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The Response of the Current Account to Terms of Trade Shocks: Persistence Matters

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The Response of the Current Account to Terms of Trade Shocks: Persistence Matters

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Abstract

Is the relationship between the current account balance and the terms of trade affected by the persistence of terms of trade shocks? In intertemporal models of the current account that incorporate a consumption-smoothing and an investment response to shocks, the effect of the terms of trade on external balances is predicted to be dependent on the duration of terms of trade shocks. Using a median-unbiased estimator, an unbiased model-selection rule, and terms of trade data for 128 countries over the period 1960–99 we identify two groups of countries—those that typically experience temporary terms of trade shocks and those that typically experience permanent terms of trade shocks. The results from panel-data regressions of the two groups of countries support the theoretical predictions of the intertemporal approach to the current account. We find that the greater (lesser) the persistence of the terms of trade shock, the more (less) the investment effect dominates the consumption-smoothing effect on saving, so that the current account balance moves in the opposite (same) direction as that of the shock.

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Contents

I. Introduction

How does the current account respond to shocks such as changes in a country's terms of trade? This question, posed in early contributions by Harberger (1950) and Laursen and Metzler (1950), has generated a great deal of debate in the literature on international economics. The Harberger-Laursen-Metzler (or HLM) effect predicts a positive relationship between (temporary) exogenous changes in the terms of trade and national saving, through consumption-smoothing behavior. For example, a deterioration in the terms of trade results in a decrease in a country's current real income that is larger than the fall in its permanent income. Using a single-good, Keynesian open-economy model and given that the marginal propensity to consume is less than unity, national consumption is also predicted to fall. Moreover, since investment is implicitly unchanged, the current account balance must worsen.

This work was extended into the perfect-foresight (intertemporal) framework by Obstfeld (1982) and Svensson and Razin (1983), who introduced two-good models (importables and exportables) of a small, open endowment economy to examine the influence of shocks to the terms of trade on intertemporal decisions. These intertemporal models show that the strength of any HLM-like income effect diminishes with the *duration* of the terms of trade shock. For example, an (unanticipated) permanent deterioration in the terms of trade lowers national income in the current period and all future periods, and this leads to lower consumption without disrupting savings plans (and so leaves the current account unchanged). In contrast, if the (unanticipated) terms of trade deterioration is temporary, then current income falls relative to permanent income—consumption smoothing ensures that this loss is smoothed over future periods by lowering aggregate savings, thus worsening the current account balance.[2, 3]

However, an important shortcoming of these endowment models is that they ignore the impact of changes in the terms of trade on the optimal capital stock and, hence, the impact of investment (capital accumulation) on the current account balance. Moreover, the effect of investment on the current account balance works in the opposite direction to the consumption-smoothing effect. The change in the capital stock will be greater for more

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[2] A number of studies test the consumption-smoothing hypothesis using current account data, including Otto (1992) and Ghosh (1995). However, these papers do not require an explicit formulation for the dynamic process of shocks and the implications of this for the current account. As a result, this literature overlooks the role played by the degree of persistence in the underlying shocks.

[3] Edwards (1989) incorporates nontradables and examines the additional effects terms of trade shocks can exert through changes in the real exchange rate (the relative price of tradables and nontradables). In a three-good (importable, exportable, and nontradable) endowment economy model of intertemporal optimization, in which countries specialize in the production and transportation costs are nonzero, countries consume both importables and nontradables, and relative prices (substitution effects) can also influence saving decisions (Ostry and Reinhart, 1992; Cashin and McDermott, 2003a).

persistent shocks: while a purely temporary shock to the terms of trade will have no investment effect, a permanent shock will have a strong investment effect. The response of investment to terms of trade shocks feeds directly into the determination of current account positions (see Murphy, 1992; Servén, 1999).[4]

In periods following terms of trade shocks, the current account can move in the opposite direction to the shock if the effect on investment dominates the consumption-smoothing effect. The likelihood that investment (rather than saving) is the dominant channel for the effect of terms of trade shocks on the current account rises with the duration of the shock.[5] These theoretical implications of the intertemporal approach to the current account are tested in this paper by taking advantage of the fact that the persistence of shocks to the terms of trade varies greatly across countries.

Some of the stylized facts of the terms of trade, including their correlation with the trade balance, were examined by Backus, Kehoe, and Kydland (1994) and Mendoza (1992, 1995) using stochastic dynamic general-equilibrium models. Given the ambiguous results from economic theory, it is surprising that there have been few empirical analyses of the relationship between the current account and shocks to the terms of trade. Key exceptions have been analyses of the HLM effect and intertemporal (endowment economy) models of the current account by Ostry and Reinhart (1992); Ogaki, Ostry, and Reinhart (1996); Cashin and McDermott (2002, 2003a); and Otto (2003). Several authors have sought to identify the impact of terms of trade shocks on output and the current account by extending the Blanchard and Quah (1989) framework to an open economy setting, using structural vector autoregressive models to identify major sources of economic shocks. Both Ahmed and Park (1994) and Otto (2003) find that innovations in the terms of trade explain a large proportion

[4] Glick and Rogoff (1995) incorporate the investment decision explicitly in their structural estimation of a simple current account model. Their model contains one good and thus is restricted to productivity shocks. They show that there is a significant negative relationship between productivity shocks (which are highly persistent), gross investment, and the current account balance; however, they do not discuss the effects of less persistent shocks. Iscan (2000) extends this model to include nontraded goods and finds no significant effect of the terms of trade on the current account for the Group of Seven countries. Spatafora and Warner (1999) examine the effect of persistent terms of trade shocks on the current accounts of oil exporters, finding that innovations to the terms of trade typically had little effect on saving, a positive relationship with investment, and so a negative effect on the current account balance.

[5] Obstfeld and Rogoff (1995) provide an extensive review of the recent theoretical and empirical literature on the intertemporal approach to the current account. They discuss the theoretical importance of the degree of persistence of a shock, but do not present any direct evidence regarding persistence.

of the variation in the current account and conclude that the HLM effect plays an important role in the dynamics of the current account.[6]

The key objective of this paper is to establish whether the persistence of terms of trade shocks affects the relationship between the current account and the terms of trade. The paper includes a number of innovations with respect to earlier empirical literature on this subject. First, we put together data covering a very large set of countries (128 in the full sample) covering the post-Bretton Woods period. Second, we use the median-unbiased estimator of Andrews (1993) to obtain an unbiased scalar measure of the duration of terms of trade shocks.[7] This allows us to identify two groups of countries, one with predominantly temporary terms of trade shocks, the other with predominantly permanent terms of trade shocks. Third, using an episodic approach and dynamic panel estimates, we compare the response of the current account to unanticipated changes in the terms of trade across these two groupings.

We have several main findings. First, there is a good deal of heterogeneity across countries in the persistence of shocks to their terms of trade—about half the countries in our sample are found to have finite (temporary) terms of trade shocks, while the other half typically experience permanent shocks to their terms of trade. Second, we use an episodic approach to examine periods of large terms of trade changes and the response of the current account. We find that countries with permanent terms of trade shocks had more episodes of negative correlation between movement in the current account and their terms of trade than countries with temporary terms of trade shocks. Third, our results from panel-data regressions support the theoretical predictions of the intertemporal approach to the current account. The greater (lesser) the persistence of the terms of trade shock, the more (less) the investment effect dominates the consumption-smoothing effect on saving, so that the current account moves in the opposite (same) direction as that of the shock. That is, there is a negative relationship between the persistence of terms of trade shocks and the degree of correlation between the terms of trade and the current account balance.

The remainder of the paper is organized as follows. Section II presents a simple intertemporal representative-agent model that highlights the consumption-smoothing and investment effects of terms of trade shocks on the current account balance. The data and some stylized facts regarding correlations between changes in the current account and changes in the terms of trade are presented in Section III. Section IV sets out the empirical

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[6] These results are also consistent with those reported by Mendoza (1995) from simulating a stochastic dynamic general-equilibrium model of a small, open economy. However, while Mendoza finds that the terms of trade and the trade balance are positively correlated (supporting the HLM effect), the size of this correlation is found to be invariant to the degree of persistence of the terms of trade shock (which is inconsistent with intertemporal models of the current account).

[7] As noted by Otto (2003), at present there exists no generally accepted view as to whether or not the terms of trade are stationary in levels or in first differences.

panel regression methodology and describes the median-unbiased estimator used to measure the persistence of terms of trade shocks. Using these measures, countries are separated into groups according to the degree of persistence of innovations in their terms of trade. Section V presents the results of the panel-data regressions, which are used to compare the responsiveness of the current account balance to unanticipated changes in the terms of trade across these two groups of countries. The robustness of the empirical results to credit constraints, the role of exchange rate regimes, and the influence of unrequited transfers are also briefly considered in Section V. Some concluding remarks are offered in Section VI.

II. Theoretical Framework

This section describes a simple model of the current account that incorporates the consumption-smoothing and investment effects, and highlights the role of the degree of persistence of shocks.[8] The model is of a small open economy facing a given world interest rate. The economy consists of a single infinitely-lived representative agent. The agent is assumed to supply one unit of labor inelastically. The agent's problem is to choose the path of investment and consumption so as to maximize lifetime utility, which is given by

$$U = \sum_{t=0}^{\infty} \frac{u(c_t)}{(1+\delta)^t}, \tag{1}$$

where c_t is consumption at time t, δ is the agent's rate of time preference and $u(\circ)$ is a time-separable utility function with the usual properties, that is, $u' > 0$ and $u'' < 0$. The simple model abstracts from uncertainty, although later in the paper we discuss its relevance for the estimation methodology.

There are only two goods in this model, an import good and an export good. The agent consumes only the import good, and the export good is the only good produced domestically. The price of imports is normalized to one, such that the price of exports, p_t, is the terms of trade. Exports, y_t, are produced according to the following production function,

$$y_t = A_t f(k_t), \tag{2}$$

where k is the level of the capital stock; also, $f' > 0$ and $f'' < 0$. The unit price of capital is fixed and equal to one (by the appropriate choice of units). The depreciation rate on capital is set to zero for simplicity. The law of motion of the capital stock is

$$k_{t+1} = k_t + i_t, \tag{3}$$

where i is the level of investment.

[8] For an overview of these types of models, see Obstfeld and Rogoff (1995).

The agent can borrow or lend on the world capital market at the fixed interest rate $r_t = r$ (denominated in units of imports). The agent's dynamic budget constraint is therefore,

$$\Delta b_{t+1} = rb_t + p_t y_t - c_t - \Delta k_t , \tag{4}$$

where b_t is the stock of net foreign assets at the beginning of time period *t*, and Δ is the first difference operator. Equation (4) is also the definition of the current account balance which is the change in net foreign assets, Δb_t.[9]

The optimal level of the capital stock is given by equating the marginal value product of capital to the world interest rate,

$$p_t A_t f'(k_t) = r . \tag{5}$$

Equation (5) shows the optimal level of the capital stock at time *t*. Implicitly, equation (5) shows that investment at time *t-1* depends on the expectation at *t-1* of the terms of trade and productivity at *t*.

In this very simple model, shocks to the terms of trade have exactly the same effect as productivity shocks. Specifically, the elasticity of the capital stock with respect to the terms of trade is equal to the elasticity of the capital stock with respect to productivity,

$$\frac{\partial k}{\partial p}.\frac{p}{k} = \frac{\partial k}{\partial A}.\frac{A}{k} = \frac{-f'}{kf''} > 0 . \tag{6}$$

A more realistic model would have more than one sector producing goods. In the case of a positive terms of trade shock, the export sectors would expand and the import-competing sectors would contract (nontraded sectors could go either way). In such a model, an increase in the terms of trade would have less of an impact than an equal percentage increase in productivity (across all sectors). However, so long as a positive terms of trade shock leads to an aggregate increase in investment, the results that follow will still hold qualitatively.

In this model, the response of investment is dependent on the duration of terms of trade shocks. There is insufficient time to observe and then respond to a purely transitory unanticipated shock. However, for more persistent shocks, investment will respond according to equation (5). The investment effect by itself leads to a negative correlation between the shock and the current account in the period that the shock is observed.

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[9] There is the transversality condition, $\lim_{t\to\infty} b_t /(1+r)^t = 0$, which prevents the agent from building up debt to levels so high that it can only be financed by rolling over the debt by further borrowing.

In reality, the response of investment may be delayed and more extended than is implied by this model.[10] This could be due to a number of factors, including: delayed learning about the true nature of a shock[11]; quadratic costs of adjusting the capital stock; and time to install and remove capital equipment (Glick and Rogoff 1995; Obstfeld and Rogoff 1995).

Consumption behavior is determined by the Euler equation of this problem:

$$\frac{u'(c_{t+1})}{u'(c_t)} = \frac{1+\delta}{1+r}. \tag{7}$$

We assume that $\delta = r$ for expositional purposes.[12] Given the assumption of strict concavity of the within-period utility function, this implies a flat consumption path. Consumption will be equal to the level of permanent income, namely

$$y_t^p = r\left[b_t + \sum_{j=t}^{\infty} \frac{p_j y_j}{(1+r)^{j-t}}\right]. \tag{8}$$

Any differences between permanent and current income are reflected in the current account balance. This is the familiar consumption-smoothing effect.

The effect of a shock is best illustrated by a simple example. The economy is initially in steady state at time $t = 0$, with $p_t = p$, $A_t = A$ and the current account equal to zero. Now consider a shock to either productivity and/or the terms of trade as follows:

$$p_t A_t = \begin{cases} pA(1+\varepsilon) & \text{for } t = 0,1,\ldots,\tau \\ pA & \text{for } t = \tau+1, \tau+2,\ldots \end{cases} \tag{9}$$

[10] Also, consumption may not adjust instantaneously to shocks. We ignore this issue by presuming that consumption responds more rapidly than investment.

[11] This is particularly important if investment involves fixed costs. If investment involves significant fixed costs, then a large temporary shock to the terms of trade should have a different effect from a small temporary shock. That is, the degree of intertemporal substitutability of investment (often measured as the inverse of installation costs of capital goods) will also affect the current account response to a temporary change in the terms of trade (see Servén, 1999, for additional details). For a discussion of learning about shocks in the context of investment and the current account see Miniane (2003).

[12] With $\delta \neq r$ the consumption path has a trend. In this case, the current account will have a trend except when the paths of A_t and p_t imply the same trend for consumption and income. These possibilities are dealt with in the empirical section of this paper by detrending all of the series.

Consider a positive shock, $\varepsilon > 0$ (although the argument is symmetric for negative shocks). There are three cases to consider depending on the persistence of the shock.

Case 1: The shock is **permanent**, $\tau = \infty$.

Investment increases today, but the capital stock does not reach its new level until the following period. Hence, current income rises today but by less than permanent income. The consumption-smoothing effect leads to a current account deficit today. The investment effect also causes a current account deficit in the same period that the shock is realized. (A small current account surplus in future periods ensures that the intertemporal budget constraint is satisfied.)

Case 2: The shock is **purely temporary**, $\tau = 0$.

There is no investment effect because there is not enough time to react to the shock. Current income rises by more than permanent income and so the consumption-smoothing effect implies a current account surplus at the time of the shock.

Case 3: The shock is **temporary but persistent**, $0 < \tau < \infty$.

Now permanent income rises by less than current income.[13] Consumption smoothing would, by itself, lead to a current account surplus in all periods from $t = 0$ to $t = \tau$. The magnitude of this effect is decreasing with higher persistence, τ, because permanent income is closer to current income the greater the persistence of the shock. The investment effect by itself leads to a current account deficit in the period that the shock occurs. The net effect of consumption-smoothing and investment depends on the degree of persistence of the terms of trade shock. For less persistent (but finite) shocks, the consumption-smoothing effect will tend to dominate, in which case there will be a positive correlation between the shock and the current account (in the period of the shock).[14] For some degree of persistence, the two effects will cancel each other out. At higher degrees of persistence, the investment effect will dominate and there will be a contemporaneous negative correlation between the shock and the current account.

The key to this paper is to identify two groups of countries based on the degree of persistence of their terms of trade shocks—those with typically short-lived shocks for which the consumption-smoothing effect should dominate, and those with typically long-lived shocks for which the investment effect should dominate. This issue is taken up in Section IV.C below.

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[13] This need not be the case for a very persistent shock. However, in this case, at time $t = 0$, it could be that the one period delay in the capital stock adjustment means that current income is less than permanent income, so the story is much like the case where $\tau = \infty$.

[14] In this simple model, for some parameter values (including the form of the production function), it could be that the investment effect dominates the consumption smoothing effect even for very short-lived shocks; although, this will be less likely in the face of adjustment costs for investment.

III. Data and Correlation Analysis

This section of the paper describes the data used in this study, and determines the relative frequency of episodes of positive and negative correlations between the current account and the terms of trade at frequencies of one and two years. The episodic methodology used here is useful because it does not presume that changes in the terms of trade within a country were always either entirely temporary or entirely permanent. Because of this, the results can be regarded as complementary to the regression analysis of Section V.

A. Data Description

The data are from various sources—full details are provided in Appendix I. Series are annual from 1970 to 1999, although many countries have a much shorter sample period. There are 128 countries in the full sample, which are listed in Appendix II. The two variables discussed in this section are the current account balance (as a proportion of GDP) and the terms of trade. In order to get as complete coverage as possible, data from different sources were often spliced together to create a longer series for some countries. Despite the less than ideal data for some countries, there was no reason to expect any systematic bias in any series.

B. Bivariate Correlations, Rank Correlation, and Correlation Episodes

We leave a discussion of the important issue of stationarity until the estimation of the econometric model. At this stage, it is sufficient to point out that many countries in the sample appeared to have nonstationary terms of trade. This was dealt with in this section of the paper by transforming the data to ensure that variables are integrated of the same order (that is, stationary or I(0) variables). The terms of trade index for each country was transformed by demeaning the annual growth rate of the series. The current account (as a percent of GDP) was transformed by demeaning the first difference of the series.

The average contemporaneous correlation between the change in the current account and the change in the terms of trade across all countries was 0.19. Positive contemporaneous correlations are consistent with standard intertemporal theories of the current account (even with investment). In addition, the average correlation with the change in the terms of trade lagged by one year was -0.13. (The lagged correlation allows for a delayed or slow response of the current account balance to changes in the terms of trade). Simple correlations suggest that there were countries for which changes in the terms of trade were very persistent and hence, the investment effect should have dominated the consumption-smoothing and effect on domestic saving.

We also examine whether the observed pattern of persistence of terms of trade shocks is correlated with the strength of the relationship between the terms of trade and the current account. Since the standard assumptions of normality are unlikely to be present here, we implement Spearman's nonparametric test of rank correlation. We find that the rank correlation coefficient between the persistence of terms of trade shocks (as measured by the autoregressive parameter from least squares estimation of the AR(1) regression of equation (13); see below) and the contemporaneous correlation between the terms of trade and the current account is 0.195. The coefficient is positive yet not statistically significant (at the 5 percent level)—this result contradicts the negative relationship that would be predicted by the intertemporal approach to the current account. Indeed, our results for the full sample of countries echo those of Mendoza (1995) and Otto (2003), who also find that the magnitude of the correlation between the terms of trade and current account is weakly positive, yet invariant to the persistence of terms of trade shocks.[15]

Many countries were likely to have had episodes of changes in the terms of trade which were both transitory and persistent. This section of the paper addresses this problem by counting episodes of correlations of changes in the current account and changes in the terms of trade within each country.

There are 3,819 observations (that is, country years) in the full sample. For each country, we calculated the sample standard deviations of the transformed current account balance and the transformed terms of trade and then asked the following question: *What happened to the current account balance in years when the terms of trade changed by more than one standard deviation?*

Within this set of observations we considered six possibilities, shown in Table 1. Large positive and negative changes in the terms of trade are split into columns 1 and 2, respectively. The response of the current account is divided into one of three rows: large positive; large negative; or small changes in the current account (large being defined as a change of greater than one standard deviation). The two shaded boxes in the table represent negative correlations between the terms of trade and the current account balance. We find that almost a third of large changes in the terms of trade were associated with large changes in the current account—almost one third of these were negative correlations.

Table 1 only captures high-frequency changes. The following extension allowed the current account a longer time to respond to changes in the terms of trade. First, two-year episodes of either consecutive rises or consecutive falls in the terms of trade were identified. This set of observations was further reduced by keeping only those observations for which the change in the terms of trade over the two years was larger in absolute value than one standard deviation. The response of the current account balance during each two-year period was then recorded. These results are displayed in Table 2, with each year of every two-year episode counted separately.

[15] More accurately, Mendoza (1995) and Otto (2003) compute the correlation between the response of the trade balance to a change in the terms of trade and the persistence of shocks to the terms of trade. In Section V we will examine further whether the relationship between the terms of trade and the current account remains invariant to the persistence of terms of trade shocks, once more accurate measures of shock persistence are used to categorize shocks as temporary or persistent.

Table 1. Current Account Changes During Years with Large Changes in the Terms of Trade: One-Year Window

	Positive terms of trade changes	Negative terms of trade changes	
Large positive changes in the current account	105 (10 percent)	50 (5 percent)	
Small changes in the current account	357 (35 percent)	349 (35 percent)	
Large negative changes in the current account	40 (4 percent)	110 (11 percent))	Total
Sub-totals	502 (50 percent)	509 (50 percent)	1011

Source: Authors' calculations.

The point estimates from Table 2 show that 13 percent of large changes in the terms of trade were associated with a large movement of the current account in the opposite direction (over a two-year window). These episodes of negative correlation were almost half as frequent as episodes of positive correlation between large terms of trade changes and large current account changes.

Many observations in Table 1 do not appear in Table 2. Therefore, it makes sense to combine the results of the two tables (making sure to not double count the same country year observation). The results from this aggregation were similar to results for the tables shown above, and are not reported in the paper. However, the individual country results for one- and two-year windows combined are provided in Appendix II, which gives the breakdown according to the total number of years of positive, negative and zero correlation episodes. Countries tended to have episodes of both negative and positive correlations, although there were countries with either no positive or no negative correlation episodes. The interesting question is whether these episodes reflect the terms of trade persistence of different countries in the way that theory would suggest. This issue is taken up in the following sections of the paper.

Table 2. Current Account Changes During Years with Large Changes in the Terms of Trade: Two-Year Window

	Positive Terms of Trade Changes	Negative Terms of Trade Changes	
Large positive changes in the current account	256 (12 percent)	137 (7 percent)	
Small changes in the current account	580 (28 percent)	650 (32 percent)	
Large negative changes in the current account	121 (6 percent)	307 (15 percent)	Total
Sub-totals	957 (47 percent)	1094 (53 percent)	2 051

Source: Authors' calculations.

IV. Panel Data Regressions

A. Methodology

A panel-data regression will be used to estimate the dynamic relationship between the current account and the terms of trade for two different country groupings. The first group includes countries that tended to experience temporary terms of trade shocks; and the other group includes countries that tended to experience highly persistent (permanent) terms of trade shocks. Each panel-data regression is of the following basic form:

$$\Delta CA_{it} = \alpha \Delta CA_{it-1} + \sum_{j=0}^{4} \beta_j \Delta TOT_{it-j}^{s} + \sum_{j=0}^{4} \gamma_j \Delta GDP_{it-j}^{s} + u_{it}, \qquad (10)$$

where: ΔCA_{it} is a transformation of the annual current account balance (as a percent of nominal GDP, for country i at time t) obtained by demeaning the first difference of the original series; ΔTOT_{it}^{s} is the shock ($\hat{\upsilon}_{it}^{s}$; see below) to the terms of trade (that is, the unexplained change in the *level* of the terms of trade); and ΔGDP_{it}^{s} is the shock ($\hat{\mu}_{it}^{s}$; see below) to real GDP (again, the unexplained change in the level of real GDP).[16] [17]

There are some important issues related to the choice of this specification that need to be addressed, such as the inclusion of real GDP, the nature of the transformations of the variables, the identification of shocks, the lag structure and the question of exogeneity.

The theory in Section II implies that changes in productivity are likely to be an important determinant of the current account. However, for many countries in this study, data on productivity are unavailable or unreliable. Accordingly, real GDP growth was used as a proxy for productivity growth.

Of course, real GDP growth also captures cycles in demand, nevertheless, the current account response should be similar for both demand and supply (including productivity) shocks (given that these shocks tend to be very persistent; see below). Following a positive demand shock, the current account should fall because investment will be likely to rise by more than savings. It is a stylized fact of business cycles that both investment and consumption are procyclical, and that investment is more variable than output, which in turn is more variable than consumption. Hence, both investment and savings will typically rise with output. However, the rise in investment should dominate because the ratio of investment variability to output variability is typically much higher than the ratio of output variability to consumption variability.[18]

The data were transformed so as to ensure that all variables were integrated of order zero for valid statistical inference. Tests of stationarity (discussed in detail later in this section) revealed that a large number of countries showed evidence of nonstationary terms of trade in levels, while others showed evidence of stationarity. The level of real GDP is likely to be nonstationary (even about a deterministic trend) for most countries.[19] Finally, the current account balance shows evidence of a trend for some countries.[20]

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[16] Because changes in the terms of trade are often very large, the log difference is not a good approximation of the growth rate of this series. Therefore, growth rates of the terms of trade and real GDP were both calculated as year-to-year percentage changes.

[17] Equation (10) is a fixed effects model because the data have already been demeaned country by country. Hence, there was no need for a constant term in equation (10). All standard errors reported in the paper have the appropriate degrees of freedom correction to account for the fact that country means were estimated before panel-data regressions were conducted.

[18] For a summary of stylized real business cycle facts, see Danthine and Donaldson (1993).

[19] Glick and Rogoff (1995) show that the Solow residuals of the G-7 countries follow a random walk in levels (based on manufacturing data). Therefore, shocks to productivity are very persistent.

[20] As mentioned previously, this trend behavior could be due to differences between a country's discount rate and the world interest rate and/or expectations of trends in productivity or the terms of trade.

The lag structure of equation (10) was chosen for a number of reasons. In particular, this structure allows for uncertainty and adjustment costs. If investment involves, for example, quadratic adjustment costs, as in Glick and Rogoff (1995), the adjustment of the capital stock will be gradual. If investment involves fixed costs, then the adjustment could be delayed. Delayed adjustment of both consumption and investment will in part depend on uncertainty—it may take time to observe shocks and determine their likely size and persistence.

When estimating equation (10), it was assumed that the terms of trade and productivity growth (proxied by real GDP growth) were both exogenous with respect to the current account. For the terms of trade, this assumption was certainly valid for most of the countries in our sample, which are 'small' economies with little influence on world prices. The possible endogeneity of the terms of trade for a few large countries was accounted for by rerunning all the regressions, this time excluding the G7 countries—this had no material impact on the findings and so these regressions are not reported in the paper. However, the influence of the members of the Organization of Petroleum Exporting Countries (OPEC) on oil prices was considered important, and is accounted for below. Finally, the causality running from the current account to productivity shocks is tenuous and likely to be indirect. The level of imports of new capital equipment may embody new technology and therefore affect the productivity level (especially for developing countries). However, capital equipment is only a part of total imports of goods and services, which in turn is only a component of the current account.

B. Identifying Unanticipated Changes in the Terms of Trade

A key objective of this paper is to measure the response of the current account to *unanticipated* changes in the terms of trade—that is, the response of the current account to terms of trade shocks. The actual change in the terms of trade may contain a predictable component. If so, terms of trade changes will be an imperfect proxy for shocks to the terms of trade.[21] Measures of the unanticipated change in the terms of trade were constructed for each country as the estimated residual from the following regression:

$$\Delta TOT_{it} = c_i + \theta_i \Delta TOT_{it-1} + \upsilon_{it}, \tag{11}$$

where, ΔTOT_{it} is the growth rate of the terms of trade in country i at time t, and c_i is a constant term for country i.[22] The unanticipated component of changes in the level of the terms of trade (that is, the terms of trade shock) is $\Delta TOT^s_{it} = \hat{\upsilon}_{it}$. This specification has only one lag of the growth rate of the terms of trade to be consistent with the approach used to determine the persistence of terms of trade innovations in the following section.

[21] Except in the case where the terms of trade follows a random walk, which appears to be the case for many countries with very persistent terms of trade shocks.

[22] The sample size was not sufficient to allow the construction of *ex ante* shocks by using recursive regressions (that is, the first regression in the recursion would require a sample that ends just prior to the start of the sample period used in the panel-data regressions).

Similarly, shocks to the growth rate of real GDP ($\hat{\mu}_{it}$) were estimated from the following regression:

$$\Delta GDP_{it} = c_i + \eta_i \Delta GDP_{it-1} + \sum_{j=0}^{1} \lambda_{ji} \Delta TOT_{it-j} + \mu_{it}. \qquad (12)$$

Unlike the terms of trade (which are assumed to be exogenous), real GDP growth will depend on changes in the terms of trade. Further, by controlling for the impact of the terms of trade in equation (12), we can examine the response of the current account to terms of trade shocks having already accounted for the impact of terms of trade shocks on GDP.

C. Measuring Persistence of Shocks to the Terms of Trade

We now turn our focus to establishing the time series properties of the *level* of the terms of trade, in order to categorize countries into those which typically experience finite (temporary) terms of trade shocks, and those which typically experience permanent terms of trade shocks. In particular, we determine the duration of shocks to the terms of trade.[23]

The stationarity and persistence of the terms of trade are closely related and are crucial to both the methodology and the interpretation of our empirical results. To estimate the duration of terms of trade shocks we use the median-unbiased estimator of Andrews (1993). This provides unbiased estimates of the autoregressive parameter in the terms of trade data, and associated impulse response functions are used to calculate an unbiased scalar measure of the duration of terms of trade shocks.

The median-unbiased estimation procedure proposed by Andrews (1993) is used in preference to unit root tests (which determine whether a series is stationary or nonstationary). The use of conventional unit root testing procedures (such as AR(1) or Dickey-Fuller regressions) to characterize the persistence of time series suffers from two main disadvantages: (i) the least squares estimates of the autoregressive parameter in unit root regressions will be biased toward zero in small samples (Orcutt, 1948); and (ii) they have low power against plausible trend-stationary alternatives (DeJong et al., 1992). The downward bias in least squares estimates of the autoregressive parameter arises because there is an asymmetry in the distribution of estimators of the autoregressive parameter in auto-regressive (AR) models (the distribution is skewed to the left, resulting in the median exceeding the mean). As result, the median is a better measure of central tendency than the mean in least

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[23] While some work has been done on the persistence of shocks to the commodity terms of trade (Cashin, Liang and McDermott (2000)), there has been virtually no work on the persistence of stochastic shocks to the terms of trade of particular countries. A key exception is Cashin, McDermott and Pattillo (2004), who use median-unbiased estimators to measure the persistence of terms of trade shocks for sub-Saharan African countries. Two further exceptions are Basu and McLeod (1992) and León and Soto (1995), which use unit root and variance ratio tests to examine the persistence properties of national terms of trade data.

squares estimates of AR models. The exact median-unbiased estimation procedure proposed by Andrews (1993) can be used to correct this bias. The bias correction delivers an impartiality property to the decision making process, because there is an equal chance of under- or over-estimating the autoregressive parameter in the unit root regression. Moreover, an unbiased estimate of the autoregressive parameter allows us to calculate an unbiased scalar estimate of persistence—the half-life of a unit shock (the duration of time for half the magnitude of a unit shock to the level of a series to dissipate).

The Andrews (1993) median-unbiased estimator is concerned with the estimation of first-order AR models with independent identically distributed normal errors. The model of the time series considered is that which includes an intercept and trend:

$$Y_t = \mu + \beta t + \alpha Y_{t-1} + \varepsilon_t \quad for \ t=1,\ldots,T, \tag{13}$$

where Y_t: $t=0,\ldots,T$ is the observed series, μ is the intercept, t is the trend, α is the autoregressive parameter (where $\alpha \in (-1,1]$), and ε_t are the innovations of the model. This model is the same as that used for testing whether there is a unit root in a time series—consequently, this model is often referred to as the Dickey-Fuller or AR(1) regression. The half-life, which is the time it takes for a unit shock to dissipate by 50 percent, is calculated from the autoregressive parameter, α (see Section IV.C below for details).

Andrews (1993) presents a method for median-bias correcting the least squares estimator. To calculate the median-unbiased estimator of α, suppose $\hat{\alpha}$ is an estimator of the true α whose median function ($m(\alpha)$) is uniquely defined $\forall \alpha \in (-1,1]$. Then $\hat{\alpha}_u$ (the median unbiased estimator of α) is defined as:

$$\hat{\alpha}_u = \begin{cases} 1 \ if \ \hat{\alpha} > m(1), \\ m^{-1}(\hat{\alpha}) \ if \ m(-1) < \hat{\alpha} \leq m(1), \\ -1 \ if \ \hat{\alpha} \leq m(-1) \end{cases} \tag{14}$$

where $m(-1) = lim_{\alpha \to -1}\, m(\alpha)$, and $m^{-1}{:}(m(-1),m(1)] \to (-1,1]$ is the inverse function of $m(.)$ that satisfies $m^{-1}(m(\alpha)) = \alpha$ for $\alpha \in (-1,1]$. That is, if we have a function that for each true value of α yields the median value (0.50 quantile) of $\hat{\alpha}$, then we can simply use the inverse function to obtain a median unbiased estimate of α. Intuitively, we find the value of α that results in the least squares estimator having a median value of $\hat{\alpha}$. For example, if the least squares estimate of α equals 0.8 then we do not use that estimate, but instead use that value of α which results in the least squares estimator having a median of 0.8.[24]

Model selection rule

The median-unbiased estimator can also be used to derive an unbiased model-selection rule, where for any correct model the probability of selecting the correct model is at least as large as the probability of selecting each incorrect model (Andrews, 1993). Suppose the problem is to select one of two models defined by $\alpha \in I_a$ and $\alpha \in I_b$, where I_a and I_b are intervals partitioning the parameter space (-1, 1] for α, with $I_a = (-1, 1)$ and $I_b = \{1\}$. Then the unbiased model selection rule would indicate that model I_m should be chosen if $\hat{\alpha}_u \in I_m$, for $m = a, b$. This is also a valid level 0.50 (unbiased) test of the H_0: $\alpha \in I_a$ versus H_1: $\alpha \in I_b$.

Importantly, the median-unbiased estimator $\hat{\alpha}_u$ is the lower and upper bounds of the two one-sided level 0.5 confidence intervals for the true α when $m(.)$ is strictly increasing (Andrews, 1993, p.152). These confidence intervals have the property that their probabilities of encompassing the true α are one-half. That is, there is a 50 percent probability that the confidence interval from minus one to $\hat{\alpha}_u$ contains the true α, and a 50 percent probability that the confidence interval from $\hat{\alpha}_u$ to one contains the true α. For example, if $\hat{\alpha}_u = 0.90$, then the probability that the true α is less than 0.90 is one half, and the probability that the true α exceeds 0.90 is also one half.[25, 26]

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[24] The size of the bias correction can be large, especially when α is close to one. For example, for a sample size of 40 observations using the AR(1) model of equation (13), a least squares estimate of $\alpha = 0.78$ would correspond to a median-unbiased estimate of $\alpha = 1.00$; that is, $m(1)=0.78$. See Cashin, McDermott and Liang (2000) and Cashin and McDermott (2003b) for additional details on median-unbiased estimation.

[25] In a Monte Carlo study of the AR(p) model, Andrews and Chen (1994, p.194) demonstrate that the unbiased model-selection rule has a probability of correctly selecting the unit-root model (when the true $\alpha = 1$) of about 0.5. This is much lower than the corresponding probability for a (two-sided) level 0.10 test or (one-sided) level 0.05 test of a unit-root null hypothesis, as the unbiasedness condition does not (unlike the level 0.10 or 0.05 tests) give a bias in favor of the unit root model. The greater size of Andrews' unbiased model selection rule, in comparison with conventional tests, increases the probability of rejecting the unit root null. This indicates that if the true $\alpha < 1$, then the probability of a type II error (failure to reject the unit root model when it is false) is smaller for Andrews' model selection rule than for conventional tests, especially for the near unit root case (see Cashin and McDermott (2003b)).

[26] The bias in favor of finding a unit root in terms of trade series is illustrated by the findings of Otto (2003). In examining annual terms of trade data for 55 countries over the period 1960-97, he finds that using standard unit root tests, about 80 percent of the countries cannot reject the null of nonstationarity.

Calculating half-lives

Our interest in this paper concerns the persistence of shocks to economic time series. Rather than consider the whole impulse response function to gauge the degree of persistence, Andrews (1993) provides a scalar measure of persistence that summarizes the impulse response function: the half-life of a unit shock (HLS). For an AR(1) model (with $\alpha \geq 0$), the HLS gives the length of time until the impulse response of a unit shock is half its original magnitude, and is defined as HLS = ABS(log(½)/log(α)). Exactly median-unbiased point estimates are calculated for the HLS, and for AR(1) models the HLS is monotone in α for $\alpha \in [0,1]$.[27] Since median-unbiased point estimates of α have the desirable property that any scalar measures of persistence calculated from them (such as half-lives) will also be median unbiased (Andrews, 1993), we can calculate the median-unbiased estimate of the HLS by inserting the median-unbiased point estimate of α in the formula for the HLS.[28] These median-unbiased measures can be compared with least squares estimators of persistence, where the least squares estimates will (given they are functions of a downwardly-biased α) tend to understate the actual amount of persistence in shocks to economic time series.

The median-unbiased point estimates of the half-life of shocks (for the AR(1) model) can be interpreted in a manner similar to the estimation of α. Using the Andrews unbiased model-selection rule, there is a 50 percent probability that the confidence interval from zero to the estimated bias-corrected half-life contains the true half-life of a shock to any given time series, and a 50 percent probability that the confidence interval from the estimated bias-corrected half-life to infinity contains the true half-life of a shock to any given time series. In determining whether a terms of trade series has temporary (finitely-persistent) or permanent (infinitely-persistent) shocks, this rule designates a country as having temporary shocks if the bias-corrected half-life is finite, and designates it as having permanent shocks if the bias-corrected half-life is infinite. A listing of the countries in each of these two groups is given in Appendix III.

D. Persistence of Shocks to the Terms of Trade

In this Section we apply the median-unbiased procedures to each country's terms of trade (TOT) series, as described above. Table 8 of Appendix II sets out the results for the half-life of the duration of shocks to the TOT, which are calculated from the least squares estimates of α in the AR(1) regression of equation (13). Across all countries, the average (median) half-life of terms of trade shocks is 2.6 years for the least-squares estimation of the AR(1) regressions (column 3 of Appendix Table 8).

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[27] For AR(1) models, the half life calculated from the value of α is the same as that calculated from impulse response functions.

[28] The median-unbiased point estimates were determined using quantile functions of $\hat{\alpha}$, which were generated by numerical simulation (using 10,000 iterations) and interpolation, using the method suggested by Appendix B of Andrews (1993), for T=39 and T=34 observations (as appropriate). The results are available from the authors on request.

However, as noted above, the estimator of the autoregressive parameter in each of the least-squares based regressions is always biased downward. As a result, the least-squares based calculations of the duration of terms of trade shocks will also be biased downward (in favor of finding that shocks are finite). Consequently, we remove this bias by calculating median-unbiased point estimates for the autoregressive parameter (α) in equation (13).

Median-unbiased estimates of the autoregressive parameter are set out in column 5 of Appendix Table 8. In comparison with these median-unbiased estimates of α, the least squares estimates of α (column 3) are biased downward by between 0.30 (Cape Verde) and 0.03 (South Africa). While this is a small difference in absolute terms, it has important implications for the half-life measures of the persistence of shocks to the terms of trade. The median-unbiased point estimates of the half-lives (set out in column 5 of Appendix Table 8) are much greater than their least squares counterparts (column 3) for every country, with 65 of the countries having a bias-corrected half-life of infinity. Across all countries, the average bias-corrected half-life of reversion is infinity, clearly exceeding the average downwardly-biased least-squares AR(1) half-life of 2.6 years. This implies no reversion in the terms of trade, rather than the 24 percent per year calculated using biased AR(1) methods.

E. Interpreting the Persistence Results

Table 9 of Appendix II categorizes the point estimates of the half-lives of the duration of shocks to the TOT, which are calculated from the median-unbiased estimates of α in the AR(1) regressions of equation (13), with a constant only. The results indicate that about half (65) of the 128 countries are subject to TOT shocks which have bias-corrected half-lives that are finitely-persistent, which is consistent with mean reversion of the TOT. Using the Andrews unbiased model-selection rule, this indicates that these 65 countries experience temporary shocks to their TOT. For these countries there is a better than even chance that their terms of trade shocks are temporary, yet the speed of reversion of the national terms of trade series to their long-run trends is, in several cases, rather slow. The median-unbiased point estimates of shock persistence, and the unbiased model-selection rule, provide much stronger evidence that many countries have terms of trade that typically experience finitely-persistent (temporary) shocks.[29] Across all countries, the average (median) bias-corrected half-life of reversion is 34.3 years, clearly exceeding the average downwardly-biased least-squares AR(1) half-life of 5.2 years. This implies a rate of mean reversion in the terms of trade of only 2 percent per year, rather than the 13 percent per year calculated using biased AR(1) methods.

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[29] The presence of serial correlation in the residuals of the AR(1) or Dickey-Fuller regression would indicate that such a model would be inappropriate; in such cases we can follow Andrews and Chen (1994) and use an AR(p) model (Augmented Dickey-Fuller regression), which adds lagged first differences to account for serial correlation. However, (Breusch-Godfrey LM) tests for serial correlation carried out on the residuals from the least squares regression of equation (13), both with and without the trend term, indicate that there is very little evidence of serial correlation, and so the AR(1) regression is appropriate.

In addition, we find that the persistence of shocks to the TOT (as measured by the HLS) is less than 5 years for 27 of these 65 finitely-persistent countries. These countries have substantial scope to smooth national consumption by altering domestic savings (and drawing upon foreign savings) in response to temporary terms of trade shocks (Appendix Table 9). In contrast, 63 countries are subject to TOT shocks that have half-lives that are permanent, which is consistent with an absence of mean reversion of TOT. Using the Andrews unbiased model-selection rule, this indicates that for these 63 countries the unit root model is the most appropriate representation of their TOT, and so shocks to their terms of trade are best viewed as being permanent.

As examples of interpreting the median-unbiased persistence results, we take the particular cases of Mali (short-lived half life), and Italy (infinite half life). While there is a 50 percent probability that the confidence interval from zero to 1.6 years contains the true half life of a shock to the TOT of Mali, there is also a 50 percent probability that the confidence interval from 1.6 years to infinity contains the true half life of a shock to its TOT (Appendix Table 9). For Italy, while there is a 50 percent probability that the confidence interval with a finite upper bound contains the true half life of a shock to its TOT, there is a 50 percent probability that the true half life of a shock to its TOT will be infinite. Using the Andrews unbiased model-selection rule, the finite (Mali) and infinite (Italy) point estimates of the half-lives indicate that while shocks to Mali's terms of trade are temporary, shocks to Italy's terms of trade are best viewed as being permanent. These results indicate that external financing as a response to adverse TOT shocks is likely (not likely) to be a sensible strategy for countries like Mali (Italy), which have estimated half lives of TOT shocks which are temporary (permanent), as there is a much lower (much greater) likelihood that such borrowing will confront short-lived (long-lasting) shocks, and thus may (may not) be financially sustainable.

F. Classifying Countries by the Persistence of Terms of Trade Shocks

The objective of this section is to categorize countries into one of two groups, according to the persistence of shocks to their terms of trade. Ideally, countries would have been split into different groups according to *ex ante* information regarding the behavior of their terms of trade, not *ex post* information (that is, based on estimates from the full sample period) such as is used here. However, this was not possible because of the already limited sample size. Instead, we adopted an approach that identified (*ex post*) those countries that displayed either clearly permanent or clearly temporary shocks to the terms of trade .

Less persistent (temporary) terms of trade country group

The critical criteria for inclusion in this grouping was temporary (finitely-persistent) shocks (using the criteria of finite half-lives of mean reversion) to the terms of trade, using the model with a constant term only. Countries with finite half-lives of mean reversion in regressions including a constant and trend term were excluded because we felt that it would be hard for agents to differentiate between a trend and a preponderance of persistent shocks in one direction. The set of 65 countries included in the temporary (less persistent) group are outlined in Appendix III. The average bias-corrected half-life of terms of trade shocks for this group of countries was 5.7 years, implying a rate of reversion of about 11 percent per year.

Most persistent (permanent) terms of trade country group

The criterion for inclusion in the most persistent group was permanent (infinitely-persistent) shocks to a country's terms of trade, under both of two different specifications of the (Andrews bias-corrected) AR(1) regressions. The first regression included both a trend and a constant; the second included a constant but no trend. The point estimates of the autoregressive parameter, and associated half-lives of shocks from both of these regressions, are provided for all 128 countries in Appendix Tables 8 and 9. Some countries have terms of trade that display a high degree of persistence (a bias-corrected autoregressive parameter of one) as measured by the AR(1) regression, including both a trend and a constant term, but not in the AR(1) regression with a constant alone (and vice versa). Hence, it was thought that countries meeting *both* of these tests would be most likely to have had *ex ante* very persistent terms of trade.

The influence of the two oil price shocks is evident in the terms of trade of many countries that meet these criteria. A further refinement was to exclude members of OPEC from the most persistent grouping, because these countries influenced their terms of trade by restricting sales and production of oil and, presumably, investment in their oil industries. Therefore, to the extent that the cartel was successful, OPEC members should have the consumption-smoothing effect dominating the investment effect, whereas theory suggests the opposite for countries with highly persistent terms of trade shocks. The set of 44 countries satisfying the above conditions for permanent terms of trade shocks are listed in Appendix III.

Before presenting evidence from the panel-data regressions, it is worth reviewing the results from counting correlation episodes in Section III, in the light of the above two groups of countries. Countries with typically permanent terms of trade shocks should have had relatively more episodes of negative correlations between the current account and large terms of trade changes than the group of countries with mostly temporary terms of trade shocks. Table 3 shows the average number of positive, negative and zero correlation episodes per country within each of the two country groups. These are broadly consistent with the notion that the persistence of terms of trade shocks is an important determinant of the dynamics of the current account. Countries with predominantly permanent terms of trade shocks have had on average more negative correlations (4.0 compared with 2.5) and slightly less positive correlations (5.8 compared with 6.1) than countries with predominantly temporary terms of trade shocks.

Table 3. Shock Persistence and Correlation Episodes Between Changes in the Terms of Trade and Changes in the Current Account

One and two-year windows combined

	Average Number of Correlation Episodes per Country		
	Positive	Zero	Negative
41 countries with temporary terms of trade shocks	5.8	9.9	2.5
20 countries with permanent terms of trade shocks	6.1	9.3	4.0

Source: Authors' calculations.

V. Empirical Results Based on Persistence of Terms of Trade Shocks

The panel-data regressions were based on a set of 80 countries, as data limitations (particularly the unavailability of a time series for real GDP) meant that many of the 128 countries in the full sample were excluded from the regression analysis. A listing of those countries with data on all three series (terms of trade, current account and real GDP) for all years of the period 1970 to 1999 are listed in column 7 of Appendix II.

The theory outlined in Section II implies that the contemporaneous response of the current account to a terms of trade shock depends on the persistence of the shock. Countries experiencing more (less) persistent terms of trade shocks will have terms of trade movements which are negatively (positively) correlated with the change in the current account in the initial years following the shock. This hypothesis is confirmed by the results of panel-data regressions on the permanent and temporary country groupings shown in Table 4.[30] For countries with very persistent terms of trade, the sum of the coefficients on the terms of trade shocks was significantly negative (at the 5 percent level). In contrast, for countries with temporary terms of trade, the sum of the coefficients was not significantly different from zero.

These results are perhaps best summarized by the impulse response functions in Figure 1 (upper panel) that show the cumulative response of the current account to a positive shock to the terms of trade for each country group. For countries with predominantly temporary terms of trade shocks, the consumption-smoothing effect on the current account

[30] The estimation procedure was fixed effects, ordinary least squares. Newey-West estimates of the covariance matrix were used to correct the standard errors for heteroskedasticity and serial correlation.

appears to dominate the investment effect. Namely, a positive shock to the terms of trade has a positive effect on the current account in the year of the shock, with the current account declining (relative to baseline) only after 4 years. In contrast, for countries with predominantly permanent terms of trade shocks, the investment effect on the current account appears to dominate the consumption-smoothing effect. That is, given the same initial positive terms of trade shock, the current account rises only slightly in the same year as the shock (though this is not significantly different from zero; see below), and subsequently declines.

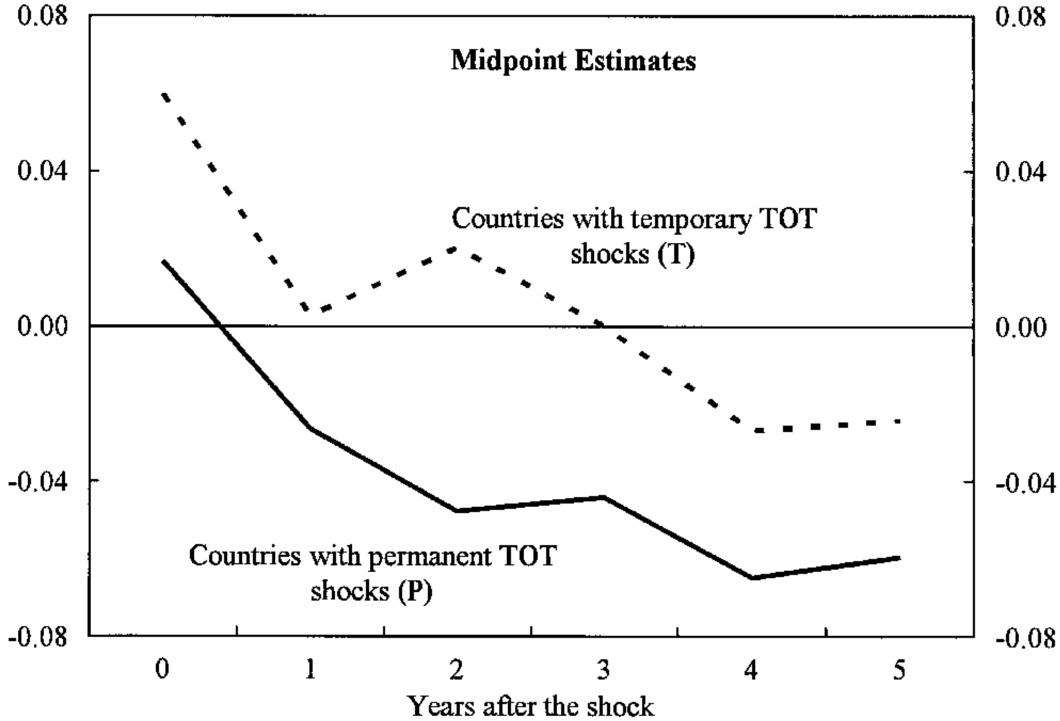
Our results can be compared with the findings of previous studies of the relationship between the terms of trade and the trade balance. The empirical impulse response functions of Otto (2003) are close to the theoretical impulse response functions derived by Mendoza (1995), in finding evidence of a HLM effect because of a (typically) positive relationship between the terms of trade and the change in the balance of trade. In addition, both Otto (2003) and Mendoza (1995) find that while the trade balance and terms of trade are positively correlated, the strength of the comovement between them is invariant to the degree of persistence of the shock to the terms of trade. However, both Otto and Mendoza use downwardly-biased unit root tests to measure the persistence of shocks to each country's terms of trade.

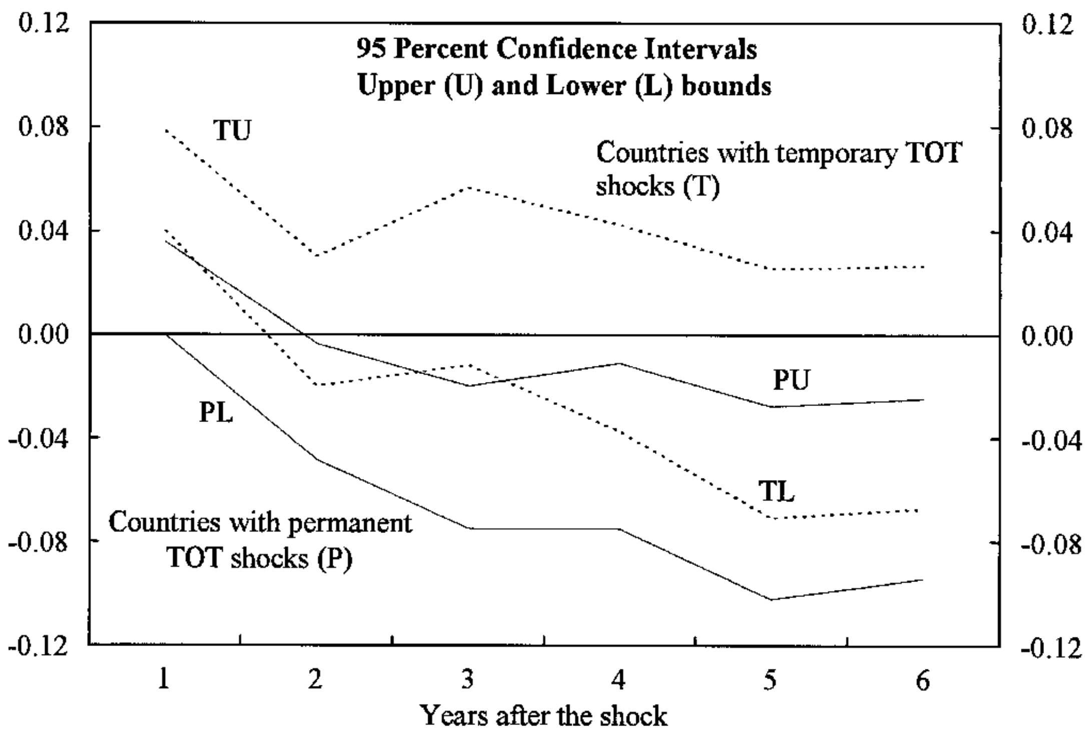
In contrast, once the persistence of terms of trade shocks is accurately measured using Andrews' (1993) unbiased model-selection rule, we find that the contemporaneous response of the current account to terms of trade shocks is strongly influenced by the persistence of the shock. Countries which experience typically temporary terms of trade shocks have a contemporaneous rise in their current account balance in response to a positive terms of trade shock. As the effect of the terms of trade shock dissipates, the current account moves into a small deficit (but statistically significant; see below) four years after the initial shock. This result is consistent with the intertemporal approach to the current account, where for temporary terms of trade shocks the consumption-smoothing (or HLM) effect on savings would dominate the investment effect. Countries which experience typically permanent terms of trade shocks have no (significant) change in their contemporaneous current account balance in response to a positive terms of trade shock, and their level of saving and investment yield current account deficits in subsequent years.[31]

[31] In the long run, the path of the current account should satisfy the intertemporal budget constraint and the transversality condition. However, the estimation technique did not include enough lags to account for longer-run behavior. Adding two more lags to the model suggests that in the case of countries with persistent terms of trade shocks, the current account moves back towards balance about five years after the shock (and is insignificantly different from zero at that point).

Figure 1. Current Account Response to a 1 Percent Positive Terms of Trade Shock

(Percent of GDP)





Overall, our results from panel-data regressions of the two groups of countries support the theoretical predictions of the intertemporal approach to the current account. The greater (lesser) the persistence of the terms of trade shock, the more (less) the investment effect dominates the consumption-smoothing effect on saving, so that the current account moves in the opposite (same) direction to the shock. That is, there is a negative relationship between the persistence of terms of trade shocks and the degree of correlation between the terms of trade and the current account balance.

The statistical significance of the differences between the impulse response functions of the two country groups (temporary and permanent terms of trade shocks) can be shown in two ways. First, the panel-regression results of Table 4 show that in the same year as the terms of trade shock, the current account response for countries with predominantly temporary shocks is significantly greater (at the 5 percent level) than it is for countries with predominantly permanent shocks (where the contemporaneous terms of trade coefficient is insignificantly different from zero). Second, bootstrap techniques were used to provide confidence intervals around the impulse response functions of the two country groups (Figure 1, lower panel).[32] The 95 percent confidence intervals for the impulse response functions of the two country groups show significant differences in the year of the shock and two years after the shock. This result suggests that consumption smoothing is the dominant effect for countries with temporary terms of trade shocks in the same year as the shock, and that for countries with permanent terms of trade shocks the investment effect is dominant (albeit somewhat spread over a period of two years).

For both country groups, the impact of shocks to real GDP growth (as a proxy for productivity shocks) was significantly negative, as expected given the high degree of persistence of these shocks. For countries with predominantly permanent terms of trade shocks, the cumulative impact of a 1 percent shock to real GDP is greater than a 1 percent shock to the terms of trade (Table 4)—as predicted by a model with more than two sectors (see comments following equation (6)).

We now examine the robustness of our findings to the possibility of credit constraints, differences in exchange rate regimes, and the impact of unrequited (current account) transfers.

[32] New current account data was created by assuming the original model estimate to be true, and generating errors from an independently identically distributed normal distribution with a mean of zero and a variance estimated from the original error estimates. New estimates of the model were produced using this new current account series, and from this a new impulse response function was constructed. This procedure was repeated one thousand times. A 95 percent confidence interval was constructed by eliminating the upper 25 and lower 25 extreme impulse responses point by point along the impulse response function.

Table 4. Panel Fixed Effects Estimates: Permanent Versus Temporary Terms of Trade Shocks

Dependent variable—ΔCA, period of estimation—1974 to 1999

		20 countries with permanent TOT shocks		41 countries with temporary TOT shocks	
Variable	Lag	Coefficient (t-statistics)			
ΔCA	1	-0.257	(-4.99)	-0.096	(-1.67)
ΔTOT^s	0	0.017	(1.04)	0.060	(4.78)
	1	-0.039	(-3.68)	-0.050	(-4.42)
	2	-0.032	(-1.65)	0.011	(0.83)
	3	-0.002	(-0.13)	-0.018	(-1.62)
	4	-0.020	(-1.48)	-0.028	(-2.80)
ΔGDP^s	0	-0.066	(-1.36)	-0.198	(-3.96)
	1	-0.132	(-4.58)	-0.012	(-0.21)
	2	-0.021	(-0.87)	-0.007	(-0.17)
	3	0.045	(1.75)	0.005	(0.12)
	4	0.002	(0.09)	-0.062	(-1.53)
$\sum_{j=0}^{4} \Delta TOT_{t-j}^s$		-0.076	(-2.50)	-0.026	(-0.86)
$\sum_{j=0}^{4} \Delta GDP_{t-j}^s$		-0.171	(-2.69)	-0.274	(-2.84)
No. Observations		520		1,066	
R^2		0.17		0.11	

Source: Authors' calculations.

Notes: The estimation procedure was fixed effects, ordinary least squares. Newey-West estimates of the covariance matrix were used to correct the standard errors for heteroskedasticity and serial correlation.

A. Robustness of Results: Allowing for Credit Constraints

Credit constraints and capital controls may circumscribe the ability of countries to alter their current account position in response to terms of trade shocks.[33] If consumers in a country face significant credit constraints, or a country has applied capital controls, the consumption-smoothing effect on saving could be dampened in the case of negative terms of trade shocks. Similarly, the investment effect could be dampened in the case of positive terms of trade shocks. However, the existence of credit-constrained consumers does not imply that large firms are also credit constrained—moreover, investment projects could be funded by foreign direct investment. The impact of potential financing constraints on our panel-regression estimates can be accounted for in three ways.

First, we note that the results of Section III suggest that there is a high degree of symmetry in terms of the response of the current account to both large positive and negative terms of trade changes. Second, the significance of possible credit constraints seems uniform across country groups of both permanent and temporary terms of trade shocks. This can be seen by examining the level of real GDP per capita of a country to proxy for the existence of credit-constrained consumers. Table 5 shows that the two country groups have similar distributions of real GDP per capita.

Table 5. Distribution of Real GDP Per Capita 1/

Constant U.S. dollars, chain weighted, base year 1996

	Average Across Group	Minimum Within Group	Maximum Within Group	Percent In Group < 1,000	Percent In Group >1,000 and < 5,000	Percent In Group >10,000
41 countries with temporary terms of trade shocks 2/	8,622	587	20,618	5	42	37
20 countries with permanent terms of trade shocks	8,343	637	23,568	5	40	30

Source: Heston, Summers, and Aten, *Penn World Table Version 6.1*, October 2002.

1/ Based on country averages taken over the period 1980 to 1990.
2/ Excludes Malta, Sudan and Western Samoa, for which these data are not available over this period.

[33] Hussein and de Mello (1999) find that international capital is sufficiently mobile in many developing countries to facilitate consumption-smoothing behavior. Earlier work by Haque and Montiel (1991) and Montiel (1994) supports the notion of a high degree of capital mobility in developing countries. Agénor and Aizenmann (2003) examine the extent to which borrowing constraints in bad states of nature can engender an asymmetric response in national savings to terms of trade shocks.

Third, for each country, we split each series for the terms of trade shocks into two separate series—using a dummy (D) equal to one when the terms of trade shock was positive and zero otherwise. This allowed the following panel equation to be estimated for each of the two country groups:

$$\Delta CA_{it} = \alpha \Delta CA_{it-1} + \sum_{j=0}^{4} \beta_j D_{it-j} \Delta TOT^{s}_{it-j} + \sum_{j=0}^{4} \delta_j (1 - D_{it-j})\, \Delta TOT^{s}_{it-j} + \sum_{j=0}^{4} \gamma_j \Delta GDP^{s}_{it-j} + u_{it}. \qquad (15)$$

To test the null hypothesis that for each country grouping the estimates of equation (15) are equivalent to the estimates of equation (10), we examined whether the impulse response functions were symmetrical about zero for both positive and negative terms of trade shocks for each country grouping. Bootstrap-based confidence intervals around these impulse response functions showed that there was no statistically significant difference between the two models, at the 5 percent level, for either country grouping. For countries with predominantly permanent terms of trade shocks, there was a significant difference, however, at the 10 percent level, though only 2 years after the shock. In this case, the response of the current account was smaller (in absolute terms) for negative terms of trade shocks. Moreover, the current account response was significantly less than zero (even at the 5 percent level) for negative terms of trade shocks. These results are unlikely to reflect credit constraints, in which case the investment effect would be smaller for positive terms of trade shocks due to an inability to raise sufficient finance. Instead, it may be that the capital stock is slow to adjust downwards following permanent negative terms of trade shocks.[34]

B. Robustness of Results: The Role of Exchange Rate Regimes

It may be that the exchange rate regime influences the response of the current account to terms of trade shocks. One mechanism through which this might occur is the impact of the shock on investment in the presence of a nontraded sector and nominal rigidities in prices/wages. For example, in the case of a flexible exchange rate regime, the exchange rate should appreciate following a positive terms of trade shock, which by itself reduces the price of exports relative to nontraded goods compared with that which would occur in a fixed exchange rate regime. This suggests the possibility of a mitigated investment effect (at least initially) in the case of more flexible exchange rate regimes.

The distribution of exchange rate regimes across the two country groupings is shown in Table 6. The group of countries with predominantly permanent terms of trade shocks have experienced proportionately more time (and have more countries that have spent more time) in flexible exchange rate regimes than countries with predominantly temporary terms of trade shocks. To measure the impact of this on the relationship between the current account and the

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[34] If disinvestment is delayed following a negative terms of trade shock, initially current income is above permanent income, leading to a small fall in the current account balance. The current account would then move towards surplus gradually.

terms of trade, equation (10) was reestimated after excluding countries from each of the two groups that had experienced mostly flexible exchange rate regimes (leaving 12 and 27 countries in the permanent and temporary terms of trade groups, respectively; see column 8 Appendix II for details). This exclusion did not significantly alter the dynamic response of the current account to terms of trade shocks for either country grouping. The impulse response functions for fixed exchange rate countries lie below those for the full sets of countries—especially for the permanent terms of trade group. However, these differences are not statistically significant—that is, the new impulse response functions fall inside the respective 95 percent confidence intervals based on the complete country groups (Figure 2).

Table 6. Distribution of Exchange Rate Regimes 1/

Percentage within each exchange rate regime

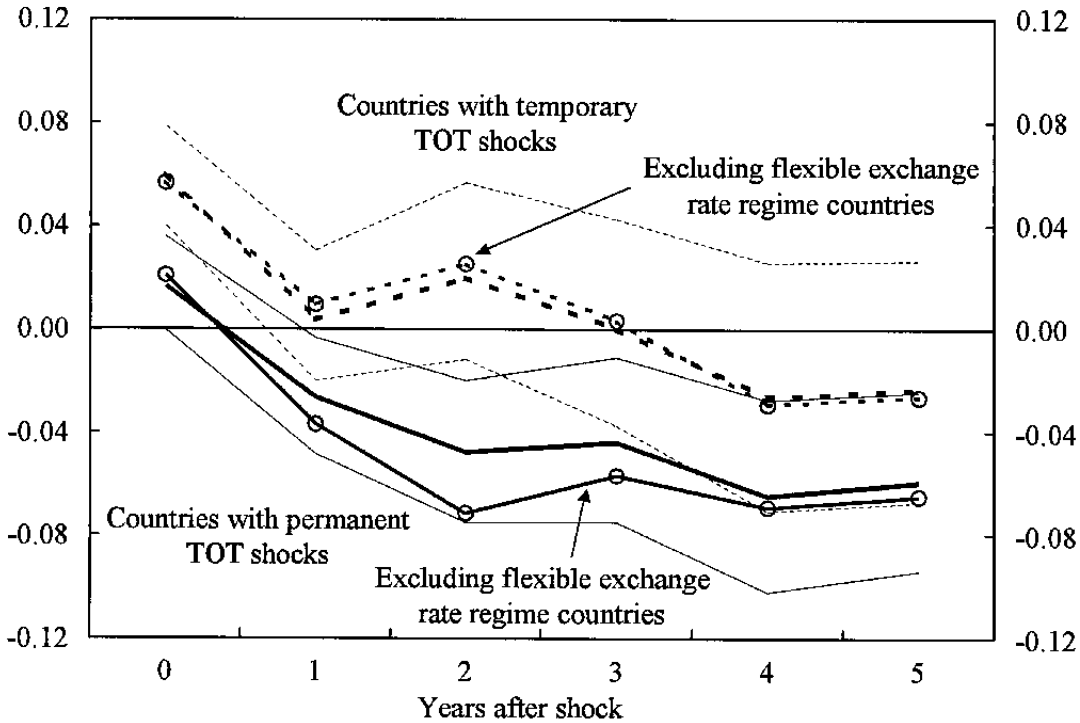
	Based on all Observations within each Country Grouping 1/		
	Fixed	Intermediate	Flexible
41 countries with temporary terms of trade shocks	46	14	40
20 countries with permanent terms of trade shocks	33	22	45
	Based on Averages Across Observations within Countries 2/		
	Fixed	Intermediate	Flexible
41 countries with temporary terms of trade shocks	37	29	34
20 countries with permanent terms of trade shocks	25	35	40

Source: Authors' calculations.

1/ Based on quarterly observations from 1975Q4 to 1999Q4. Uses the IMF's *de jure* classification of exchange rate regimes in its *Annual Report on Exchange Arrangements and Exchange Restrictions*; in particular fixed pegs (IMF categories 1-5); intermediate (IMF categories 6-7); and flexible (IMF categories 8-10).
2/ The fixed, intermediate and flexible regimes are assigned a value of 1, 2 and 3 respectively for each quarterly observation. This allows averages to be taken within countries across time. Countries with an average of less than 1 ⅔ are deemed to have a predominately fixed nominal exchange rate regime; those with averages more than 2 ⅓ are deemed to have a predominantly flexible nominal exchange rate regime; and those in between are deemed to have an intermediate nominal exchange rate regime.

Figure 2. Current Account Response to a 1 Percent Positive Terms of Trade Shock, Excluding Flexible Exchange Rate Regime Countries 1/

(Percent of GDP)



1/ Confidence bands are as in Figure 1. Midpoint estimates for groups excluding flexible exchange rate regime countries fall within these initial confidence bands.

C. Robustness of Results: Allowing for Unrequited Transfers

Unrequited transfers are a significant component of the current account for many countries. The official component of transfers may, or may not, respond to shocks in the way predicted by standard intertemporal theories of the current account. Of particular relevance for the interpretation of our results is the possibility that they might be driven largely by the response of official transfers to terms of trade shocks—as opposed to private sector behavior conforming with standard intertemporal theories. This concern is especially relevant because the country group with predominantly temporary terms of trade shocks happens to have many countries which receive sizeable credit transfers (see Table 7).

To control for transfers, we reestimated the panel regressions of equation (10) after excluding countries that have, on average over the sample period, received large unrequited transfers (more than 6 percent of GDP).[35] This left 16 countries in the permanent terms of trade group and 28 in the temporary group (see column 9 of Appendix II for details). The results are in line with those of the full sets of both country groups, suggesting that countries that receive large transfers are not significantly different in terms of the relationship between terms of trade shocks and the current account.

Table 7. Distribution of Transfer Receipts 1/

Percent of GDP

	Percent in the Group Receiving Transfers that are			
	Less than 1 percent	Between 1 and 6 percent	Between 6 and 10 percent	More than 10 percent
41 countries with temporary terms of trade shocks	27	60	20	12
20 countries with permanent terms of trade shocks	25	41	10	5

Source: IMF, *Balance of Payments Statistics.*

1/ Based on country averages taken over the period 1980 to 1990.

VI. Conclusion

This paper attempts to establish whether the persistence of terms of trade shocks affects the relationship between the current account and the terms of trade. A key theoretical implication of the intertemporal approach to the determination of the current account is that the response of the current account balance to terms of trade shocks depends on the persistence of such shocks. The consumption-smoothing effect on savings and the investment effect work in opposite directions—the greater the persistence of a terms of trade shock, the more the investment effect will dominate the saving effect. Therefore, in the period following a more (less) persistent shock, the current account will tend to move in the opposite (same) direction as that of the shock.

[35] One alternative was to examine the current account net of credit transfers; however, this data is not readily available for the full sample period.

In analyzing terms of trade data for 128 countries over the period 1960–99, we find that there is a good deal of heterogeneity across countries in the persistence of shocks to their terms of trade—about half the countries in our sample are found to have finite terms of trade shocks, while the other half typically experiences permanent shocks to their terms of trade. Using dynamic panel estimates, we then compare the response of the current account to unanticipated changes in the terms of trade across these two groupings. The results obtained from the panel-data regressions indicate that the current account response is positively related to unanticipated changes in the terms of trade (in the first three years following the change) for countries with predominantly *temporary* terms of trade shocks, and negatively related for countries with predominantly *permanent* terms of trade shocks. Our empirical results accord with the theoretical predictions of the intertemporal approach to the current account, since they emphasize that the persistence of terms of trade shocks is an important determinant of the response of a country's current account to changes in its terms of trade.

Data

The data sources used in this paper include: the IMF's *International Financial Statistics, World Economic Outlook, Annual Report on Exchange Arrangements and Exchange Restrictions,* and *Balance of Payments Statistics* databases; the World Bank's *World Development Indicators* database; the Summers and Heston database in the Mark 6.1 version of the Penn World Tables; and the OECD's *National Accounts* and *Yearbook of Employment Statistics*. We describe the primary data source for each series below. To obtain extensive coverage across countries and time it was often necessary to supplement the primary data source with an alternative source. Also, obvious errors in original data were identified and corrected using graphical techniques. The data are annual in frequency, for the sample period 1970-99 (unless otherwise denoted). There are 128 developing and developed countries in the full sample, which are listed in Appendices II and III.

Current account balance: The IMF's *International Financial Statistics* (line '78ald'), recorded in U.S. dollars.

Nominal GDP in local currency: The IMF's *International Financial Statistics* (line '99b..' or '99b.c').

Exchange rates: World Bank's 'Atlas' exchange rate series.

Terms of trade: World Bank, *World Development Indicators* (terms of trade index, base 1987=100). Starting in 1998, the terms of trade are no longer included in the World Bank's database. The World Bank obtained its terms of trade data from the United Nations Conference on Trade and Development's *Handbook of International Trade and Development Statistics*, which was used by the authors to derive a linked index for the period 1960-99. See Cashin, McDermott and Pattillo (2004) for additional details.

Real GDP: World Bank, World Development Indicators, real GDP at market prices in local currency.

Exchange Rate Regime: The IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*, (*de jure* classification). Under the 'old' classification scheme, regimes 1-5 are defined as fixed pegs; regimes 6-7 (limited flexibility with respect to a single currency, cooperative arrangements) are intermediate, and regimes 8-10 (including managed floating and independently floating) are flexible arrangements.

Unrequited Transfers: Current transfers, credit, from the IMF's *Balance of Payments Statistics*.

Correlation Episodes, Data, and Country Characteristics

Country	Correlation of change in current account (ΔCA_t) with		Episodes from Tables 1 & 2 Correlations			Data exists 1/	Flexible exch. rate regime 2/	Current account transfer credits 3/
	ΔTOT_t	ΔTOT_{t-1}	positive	zero	negative	'70-'99		(percent of GDP)
Average/Sum	0.19	-0.13	636	1331	307			5.4
Algeria	0.56	-0.41	5	4	0			1.1
Antigua and Barbuda	0.06	-0.29	2	15	4			6.0
Argentina	-0.08	0.11	10	11	9	yes		0.2
Australia	0.14	-0.36	5	7	6	yes		0.6
Austria	0.22	-0.17	6	11	0	yes		0.9
Bahamas, The	-0.09	0.57	2	15	2			0.9
Bahrain	0.50	0.00	8	4	2			3.1
Bangladesh	0.17	0.10	1	14	3			5.6
Barbados	0.28	-0.19	2	8	2	yes		3.5
Belgium	0.47	-0.21	9	3	2	yes		na
Bolivia	0.47	-0.49	7	6	0	yes	yes	2.6
Botswana	0.05	-0.11	0	6	4			10.4
Brazil	-0.03	0.11	6	15	2	yes		0.2
Bulgaria	0.48	-0.18	4	4	4			1.4
Burkina Faso	0.02	0.02	4	17	3	yes		19.9
Burundi	0.54	0.00	9	12	0			11.7
Cameroon	0.52	-0.02	7	11	2			1.3
Canada	0.13	-0.31	9	17	4	yes	yes	0.4
Cape Verde	0.36	-0.31	2	13	0			31.8
Central African Republic	0.05	-0.21	4	6	3	yes		11.4
Chad	0.00	0.03	5	16	3	yes		12.6
Chile	0.54	-0.14	10	12	0	yes		0.9
China	0.21	0.00	4	15	0			0.3
Colombia	0.18	-0.04	4	8	4	yes		1.3
Costa Rica	0.39	-0.30	6	17	0	yes	yes	2.4
Côte d'Ivoire	0.30	-0.30	9	15	2	yes		2.5
Cyprus	-0.11	-0.13	3	8	4	yes		2.2
Denmark	0.29	-0.27	6	5	2	yes		1.6
Dominica	-0.25	-0.20	0	11	4			16.1
Dominican Republic	0.34	0.03	6	7	2	yes		4.8
Ecuador	0.12	-0.20	2	6	0	yes		1.6
Egypt, Arab Rep.	-0.27	-0.04	3	8	8	yes		9.3
El Salvador	0.27	-0.29	2	22	0	yes		8.8
Equatorial Guinea	0.02	-0.04	0	16	0			22.9
Ethiopia	-0.23	0.00	4	10	4	yes		6.4
Fiji	0.26	-0.21	4	12	2	yes		2.8
Finland	-0.12	-0.09	4	11	11	yes		0.4
France	0.54	-0.46	9	3	0	yes		1.1
Gabon	0.57	-0.31	6	6	0	yes		1.3
Gambia, The	0.26	-0.11	4	16	4			14.7
Germany	0.15	-0.07	5	9	4	yes		0.9
Ghana	0.05	-0.03	2	15	5	yes	yes	5.3
Greece	-0.08	-0.01	5	13	4	yes	yes	5.2
Grenada	0.05	-0.11	2	14	3			15.4

Correlation Episodes, Data, and Country Characteristics (Continued)

Country	Correlation of change in current account (ΔCA_t) with		Episodes from Tables 1 & 2 Correlations			Data exists 1/	Flexible exch. rate	Current account transfer credits 3/
	ΔTOT_t	ΔTOT_{t-1}	positive	zero	negative	'70-'99	regime 2/	(percent of GDP)
Average/Sum	0.19	-0.13	636	1331	307			5.4
Guatemala	0.36	-0.31	4	7	0	yes		2.4
Guinea	0.16	-0.60	1	20	0			4.7
Guyana	0.36	-0.25	4	9	0			5.0
Haiti	0.44	-0.11	8	9	1			10.8
Honduras	-0.13	0.15	5	5	9	yes		4.6
Hong Kong SAR	0.42	-0.02	2	10	0			0.4
Hungary	-0.11	0.09	4	8	3			2.3
Iceland	-0.02	-0.42	4	16	8	yes		0.1
India	0.13	0.02	7	9	5	yes	yes	1.6
Indonesia	0.35	-0.43	6	1	2	yes		0.4
Iran, Islamic Republic	0.51	-0.43	2	3	2	yes		0.3
Iraq	0.59	-0.27	1	8	0			0.0
Ireland	0.32	-0.50	5	11	0	yes		6.1
Israel	0.24	0.06	9	10	1	yes	yes	10.9
Italy	0.58	-0.26	10	8	0	yes	yes	1.2
Jamaica	0.19	-0.44	4	6	1	yes	yes	8.9
Japan	0.37	-0.42	10	15	0	yes	yes	0.1
Jordan	0.00	0.10	2	13	2	yes		34.5
Kenya	0.21	-0.46	6	9	4	yes		4.0
Korea, Republic of	0.05	0.12	7	11	6	yes	yes	1.1
Kuwait	0.11	-0.14	0	7	0			0.1
Lebanon	0.22	0.14	2	15	0			na
Liberia	-0.14	-0.17	5	18	2			8.8
Libya	0.37	-0.42	4	6	4	yes		0.0
Madagascar	0.01	0.28	0	15	5			4.8
Malawi	0.20	-0.28	5	17	0			7.1
Malaysia	0.26	-0.49	4	15	0			0.6
Mali	0.23	0.25	7	15	4			11.9
Malta	0.21	-0.12	5	9	5	yes		6.7
Mauritania	-0.32	-0.06	4	12	6			na
Mauritius	0.44	-0.34	6	7	0	yes		3.4
Mexico	-0.04	-0.21	5	7	4	yes	yes	1.0
Morocco	0.04	-0.52	2	1	5	yes		7.6
Mozambique	0.25	0.09	2	17	0			14.7
Namibia	-0.53	0.35	0	20	1			13.2
Netherlands	0.27	-0.10	10	12	2	yes		1.3
Netherlands Antilles	-0.07	0.37	0	17	2			15.5
New Zealand	0.24	-0.48	9	10	1	yes	yes	0.9
Nicaragua	-0.19	0.16	2	17	4	yes		11.9
Niger	-0.32	0.45	4	14	3	yes		7.3
Nigeria	0.55	-0.48	8	5	2	yes		0.8
Norway	0.66	-0.11	10	9	0	yes		0.5
Oman	0.58	-0.45	4	2	0			1.8
Pakistan	-0.38	0.17	2	10	4	yes	yes	7.8

Correlation Episodes, Data, and Country Characteristics (Concluded)

Country	Correlation of change in current account (ΔCA_t) with		Episodes from Tables 1 & 2 Correlations			Data exists 1/	Flexible exch. rate	Current account transfer credits 3/
	ΔTOT_t	ΔTOT_{t-1}	positive	zero	negative	'70-'99	regime 2/	(percent of GDP)
Average/Sum	0.19	-0.13	636	1331	307			5.4
Panama	-0.27	0.14	2	13	5	yes		2.7
Papua New Guinea	0.37	-0.18	8	12	0			8.6
Paraguay	0.49	0.24	7	16	0	yes		0.8
Peru	0.10	-0.44	11	13	5	yes		1.0
Philippines	-0.13	-0.25	4	12	3	yes	yes	1.5
Poland	-0.16	0.62	3	8	1			3.2
Portugal	0.32	-0.40	12	13	3			9.3
Qatar	0.58	-0.53	3	3	0			na
Rwanda	0.15	-0.24	5	7	1	yes		13.1
Saudi Arabia	0.72	-0.34	4	4	0			0.0
Senegal	0.23	0.07	7	3	2	yes		6.7
Sierra Leone	0.30	-0.19	7	18	0			2.7
Singapore	0.18	-0.02	4	11	0	yes		0.7
Solomon Islands	0.40	-0.17	12	9	0			17.7
South Africa	-0.16	-0.28	8	10	8	yes	yes	0.4
Spain	0.21	-0.33	6	9	6	yes	yes	1.5
Sri Lanka	0.51	-0.23	11	8	0	yes	yes	6.7
St. Kitts and Nevis	0.15	0.26	6	14	0			13.0
St. Lucia	0.04	0.34	2	14	2			8.2
Sudan	0.13	-0.03	6	16	2	yes		3.3
Swaziland	0.49	0.17	6	3	0			20.7
Sweden	0.28	-0.18	8	7	4	yes		0.2
Switzerland	0.25	-0.17	7	12	6	yes		1.0
Syrian Arab Republic	-0.27	-0.21	0	9	3	yes		4.8
Tanzania	-0.05	-0.14	8	9	2	yes		7.6
Thailand	-0.14	0.13	0	16	1	yes		0.6
Tonga	-0.22	-0.07	0	10	5			29.2
Trinidad and Tobago	0.43	-0.26	7	9	0	yes		0.2
Tunisia	0.18	-0.40	1	9	0	yes		5.0
Turkey	0.08	0.12	4	10	6	yes	yes	2.8
Uganda	0.18	-0.11	7	7	1	yes		6.9
United Arab Emirates	0.87	-0.31	6	1	0			na
United Kingdom	0.49	0.07	7	9	0	yes	yes	1.2
United States	0.00	-0.58	2	8	11	yes	yes	0.1
Uruguay	0.17	-0.20	7	6	3	yes	yes	0.3
Venezuela	0.55	-0.34	8	1	0	yes		0.3
Western Samoa	0.24	-0.13	7	8	2	yes		35.4
Zaïre	-0.12	0.36	2	14	5			2na
Zambia	0.71	-0.33	12	12	0			2.3
Zimbabwe	-0.10	-0.19	1	19	4			2.4

1/ Data exists for all years for current account (CA), gross domestic product (GDP) and terms of trade (TOT).
2/ Only provided for countries classified as having permanent or temporary half-lives of terms of trade shocks (see Appendix Table 9 and Appendix III). See Table 6 for definition of the nominal exchange rate regime.
3/ Average over years for which data is available. Na denotes no data available.

Table 8. Half-Lives of Terms of Trade Shocks: Biased Least Squares and Median-Unbiased Estimation of AR(1) Regressions, Trend and Constant

	Biased Least Squares		Median Unbiased	
Country	**α**	**Half-life (years)**	**α**	**Half-life (years)**
Algeria	0.898	6.41	1.000	∞
Antigua and Barbuda	0.722	2.13	0.930	9.59
Argentina	0.819	3.48	1.000	∞
Australia	0.622	1.46	0.755	2.47
Austria	0.734	2.24	0.904	6.88
Bahamas	0.794	3.00	1.000	∞
Bahrain	0.820	3.49	1.000	∞
Bangladesh	0.484	0.95	0.593	1.33
Barbados	0.701	1.95	0.855	4.41
Belgium	0.816	3.40	1.000	∞
Bolivia	0.892	6.08	1.000	∞
Botswana	0.876	5.21	1.000	∞
Brazil	0.712	2.04	0.871	5.01
Bulgaria	0.779	2.77	1.000	∞
Burkina Faso	0.614	1.42	0.745	2.35
Burundi	0.551	1.16	0.691	1.88
Cameroon	0.831	3.75	1.000	∞
Canada	0.793	2.99	1.000	∞
Cape Verde	0.697	1.92	1.000	∞
Central African Rep.	0.641	1.56	0.778	2.77
Chad	0.679	1.79	0.826	3.63
Chile	0.818	3.44	1.000	∞
China	0.666	1.71	0.842	4.03
Colombia	0.747	2.38	0.927	9.19
Costa Rica	0.402	0.76	0.501	1.00
Côte d'Ivoire	0.852	4.32	1.000	∞
Cyprus	0.814	3.37	1.000	∞
Denmark	0.767	2.62	0.969	21.83
Dominica	0.731	2.22	0.954	14.56
Dominican Republic	0.494	0.98	0.604	1.38
Ecuador	0.914	7.75	1.000	∞
Egypt	0.728	2.18	0.894	6.17
El Salvador	0.767	2.62	0.969	21.84
Equatorial Guinea	0.372	0.70	0.482	0.80
Ethiopia	0.658	1.65	0.798	3.08
Fiji	0.576	1.26	0.699	1.94
Finland	0.757	2.49	0.947	12.66
France	0.770	2.65	0.980	34.24
Gabon	0.925	8.89	1.000	∞
Gambia	0.511	1.03	0.624	1.47
Germany	0.758	2.51	0.950	13.48
Ghana	0.843	4.07	1.000	∞
Greece	0.753	2.44	0.939	10.95
Grenada	0.756	2.48	1.000	∞
Guatemala	0.454	0.88	0.559	1.19
Guinea	0.792	2.97	1.000	∞

Table 8 (Continued). Half-Lives of Terms of Trade Shocks: Biased Least Squares and Median-Unbiased Estimation of AR(1) Regressions, Trend and Constant

	Biased Least Squares		Median Unbiased	
Country	**α**	**Half-life (years)**	**α**	**Half-life (years)**
Guyana	0.521	1.06	0.635	1.53
Haiti	0.748	2.38	1.000	∞
Honduras	0.559	1.19	0.679	1.79
Hong Kong SAR	0.206	0.44	0.288	0.56
Hungary	0.863	4.71	1.000	∞
Iceland	0.686	1.84	0.834	3.83
India	0.816	3.41	1.000	∞
Indonesia	0.905	6.94	1.000	∞
Iran	0.898	6.42	1.000	∞
Iraq	0.905	6.94	1.000	∞
Ireland	0.619	1.44	0.751	2.42
Israel	0.771	2.67	1.000	∞
Italy	0.927	9.19	1.000	∞
Jamaica	0.331	0.63	0.423	0.80
Japan	0.893	6.14	1.000	∞
Jordan	0.598	1.35	0.726	2.16
Kenya	0.844	4.08	1.000	∞
Korea	0.774	2.71	1.000	∞
Kuwait	0.880	5.43	1.000	∞
Lebanon	0.689	1.86	0.839	3.94
Liberia	0.794	3.00	1.000	∞
Libya	0.899	6.50	1.000	∞
Madagascar	0.713	2.05	0.872	5.05
Malawi	0.519	1.06	0.633	1.52
Malaysia	0.699	1.94	0.852	4.33
Mali	0.456	0.88	0.562	1.20
Malta	0.879	5.36	1.000	∞
Mauritania	0.894	6.18	1.000	∞
Mauritius	0.692	1.88	0.842	4.02
Mexico	0.885	5.67	1.000	∞
Morocco	0.623	1.47	0.756	2.48
Mozambique	0.412	0.78	0.512	1.04
Namibia	0.503	1.01	0.633	1.51
Netherlands Antilles	0.798	3.07	1.000	∞
Netherlands	0.791	2.96	1.000	∞
New Zealand	0.674	1.76	0.820	3.49
Nicaragua	0.760	2.53	0.954	14.67
Niger	0.680	1.80	0.827	3.66
Nigeria	0.919	8.21	1.000	∞
Norway	0.826	3.62	1.000	∞
Oman	0.899	6.49	1.000	∞
Pakistan	0.775	2.72	1.000	∞
Panama	0.883	5.58	1.000	∞
Papua New Guinea	0.820	3.49	1.000	∞
Paraguay	0.734	2.24	0.903	6.82
Peru	0.834	3.83	1.000	∞
Philippines	0.731	2.21	0.898	6.47

Table 8 (Concluded). Half-Lives of Terms of Trade Shocks: Biased Least Squares and Median-Unbiased Estimation of AR(1) Regressions, Trend and Constant

	Biased Least Squares		**Median Unbiased**	
Country	**α**	**Half-life (years)**	**α**	**Half-life (years)**
Poland	0.447	0.86	0.567	1.22
Portugal	0.675	1.76	0.820	3.49
Qatar	0.893	6.15	1.000	∞
Rwanda	0.792	2.98	1.000	∞
Saudi Arabia	0.881	5.45	1.000	∞
Senegal	0.701	1.95	0.855	4.41
Sierra Leone	0.683	1.82	0.831	3.75
Singapore	0.817	3.42	1.000	∞
Solomon Islands	0.689	1.86	0.876	5.25
South Africa	0.971	23.60	1.000	∞
Spain	0.923	8.69	1.000	∞
Sri Lanka	0.534	1.10	0.651	1.61
St. Kitts and Nevis	0.810	3.30	1.000	∞
St. Lucia	0.748	2.38	1.000	∞
Sudan	0.774	2.70	1.000	∞
Swaziland	0.780	2.79	1.000	∞
Sweden	0.916	7.90	1.000	∞
Switzerland	0.577	1.26	0.701	1.95
Syrian Arab Republic	0.888	5.85	1.000	∞
Tanzania	0.733	2.23	0.901	6.65
Thailand	0.384	0.72	0.482	0.95
Tonga	0.669	1.72	0.846	4.14
Trinidad and Tobago	0.826	3.63	1.000	∞
Tunisia	0.876	5.21	1.000	∞
Turkey	0.814	3.37	1.000	∞
Uganda	0.830	3.71	1.000	∞
United Arab Emirates	0.897	6.35	1.000	∞
United Kingdom	0.747	2.38	0.927	9.12
United States	0.904	6.88	1.000	∞
Uruguay	0.646	1.59	0.784	2.85
Venezuela	0.893	6.12	1.000	∞
Western Samoa	0.821	3.51	1.000	∞
Zaïre	0.743	2.34	0.920	8.31
Zambia	0.746	2.36	0.924	8.81
Zimbabwe	0.631	1.50	0.792	2.97
Average (median)	0.764	2.57	1.000	∞

Notes: *Least Squares*—The results in columns 2-3 of this table are based on least squares estimation of the AR(1) regression of equation (13). The half-life is the length of time it takes for a unit impulse to dissipate by half. It is derived using the formula: HLS = ABS(log(1/2)/log(α)), where α is the autoregressive parameter. The least squares estimate of the HLS is calculated using the least squared estimate of α in the formula for HLS. The half-lives measured in years. *Median Unbiased*—The results in columns 4-5 of this table are based on the median-unbiased estimates of the AR(1) regression of equation (13), as given by Andrews (1993). The half-life is the length of time it takes for unit impulse to dissipate by half. It is derived using the formula: HLS = ABS(log(1/2)/log(α)), where α is the median-unbiased autoregressive parameter. The median-unbiased estimate of the HLS is calculated using the median-unbiased estimate of α in the formula for the HLS. The quantile functions of $\hat{\alpha}$ were generated by numerical simulation (using 10,000 iterations) for T=39 and T=34 observations (as appropriate). The half-lives are measured in years. The terms of trade data is annual in frequency, for the period 1960-99 and 1965-99 (as appropriate).

Table 9. Half-Lives of Terms of Trade Shocks: Biased Least Squares and Median-Unbiased Estimation of AR(1) Regressions, Constant Only

Country	Persistence group	Biased Least Squares		Median Unbiased	
		α	Half-life (years)	α	Half-life (years)
Algeria	P	0.933	10.02	1.000	∞
Antigua and Barbuda	T	0.725	2.16	0.814	3.37
Argentina	P	0.979	33.22	1.000	∞
Australia		0.960	17.19	1.000	∞
Austria		0.915	7.78	1.000	∞
Bahamas	T	0.828	3.68	0.939	10.94
Bahrain	T	0.820	3.50	0.928	9.25
Bangladesh	T	0.855	4.42	0.950	13.62
Barbados		0.888	5.85	1.000	∞
Belgium	P	0.937	10.67	1.000	∞
Bolivia	T	0.870	4.98	0.971	23.88
Botswana	P	0.878	5.33	1.000	∞
Brazil		0.904	6.90	1.000	∞
Bulgaria	P	0.980	35.08	1.000	∞
Burkina Faso	T	0.653	1.63	0.719	2.10
Burundi		0.871	5.03	1.000	∞
Cameroon	P	0.897	6.40	1.000	∞
Canada	T	0.793	2.99	0.874	5.16
Cape Verde	P	0.927	9.20	1.000	∞
Central African Rep.	T	0.762	2.55	0.839	3.94
Chad		0.964	18.84	1.000	∞
Chile	P	0.939	11.05	1.000	∞
China	T	0.730	2.21	0.820	3.50
Colombia	T	0.796	3.04	0.878	5.32
Costa Rica	T	0.799	3.09	0.881	5.49
Côte d'Ivoire	T	0.854	4.39	0.949	13.35
Cyprus	P	0.959	16.42	1.000	∞
Denmark	T	0.811	3.31	0.895	6.27
Dominica		0.883	5.57	1.000	∞
Dominican Republic	T	0.565	1.21	0.624	1.47
Ecuador	P	0.934	10.19	1.000	∞
Egypt	T	0.820	3.49	0.906	7.00
El Salvador		0.961	17.56	1.000	∞
Equatorial Guinea	T	0.391	0.74	0.450	0.87
Ethiopia		0.905	6.94	1.000	∞
Fiji	T	0.869	4.95	0.970	22.99
Finland	T	0.782	2.81	0.861	4.64
France	T	0.814	3.37	0.899	6.50
Gabon	P	0.922	8.55	1.000	∞
Gambia	T	0.822	3.54	0.909	7.25
Germany	T	0.753	2.44	0.828	3.67
Ghana	P	0.895	6.28	1.000	∞
Greece	T	0.860	4.59	0.957	15.85
Grenada	P	0.945	12.32	1.000	∞
Guatemala	T	0.849	4.22	0.942	11.57
Guinea	P	0.942	11.51	1.000	∞

Table 9 (Continued). Half-Lives of Terms of Trade Shocks: Biased Least Squares and Median-Unbiased Estimation of AR(1) Regressions, Constant Only

Country	Persistence group	Biased Least Squares		Median Unbiased	
		α	Half-life (years)	α	Half-life (years)
Guyana	T	0.757	2.49	0.833	3.80
Haiti	P	0.960	16.87	1.000	∞
Honduras		0.949	13.28	1.000	∞
Hong Kong SAR	T	0.420	0.80	0.477	0.94
Hungary	P	0.934	10.22	1.000	∞
Iceland	T	0.732	2.22	0.805	3.19
India	P	0.906	7.00	1.000	∞
Indonesia	P	0.934	10.10	1.000	∞
Iran	P	0.926	8.99	1.000	∞
Iraq	P	0.928	9.28	1.000	∞
Ireland	T	0.690	1.87	0.759	2.51
Israel	T	0.803	3.16	0.886	5.72
Italy	P	0.904	6.87	1.000	∞
Jamaica	T	0.399	0.75	0.448	0.86
Japan	T	0.881	5.47	0.985	34.31
Jordan	T	0.629	1.50	0.693	1.89
Kenya	P	0.882	5.50	1.000	∞
Korea	T	0.800	3.11	0.883	5.57
Kuwait	P	0.943	11.71	1.000	∞
Lebanon	T	0.770	2.65	0.847	4.18
Liberia	P	0.889	5.92	1.000	∞
Libya	P	0.923	8.65	1.000	∞
Madagascar	T	0.867	4.86	0.967	20.96
Malawi	T	0.848	4.19	0.941	11.31
Malaysia	T	0.707	2.00	0.778	2.76
Mali	T	0.580	1.27	0.640	1.56
Malta	T	0.863	4.70	0.983	34.31
Mauritania	P	0.954	14.56	1.000	∞
Mauritius	T	0.727	2.17	0.799	3.08
Mexico	T	0.881	5.45	0.985	34.31
Morocco	T	0.654	1.64	0.720	2.11
Mozambique	T	0.447	0.86	0.499	1.00
Namibia	T	0.843	4.06	0.959	16.49
Netherlands Antilles	T	0.809	3.27	0.893	6.14
Netherlands	P	0.882	5.52	1.000	∞
New Zealand	T	0.734	2.25	0.807	3.24
Nicaragua		0.979	33.45	1.000	∞
Niger		0.942	11.58	1.000	∞
Nigeria	P	0.933	10.04	1.000	∞
Norway	T	0.829	3.70	0.917	8.00
Oman	P	0.881	5.48	1.000	∞
Pakistan	P	0.936	10.48	1.000	∞
Panama	T	0.871	5.02	0.973	25.17
Papua New Guinea	T	0.837	3.89	0.950	13.60
Paraguay		0.983	41.28	1.000	∞
Peru	P	0.943	11.74	1.000	∞

Table 9 (Concluded). Half-Lives of Terms of Trade Shocks: Biased Least Squares and Median-Unbiased Estimation of AR(1) Regressions, Constant Only

		Biased Least Squares		Median Unbiased	
Country	Persistence group	α	Half-life (years)	α	Half-life (years)
Philippines	T	0.813	3.34	0.897	6.39
Poland	T	0.766	2.61	0.862	4.68
Portugal		0.972	24.45	1.000	∞
Qatar	P	0.921	8.44	1.000	∞
Rwanda	P	0.923	8.63	1.000	∞
Saudi Arabia	P	0.923	8.69	1.000	∞
Senegal	T	0.784	2.85	0.864	4.76
Sierra Leone		0.930	9.56	1.000	∞
Singapore	T	0.816	3.40	0.922	8.52
Solomon Islands	T	0.694	1.90	0.779	2.77
South Africa	P	0.964	18.84	1.000	∞
Spain	P	0.918	8.14	1.000	∞
Sri Lanka	T	0.733	2.23	0.806	3.21
St. Kitts and Nevis	T	0.820	3.50	0.928	9.24
St. Lucia	T	0.777	2.75	0.875	5.20
Sudan	T	0.831	3.74	0.919	8.18
Swaziland	T	0.766	2.61	0.902	6.72
Sweden	P	0.920	8.36	1.000	∞
Switzerland		0.967	20.52	1.000	∞
Syrian Arab Republic	P	0.947	12.66	1.000	∞
Tanzania	T	0.862	4.69	0.961	17.43
Thailand	T	0.857	4.48	0.953	14.42
Tonga	T	0.814	3.38	0.921	8.38
Trinidad and Tobago	T	0.855	4.42	0.950	13.64
Tunisia	P	0.920	8.31	1.000	∞
Turkey	P	0.908	7.18	1.000	∞
Uganda	P	0.956	15.53	1.000	∞
United Arab Emirates	P	0.920	8.36	1.000	∞
United Kingdom	T	0.750	2.41	0.825	3.61
United States	P	0.948	13.01	1.000	∞
Uruguay	T	0.731	2.21	0.803	3.16
Venezuela	P	0.913	7.61	1.000	∞
Western Samoa	T	0.820	3.48	0.927	9.15
Zaïre		0.918	8.12	1.000	∞
Zambia		0.910	7.33	1.000	∞
Zimbabwe		0.901	6.63	1.000	∞
Average (median)		0.875	5.184	0.985	34.31

Notes: *Least Squares*—The results in columns 3-4 of this table are based on least squares estimation of the AR(1) regression of equation (13), excluding the trend term. The half-life is the length of time it takes for a unit impulse to dissipate by half. It is derived using the formula: HLS = ABS(log(1/2)/log(α)), where α is the autoregressive parameter. The least squares estimate of the HLS is calculated using the least squared estimate of α in the formula for HLS. The half-lives measured in years. *Median Unbiased*—The results in columns 5-6 of this table are based on the median-unbiased estimates of the AR(1) regression of equation (13), excluding the trend term, as given by Andrews (1993). The half-life is the length of time it takes for unit impulse to dissipate by half. It is derived using the formula: HLS = ABS(log(1/2)/log(α)), where α is the median-unbiased autoregressive parameter. The median-unbiased estimate of the HLS is calculated using the median-unbiased estimate of α in the formula for the HLS. The quantile functions of $\hat{\alpha}$ were generated by numerical simulation (using 10,000 iterations) for T=39 and T=34 observations (as appropriate). The half-lives are measured in years. Column 2 denotes the grouping of countries by persistence of shocks to their terms of trade: (P) denotes permanent shock (bias-corrected infinite half-life of terms of trade shock), for both constant only *and* trend and constant AR(1) regression); (T) denotes temporary shock (bias-corrected finite half-life of terms of trade shock) for constant only AR(1) regression). The terms of trade data is annual in frequency, for the period 1960-99 and 1965-99 (as appropriate).

Classifying Countries by Persistence of Terms of Trade Shock

The 128 countries in our sample have been grouped using Andrews (1993) unbiased model-selection rule, given the persistence of shocks to their terms of trade. Those countries with **permanent** (P, infinitely-persistent) bias-corrected half-life of terms of trade shocks (for *both* the constant only and trend and constant AR(1) regressions) will be designated as members of the most persistent group. Those countries with **temporary** (T, finitely-persistent) bias-corrected half-life of terms of trade shocks (for the constant only AR(1) regression) will be designated as members of the least persistent group.

Permanent (P):

The set of 44 countries satisfying the conditions for permanent terms of trade shocks are: Algeria*§, Argentina, Belgium, Botswana*, Bulgaria*, Cameroon*, Cape Verde*, Chile, Cyprus, Ecuador§, Gabon§, Ghana, Grenada*, Guinea*, Haiti*, Hungary*, India, Indonesia§, Iran§, Iraq*§, Italy, Kenya, Kuwait*§, Liberia*, Libya§, Mauritania*, Netherlands, Nigeria§, Oman*, Pakistan, Peru, Qatar*§, Rwanda, Saudi Arabia*§, South Africa, Spain, Sweden, Syrian Arab Republic, Tunisia, Turkey, Uganda, United Arab Emirates*§, United States, and Venezuela§.

Temporary (T):

The set of 65 countries satisfying the conditions for temporary terms of trade shocks are: Antigua and Barbuda*, Bahamas*, Bahrain*, Bangladesh*, Bolivia, Burkina Faso, Canada, Central African Republic, China*, Colombia, Costa Rica, Côte d'Ivoire, Denmark, Dominican Republic, Egypt, Equatorial Guinea*, Fiji, Finland, France, Gambia*, Germany, Greece, Guatemala, Guyana*, Hong Kong SAR*, Iceland, Ireland, Israel, Jamaica, Japan, Jordan, Korea, Lebanon*, Madagascar*, Malawi*, Malaysia*, Mali*, Malta, Mauritius, Mexico, Morocco, Mozambique*, Namibia*, Netherlands Antilles*, New Zealand, Norway, Panama, Papua New Guinea*, Philippines, Poland*, Senegal, Singapore, Solomon Islands*, Sri Lanka, St. Kitts and Nevis*, St. Lucia*, Sudan, Swaziland*, Tanzania, Thailand, Tonga*, Trinidad and Tobago, United Kingdom, Uruguay, and Western Samoa.

Countries with Neither Permanent Nor Temporary Terms of Trade Shocks:

In addition, the following 19 countries were classified as possessing terms of trade shocks which were neither permanent nor temporary: Australia, Austria, Barbados, Brazil, Burundi*, Chad, Dominica*, El Salvador, Ethiopia, Honduras, Nicaragua, Niger, Paraguay, Portugal, Sierra Leone*, Switzerland, Zaire*, Zambia*, and Zimbabwe*.

Data Availability for Panel Regressions:

Of the above 128 countries, those 48 countries denoted with an asterisk (*) were excluded from the panel regressions of Section V, due to the unavailability of data on the current account and/or real gross domestic product for the full 1970-99 period (see also Appendix II). Those 13 countries which are past or present members of OPEC are denoted by the symbol (§).

Of the 67 non-OPEC countries with full data availability, six were excluded from the group panel regression analysis as they were countries with neither permanent nor temporary terms of trade shocks. Of the remaining 61 countries, 41 were classified as countries with temporary terms of trade shocks, while 20 were classified as countries with permanent shocks.

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