income countries:				
< 0	13	14	61.9	66.7
0–0.008	7	4	33.3	19.0
0.008–0.012	0	1	0.0	4.8
> 0.012	1	2	4.8	9.5
Total	21	21	100.0	100.0
Lower-middle-income countries:				
< 0 (a)	8	10	34.8	43.5
0–0.008	10	4	43.5	17.4
0.008–0.012	2	2	8.7	8.7
> 0.012	3	7	13.0	30.4
Total	23	23	100.0	100.0
Upper-middle-income countries:				
< 0 (a)	6	3	37.5	18.8
0–0.008	4	6	25.0	37.5
0.008–0.012	0	0	0.0	0.0
> 0.012	6	7	37.5	43.8
Total	16	16	100.0	100.0
Total 60 developing countries:				
< 0 (a)	27	27	45.0	45.0
0–0.008	21	14	35.0	23.3
0.008–0.012	2	3	3.3	5.0
> 0.012	10	16	16.7	26.7
Total	60	60	100.0	100.0

Conclusions

The results are not encouraging to those who would like to use the international record of agricultural production for precise comparisons of country performance over time. The discrepancies found between the USDA and World Bank series appear to be very little associated with conceptual differences in the measures being used, and they are so numerous that the method used here does not give much promise of identifying a few country cases where the most serious inconsistencies appear. With discrepancies of one sort or another occurring in over half the country cases, little can be done to identify the source of these disparities on the basis of a few crucial country studies.

Finally, it must be noted that even results indicating far more consistency between the World Bank and USDA estimates would not necessarily imply that these estimates were correct. As budgets for the type of field work that underlies good agricultural reporting are cut in Third-World countries and in the international agencies that have in the past supported development of agricultural statistics, the developers of the international statistical base must rely increasingly on indirect estimates and attempts to develop consensus estimates. That indirect methods are inadequate has long been recognized (Farnsworth, 1961), but the types of effort needed to improve the international statistical base have not received the priority in funding necessary to develop a fully reliable and useful data base.

Notes

[1]University of Pittsburgh.

[2]Throughout this paper, (*) indicates the (exponential) growth rate of a variable. Here also, e_y is presumably a pattern variable ranging (per Johnston and Mellor's initial estimates) from 0.8–0.9 in low-income countries to 0.2–0.3 in developed economies.

[3]Self-sufficiency implies that $A = D$, thus presuming that each country has no starting point in development as a net importer or exporter of agricultural product (Wells, 1989, pp. 167–169).

[4]"Needless to say, agricultural production estimates for less developed countries need to be treated with reserve, although we have confidence in the broad trends that they reveal" (Mellor and Johnston, 1984, p. 538).

[5]The FAO series also measures gross agricultural output.

[6]An alternative approach, disaggregating the production indices into their component parts and prices, is possible when comparing the USDA and FAO series (Wells, 1988) but cannot be used with World Bank data because an aggregate amount for the value added in agriculture is all that is reported.

[7]For comparability between the USDA and World Bank series, indices of V_t/V_O and A_t/A_O are used, based on $t = 0$ for 1980.

[8]That is, for 80 percent of the years where $dV_t > 0$, dA_t is also > 0. The 80-percent standard is arbitrary and can be replaced by a formal test of H_0: $d\hat{A} - d\hat{V} \leq 0$ versus H_A: $d\hat{A} - d\hat{V} > 0$.

[9]The test of whether per-capita agricultural output grows at 1.2 percent corresponds to matching the growth of demand where per-capita output is seen to be growing at 2 percent and e_y, is 0.6. The 0.8-percent per-capita growth corresponds to expected demand growth if per-capita income is growing at 1 percent in a country where e_y is 0.8. The assumption of deepening of intermediate goods would imply that A^* is expectedly greater than V^*, but we have no basic estimates of v^* to allow us to convert the World Bank's V^*s into corresponding A^*s.

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Discussion Opening—*Habibullah Khan* (National University of Singapore)

Maeshiro and Wells illustrate the age-old problem of inconsistency in economic data. Although the main focus of the paper is on agricultural statistics, various issues pertaining to economic data limitations are relevant to the discussion.

Ever since empirical research in economics began, there has been concern about the lack of precision in economic statistics and the consequences for the validity of econometric forecasts. About 40 years ago, Morgenstern raised serious doubts about the quality of many economic data series and asked whether such data were good enough for the purposes for which economists and econometricians were using them. He viewed errors in economic statistics as an expression of imperfection and of incompleteness in description and claimed that such errors might come from at least eight different sources.

There has been very little coherent response to Morgenstern's criticisms. Only recently, the Harvard econometrician Griliches made a thorough examination of economic data problems and gave four responses to Morgenstern's criticisms: (1) The data are not as bad as suggested. There has been significant progress both in the quality and quantity of the available data in the past decades. (2) The data are poor, but it does not matter. Empirical economists have over generations adopted the attitude that having bad data is better than having no data at all, that their task is to learn as much as possible about how the world works from these available poor data. (3) The data are bad, but we have learned how to live with them and adjust for their foibles. (4) The data available are all there are.

I am inclined to adopt a similar attitude towards economic data as Griliches. The paper under review has unnecessarily expressed pessimism about the quality of agricultural data and their future improvement. The finding that, in less than half the country cases, the two sets of output data (USDA versus World Bank) are consistent with each other is not surprising at all. First of all, the result is based upon the so-called "deepening of intermediate goods" hypothesis, which is yet to be firmly established. Because of complexities in the nature of the development process, any generalization in economic development is bound to be tentative. Secondly, the agricultural data are likely to contain relatively more errors due to well-known factors such as presence of large-scale subsistence farming, illiteracy of rural population, fluctuations caused by climatic or natural factors, and so on.

Finally, in order to reduce the sensitivity of the results to data errors, multiple indicators of agricultural performance should be used, rather than a single output indicator. This would make the estimated results much more stable.

[Other discussion of this paper and the authors' reply appear on the following page.]

General Discussion—*Sophia Wu Huang, Rapporteur* (US Department of Agriculture)

In response to the opener's question about the use of the difference between procurement price and export price to represent an *ad valorem* export tax, Chishti and Schmidt replied that the average ratio between procurement and export prices has been 0.47, which means that 53 percent of the export price has been going to the government while only 47 percent to the farmers. This is an export tax and not just handling and transport charges; according to rough estimates, handling and transport charges may range from 5 to 8 percent of the export tax amount. Regarding the validity of large country assumption, Basmati rice is a distinct rice variety with special aroma and good cooking quality. Basmati rice is usually sold at a price three times that of IRRI rice, while its export price has been more than three times of and twice that of Thai rice (5 percent broken) and US long-grain rice (Zenith No. 2), respectively. Thus, Basmati rice has a special edge over the other rice varieties; and it would be inappropriate if a small country assumption were used for its export demand. The opener's impression of using price as the only explanatory variable is incorrect. The demand and supply functions were fully specified, but the detailed specification could not be given in the paper due to the page limitation. The basic diagnostic statistics could not be given for the same reason. Regarding a question about the significance of the coefficient of export price of world demand for Pakistani Basmati rice, the coefficient is significant at the 5-percent level.

In response to the opener, Maeshiro and Wells agreed that he correctly invokes Morgenstern's curse and the antidote for it from Griliches to defend them from the charge that economic data are meaningless. Their intent is not to express Morgenstern-like shock as much as to ask where discrepancies in the data make a serious difference to the reading of performance. Their standards are fairly forgiving. They are dealing with directions of change over a 25-year period; so the 50 percent or so of inconsistences do indicate problems. They feel that deepening of intermediate goods is virtually received doctrine—it amounts to saying little more than that the proportion of fertilizer, chemical, etc. inputs to output increases over time. In reply to comments on the inconsistency between FAO and World Bank data series, they reply that the inconsistency is caused by factors such as different national offices collecting data, different handling of subsistence estimates, and different data coverage. As budgets for data collection are reduced, the agencies are forced to resolve inconsistencies via consensus estimates. Even perfect consistency would not allow the assumption of truly reliable data.

Participants in the discussion included N. Alexandratos (FAO), P. Dixit (US Department of Agriculture), H. Tsujii (Kyoto University), and C.L.J. van der Meer (Agricultural Research Council, Netherlands).