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Cross-Regime Tests of the Lucas Supply Function in Developing Countries

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Abstract

The paper assesses the empirical relevance of the Lucas supply function for developing countries. The prediction of Lucas' model that the short-run effects of monetary disturbances on real output are negatively related to the variability of such disturbances is tested for a large sample of developing countries using distribution-free statistical methods. The negative relationship seems to be a robust feature of developing country data, and holds true for almost all of the analytical subgroups examined.

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Table of Contents

Summary

This paper presents further international evidence on the output-inflation tradeoff implied by Lucas' model of the Phillips curve. Lucas has argued that a Phillips curve relating output to unexpected inflation can be derived from models in which there are rational expectations, competitive markets, and imperfect information. His model postulates that the individual's economic decisions depend on relative prices but that economic agents cannot always distinguish between contemporaneous relative and general price movements because of imperfect information. Given the possibility of confusion between aggregate and relative price changes, an increase in monetary growth will cause an increase in output to the extent that agents attribute part of the observed price change to a change in relative prices. An implication of the model is that in countries that have erratic monetary growth, agents are likely to attribute price increases to general inflation rather than to relative price shifts, so that money supply increases will not cause large fluctuations in output. In this respect, differences in the variability of monetary growth among different countries could explain differences in the responsiveness of output to unanticipated monetary growth.

This paper attempts an assessment of the empirical relevance of the Lucas supply function for developing countries by testing the model's prediction that the short-run effects of monetary disturbances on real output are negatively related across policy regimes to the variability of such disturbances. Although this issue has been examined previously for cross-country samples that included developing countries, this paper extends the analysis by focusing exclusively on a large sample of developing countries and employing distribution-free statistical methods to test the statistical significance of the relationship. The large sample size makes it possible to test the robustness of the results by examining whether the key relationship that is tested continues to hold within various analytical subsamples.

The central implication of the Lucas supply hypothesis that the variance of unanticipated demand disturbances is negatively related to the peak impact of such disturbances on real output is strongly supported by the data. This negative correlation shows up in simple and rank correlation coefficients, and proves to be statistically significant in the Mann-Whitney tests. The negative relationship seems to be a robust feature of developing country data, and holds true for almost all of the analytical subgroups examined.

Although the empirical tests in this paper provide strong support for the Lucas supply function, they do not exclude other explanations. Alternative hypotheses, including a tendency toward shorter nominal wage contracts, or greater prevalence of indexing in the presence of greater variance of aggregate monetary disturbances, may also be consistent with the observed relationships. Nonetheless, the empirical results provide useful information regarding the short-run tradeoff between inflation and output, which is an extremely important issue for the formulation of macroeconomic policy in developing countries.

A large number of developing countries have experienced very high rates of inflation. 1/ In the presence of nominal rigidities, such rates of inflation are likely to introduce relative price distortions, resulting in inefficiencies which impede medium-term real output growth. However, an important constraint on the implementation of anti-inflationary aggregate demand policies is that such policies could entail significant short-run real output losses. The nature of the short-run tradeoff between output and inflation is thus an extremely important issue for the formulation of macroeconomic policy in developing countries.

Macroeconomic models that embody the assumptions of rational expectations and continuous market clearing--i.e., "new classical" models--generate a positive relationship between unanticipated price movements and deviations of real output from its capacity level. However, changes in the price level which can be foreseen do not give rise to such deviations. Many new classical models rely on the "Lucas supply function" to generate these results. According to Lucas (1973), the key nonneutrality which permits monetary shocks to cause deviations of output from capacity levels is the existence of an information lag. Production takes place in localized markets in response to movements in relative prices, i.e., the local price relative to the aggregate price level. However, agents in the local markets cannot observe the current aggregate price level. Their information set consists of the history of the economy and the currently prevailing local price. They therefore face a signal-extraction problem, needing to infer the aggregate price level from their knowledge of the past and their observation of the current local price. Output will deviate from normal in each market to the extent that the local price observed by agents differs from their expectations of the aggregate price level, so that agents believe that a relative price change has taken place. Since only unanticipated aggregate demand shocks can be misperceived as affecting relative prices, this explains the neutrality of real output with respect to systematic stabilization policies. These models have the important policy implication that a credible and well-understood anti-inflationary aggregate demand policy should succeed in reducing the rate of inflation at minimal cost in terms of foregone real output. If such models prove to be empirically relevant to developing countries, therefore, the pain associated with taking the anti-inflation medicine may be minimized by the adoption of a well-articulated believable package of restrictive policy measures.

One way to test the empirical relevance of such models in developing countries is to use time series data for individual countries to estimate reduced-form output equations which distinguish the effects of anticipated and unanticipated aggregate demand shocks, following Barro

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1/ It should be noted that the term "country" used in this report does not in all cases refer to a territorial entity that is a state as understood by international law and practice.

(1978). Such tests have been conducted, with mixed results, by Barro (1979), Hanson (1980), Edwards (1983a, 1983b), and others. An important problem with this methodology is that, during any given sample period and policy regime, the data may be unable to discriminate between classical and nonclassical models in the absence of overidentifying restrictions which are not intrinsic to the hypotheses being tested. 1/

An alternative procedure is to test the Lucas supply function directly using the properties of the solution to the signal-extraction problem faced by agents. As Lucas (1973) shows, the responsiveness of output to unanticipated price changes is predicted by his model to be inversely related to the variability of the unanticipated component of aggregate demand. This relationship can therefore be tested with data drawn from different policy regimes. A natural application is to a cross-section of countries, as pioneered by Lucas (1973).

This paper attempts an assessment of the empirical relevance of the Lucas supply function for developing countries by testing the relationship described above for a large cross-section of such countries. Although this issue has been examined previously for cross-country samples that included developing countries (see Section I), this paper differs from previous studies in three important ways. We attempt to overcome the shortcomings of earlier studies by using distribution-free statistical methods. Distribution-free statistical methods are used to test the statistical significance of the observed relationship between the variance of unanticipated demand shocks and the slope of the output-inflation tradeoff. Previous studies have relied on less systematic inspection of the data. Furthermore, our sample consists only of developing countries. Previous authors have not conducted cross-regime tests for this subset of their data. Finally, we make use of the World Economic Outlook data file maintained by the International Monetary Fund, which enables us to expand greatly the number of developing countries included in our sample, relative to previous studies. Our sample consists of 128 countries, with underlying relationships estimated over the period 1965-85. Due to the size of our sample, we are also able to test the robustness of our results by examining whether the key relationship we are testing continues to hold within various analytical subsamples.

The rest of the paper is organized into four sections. The next section briefly reviews previous work on the Lucas supply curve. Section II discusses the results of estimating money growth equations and real output equations. Section III reports the test of the hypothesis that unanticipated demand variability is inversely related to the responsiveness of output to unanticipated price changes. Section IV summarizes the principal results and offers some conclusions.

1/ See the discussion of the Barro-Rush paper in Fischer (1980).

I. Previous Work on the Lucas Supply Curve

Lucas' (1973) formulation of the aggregate supply function led him to specify a reduced-form real output equation of the form:

$$(1) \quad Y_{ct} = -\pi\delta + \pi\Delta X_t + \lambda Y_{c,t-1},$$

where Y_{ct} is the deviation of the logarithm of real GNP from a linear trend, ΔX_t is the change in the logarithm of nominal GNP, and π, δ, and λ are positive parameters. The parameter π measures the share of the change in nominal GNP which takes the form of a change in real output. The larger π, the more responsive is real output to an unanticipated change in demand (nominal GNP was modeled as a random walk process by Lucas). The solution of agents' signal-extraction problem implies that π should be inversely related to σ_x^2, the variance of the unanticipated aggregate demand shock ΔX_t.

Lucas tested this hypothesis for a sample of 18 countries, including six developing countries. He estimated equation (1) for the period 1951-67 and calculated σ_x^2 for each country during this period. He found that two countries (Argentina and Paraguay) exhibited much higher variance of ΔX_t than the remaining countries in his sample and that the estimates of π for these countries were much smaller than those for the more stable countries, in conformity with his hypothesis. Lucas did not investigate the relationship between σ_x^2 and π within the group of stable countries.

Froyen and Waud (1980) tested a slightly modified version of Lucas' model for ten industrial countries. They utilized both cross-section data (based on estimates of π and σ_x^2 over the period 1956-76) and intra-country comparisons derived by splitting the sample period for each country at 1967. Based on estimated correlation coefficients, they found no general support for an inverse relationship between σ_x^2 and π. They did, however, find evidence consistent with a negative correlation between π and the variance of the price level, which supports the informational assumptions in Lucas' model. Their results, however, led them to emphasize the role of supply, rather than demand, shocks for their sample.

Alberro (1981) extended Lucas' work to a much larger sample of countries. He examined a group of 49 countries (including 31 developing countries) for the period 1953-69. This sample included a total of six countries with highly variable rates of nominal income growth. Alberro concluded that an inverse relationship between σ_x^2 and π was indeed present in his data by examining a scatter diagram between these two variables.

The preceding studies all estimated equation (1) as initially formulated by Lucas. Parkin, Bentley and Fader (1981) modified Lucas' model substantially to take into account the openness of the economies under study, producing different versions of the output equation (1) for fixed and flexible exchange-rate regimes. The authors tested their model for a sample of 21 countries, consisting of the 18 countries examined by Lucas plus three additional countries. Their data covered the period 1953-78. They concluded that "the way we have modelled economic openness does not seem to have produced a dramatic improvement over Lucas' simpler formulation" (p. 148). Overall support for their model is weak, and the cross-regime predictions of their model do not meet with strong empirical success.

These conclusions are supported in an extensive study by Ram (1984). A sample of 79 countries (including 60 developing countries) with data for the period 1960-78 was used to test the models of both Lucas and Parkin, Bentley and Fader. Using a nonlinear estimation technique to take account of serial correlation in the residuals in the presence of a lagged dependent variable, Ram found that the two models fit the intracountry data about equally well. However, rank correlation tests provided much stronger support for the cross-regime implications of the Lucas model than for those of the more elaborate model of Parkin et al.

The most important recent study for our purposes is that by Kormendi and Meguire (1984). They demonstrate that finding an inverse relationship between σ_x^2 and π does not provide powerful support for the Lucas supply function, since--as long as the assumption of unitary aggregate demand elasticity is retained--this relationship is also implied by a class of models that incorporate policy-invariant Phillips curves and do not assume that expectations are formed rationally. The assumption that aggregate demand is unit-elastic is made explicitly by Lucas and permits him to treat ΔX as an exogenous variable in (1). Kormendi and Meguire drop this assumption and replace (1) by:

$$(2) \quad DY_t = \beta(L)\, RM_t + \gamma(L)\, DY_{t-1} + RY_t,$$

where RM is unanticipated money growth, DY is the growth of real output, RY_t is a random term and $\beta(L)$ and $\gamma(L)$ are lag polynomials, with $\beta(L) = \sum_{i=0}^{N_1} \beta_i L^i$ and $\gamma(L) = \sum_{i=0}^{N_2} \gamma_i L^i$, where L is the lag operator. The test of Lucas' supply function consists of examining the relationship between the variance of RM, denoted VRM, and the peak effect of an RM shock on real output, denoted χ, where $\chi = \max \{\chi_\tau\}$, $\tau = 0, \ldots N$, and:

$$\chi_\tau = \sum_{i=0}^{\tau} \beta_i .$$

This test is conducted for a sample of 47 countries including 27 developing countries, with time series of varying lengths over the period 1948-77. Kormendi and Meguire examine both the full sample containing five countries with extreme values of VRM, and the subsample of stable countries. Both scatter diagrams and rank correlation coefficients support the view that VRM and χ are inversely related, as predicted by the Lucas supply function.

II. Estimation of VRM and χ

None of the studies reviewed in the previous section focus specifically on the role of the Lucas supply function in developing countries. It is therefore unclear whether the negative association observed by many authors between the variance of unanticipated aggregate demand shocks and the responsiveness of real output to such shocks would be corroborated for subsamples consisting solely of developing countries. Our sample consists of 128 developing country members of the International Monetary Fund. No industrial countries appear in this sample, and all developing countries for which data were available at the time of the Fund's Spring 1986 World Economic Outlook exercise are included. The country-specific time series employed cover the period 1962-85. These data were compiled by Fund country desk economists in association with the World Economic Outlook exercise. They reflect country sources and Fund staff estimates. Although their quality is likely to be uneven, they have the important virtue of permitting a breadth of coverage which is not available from any other source of developing-country data.

To sharpen our test of the Lucas supply function with these data, we follow Kormendi and Meguire and do not assume unitary elasticity of aggregate demand in the countries under review. We therefore test for a negative association between the variance of unanticipated monetary growth (VRM) and the peak response (χ) of real output growth (DY) to unanticipated monetary growth (RM). For this purpose we require estimates of VRM and χ for each of our 128 countries. The results of this estimation are described in this section.

The first step in the estimation of VRM is to fit a money growth equation for each country. In view of the size of our sample, we used a parsimonious specification which was uniform across countries. Since the fitted values of these equations are intended to describe rational expectations of future money growth, the most important diagnostic statistic is the absence of serial correlation in the residuals.

Our specification of the money growth equation is slightly more general than that of Kormendi and Meguire. Barro's (1976) original formulation for the U.S. assigned an important role to fiscal deficits in explaining future monetary growth. Edwards (1983) has recently emphasized that the role of fiscal deficits in the growth of money supply is much more important in developing countries, since the absence of a domestic bond market requires that deficits be financed either through the domestic banking system or abroad. Since our sample is restricted to developing countries, we follow Edwards and specify the money growth equation as:

$$(3) \quad DM_t = \alpha_0 + \alpha_1 DEF_{t-1} + \alpha_2 DM_{t-1} + \alpha_3 DM_{t-2} + RM_t,$$

where DEF_{t-1} is the ratio of the fiscal deficit during the previous period to gross domestic product, and the other variables are as defined previously.

Equation (3) was estimated by ordinary least squares for each of our 128 countries using annual data for the period 1965 to 1985. The results are reported in Appendix Table 2. The degree of systematic behavior in money growth captured by this specification varies widely across countries. R^2 ranges from over 0.92 for Bolivia to about 0.02 for Benin and St. Lucia. In general the equation works best for countries with significant inflationary episodes during the sample period, such as Argentina, Bolivia, Brazil, Korea, and Mexico. For the Latin American countries in the sample, the percentage of variation in DM explained by (3) is comparable to that in Edwards (1983). 1/ For those countries also included in the sample of Kormendi and Meguire, estimated standard errors are quite similar. The fiscal deficit variable is lagged one period and has a negative sign for almost half the countries in our sample. Most importantly, though, the Box-Pierce Q statistic reported in Column 7 of Appendix Table 2 indicates that for all but three of our countries (Chile, Libya, and St. Vincent) there is no evidence of serial correlation in the residuals of equation (3). The variance of these residuals is our estimate of VRM and is reported for each country in Column 8 of Appendix Table 2.

Turning to the output equation, our empirical counterpart to equation (2) included two lags of RM and a single autoregressive term for DY. We therefore estimated, using OLS, the equation:

$$(4) \quad DY_t = \beta_0 + \beta_1 RM_t + \beta_2 RM_{t-1} + \beta_3 RM_{t-2} + \beta_4 DY_{t-1} + RY_t$$

for each country. The results of this estimation are contained in Appendix Table 3.

1/ This is not true for Chile, where our equation performs very poorly. Edward's results are also somewhat better by this standard for Colombia.

The proportion of the variance in real output growth explained by this specification once again varied greatly across the countries in our sample. The overall fit of the output equations is quite similar to that obtained for developing countries by other researchers. To judge the overall conformity of these equations with the underlying model, note the following:

a. The model suggests that the response of output growth to unanticipated monetary shocks should be positive in the short run, but no permanent effects should be observed, so negative values of βs are consistent with the model as long as they occur for the higher lags of RM.

b. The adjustment of DY to unanticipated shocks may be protracted, so the coefficient of DY_{t-1}, which measures the speed of adjustment, should lie between zero and one.

Based on these observations, we judge that the results for the output equations will be in conflict with the underlying model if:

a. The impact effect of unanticipated monetary shocks is significantly negative, or

b. We can reject the hypothesis that the coefficient of DY_{t-1}, lies inside the unit interval.

The impact effect of unanticipated monetary shocks is positive for 82 countries, and negative for the remaining 46. Thus the coefficient β_1 has the expected positive sign in about two-thirds of the countries studied. However, in only one case (the People's Democratic Republic of Yemen) is the parameter β_1 negative and statistically significant (at the 10 percent level). Thus, for the remaining 127 countries we cannot reject the null hypothesis that the impact effect of an unanticipated monetary shock on the rate of growth of real output is positive.

With regard to the second prediction of the model, the coefficient of the lagged dependent variable lies between zero and one for 91 countries, is negative for 37 countries, and is never greater than one. However, the negative coefficient is only statistically significant in four cases (Dominica, Lesotho, Morocco, and the People's Democratic Republic of Yemen). This means that the hypothesis that β_4 lies within the unit interval cannot be rejected for 124 out of our 128 countries.

We conclude, therefore, that the estimated output equations are in broad conformity with our expectations. These equations are thus used to construct our estimate of the peak effect of unanticipated monetary growth on the rate of growth of output, χ. Following Kormendi and Meguire, we define χ as:

$$\chi = \max_{\tau} \{\chi_{\tau}\}, \qquad \tau = 0, 1, 2$$

where:

$$\chi_\tau = \sum_{i=0}^{\tau} \beta_i.$$

The resulting values of χ are displayed in Column 9 of Appendix Table 3. The point estimates of χ are positive in 98 cases. We now turn to an examination of the relationship between χ and VRM.

III. Cross-Regime Tests

In this section we examine the relationship between the estimates of VRM and χ derived from the money and output growth equations described in Section II. To examine the robustness of our results, we consider various subgroups of developing countries and apply several statistical techniques.

The various subgroups to be examined here are drawn from the analytical classifications of developing countries employed by the International Monetary Fund for its World Economic Outlook report. Two alternative classification criteria are used. When classified by primary export, countries are grouped into the categories of fuel exporters and other (nonfuel) exporters. When debt classifications are used, capital importing developing countries are divided into countries that have recently experienced debt-servicing problems and those that have not. Within the capital-importing countries, subgroups of market borrowers and official borrowers are also identified. In this section we examine the relationship between VRM and χ within each of these groups.

Systematic statistical analysis of this relationship encounters the difficulties that, as Kormendi and Meguire put it, "Since the data on χ_j and VRM_j were themselves generated through estimation procedures, their distributional properties are not fully known" (p. 900). Since the distribution of χ_j and VRM_j are unknown, the distribution of their sample correlation coefficient under the null hypothesis of no linear association between the variables is not determined. Thus, the statistical significance of the measured correlations cannot be inferred. Nevertheless, we follow most previous studies and calculate both the simple correlation coefficient and the rank correlation coefficient for each of our eleven groups. These are reported respectively in columns 1 and 2 of Table 1. For indicative purposes only, the standard errors of these correlation coefficients are reported in parentheses under each entry. With only few exceptions, the signs of these correlations are negative, and the measured coefficients are in many cases more than double their standard errors.

We can be more precise statistically through the use of distribution-free methods. The real output response to unanticipated money is not observed but is estimated as a regression coefficient, and the variance of unanticipated money is also an estimated parameter. Since it is not possible to obtain actual measurements for these samples, the correlation coefficient of the output response and the variance of unanticipated money is a function of estimated parameters and not of actual measurements from a sample whose population distribution is known. In this respect, we need to employ statistical analyses which do not depend upon the knowledge of the distribution and parameters of the population, that is, nonparametric methods. The information used in makng nonparametric inferences generally relates to some function of the actual magnitudes of the random variables in the sample. For example, if the actual observations are replaced by their relative rankings within the sample and the probability distribution of some function of these sample ranks can be determined on the basis of general assumptions about the basic population sampled, then this function will provide a distribution-free technique for hypothesis testing. Inferences based on descriptions of these derived sample data may relate to whatever parameters are relevant and adaptable, such as the median for a location parameter. It might seem that since information about actual observed sample magnitudes is not used in drawing the inference, the nonparametric method is not efficient because some of the available information is discarded. However, the information embodied in these actual magnitudes, which is not directly employed in the nonparametric inference procedure, really relates to the underlying distribution, and this information is not relevant for the distribution-free tests. On the other hand, if the underlying distribution is known, a parametric approach to testing may legitimately be used and that would not be a situation requiring nonparametric tests.

Columns 3-7 in Table 1 report the results of Mann-Whitney tests of negative association between VRM_j and χ_j for each of our eight groups. This test does not require knowledge of the underlying distributions of VRM_j and χ_j but only that these random variables be continuous. The test is conducted as follows: first, countries in each group are ranked according to the order of χ_j and an order statistic, which is simply the value of the country's ranking, is assigned to each country. Next, each country is classified into one of two groups according to whether the value of VRM_j for that country falls above or below the median VRM_j for the group as a whole. Median values of χ_j and rank sums (the sums of the order statistics) are then calculated for each of the two subgroups. These are finally used to calculate a Z statistic, the distribution of which is known under the null hypothesis that the below-median and above-median subgroups are drawn from the same distribution (i.e., from distributions with the same median value of χ_j). The null hypothesis that above-median values of VRM_j are not associated with below-median values of χ_j can be rejected for sufficiently negative values of the Z statistic.

Table 1: Tests of Association Between VRM and χ

Country Group 1/	Simple Correlation Coefficient 2/	Rank Correlation Coefficient 2/	Below-Median VRM		Above-Median VRM		Z-Statistic 3/
			Median χ	Rank Sum	Median χ	Rank Sum	
Developing countries (128)	-0.178 (2.035)	-0.250 (2.894)	0.273	4,601	0.095	3,655	-2.254*
Fuel exporters (20)	-0.125 (0.535)	0.191 (0.825)	0.062	88	0.278	1,222	1.285
Nonfuel exporters (108)	-0.186	-0.316	0.277	3,368	0.095	2,518	-2.611**
Capital-importing countries (120)	-0.188 (2.081)	-0.286 (3.243)	0.277	4,112	0.095	3,148	-2.530*
Debt-problem countries (57)	-0.278 (2.147)	-0.497 (4.244)	0.306	1,117	0.078	713	-2.986**
Other (63)	-0.131 (1.034)	-0.129 (1.017)	0.247	1,001	0.122	829	-1.271
Market borrowers (33)	-0.280 (1.625)	-0.371 (2.224)	0.336	352	0.071	243	-1.877
Official borrowers (59)	-0.183 (1.404)	-0.336 (2.690)	0.224	1,001	0.095	769	-1.986*

1/ Numbers in parentheses indicate the number of countries in each group.
2/ t-statistics are given in parentheses.
3/ A single asterisk denotes statistical significance at the 5 percent level, while a double asterisk indicates significance at the 1 percent level.

For each group of developing countries analyzed here, columns 3 and 4 in Table 1 list the median value of χ_j and the rank-sum respectively for the subgroup of countries with below-median VRM_j. Notice that, with the exception of the fuel exporters, in each group the median χ_j and the rank sum are lower for the subgroup with above-median VRM_j than for the subgroup with below-median VRM_j, suggesting a negative relationship between VRM_j and χ_j for seven of our eight groups. Column 7 shows that this negative relationship is statistically significant in five of the seven cases. The results of the Mann-Whitney test therefore support those obtained from both simple and rank correlations. The finding of a negative relationship between the variance of unanticipated demand shocks and the peak effects of such shocks on real output growth, as predicted by the Lucas supply hypothesis, appears to be rather robust in our developing-country data.

IV. Conclusions

If empirically relevant in developing countries, the analysis of aggregate supply behavior developed by Lucas would have important implications for stabilization policy. At first blush, the assumptions of continuous market clearing and rational expectations formation incorporated in Lucas' analysis seem at variance with common perceptions of the economies of developing countries. If these assumptions were far off the mark, however, it would presumably be quite easy to reject the implications of Lucas' analysis in the context of developing countries. Nonetheless, we have been unable to do so.

Our work differs from that of previous authors in three respects:

a. Our sample consists only of developing countries.

b. The breadth of developing-country coverage in our sample is much more extensive than that in previous work.

c. Our use of distribution-free methods permits us to subject measures of association to meaningful tests of statistical significance.

Our key finding is that the central empirical implication of Lucas' supply hypothesis--that the variance of unanticipated demand shocks is negatively related to the peak impact of such shocks on real output growth--is strongly supported by our data. This negative correlation shows up in simple and rank correlation coefficients, and--most importantly--it proves to be statistically significant in Mann-Whitney tests. This holds true for almost all of the subgroups examined. The negative relationship, therefore, seems to be a robust feature of developing-country data.

Although this finding is consistent with Lucas' supply analysis we cannot, of course, rule out the possibility that alternative hypotheses may also be consistent with this relationship--perhaps a tendency toward shorter nominal wage contracts or greater prevalence of indexing in the presence of greater variance of aggregate demand shocks. Until such hypotheses emerge in well-specified forms, however, our results would seem to at least equalize the burden of proof between opponents and adherents of the view that the Lucas supply function is a useful tool for macroeconomic analysis in developing countries.

Appendix Tables

Table 2: Estimates of the Money Growth Equation 1/

Country	α_0	α_1	α_2	α_3	R^2	S.E.E.	Q(5) 2/	VRM 3/
Afghanistan	0.20 (2.78)	59.26 (0.61)	0.15 (0.70)	-0.44 (2.01)	0.20	0.07	2.61	0.49
Algeria	0.24 (4.62)	0.02 (0.58)	0.21 (1.05)	-0.43 (2.42)	0.30	0.07	2.46	0.43
Antigua & Barbuda	0.03 (0.27)	-168.19 (1.37)	0.14 (0.68)	0.04 (0.20)	0.12	0.13	3.42	1.71
Argentina	-0.28 (1.90)	-0.45 (1.55)	1.00 (4.23)	-0.23 (0.87)	0.80	0.28	4.75	7.87
Bahamas	0.05 (1.38)	-14.43 (1.33)	0.22 (0.98)	0.11 (0.50)	0.19	0.08	5.31	0.63
Bahrain	0.07 (1.29)	18.94 (2.21)	0.11 (0.49)	0.31 (1.33)	0.28	0.11	3.89	1.18
Bangladesh	0.25 (2.71)	0.10 (0.52)	0.27 (0.93)	-0.35 (1.23)	0.15	0.15	3.96	2.36
Barbados	0.14 (2.37)	9.67 (1.58)	0.21 (0.95)	0.24 (1.10)	0.26	0.06	7.33	0.40
Belize	0.04 (0.58)	-22.42 (0.35)	0.45 (1.99)	-0.12 (0.52)	0.20	0.18	4.26	3.31
Benin	0.14 (2.40)	0.03 (0.60)	0.00 (0.02)	0.03 (0.15)	0.02	0.15	2.58	2.32
Bhutan	-0.05 (0.69)	-92.07 (1.96)	0.23 (0.97)	0.22 (0.86)	0.26	0.10	7.91	0.92
Bolivia	-0.28 (2.73)	-36.86 (1.66)	0.74 (3.10)	1.15 (3.32)	0.92	0.32	2.11	10.10
Bostwana	0.16 (2.64)	5.67 (0.65)	0.21 (0.83)	-0.06 (0.22)	0.07	0.14	5.35	1.91
Brazil	-0.03 (0.37)	0.02 (2.47)	0.72 (3.48)	0.42 (1.58)	0.85	0.14	5.22	1.92
Burkina Faso	0.02 (0.39)	-0.05 (0.81)	0.37 (1.64)	0.16 (0.71)	0.28	0.08	6.72	0.64
Burma	0.06 (2.52)	0.38 (1.09)	0.63 (3.73)	-0.16 (1.10)	0.51	0.06	3.43	0.36
Burundi	0.14 (2.47)	-0.06 (0.15)	-0.07 (-0.29)	0.02 (0.10)	0.01	0.13	4.05	1.81
Cameroon	0.11 (1.98)	0.00 (0.28)	0.06 (0.26)	0.34 (1.54)	0.16	0.08	4.93	0.57
Cape Verde	0.06 (1.53)	-0.33 (0.56)	0.03 (0.12)	0.38 (1.64)	0.25	0.07	0.47	0.44
Cent. African Rep.	0.16 (2.55)	0.02 (0.08)	-0.32 (-1.32)	0.03 (0.12)	0.11	0.11	0.88	1.29

Table 2 (continued): Estimates of the Money Growth Equation 1/

Country	α_0	α_1	α_2	α_3	R^2	S.E.E.	Q(5) 2/	VRM 3/
Chad	0.21 (2.24)	0.20 (1.29)	-0.08 (0.34)	0.02 (0.06)	0.10	0.14	5.85	2.05
Chile	0.50 (2.91)	0.44 (0.57)	0.02 (0.17)	0.04 (0.41)	0.03	0.50	24.98	24.70
China	0.12 (2.79)	-0.11 (2.19)	-0.05 (0.17)	0.01 (0.03)	0.43	0.08	6.22	0.60
Taiwan Province of China	0.16 (2.59)	0.01 (0.75)	0.21 (0.89)	-0.05 (0.20)	0.07	0.06	2.27	0.33
Colombia	0.08 (1.64)	0.00 (0.26)	0.43 (1.76)	0.25 (1.05)	0.39	0.06	2.07	0.38
Comoros	0.39 (2.66)	0.56 (1.37)	-0.46 (1.91)	-0.06 (0.21)	0.26	0.14	8.18	1.97
Congo	0.01 (2.93)	-0.01 (0.62)	0.65 (3.20)	-0.49 (2.16)	0.39	0.09	1.71	0.90
Costa Rica	0.06 (0.88)	-1.25 (2.16)	0.19 (0.91)	0.02 (0.12)	0.30	0.12	6.63	1.40
Cote d'Ivoire	0.18 (2.00)	0.01 (0.84)	-0.01 (0.05)	0.04 (0.16)	0.06	0.13	2.80	1.68
Cyprus	0.12 (2.76)	-0.94 (0.82)	-0.07 (0.29)	0.16 (0.70)	0.09	0.04	5.37	0.20
Djibouti	0.14 (3.66)	0.34 (3.98)	-0.49 (2.39)	-0.02 (0.08)	0.53	0.07	2.51	0.54
Dominica	0.05 (0.61)	-82.98 (-1.51)	0.23 (1.03)	-0.29 (1.38)	0.23	0.10	1.42	1.04
Dominican Republic	0.13 (2.45)	1.83 (0.68)	-0.03 (0.12)	0.14 (0.58)	0.06	0.12	1.92	1.32
Ecuador	0.06 (0.89)	-0.05 (0.66)	0.40 (1.60)	0.37 (1.33)	0.26	0.10	1.98	0.96
Egypt	-0.02 (0.40)	-0.71 (1.50)	0.89 (3.94)	-0.20 (0.82)	0.76	0.06	1.33	0.41
El Salvador	0.08 (1.80)	-0.52 (0.27)	0.65 (2.67)	-0.26 (1.10)	0.30	0.09	0.30	0.78
Equatorial Guinea	-0.66 (2.46)	-13.97 (3.31)	-0.15 (0.73)	0.44 (2.03)	0.41	0.39	1.61	15.35
Ethiopia	0.14 (4.02)	0.12 (0.83)	0.06 (0.27)	-0.35 (1.78)	0.20	0.05	2.35	0.29
Fiji	0.13 (2.08)	6.48 (0.70)	0.15 (0.60)	-0.09 (0.34)	0.06	0.09	2.90	0.81

Table 2 (continued): Estimates of the Money Growth Equation 1/

Country	α_0	α_1	α_2	α_3	R^2	S.E.E.	Q(5) 2/	VRM 3/
Gabon	0.11 (1.67)	0.00 (0.20)	0.61 (2.56)	-0.20 (0.83)	0.29	0.17	1.27	2.87
Gambia	0.14 (2.20)	-11.01 (0.42)	-0.25 (1.10)	0.13 (0.54)	0.10	0.16	5.34	2.58
Ghana	0.40 (3.54)	-0.00 (3.29)	-0.24 (0.92)	0.07 (0.31)	0.57	0.13	2.98	1.60
Greece	0.24 (3.76)	0.00 (3.03)	0.18 (0.81)	-0.26 (1.14)	0.58	0.03	3.83	0.12
Grenada	0.04 (1.02)	-14.43 (0.67)	0.48 (2.02)	-0.28 (1.21)	0.20	0.08	2.45	0.58
Guatemala	0.12 (2.77)	0.10 (0.29)	0.48 (1.77)	-0.34 (1.23)	0.17	0.07	2.35	0.45
Guinea	0.22 (7.03)	-0.31 (3.86)	-0.13 (0.83)	-0.49 (3.00)	0.59	0.06	5.78	0.41
Guinea-Bissau	0.25 (2.95)	0.85 (1.72)	0.31 (1.41)	-0.34 (1.41)	0.27	0.09	3.06	0.73
Guyana	0.03 (0.44)	-1.87 (1.31)	0.08 (0.34)	0.11 (0.46)	0.14	0.08	1.27	0.56
Haiti	0.06 (1.97)	1.01 (1.22)	0.57 (2.52)	0.15 (0.67)	0.55	0.06	6.30	0.42
Honduras	0.16 (3.74)	0.86 (0.83)	0.29 (1.28)	-0.46 (2.00)	0.25	0.06	2.01	0.32
Hong Kong	0.09 (2.03)	0.15 (1.69)	0.30 (1.30)	0.09 (0.39)	0.30	0.08	8.90	0.61
Hungary	0.09 (2.47)	-0.02 (1.40)	-0.04 (0.14)	0.03 (0.25)	0.18	0.05	2.09	0.21
India	0.15 (2.76)	0.00 (2.02)	0.15 (0.61)	-0.00 (0.02)	0.52	0.03	4.19	0.07
Indonesia	0.21 (1.51)	0.00 (0.90)	0.64 (2.58)	-0.10 (0.42)	0.46	0.37	0.74	13.68
Iran, Islamic Republic of	0.08 (1.78)	-0.00 (0.72)	0.36 (1.53)	0.16 (0.71)	0.27	0.06	1.25	0.36
Iraq	0.09 (2.08)	0.80 (2.67)	0.18 (0.86)	0.31 (1.46)	0.42	0.10	5.18	0.95
Israel	0.04 (0.39)	0.00 (0.64)	-0.04 (0.11)	1.26 (2.63)	0.76	0.23	6.99	5.17
Jamaica	0.18 (2.80)	-0.00 (1.36)	-0.09 (0.35)	0.07 (0.30)	0.14	0.05	4.25	0.28
Jordan	0.04 (1.39)	2.40 (1.00)	0.93 (3.98)	-0.13 (0.49)	0.60	0.05	4.20	0.25

Table 2 (continued): Estimates of the Money Growth Equation 1/

Country	α_0	α_1	α_2	α_3	R^2	S.E.E.	Q(5) 2/	VRM 3/
Kenya	0.12 (2.25)	0.00 (0.45)	0.17 (0.66)	-0.01 (0.05)	0.05	0.09	0.69	0.74
Korea	0.22 (3.93)	0.00 (2.34)	0.90 (4.78)	-0.51 (2.88)	0.70	0.07	7.13	0.53
Kuwait	-0.06 (0.92)	0.73 (2.80)	0.08 (0.36)	0.32 (1.61)	0.41	0.10	2.78	0.97
Lao P.D. Republic	-0.22 (0.88)	-2.94 (2.23)	-0.32 (1.53)	0.01 (0.04)	0.26	0.23	5.16	5.07
Lebanon	0.05 (1.05)	-0.52 (0.77)	0.49 (1.83)	0.05 (0.18)	0.32	0.09	2.69	0.82
Lesotho	0.13 (2.88)	-56.28 (1.80)	-0.15 (0.54)	0.02 (0.10)	0.18	0.07	4.79	0.47
Liberia	0.14 (4.42)	22.32 (3.59)	0.13 (0.71)	-0.48 (2.68)	0.52	0.09	5.28	0.87
Libya	0.22 (2.62)	4.07 (2.10)	0.08 (0.31)	0.10 (0.44)	0.34	0.13	14.63	1.67
Madagascar	0.10 (2.37)	-0.01 (0.53)	-0.09 (0.31)	0.14 (0.46)	0.07	0.07	2.51	0.46
Malawi	0.22 (4.26)	0.06 (0.74)	-0.17 (0.75)	-0.40 (1.72)	0.18	0.10	4.35	0.91
Malaysia	0.27 (7.14)	-0.01 (1.18)	-0.13 (1.05)	-0.46 (3.87)	0.48	0.09	10.36	0.79
Maldives	0.24 (4.30)	-14.93 (0.33)	-0.56 (1.96)	-0.41 (1.63)	0.26	0.10	7.27	1.08
Mali	0.20 (2.86)	0.26 (1.27)	-0.02 (0.10)	0.07 (0.29)	0.09	0.09	3.12	0.86
Malta	0.09 (3.01)	8.87 (0.24)	0.35 (1.39)	-0.22 (0.90)	0.11	0.04	3.05	0.18
Mauritania	0.15 (1.80)	0.10 (0.27)	0.14 (0.57)	0.02 (0.10)	0.03	0.14	5.94	1.92
Mauritius	0.13 (1.86)	0.15 (0.23)	0.28 (1.21)	-0.05 (0.23)	0.08	0.14	1.11	1.86
Mexico	0.01 (0.24)	-0.02 (1.74)	0.24 (0.91)	0.43 (1.90)	0.78	0.08	5.32	0.64
Morocco	0.07 (1.31)	-0.00 (0.40)	0.22 (0.76)	0.34 (1.55)	0.45	0.04	0.74	0.19
Mozambique	0.03 (0.88)	-0.13 (1.49)	0.43 (1.60)	-0.06 (0.26)	0.46	0.05	6.83	0.28
Nepal	0.24 (4.30)	0.00 (0.94)	-0.21 (0.96)	-0.24 (1.10)	0.16	0.06	5.54	0.38

Table 2 (continued): Estimates of the Money Growth Equation 1/

Country	α_0	α_1	α_2	α_3	R^2	S.E.E.	Q(5) 2/	VRM 3/
Neth. Antilles	0.01 (0.23)	-7.31 (1.04)	0.24 (1.02)	0.31 (1.23)	0.22	0.05	3.48	0.26
Nicaragua	0.04 (0.46)	0.00 (0.38)	0.70 (2.51)	0.30 (0.89)	0.36	0.20	3.94	3.80
Niger	0.15 (2.91)	0.07 (1.85)	0.09 (0.43)	0.17 (0.80)	0.22	0.11	1.85	1.17
Nigeria	0.10 (1.09)	-0.18 (0.44)	0.40 (1.64)	-0.19 (0.69)	0.15	0.17	1.37	2.79
Oman	0.17 (2.41)	1.78 (0.63)	0.20 (0.84)	-0.00 (0.02)	0.06	0.13	5.99	1.79
Pakistan	0.24 (3.75)	-0.00 (1.09)	0.02 (0.09)	-0.54 (1.89)	0.26	0.70	1.64	0.43
Panama	0.11 (1.95)	0.04 (0.88)	0.17 (0.71)	0.07 (0.34)	0.06	0.09	7.13	0.78
Papua New Guinea	0.25 (3.33)	19.74 (0.99)	-0.39 (1.77)	-0.47 (2.03)	0.25	0.15	2.01	2.15
Paraguay	0.20 (2.82)	0.10 (1.65)	-0.04 (0.20)	0.11 (0.49)	0.18	0.08	1.76	0.65
Peru	-0.02 (0.13)	-0.03 (0.74)	0.58 (1.96)	0.29 (0.83)	0.65	0.15	1.84	2.36
Philippines	0.12 (3.04)	-0.06 (1.37)	0.21 (0.97)	-0.11 (0.50)	0.16	0.05	2.02	0.27
Portugal	0.16 (2.68)	-0.01 (1.58)	0.34 (1.26)	-0.14 (0.58)	0.39	0.07	6.73	0.44
Qatar	0.11 (1.94)	0.26 (1.80)	0.25 (1.07)	-0.02 (0.10)	0.27	0.12	3.51	1.49
Romania	0.14 (2.90)	-0.00 (1.39)	0.09 (0.39)	-0.21 (0.86)	0.14	0.06	0.74	0.37
Rwanda	0.15 (2.72)	0.00 (0.15)	-0.17 (0.72)	0.14 (0.59)	0.06	0.10	4.43	1.06
Sao Tome & Principe	0.18 (4.30)	-0.90 (0.77)	0.09 (0.41)	-0.52 (2.47)	0.27	0.08	2.24	0.72
Saudi Arabia	0.06 (1.40)	0.00 (0.36)	0.97 (3.82)	-0.28 (1.14)	0.63	0.10	1.33	1.10
Senegal	0.06 (1.54)	0.00 (0.05)	0.14 (0.63)	0.38 (1.86)	0.24	0.11	3.78	1.22
Seychelles	0.19 (3.58)	29.74 (1.95)	0.36 (1.66)	-0.49 (2.25)	0.38	0.10	8.71	1.01
Sierra Leone	0.20 (2.65)	0.38 (1.88)	0.15 (0.51)	-0.15 (0.54)	0.30	0.10	2.24	1.00

Table 2 (continued): Estimates of the Money Growth Equation 1/

Country	α_0	α_1	α_2	α_3	R^2	S.E.E.	Q(5) 2/	VRM 3/
Singapore	0.11	-0.62	0.56	-0.22	0.45	0.05	5.67	0.21
	(3.28)	(2.11)	(2.80)	(1.04)				
Solomon Islands	0.17	-17.87	-0.06	-0.28	0.76	0.12	6.12	1.37
	(3.13)	(0.16)	(0.25)	(1.10)				
Somalia	0.11	-0.50	-0.06	0.32	0.13	0.12	1.79	1.55
	(1.20)	(0.30)	(0.25)	(1.41)				
South Africa	0.14	-0.00	0.28	-0.28	0.16	0.05	0.54	0.29
	(3.23)	(0.78)	(1.24)	(1.12)				
Sri Lanka	0.14	-0.00	0.29	0.03	0.57	0.07	1.98	0.50
	(2.67)	(2.20)	(1.22)	(0.14)				
St. Lucia	0.18	33.10	0.14	0.05	0.02	0.08	1.55	0.59
	(1.93)	(0.19)	(0.58)	(0.22)				
St. Vincent	0.10	-170.67	-0.17	-0.33	0.25	0.12	11.12	1.37
	(2.14)	(1.79)	(0.67)	(1.58)				
Sudan	0.12	-17.07	0.20	-0.00	0.53	0.08	3.20	0.68
	(2.94)	(2.49)	(1.05)	(0.03)				
Suriname	0.14	-5.17	0.10	-0.10	0.15	0.06	0.98	0.42
	(2.79)	(1.63)	(0.40)	(0.42)				
Swaziland	0.08	0.40	0.38	0.11	0.19	0.09	4.50	0.80
	(1.78)	(0.04)	(1.58)	(0.44)				
Syrian Arab Republic	0.12	0.08	0.18	0.41	0.29	0.07	3.08	0.43
	(2.66)	(0.85)	(0.78)	(2.12)				
Tanzania	0.32	0.00	-0.42	-0.23	0.32	0.05	7.44	0.29
	(4.20)	(2.72)	(1.76)	(0.94)				
Thailand	0.10	0.00	0.23	0.15	0.08	0.04	4.66	0.15
	(1.87)	(0.80)	(0.83)	(0.63)				
Togo	0.27	0.01	-0.45	-0.09	0.17	0.15	1.37	2.39
	(2.73)	(0.08)	(1.82)	(0.37)				
Trinidad & Tobago	0.07	0.39	0.47	0.04	0.42	0.08	9.24	0.70
	(1.70)	(2.29)	(2.44)	(0.20)				
Tunisia	0.07	0.00	0.48	0.04	0.31	0.04	3.28	0.19
	(1.60)	(0.02)	(2.43)	(0.22)				
Turkey	0.14	0.00	0.70	-0.08	0.66	0.09	0.65	0.73
	(2.17)	(1.47)	(2.94)	(0.33)				
Uganda	0.05	0.02	0.52	0.51	0.57	0.13	2.80	1.71
	(0.37)	(0.24)	(2.35)	(1.59)				
U.A.R.	0.13	-0.13	0.12	0.33	0.10	0.23	7.41	5.27
	(1.48)	(0.38)	(0.51)	(1.21)				
Uruguay	0.01	-6.01	0.34	0.43	0.22	0.16	4.13	2.53
	(0.04)	(1.75)	(1.22)	(1.78)				

Table 2 (concluded): Estimates of the Money Growth Equation 1/

Country	α_0	α_1	α_2	α_3	R^2	S.E.E.	Q(5) 2/	VRM 3/
Venezuela	0.06 (1.34)	0.05 (1.35)	0.33 (1.45)	0.16 (0.69)	0.25	0.09	2.31	0.85
Vietnam	0.22 (1.27)	11.48 (0.93)	0.92 (2.45)	0.14 (0.39)	0.34	0.24	6.61	5.82
Western Samoa	0.98 (1.69)	-71.38 (0.90)	-0.08 (0.32)	0.14 (0.58)	0.09	0.12	4.57	1.39
Yemen Arab Republic	0.18 (2.01)	0.30 (0.95)	0.59 (2.41)	-0.10 (0.43)	0.42	0.15	2.95	2.19
Yemen P.D. Republic	0.06 (1.59)	-0.32 (0.75)	0.49 (2.04)	0.11 (0.46)	0.36	0.11	0.43	1.23
Yugoslavia	0.07 (0.98)	-0.01 (0.39)	0.46 (1.81)	0.31 (1.14)	0.29	0.07	1.44	0.53
Zaire	0.18 (1.95)	0.00 (0.67)	0.27 (1.12)	0.10 (0.44)	0.10	0.15	0.95	2.24
Zambia	0.19 (3.19)	0.96 (0.38)	-0.04 (0.15)	-0.19 (0.80)	0.04	0.12	5.37	1.46
Zimbabwe	0.12 (1.82)	4,437.76 (1.33)	-0.46 (1.32)	-0.15 (0.48)	0.30	0.06	3.74	0.22

1/ Absolute t-statistics in parenthesis.
2/ The critical value of the χ^2 distribution with 5 degrees of freedom at the 5 percent level of significance is 11.1.
3/ Measured in percentage points.

Table 3: Estimates of the Output Equation 1/

Country	β_0	β_1	β_2	β_3	β_4	R^2	S.E.E.	Q(5) 2/	χ
Afghanistan	0.01	-0.20	0.19	-0.05	0.05	0.12	0.06	3.83	-0.01
	(1.03)	(0.93)	(0.97)	(0.25)	(0.21)				
Algeria	0.06	0.44	0.15	-0.05	-0.01	0.72	0.02	2.40	0.59
	(5.13)	(4.98)	(1.12)	(0.69)	(0.05)				
Antigua & Barbuda	0.05	-0.03	-0.03	0.01	-0.02	0.10	0.02	5.47	-0.03
	(3.57)	(0.66)	(0.53)	(0.21)	(0.08)				
Argentina	0.01	-0.03	0.05	-0.03	0.05	0.19	0.04	4.27	0.01
	(1.05)	(0.87)	(1.33)	(0.87)	(0.21)				
Bahamas	0.03	0.06	0.22	0.15	-0.11	0.10	0.06	3.62	0.43
	(2.15)	(0.21)	(1.04)	(0.74)	(0.35)				
Bahrain	0.06	0.27	0.08	0.35	-0.03	0.45	0.05	11.72	0.70
	(3.21)	(2.02)	(0.62)	(2.80)	(0.13)				
Bangladesh	0.05	0.20	0.07	0.16	-0.11	0.81	0.02	5.89	0.43
	(7.84)	(4.14)	(1.14)	(3.82)	(1.14)				
Barbados	0.02	0.11	0.09	-0.24	0.57	0.47	0.03	8.61	0.20
	(1.30)	(0.74)	(0.62)	(1.67)	(2.30)				
Belize	0.03	0.00	0.02	-0.05	0.15	0.09	0.04	6.15	0.03
	(2.27)	(0.02	(0.46)	(0.96)	(0.61)				
Benin	0.04	-0.02	-0.01	0.01	-0.09	0.02	0.05	8.53	-0.02
	(2.66)	(0.23)	(0.15)	(0.18)	(0.32)				
Bhutan	0.03	0.10	-0.14	0.02	0.24	0.25	0.03	4.12	0.10
	(2.62)	(1.30)	(1.89)	(0.29)	(0.92)				
Bolivia	0.00	-0.02	-0.02	0.01	0.78	0.56	0.04	4.00	-0.02
	(0.18)	(0.60)	(0.73)	(0.27)	(4.20)				
Bostwana	0.08	0.21	0.07	-0.17	0.31	0.50	0.05	3.54	0.27
	(2.41)	(2.12)	(0.54)	(1.72)	(1.15)				
Brazil	0.03	-0.07	0.04	-0.18	0.47	0.50	0.04	2.61	-0.03
	(2.37)	(0.91)	(0.61)	(2.63)	(2.39)				
Burkina Faso	0.02	-0.27	-0.17	-0.19	-0.18	0.25	0.05	4.20	-0.27
	(1.61)	(1.74)	(1.08)	(1.29)	(0.64)				
Burma	0.03	-0.11	-0.13	0.21	0.39	0.37	0.03	5.10	-0.03
	(2.86)	(0.87)	(1.00)	(1.61)	(2.01)				
Burundi	0.04	0.23	0.06	-0.24	-0.27	0.44	0.06	7.63	0.29
	(2.68)	(2.03)	(0.53)	(2.20)	(1.24)				
Cameroon	0.04	-0.11	0.02	-0.19	0.31	0.26	0.03	3.97	-0.09
	(2.23)	(0.83)	(0.19)	(1.62)	(1.17)				
Cape Verde	0.03	-0.23	0.46	0.13	0.11	0.29	0.06	6.64	0.37
	(1.58)	(1.00)	(1.98)	(0.53)	(0.43)				
Cent. African Rep.	0.03	-0.02	0.04	-0.06	-0.21	0.10	0.04	3.54	0.02
	(2.94)	(0.24)	(0.52)	(0.80)	(0.83)				

Table 3 (continued): Estimates of the Output Equation 1/

Country	β_0	β_1	β_2	β_3	β_4	R^2	S.E.E.	Q(5) 2/	χ
Chad	0.01 (0.59)	-0.19 (0.92)	0.11 (0.74)	-0.09 (0.51)	0.53 (1.40)	0.17	0.08	0.67	-0.08
Chile	0.02 (0.95)	-0.06 (0.74)	0.06 (0.54)	-0.04 (0.52)	0.08 (0.31)	0.07	0.08	7.93	0.00
China	0.09 (4.22)	0.49 (3.92)	0.20 (1.11)	-0.13 (0.99)	-0.26 (0.95)	0.58	0.04	2.98	0.69
Taiwan Province of China	0.05 (2.35)	0.28 (1.49)	0.26 (1.34)	-0.13 (0.75)	0.28 (1.06)	0.31	0.04	5.55	0.54
Colombia	0.01 (1.44)	0.04 (0.49)	0.01 (0.17)	-0.15 (1.99)	0.66 (3.42)	0.52	0.02	17.81	0.05
Comoros	0.05 (4.08)	0.03 (0.54)	-0.06 (1.23)	-0.13 (2.25)	-0.16 (0.64)	0.31	0.03	3.77	0.03
Congo	0.03 (1.91)	0.52 (4.23)	0.03 (0.16)	0.09 (0.71)	0.34 (1.33)	0.66	0.05	12.69	0.64
Costa Rica	0.01 (1.27)	-0.03 (0.49)	0.14 (1.95)	0.13 (1.83)	0.58 (3.01)	0.52	0.03	1.47	0.23
Cote d'Ivoire	0.02 (1.86)	0.04 (0.48)	0.07 (0.92)	0.09 (1.18)	0.35 (1.53)	0.33	0.04	7.86	0.20
Cyprus	0.03 (1.73)	1.13 (2.75)	-0.97 (1.84)	-0.70 (1.88)	0.36 (1.43)	0.65	0.06	2.42	1.13
Djibouti	0.06 (3.94)	0.14 (1.02)	-0.16 (1.14)	0.06 (0.44)	-0.32 (1.28)	0.30	0.04	7.11	0.14
Dominica	0.06 (3.71)	-0.09 (0.62)	-0.29 (2.16)	0.18 (1.44)	-0.43 (1.99)	0.52	0.05	4.51	-0.09
Dominican Republic	0.01 (0.35)	-0.23 (1.68)	0.24 (2.29)	-0.14 (1.28)	0.81 (2.72)	0.40	0.03	6.33	0.01
Ecuador	0.03 (1.79)	0.03 (0.25)	-0.07 (0.46)	0.01 (0.07)	0.44 (1.80)	0.20	0.05	1.07	0.03
Egypt	0.04 (2.46)	-0.02 (0.17)	0.04 (0.29)	0.25 (1.71)	0.29 (1.30)	0.24	0.04	8.10	0.26
El Salvador	0.00 (0.52)	0.06 (0.72)	0.16 (1.76)	0.03 (0.35)	0.68 (4.29)	0.69	0.03	6.95	0.25
Equatorial Guinea	0.03 (2.69)	0.01 (0.22)	0.08 (3.10)	-0.05 (1.35)	-0.03 (0.10)	0.46	0.04	5.79	0.09
Ethiopia	0.01 (0.76)	-0.16 (1.18)	0.07 (0.49)	-0.25 (1.80)	0.48 (1.48)	0.34	0.03	9.67	-0.09
Fiji	0.04 (2.38)	0.16 (0.78)	0.04 (0.22)	-0.04 (0.25)	-0.09 (0.34)	0.05	0.06	6.98	0.20

Table 3 (continued): Estimates of the Output Equation 1/

Country	β_0	β_1	β_2	β_3	β_4	R^2	S.E.E.	Q(5) 2/	x
Gabon	-0.00 (0.20)	0.34 (4.48)	-0.01 (0.11)	-0.40 (5.00)	0.57 (4.12)	0.81	0.05	6.42	0.34
Gambia	0.05 (2.24)	0.03 (0.28)	0.11 (0.91)	-0.27 (2.22)	-0.05 (0.23)	0.31	0.08	2.03	0.14
Ghana	0.02 (1.03)	0.13 (0.89)	0.14 (0.80)	0.18 (0.98)	0.02 (0.09)	0.14	0.07	3.47	0.45
Greece	0.03 (2.02)	-0.30 (1.01)	0.01 (0.04)	-0.31 (1.11)	0.27 (0.97)	0.25	0.03	1.80	-0.29
Grenada	0.04 (2.62)	0.09 (0.82)	0.21 (2.01)	0.20 (1.72)	0.29 (1.27)	0.47	0.03	7.45	0.50
Guatemala	0.01 (1.02)	0.02 (0.14)	0.07 (0.54)	0.08 (0.68)	0.65 (2.89)	0.50	0.03	2.83	0.16
Guinea	0.04 (4.20)	0.11 (1.11)	-0.02 (0.14)	0.13 (1.04)	-0.38 (1.52)	0.31	0.03	1.24	0.22
Guinea-Bissau	0.07 (2.90)	0.47 (2.04)	-0.04 (0.13)	0.01 (0.03)	-0.26 (1.01)	0.32	0.08	6.90	0.47
Guyana	0.01 (0.60)	-0.15 (0.82)	-0.22 (1.17)	-0.19 (1.02)	0.19 (0.76)	0.26	0.05	5.50	-0.15
Haiti	0.02 (2.10)	0.15 (0.76)	0.16 (1.01)	0.16 (0.96)	0.03 (0.11)	0.10	0.04	3.43	0.47
Honduras	0.02 (2.13)	0.28 (2.30)	0.30 (2.24)	-0.14 (0.93)	0.34 (1.43)	0.57	0.03	4.51	0.57
Hong Kong	0.06 (2.75)	0.27 (2.44)	-0.19 (1.33)	-0.21 (1.86)	0.17 (0.63)	0.52	0.03	4.85	0.27
Hungary	0.03 (2.01)	0.65 (3.78)	-0.08 (0.28)	0.42 (2.45)	0.31 (1.10)	0.65	0.03	3.21	0.99
India	0.06 (4.52)	-0.23 (0.69)	-0.49 (1.49)	0.08 (0.24)	-0.43 (1.72)	0.30	0.03	5.59	-0.23
Indonesia	0.04 (2.21)	0.05 (0.70)	-0.00 (0.11)	0.02 (0.90)	0.41 (1.29)	0.23	0.03	6.47	0.07
Iran, Islamic Republic of	0.02 (1.35)	-0.10 (0.37)	-0.44 (1.70)	-0.73 (2.46)	0.59 (3.65)	0.69	0.06	9.03	-0.10
Iraq	0.03 (1.16)	-0.33 (1.00)	-0.02 (0.06)	-0.41 (1.30)	0.24 (0.95)	0.19	0.12	1.83	-0.33
Israel	0.02 (1.44)	-0.03 (0.54)	0.01 (0.18)	-0.10 (1.12)	0.58 (2.58)	0.42	0.04	3.16	-0.02
Jamaica	0.01 (0.61)	0.12 (0.57)	0.33 (1.50)	0.17 (0.75)	0.20 (0.78)	0.28	0.04	3.58	0.62
Jordan	0.04 (2.44)	0.19 (0.65)	0.02 (0.07)	1.14 (3.85)	0.11 (0.61)	0.55	0.06	4.34	1.35

Table 3 (continued): Estimates of the Output Equation 1/

Country	β_2	β_1	β_2	β_3	β_4	R^2	S.E.E.	Q(5) 2/	χ
Kenya	0.05 (3.17)	0.12 (1.16)	0.06 (0.53)	0.15 (1.44)	0.03 (0.14)	0.22	0.03	1.93	0.33
Korea	0.06 (2.71)	-0.05 (0.28)	0.48 (3.09)	0.01 (0.06)	0.25 (0.95)	0.44	0.04	5.48	0.45
Kuwait	0.01 (0.83)	0.07 (0.29)	-0.09 (0.51)	0.04 (0.24)	0.39 (1.41)	0.14	0.07	4.30	0.07
Lao P.D. Rep.	0.04 (2.55)	-0.03 (0.62)	-0.04 (0.88)	-0.02 (0.45)	0.15 (0.59)	0.10	0.04	7.49	-0.03
Lebanon	-0.05 (0.89)	1.82 (2.34)	-0.18 (0.19)	-0.69 (0.99)	0.10 (0.34)	0.35	0.24	5.43	1.82
Lesotho	0.04 (1.96)	-0.39 (1.16)	-0.61 (2.05)	0.15 (0.44)	-0.71 (3.30)	0.63	0.08	4.17	-0.39
Liberia	0.00 (0.20)	0.42 (2.69)	-0.26 (1.51)	0.03 (0.17)	0.36 (1.40)	0.38	0.05	5.05	0.42
Libya	0.02 (0.85)	0.24 (1.05)	-0.01 (0.05)	0.05 (0.23)	0.51 (2.30)	0.32	0.11	7.07	0.27
Madagascar	0.01 (0.65)	0.14 (0.84)	-0.00 (0.01)	-0.25 (1.58)	0.15 (0.61)	0.20	0.04	4.33	0.14
Malawi	0.04 (2.16)	-0.08 (0.55)	0.12 (0.86)	0.09 (0.62)	-0.06 (0.22)	0.10	0.05	1.75	0.13
Malaysia	0.08 (5.02)	0.30 (3.56)	-0.06 (0.76)	-0.21 (2.56)	-0.14 (0.62)	0.51	0.02	3.94	0.30
Maldives	0.02 (1.15)	0.37 (3.12)	-0.24 (1.95)	0.17 (1.60)	0.70 (3.33)	0.59	0.04	1.02	0.37
Mali	0.03 (1.83)	-0.01 (0.07)	-0.16 (0.78)	0.03 (0.14)	-0.26 (1.00)	0.10	0.07	1.69	-0.01
Malta	0.05 (2.13)	0.44 (1.37)	0.59 (1.77)	-0.07 (0.20)	0.21 (0.67)	0.46	0.04	1.97	1.03
Mauritania	0.03 (2.43)	0.14 (1.65)	-0.03 (0.31)	-0.06 (0.86)	0.00 (0.01)	0.21	0.04	5.18	0.14
Mauritius	0.04 (2.49)	0.08 (0.56)	0.04 (0.31)	0.12 (1.02)	-0.12 (0.46)	0.09	0.06	0.85	0.23
Mexico	0.02 (1.40)	-0.03 (0.27)	-0.28 (2.92)	-0.03 (0.36)	0.63 (2.87)	0.53	0.03	1.00	-0.03
Morocco	0.06 (4.86)	0.60 (2.69)	0.19 (0.83)	0.12 (0.60)	-0.46 (1.93)	0.40	0.03	6.30	0.91
Mozambique	-0.00 (0.17)	0.27 (1.13)	-0.35 (1.26)	-0.40 (1.46)	0.73 (3.92)	0.59	0.05	2.37	0.27
Nepal	0.03 (4.41)	0.11 (1.30)	0.25 (3.04)	-0.04 (0.36)	-0.24 (1.05)	0.54	0.02	3.17	0.35

Table 3 (continued): Estimates of the Output Equation 1/

Country	β_0	β_1	β_2	β_3	β_4	R^2	S.E.E.	Q(5) 2/	χ
Netherland Antilles	-0.04	0.08	-0.09	0.24	1.54	0.83	0.02	1.01	0.22
	(2.78)	(0.67)	(0.71)	(2.10)	(5.77)				
Nicaragua	0.01	-0.03	-0.16	0.03	0.17	0.13	0.10	12.73	-0.03
	(0.43)	(0.20)	(1.23)	(0.22)	(0.64)				
Niger	0.01	-0.00	0.47	0.25	0.18	0.40	0.08	11.84	0.71
	(0.65)	(0.03)	(2.56)	(1.09)	(0.87)				
Nigeria	0.01	0.19	0.14	-0.15	0.32	0.24	0.12	4.42	0.33
	(0.51)	(1.09)	(0.77)	(0.80)	(1.26)				
Oman	0.06	0.59	0.09	-0.08	0.27	0.61	0.07	6.67	0.68
	(2.20)	(4.27)	(0.46)	(0.55)	(0.96)				
Pakistan	0.06	0.00	0.08	0.12	-0.02	0.36	0.01	5.34	0.21
	(4.52)	(0.00)	(1.36)	(1.54)	(0.08)				
Panama	0.05	0.15	0.25	-0.02	-0.03	0.40	0.03	10.25	0.39
	(3.11)	(1.47)	(2.45)	(0.19)	(0.12)				
Papua New Guinea	0.04	0.07	-0.05	-0.11	0.03	0.16	0.05	1.60	0.07
	(2.31)	(0.80)	(0.56)	(1.18)	(0.12)				
Paraguay	0.02	0.26	0.09	-0.02	0.58	0.62	0.03	6.71	0.35
	(1.46)	(2.53)	(0.88)	(0.17)	(2.46)				
Peru	0.02	-0.00	0.05	-0.01	0.16	0.04	0.05	2.25	0.05
	(1.31)	(0.02)	(0.55)	(0.08)	(0.48)				
Philippines	0.01	0.18	0.09	0.07	0.73	0.66	0.02	2.80	0.33
	(0.53)	(1.32)	(0.63)	(0.54)	(2.87)				
Portugal	0.02	0.04	0.24	-0.38	0.45	0.54	0.03	5.09	0.28
	(1.82)	(0.36)	(2.10)	(3.10)	(2.29)				
Qatar	0.03	0.28	-0.07	0.07	0.11	0.23	0.08	1.66	0.28
	(1.34)	(1.70)	(0.39)	(0.40)	(0.35)				
Romania	0.04	0.17	0.01	0.25	0.08	0.36	0.03	1.64	0.42
	(3.22)	(1.51)	(0.04)	(2.44)	(0.35)				
Rwanda	0.02	0.06	-0.03	0.05	0.53	0.32	0.03	6.46	0.09
	(1.56)	(0.75)	(0.34)	(0.66)	(2.41)				
Sao Tome & Principe	0.02	-0.21	-0.49	0.27	0.16	0.25	0.10	4.37	-0.21
	(0.85)	(0.73)	(1.72)	(0.85)	(0.61)				
Saudi Arabia	0.02	0.07	-0.01	0.10	0.54	0.33	0.08	1.32	0.17
	(0.87)	(0.35)	(0.05)	(0.55)	(1.78)				
Senegal	0.04	-0.03	0.10	0.17	-0.40	0.25	0.06	3.32	0.24
	(2.46)	(0.20)	(0.80)	(1.33)	(1.59)				
Seychelles	0.02	0.04	-0.14	-0.05	0.47	0.31	0.05	6.47	0.04
	(1.31)	(0.32)	(1.16)	(0.44)	(1.89)				
Sierra Leone	0.03	-0.07	0.27	0.03	0.19	0.45	0.03	3.42	0.23
	(2.43)	(0.99)	(3.12)	(0.31)	(0.75)				

Table 3 (continued): Estimates of the Output Equation 1/

Country	β_0	β_1	β_2	β_3	β_4	R^2	S.E.E.	Q(5) 2/	χ
Singapore	0.10 (4.60)	0.17 (0.62)	0.31 (1.16)	0.12 (0.47)	-0.27 (1.27)	0.19	0.05	9.41	0.59
Solomon Islands	0.04 (2.93)	0.46 (4.96)	-0.10 (0.69)	0.15 (1.49)	-0.10 (0.38)	0.69	0.04	7.61	0.51
Somalia	0.04 (2.33)	0.07 (0.57)	-0.02 (0.18)	-0.05 (0.50)	0.06 (0.24)	0.05	0.05	13.18	0.07
South Africa	0.02 (2.05)	0.09 (0.68)	-0.10 (0.73)	-0.16 (1.11)	0.24 (0.91)	0.19	0.03	1.37	0.09
Sri Lanka	0.07 (4.56)	0.01 (0.12)	-0.01 (0.10)	0.12 (1.13)	-0.27 (1.10)	0.16	0.03	1.64	0.12
St. Lucia	0.03 (1.81)	-0.18 (0.94)	0.31 (1.66)	0.32 (1.71)	0.47 (2.31)	0.49	0.06	3.61	0.46
St. Vincent	0.06 (3.73)	0.04 (0.77)	0.06 (1.19)	0.05 (1.01)	-0.11 (0.42)	0.19	0.02	6.62	0.15
Sudan	0.02 (1.82)	0.05 (0.32)	-0.15 (0.81)	0.66 (3.63)	0.16 (0.79)	0.51	0.05	4.82	0.56
Suriname	0.02 (1.84)	0.35 (2.13)	0.31 (1.64)	0.41 (2.77)	0.12 (0.55)	0.51	0.04	5.86	1.07
Swaziland	0.07 (4.09)	-0.05 (0.48)	-0.06 (0.64)	-0.11 (1.23)	-0.45 (1.54)	0.22	0.03	3.29	-0.04
Syrian Arab Rep.	0.06 (2.17)	0.22 (0.57)	0.27 (0.71)	0.20 (0.51)	-0.13 (0.47)	0.08	0.11	2.45	0.68
Tanzania	0.02 (2.07)	-0.02 (0.15)	-0.04 (0.31)	0.00 (0.14)	0.32 (1.43)	0.19	0.03	4.06	-0.02
Thailand	0.05 (2.74)	0.01 (0.11)	0.07 (0.49)	-0.04 (0.30)	0.21 (0.83)	0.07	0.02	6.38	0.08
Togo	0.01 (1.00)	0.09 (1.28)	-0.02 (0.24)	-0.02 (0.33)	0.47 (2.09)	0.26	0.04	14.62	0.09
Trinidad & Tobago	0.00 (0.38)	0.28 (1.82)	-0.01 (0.07)	0.02 (0.16)	0.57 (2.26)	0.33	0.04	2.25	0.29
Tunisia	0.05 (2.98)	-0.10 (0.44)	0.19 (0.82)	-0.55 (2.24)	0.23 (1.01)	0.32	0.04	6.60	0.09
Turkey	0.04 (2.68)	-0.09 (1.02)	-0.09 (1.18)	-0.07 (0.85)	0.16 (0.61)	0.33	0.02	2.84	-0.09
Uganda	0.01 (1.15)	-0.06 (0.66)	-0.00 (0.03)	-0.00 (0.04)	0.25 (0.95)	0.07	0.04	2.04	-0.06
U.A.R.	0.02 (1.19)	0.09 (1.44)	-0.03 (0.46)	0.02 (0.33)	0.55 (2.38)	0.41	0.06	4.63	0.09
Uruguay	0.01 (0.92)	0.07 (1.10)	0.08 (1.27)	0.05 (0.74)	0.32 (1.37)	0.39	0.04	11.26	0.21

Table 3 (concluded): Estimates of the Output Equation 1/

Country	β_0	β_1	β_2	β_3	β_4	R^2	S.E.E.	Q(5) 2/	χ
Venezuela	0.00 (0.62)	-0.11 (1.36)	0.15 (1.96)	-0.01 (0.11)	0.80 (4.54)	0.65	0.03	1.88	0.03
Vietnam	0.04 (2.42)	0.03 (0.52)	0.02 (0.36)	0.07 (1.01)	0.14 (0.60)	0.13	0.05	7.50	0.13
Western Samoa	0.01 (0.93)	0.21 (1.23)	-0.27 (1.49)	-0.12 (0.90)	0.48 (1.83)	0.44	0.06	10.55	0.21
Yemen Arab Rep.	0.01 (0.50)	0.18 (3.27)	-0.19 (2.95)	0.04 (0.71)	0.86 (4.77)	0.71	0.03	6.68	0.18
Yemen P.D. Rep.	0.04 (1.93)	-0.31 (1.83)	-0.00 (0.01)	0.05 (0.32)	-0.47 (1.90)	0.31	0.08	4.90	-0.26
Yugoslavia	0.02 (1.85)	-0.16 (1.59)	0.02 (0.20)	-0.28 (2.79)	0.37 (1.57)	0.52	0.02	2.80	-0.14
Zaire	0.01 (1.13)	-0.06 (0.85)	-0.02 (0.20)	-0.05 (0.75)	0.29 (1.24)	0.24	0.04	8.80	-0.06
Zambia	0.02 (1.11)	0.02 (0.10)	0.03 (0.16)	0.05 (0.34)	-0.09 (0.27)	0.01	0.08	3.01	0.10
Zimbabwe	0.03 (1.82)	0.44 (1.33)	-0.46 (1.32)	-0.15 (0.48)	0.13 (0.47)	0.30	0.06	2.57	0.44

1/ See note in Table 2.
2/ See note in Table 2.

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