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OUTPUT ADJUSTMENT IN DEVELOPING COUNTRIES: A STRUCTURAL VAR APPROACH

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I. INTRODUCTION

THE output gap—the gap between actual and potential output—plays an important role in macroeconomic modeling and policy formulation (Nickell 1988; Chadha, Masson, and Meredith 1992; De Masi 1997). Fluctuations around potential output reflect an accumulation of aggregate demand shocks and temporary aggregate supply shocks. Demand shocks are generally considered to dominate these processes, at least in developed countries.

In developing countries, however, short-term fluctuations in output around potential are also likely to be influenced by the effects of temporary economywide supply shocks such as oil price shocks, terms of trade shocks, and other disruptions such as droughts, floods, cyclones, and social and political upheavals. Hoffmaister and Roldós (1996, 1997), for example, observe that supply shocks play a major role in short-term output fluctuations in Asian and Latin American countries; Hoffmaister, Roldós, and Wickham (1998) report similar results for sub-Saharan African countries.

Given the heterogeneity of developing countries, it remains therefore to be determined whether conventional measures of the output gap are capturing demand- or supply-induced fluctuations in output for individual countries. Not surprisingly, this distinction has important implications for how policymakers interpret these measures when inflation and policy implementation are considered.

To determine whether output gaps in developing countries are dominated by the effects of aggregate demand shocks or temporary aggregate supply shocks, temporary shocks are identified for a large sample of developing countries using structural vector autoregression (VAR) methodology. Long-run identifying restrictions based on the concept of Blanchard and Quah (1989) and Shapiro and Watson (1989) are used to identify structural shocks and to decompose shifts in output into permanent and temporary components. Impulse response functions are used to examine whether temporary shocks to output behave like demand or supply shocks in these developing countries.

II. THEORETICAL BACKGROUND

A useful framework for considering the effects of various shocks on output is a basic "bare bones" aggregate supply–aggregate demand (AS-AD) model. The AS-AD model is a basic textbook model for examining the joint determination of output and price. The aggregate demand curve shows combinations of prices and output at which there is a joint equilibrium in goods and asset markets. The aggregate demand curve is based on the IS-LM model. The aggregate supply curve shows the relationship between the price level and the output that producers are willing to supply. Underpinning the relationship is a production function, cost-price relationship, and a Phillips curve. The model is depicted below in equations (1) to (5):

$$y_t = \alpha + \alpha_1 r_t^e + \varepsilon_t^{IS} + \varepsilon_t^{as}, \tag{1}$$

$$m_t - p_t = \alpha_2 y_t - \alpha_3 i_t + \varepsilon_t^{md}, \tag{2}$$

$$\Delta m_t = \varepsilon_t^{ms}, \tag{3}$$

$$\Delta p_t = \delta \Delta p_{t-1} + (1 - \delta)\Delta p_t^e + \phi(L)[\varepsilon_t^{IS} + \varepsilon_t^{md} + \varepsilon_t^{ms}] + \theta(L)\varepsilon_t^{as}, \tag{4}$$

$$E_t[\Delta e_{t+1}] = (i - i^*) + \psi_t, \tag{5}$$

where y is the log of output, r^e is the expected real interest rate, i is the nominal interest rate, p is the log of the price level, Δp^e is the expected rate of inflation during the period $t + 1$ (conditional on information available at t), m is the log of the money supply, and e is the log of the nominal exchange rate. The terms ε^{IS}, ε^{as}, ε^{md}, and ε^{ms} are exogenous shocks to domestic absorption, aggregate supply, money demand, and money supply, respectively. IS shocks are interpreted as exogenous shifts in fiscal policy. The supply shocks include technology and labor supply disturbances as well as temporary aggregate supply shocks.[1] Structural reforms are also likely to be a significant source of domestic supply shocks in developing economies.[2] The money shocks are interpreted as domestic shifts in money demand and exogenous money supply changes. ψ is a wedge to allow for the possibility of capital controls. L is a lag operator.

Equations (1) and (2) are relatively standard IS and LM equations describing equilibrium conditions in goods and asset markets.[3] Equation (3) is a money supply

[1] Since developing countries are often relatively open, supply shocks may also include changes in world oil prices, terms of trade changes, and shifts in world real interest rates.

[2] These reforms include: public sector reforms, including tax reforms and restructuring and privatization of public enterprises, the removal of trade and capital controls, relaxation and/or removal of price controls, and labor market reforms.

[3] The interest rate is retained in equations (1) and (2) for expositional sake although its role is likely to be severely limited by the relatively undeveloped nature of the financial markets in developing countries and the controls or ceilings on interest rates often imposed by the monetary authorities. The opportunity cost of holding financial assets in terms of goods—expected inflation—is the

equation and (4) is a loosely specified price adjustment equation. Equation (5) is the usual open-economy uncovered interest rate parity condition, modified to allow for the possibility of risk premiums and/or capital controls.

In the model depicted above the long-run aggregate supply curve is vertical, while the aggregate demand curve is downward sloping. Permanent movements in output are due to supply shocks as demand shocks do not have permanent effects on output.[4] The short-run aggregate supply curve is upward sloping, because the prices of some inputs are assumed to be determined under auction-like conditions, due to markup pricing and/or due to assumed informational asymmetries. This allows for the possibility that output can be varied in the short term in response to shifts in aggregate demand. In practice, the slope of the short-run aggregate supply curve is expected to be relatively steep, so that a substantial portion of the adjustment to demand shocks is likely to be borne by shifts in prices, or temporarily, through excess money holdings. Some of the short-term shifts in output are likely to be due to temporary supply shocks. As discussed below, this has important implications for observed price and output dynamics.

The price adjustment equation is loosely specified. The first two terms reflect the role of inflation expectations and the degree of price flexibility in the price adjustment process. The lagged inflation term allows for the possibility of backward-looking expectations (adaptive expectations) and/or wage and price inertia. The third term in the price adjustment equation is a vector of exogenous demand shocks. While the incorporation of the expected inflation terms allows for inflation expectations to adjust instantaneously to expected or anticipated changes in endogenous variables (such as changes in the money supply, output, or the exchange rate), the model allows for the possibility that unexpected demand shocks may affect prices indirectly through temporary disequilibrium in goods and/or money markets. A relatively steep supply curve, for example, would indicate that demand shocks directly affect prices, while a relatively shallow curve (for example in the presence of employee misperceptions in the new classical model or sticky prices/wages in new Keynesian models) would indicate that much of the initial effect falls on output or, in the absence of well-functioning financial markets, on excess holdings of money. The fourth term in the price adjustment equation represents exogenous supply shocks. These exogenous shocks include permanent shocks, and temporary shocks, which may temporarily drive a wedge between actual and potential output.

The standard model can be used to show the effects on output of a demand shock

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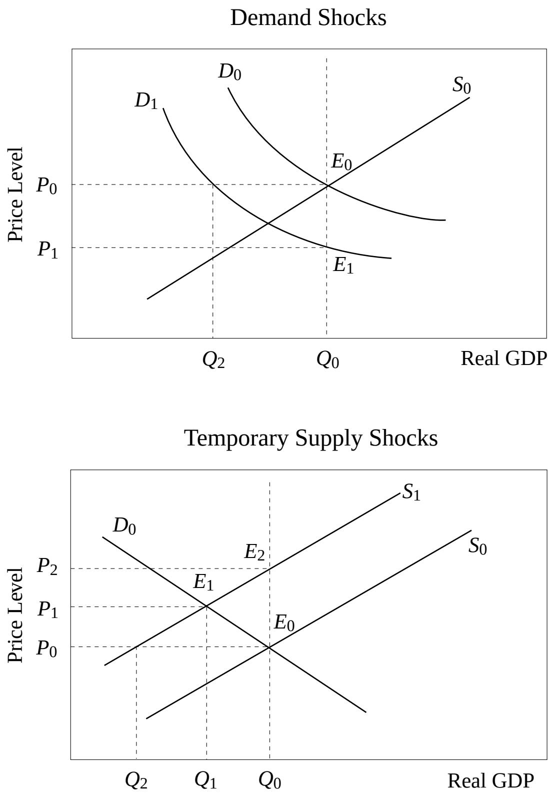
component of the nominal interest rate that is likely to be most relevant for many developing countries.

[4] Although the simplification according to which demand shocks do not have permanent effects on output is widely used in the literature, it may be an object of controversy (for example, see Galí 1992). For the purposes of this study the requirement is only that the effects should be relatively limited, compared with supply shocks (Blanchard and Quah 1989).

Fig. 1. Demand Shocks and Temporary Supply Shocks



and a temporary supply shock under the usual new Keynesian assumptions of sticky prices and wages (Figure 1). The demand case is straightforward. A decrease in demand from D_0 to D_1, to the extent that prices are fixed, falls initially on output, which temporarily decreases from Q_0 to Q_2. If some prices are flexible, the decrease in demand will be moderated by an initial decline in prices. Over time, the short-run supply curve will shift down when new price and wage agreements are negotiated. The initial negative disequilibrium (the output gap) will be associated with a fall in prices (from P_0 to P_1).

In the case of a supply shock, however, an initial negative disequilibrium is associated with a rise in prices. In the case of a temporary adverse supply shock, the production function and the labor demand curve shift downward. If wages and prices are sticky, real wages will not initially adjust to clear the labor market and the economy will temporarily operate at a level of output below the natural rate (such as Q_2). Over time, prices will rise as price and wage contracts are renegotiated. If monetary authorities accommodate the temporary shock, output will initially fall and prices will rise (to P_1); if authorities adopt a neutral policy, the aggregate demand curve would shift to the right to intersect the new aggregate supply curve at the (permanent) natural level of output (at E_2), putting further upward pressure on wages and prices.

Over time, the output effects will be reversed as the effects of the temporary supply shock abate. The permanency of the effects on the price level depends on the stance of the monetary authorities.

In both the demand and the temporary supply shock cases, there is the familiar temporary deficit capacity in the goods and factor markets. In the former case, however, the negative gap is associated with a fall in prices; in the latter case the negative gap is associated with a rise in prices.

III. ESTIMATING THE OUTPUT GAP USING STRUCTAURAL VAR METHODOLOGY

Since potential output and the output gap cannot be observed, various econometric techniques are commonly used to construct them. These techniques include univariate and multivariate filters and structural models. The various methods have been reviewed recently by several authors including De Masi (1997), Dupasquier, Guay, and St-Amant (1997), and St-Amant and van Norden (1997).

An alternative technique to the mechanical filters and the more sophisticated structural models discussed above is the structural VAR technique. This method uses minimum theoretical restrictions to identify the major shocks to the system and to decompose movements in output into permanent and transitory components. Those shocks can then be used to construct the measures of the output gap. A particular variant of that approach—based on long-run restrictions on output proposed by Blanchard and Quah (1989) and Shapiro and Watson (1989)—is used in this paper.

Within the structural VAR approach, several techniques can be used to recover the information required. The reduced-form VAR provides reduced-form errors from which the structural shocks can be recovered. Blanchard and Quah (1989) show that the recovery of the structural shocks from the reduced-form errors requires the identification of the elements of the matrix of contemporaneous coefficients that relates the structural shocks to the reduced-form errors.

One way to do this is to use a Choleski decomposition, which restricts the matrix of contemporaneous coefficients to a lower triangular matrix. As a result, one variable is assumed not to have a contemporaneous effect on the other(s). Both shocks may affect the contemporaneous value of one variable, but only one shock is allowed to affect the other. Unfortunately this mechanical procedure is very sensitive to the ordering of the VAR variables, particularly when the correlation between the reduced-form errors is high. Bernanke (1986) and Sims (1986) use direct restrictions on the contemporaneous interactions amongst the variables based on economic theory. An alternative approach—the one used in this paper—follows Blanchard and Quah (1989) and Shapiro and Watson (1989) and uses restrictions on the long-run dynamic effects of the shocks on particular variables in the system to identify the structural shocks.

An advantage of the Blanchard and Quah approach is that it does not impose any restrictions on the contemporaneous interaction amongst the variables in the system and leaves the dynamics of the system unconstrained. This is particularly useful for developing countries where short-run structural relationships are less clearly defined. The identifying restrictions used in this approach are the orthogonality restriction, the restrictions embedded in the variance-covariance matrix of the reduced-form innovations and the long-run restriction.

The basic AS-AD model depicted above provides the theoretical underpinnings for the long-run restrictions used here. The AS-AD model assumes that aggregate supply shocks have permanent effects on the level of output while aggregate demand shocks, and temporary aggregate supply shocks, exert only temporary effects. A positive permanent supply shock shifts the long-run supply curve out, resulting in a permanent increase in output and a permanent fall in prices. A positive demand shock shifts the aggregate demand curve out, which increases output (temporarily) and prices. Since the long-run aggregate supply curve remains unchanged, prices will rise further over time and output will eventually return to the long-run equilibrium level—accordingly, only the price level is affected in the long run. A positive temporary supply shock shifts the aggregate supply curve out which increases output (temporarily) and reduces prices. These identifying restrictions are generally accepted—the short-run, long-run dichotomy and the notion of long-run neutrality of money are consistent with most models including Mundell-Flemming-type models.

A bivariate VAR system using output and price data is used to estimate permanent and transitory output shocks. This specification follows Bayoumi (1992) and Bayoumi and Eichengreen (1994), who extend Blanchard and Quah by using output and prices rather than output and unemployment. Bergman (1996) and Keating and Nye (1998) also use a bivariate VAR using output and price data.

The choice of this system reflects both theoretical and practical considerations. The approach is relatively straightforward and the underlying assumptions of this approach are consistent with the AS-AD framework discussed earlier. The advantage is that data requirements are limited—only output and price data are required for each country. This is an important consideration, since the paucity of developing country data and their poor quality are well recognized (Heston 1994; Srinivasan 1994). Therefore, using a limited number of the better-quality series has practical advantages. While there may be some gains in including more information to identify the structural components, there is also a cost in terms of less precise estimates and in imposing additional identifying restrictions.

The identification procedure follows Blanchard and Quah (1989), using the simplification proposed by Lastrapes (1992), as followed recently, for example, by Hoffmaister and Roldós (1997), as outlined below.

The model is expressed as an infinite moving average representation of the variables such that:

$$\Delta x_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + \ldots = \sum_{i=0}^{\infty} A_i\varepsilon_{t-i} = A(L)\varepsilon_t, \tag{6}$$

where $\Delta x_t = \begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix}$, $\Delta\varepsilon_t = \begin{bmatrix} \varepsilon_t^P \\ \varepsilon_t^T \end{bmatrix}$. It is assumed that the change in output, Δy, and the change in prices, Δp, are stationary, and that the permanent and transitory structural errors, ε^P, and ε^T respectively, are uncorrelated white noise disturbances. The variance of the structural shocks is normalized so that $E(\varepsilon_t\varepsilon_t) = I$, the identity matrix.

The moving-average representation of the reduced-form of the model is:

$$\Delta x_t = \boldsymbol{e}_t + C_1\boldsymbol{e}_{t-1} + \ldots = \sum_{i=0}^{\infty} C_i\boldsymbol{e}_{t-i} = C(L)\boldsymbol{e}_t, \tag{7}$$

where $\boldsymbol{e}_t$ is a vector of estimated reduced-form residuals with variance $E(\boldsymbol{e}_t\boldsymbol{e}_t) = \boldsymbol{\Omega}$ and the matrices C_i represent the impulse response functions of shocks to Δy and Δp.

From equations (6) and (7) it follows that the structural innovations are a linear transformation of the reduced-form innovations. The reduced-form residuals are related to the structural residuals by:

$$\boldsymbol{e}_t = A(0)\varepsilon_t, \tag{8}$$

where $A(0)$ is a matrix of the contemporaneous effects of the structural innovations. As a result:

$$E(\boldsymbol{e}_t\boldsymbol{e}_t) = A(0)E(\varepsilon_t\varepsilon_t)A(0)', \tag{9}$$

and since $E(\varepsilon_t\varepsilon_t) = I$:

$$A(0)A(0)' = \boldsymbol{\Omega}. \tag{10}$$

To recover the structural innovations it is necessary to provide sufficient restrictions to identify the elements of the matrix $A(0)$.

From equations (6) and (7) note that $C(0) = 0$ and hence:

$$A(0)\varepsilon = \boldsymbol{e}. \tag{11}$$

Lagging equation (6) gives:

$$A(j)\varepsilon_{-j} = C(j)\boldsymbol{e}_{-j}, \tag{12}$$

and therefore:

$$A(j) = C(j)A(0). \tag{13}$$

Using the simplification proposed by Lastrapes (1992), from equation (13) for $j = 1$:

$$A(1) = C(1)A(0), \tag{14}$$

and using equation (10):

$$A(1)A(1)' = C(1)\Omega C(1)'. \tag{15}$$

Where $A(1)$ is lower triangular (as in the case where the cumulative effect of an ε^T shock on the Δy sequence is equal to zero), it can be calculated as the lower Choleski decomposition of $C(1)\Omega C(1)'$. The matrix $A(0)$ is then calculated as:

$$A(0) = C(1)^{-1}A(1). \tag{16}$$

This allows the retrieval of the structural shocks using the residuals from equation (7). The exogenous shocks identified from the bivariate structural models (6–16) and the A matrix of coefficients can be used to construct measures of the output gap.

Following St-Amant and van Norden (1997), potential output is constructed as the level to which output reverts as the effects of demand disturbances, or temporary supply disturbances dissipate—that is, the level of aggregate output achievable over time without placing undue pressures on resources. It is assumed that shifts in potential output reflect permanent labor supply and productivity shocks—that is, those types of disturbances that are likely to have permanent effects on aggregate output. Other disturbances are treated as demand disturbances or temporary supply disturbances, that is, the cyclical (or in the case of supply disturbances, irregular) component of output. From equation (6) potential output, y^*, is given by the sum of the projected deterministic trend in output and the cumulative effects of past permanent supply shocks:

$$y_t^* = \mu + A_1(L)\varepsilon_t^P, \tag{17}$$

where μ is the projected deterministic trend in output and ε^P are permanent aggregate supply shocks. The output gap is given by:

$$(y - y^*) = y_t - [\mu + A_1(L)\varepsilon_t^P]. \tag{18}$$

The interpretation of the output gap recovered in equation (18) depends on the nature of ε^T, the temporary shocks introduced above. If demand shocks dominate movements in actual output around potential, the permanent/transitory decomposition will separate fluctuations in output into supply and demand shocks; if however, short-term fluctuations in output are dominated by temporary supply shocks, the permanent/transitory decomposition will separate fluctuations in output into these two components.[5] The impulse response functions, reported below, provide an indication of the nature of these shocks.

IV. ESTIMATION

The structural VAR model is estimated using annual data over the period 1973 to 1998. The sample period was chosen to cover a maximum estimation period while covering a critical mass of countries.[6] The starting point coincides with the onset of the post–Bretton Woods era.[7] Fifty-six developing countries produce the required data over that period (Appendix Table I).[8] The gaps are estimated separately for each of the countries in the sample. For analysis, the countries are grouped into five regional groups—Africa, Asia, the Middle East, the Western Hemisphere, and the Western Hemisphere (high-inflation countries). This is because regional groups are more likely to share similar structural and institutional characteristics and be affected by similar disturbances compared with a broader grouping.

Data are derived from the International Monetary Fund, *International Financial Statistics, 2000* (IMF 2000). The price measure is the gross domestic product deflator (99b/99bp). The gross domestic product deflator is used, since this measure is generally considered to be the most comprehensive measure of a country's price level (Brajer 1992). The output measure is the gross domestic product at constant prices (99bp).

Prior to the estimation, the statistical properties of the data were examined as they play an important role in the type of empirical analysis conducted here. There are important differences, for example, in data with a unit-root process and those with a trend-stationary process. Shocks to difference-stationary processes permanently shift the trend while shocks to trend-stationary processes have a transitory effect as the effects dissipate over time. Accordingly, identification of permanent and transitory shocks to series requires different techniques depending on the nature of the data-generating process. Similarly, the types of transformations that are necessary to induce stationarity will vary depending on the statistical properties of the data.

[5] Keating and Nye (1998, p. 245) make a similar observation. In referring to nineteenth-century (then developing) countries, they note "Suppose there are only two kinds of shocks in these three nineteenth-century economies: Supply shocks that have temporary output effects and supply shocks that have permanent effects on output. Under this assumption, a permanent-transitory decomposition would effectively separate output into these two supply shocks."

[6] Most developing countries publish only annual output data. Since other studies suggest that adjustment to disequilibrium conditions appears to be relatively slow in developing countries, this may not be too limiting.

[7] The mid-1970s was also a period of substantial shifts in exchange rate regimes in developing countries (Aghevli, Khan, and Montiel 1991).

[8] Within this group of countries, some countries were excluded following tests on the statistical properties of the data. The structural VAR procedure requires that the order of integration of the series to be decomposed—in this case output—is one.

An integrated series is denoted by $I(d)$, where d is the number of differences required on the level series to ensure that the new series is stationary or mean-reverting, that is, it has a constant mean and a finite variance. The structural VAR approach requires that the growth rate of output follows a stationary stochastic process, that is, the level of output is $I(1)$. The order of integration of prices in the VAR can vary. An $I(1)$ or $I(2)$ variable can be differenced accordingly and a trend-stationary variable can be used by taking the residuals from the deterministic trend.

Three tests are used to examine the order of integration of the series: the Augmented Dickey-Fuller (ADF) test,[9] the Phillips-Perron (1988) (PP) test, and the Kwiatkowski, Phillips, Schmidt, and Shin (1992) (KPSS) test.[10] The results suggest that output is generally $I(1)$ although for several countries the evidence suggests that it is trend stationary. Prices generally appear to be $I(1)$, but for several countries the results suggest that the series may be better described by $I(2)$ processes and for a couple of countries they appear to be trend stationary.[11]

The first step in the process was to estimate reduced-form VARs for each country in the sample using the bivariate systems as described above.[12] Output was first differenced and prices were differenced once or twice, depending on the order of integration, or taken as a deviation from trend in the case of trend-stationary series.[13]

The lag structure of the VARs was based on a general to specific approach, with a sequential likelihood ratio statistic used to determine the appropriate lag length. Generally the tests indicated a lag length of one, although in a few cases two lags were necessary to ensure that the null of no autocorrelation was rejected. However, DeSerres and Guay (1995) argue that the standard information criteria often suggest the inclusion of an insufficient number of lags. A one-period lag length may be inadequate to properly capture the dynamic responses of the system to economic disturbances (Ahmed and Park 1994). Accordingly, a lag length of two was used for all the countries.[14]

The structural shocks were recovered as described above. The historical decom-

[9] See Dickey and Fuller (1979), Dickey and Pantula (1987), and Said and Dickey (1984).

[10] The results are not reported here but are available on request.

[11] Although the order of integration of prices remains a controversial area, Phillips (1995) shows that the structural VAR technique does not perform adequately if either nonstationary or quasi-nonstationary series is used. Accordingly, the change in inflation is included in the vector autoregession for those countries where the unit roots tests could not reject the hypothesis that prices are $I(2)$.

[12] Estimation was conducted using RATS software.

[13] Where output was $I(2)$ or trend-stationary, the structural VAR procedure was not appropriate and those countries were removed from the sample.

[14] As part of the early screening, the residuals from the reduced-form VAR were examined for the presence of outliers. While outliers can contain useful information at times, they may also reflect measurement problems, breaks in series and one-off shocks that cannot be adequately covered in a

position of the variable was constructed by setting all the transitory shocks to zero and using the permanent shocks to obtain the permanent changes in the variable. The disequilibrium terms were constructed as deviations from the accumulation of these permanent shocks (and the trend).

Before proceeding to the results, some important caveats should be raised. At a general level the structural VAR approach suffers from much the same criticism as that leveled against ordinary VARs—the absence of a complete specification derived from first principles including preferences, technologies, and explicit equilibrium conditions. The parsimonious nature of bivariate structural VARs, while commonly used in econometric research, could attract analogous criticism at a macroeconomic level.

More specifically, inappropriate shock aggregation and time aggregation may become an issue with the structural VAR methodology (Faust and Leeper 1997). Small-dimension structural VARs allow the identification of only a limited number of shocks. In practice, however, it is likely that there are many different types of shocks affecting a system so that the shocks identified by the VAR methodology could be an aggregation of shocks. If the shocks are dissimilar, then the aggregation may provide a poor representation of the underlying relationships and the aggregate shocks may be inadequately identified.[15]

The issue of inappropriate time aggregation is a common problem in all empirical time series work in that the causal relationships between variables may occur within the periodicity of the data used. This is particularly likely when annual data are used, and where the focus is on disequilibrium dynamics, as in this study. Rossana and Seater (1995) argue that annual data distort the dynamic effects of the shocks, relative to higher-periodicity data. Some comfort is provided, however, by widespread evidence of rigidities and inertia in developing country macro-aggregates and by the findings of other studies, which confirm the slow pace of adjustment to disturbances in many of these countries.

A final caveat is the usual, but important problem about the quality of developing country data. The lack of data in developing countries and their poor quality are widely recognized. This paper uses a limited set of what is regarded as the more important, and hence more widely available and "better"-quality macro-data. Streamlined theoretical and empirical structures are used to keep the data needs within the

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parsimonious model specification. These distortions are likely to be particularly important for developing countries. Outliers were omitted from the reduced-form VAR if they exceeded three standard errors.

15 Larger-dimension structural VARs, however, require additional identification restrictions, which may be difficult to support. There is also a loss of precision with the large-dimension VARs, particularly where data are limited. The assumption made in this study is that the shocks are dominated by two main underlying shocks; supporting information from impulse response functions is used to provide some confirmation of the theoretical priors.

constraints of the available data. Nevertheless, the data are clearly of poor quality and this is an important caveat to the results.

V. RESULTS

A. *Impulse Responses*

The adjustment of output to shocks was examined using impulse response functions for each country. Impulse response functions show the response of the system to *a one-standard-deviation* shock to one of the variables.

As expected, impulse response functions suggested that permanent shocks to output behave like aggregate supply shocks, with positive supply shocks boosting output and permanently lowering prices.[16] These results are consistent across each of the subsamples, suggesting that, in accordance with the findings in other studies (Hoffmaister and Roldós 1996, 1997; Hoffmaister, Roldós, and Wickham 1998), supply shocks are the dominant source of permanent movements in output in developing countries.

The most interesting result, however, is the effect of a temporary shock on output. In the case of a (positive) nominal shock, output and price would be expected to move upwards together. In the case of a temporary supply shock, however, a rise in prices would be expected to be associated with a temporary fall in output.

Results of the impulse response functions for each of the five subsample groups, are shown in Figure 2. In slightly more than half of the countries, a temporary shock (to the orthogonalized error in the price equation) leads to a temporary fall in output and a rise in prices. This suggests that temporary shocks to output in many developing countries are dominated by supply shocks with the effects dissipating over a horizon of two or three years and in some cases longer. In slightly less than half of the developing countries examined, the shocks behave like more traditional demand-side shocks, leading to a temporary rise in output and higher prices.

A simple check on the results is to examine the correlation between inflation and the estimated cyclical component of output (Chadha and Prasad 1993). If temporary movements in output are primarily due to demand shocks, the correlation between inflation and the cyclical movements in output would be expected to be positive; if temporary movements are mainly due to supply shocks it would be expected to be negative. The results confirm the findings from the impulse response functions.

[16] The stance of monetary policy is a major determinant of the permanency of price changes. This suggests that the nature of the exchange rate regime is an important consideration. Most countries in the study had flexible exchange rate arrangements over the period; most of those that had fixed arrangements were unable to hold the level of the peg steady for sustained periods. Only two of the fifty-eight countries in the sample maintained a fixed exchange rate at the same level of the full period, and the results for these two countries were broadly consistent with the AS-AD framework.

Fig. 2. Output Response to a Temporary Shock

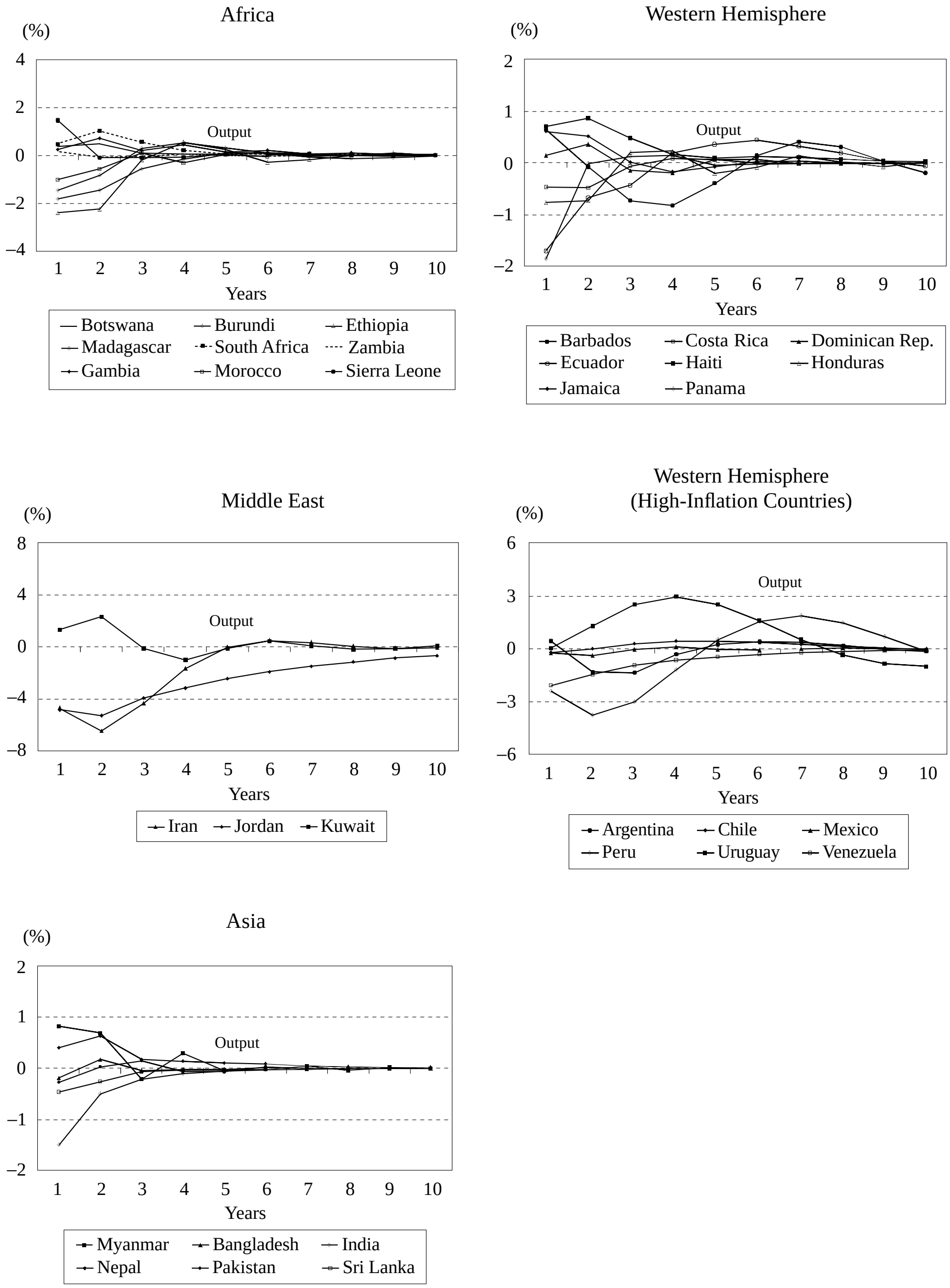

TABLE I

VARIANCE DECOMPOSITION

Years	Output		Prices	
	Shock to Output	Shock to Prices	Shock to Output	Shock to Prices
Developing countries:				
1	87.62	12.38	14.08	85.92
3	91.64	8.36	20.02	79.98
5	94.08	5.92	22.16	77.84
Africa:				
1	89.41	10.59	6.95	93.05
3	94.04	5.96	9.78	90.22
5	96.04	3.96	10.66	89.34
Asia:				
1	90.53	9.47	17.37	82.63
3	95.28	4.72	31.55	68.45
5	97.13	2.87	35.52	64.48
Middle East:				
1	60.92	39.08	25.98	74.02
3	68.58	31.42	26.92	73.08
5	81.44	18.56	27.75	72.25
Western Hemisphere:				
1	90.60	9.40	14.75	85.25
3	96.47	3.53	24.50	75.50
5	97.88	2.12	28.02	71.98
Western Hemisphere (high-inflation countries):				
1	91.42	8.58	14.64	85.36
3	89.49	10.51	14.44	85.56
5	89.32	10.68	15.46	84.54

B. *Variance Decomposition*

Variance decomposition for the full sample and for each of the subsamples is reported in Table I. The variance decomposition shows the proportion of the variance of the forecast error that can be attributed to each of the endogenous variables. Each panel shows the percentage of the output and price variance that can be attributed to shocks to output and price, respectively; forecast horizons of one, three and five years are reported.

For the full sample, the results suggest that permanent supply shocks explain a large part of the movements in output in developing countries. Supply shocks explain around 88 per cent over a one-year forecast horizon, rising to around 94 per cent over a five-year horizon; nominal shocks account for around 12 per cent over a one-year horizon. For prices, permanent real shocks explain only 14 per cent over a one-year horizon, rising to around 22 per cent over a five-year horizon; nominal shocks account for a large part of the forecast variance in prices. These results are broadly similar across the five subsample groups.

For Africa, shocks to output are dominated by “own shocks,” with nearly 90 per cent of the forecast error variance explained by supply shocks over a one-year horizon. Nominal shocks account for around 10 per cent over a one-year horizon and less than 6 per cent over a five-year horizon. For Asia, the results are similar, with output shocks accounting for more than 90 per cent of the forecast error variance for a one-year horizon, rising to more than 97 per cent over a five-year horizon.

For the Middle East, “own shocks” dominate shocks to output although nominal shocks explain a substantial proportion of the forecast error variance. Over a one-year forecast horizon, more than 39 per cent of the variance is explained by shocks to prices, and over a three-year horizon, more than 31 per cent is explained by nominal shocks, well above the average for other regional groups. For the Western Hemisphere countries, the results are similar to those for the developing countries as a group, although in the high-inflation group of the Western Hemisphere countries, nominal shocks appear to have longer-lasting effects on output than in the countries that have experienced more moderate inflation rates.

In terms of prices, the results are generally consistent across regional groups, although there are some interesting differences within the regional groups. For Africa, nominal shocks account for a large part of the movement in prices; shocks to output account for less than 7 per cent over a one-year horizon. For Asia, nominal shocks also dominate price movements, although the contribution from real shocks is substantially above the developing-country average. Around 17 per cent of the forecast error variance is explained over a one-year horizon and this rises to more than 35 per cent over a five-year horizon. In the Middle East real shocks also appear to account for an above-average contribution to movements in prices. For the Western Hemisphere countries nominal shocks dominate price movements, although real shocks exert substantial effects, particularly for the lower-inflation group of countries for longer-term horizons.

VI. CONCLUSION

The results suggest that the decomposition of output into permanent and transitory shocks is not sufficient to properly identify demand and supply shocks for many developing countries. Rather the technique appears to split the shocks into permanent supply shocks, and temporary demand or supply shocks depending on which influence dominates in a particular country. While the permanent/temporary decomposition is still useful, clear caveats apply to the interpretation of the temporary component, at least for developing countries.

Since output gaps are effectively just an accumulation of temporary output shocks, the same caveats apply. The results suggest that measures of the output gap constructed for developing countries are likely to capture a mix of supply- and demand-induced deviations in actual output from potential output. The dominant influence may, or may not be, demand shocks.

Accordingly, the results suggest that output gap measures are a less useful guide for assessing inflationary pressures and for conducting monetary policy in developing countries. Given the ambiguity of these measures, other measures of excess or deficient demand—such as money velocity gaps or external price gaps—may be more useful guides for policy making in developing countries.[17]

[17] For money gaps see for example Hendry (1995) and Fung and Kasumovich (1998). For external price gaps see Kool and Tatom (1994) and Garcia-Herrero and Pradhan (1998).

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APPENDIX TABLE I

COUNTRY LIST

Africa	Botswana, Burundi, Cameroon, Ethiopia, The Gambia, Ghana, Kenya, Madagascar, Malawi, Mauritius, Nigeria, South Africa, Sierra Leone, Tanzania, Togo, Uganda, Zambia
Middle East	Iran, Israel, Jordan, Kuwait, Morocco, Saudi Arabia, Syrian Arab Republic, Tunisia
Asia	Bangladesh, India, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand
Western Hemisphere	Barbados, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Haiti, Honduras, Jamaica, Panama, Paraguay, Trinidad and Tobago
Western Hemisphere (high-inflation countries)	Argentina, Bolivia, Brazil, Chile, Mexico, Peru, Uruguay, Venezuela