

THE STRUCTURAL DETERMINANTS OF EXTERNAL VULNERABILITY*

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Abstract: This paper examines empirically how domestic structural characteristics related to openness and product- and factor-market flexibility influence the impact that terms-of-trade shocks can have on aggregate output. For this purpose, it applies an econometric methodology based on semi-structural vector auto-regressions to a panel of 88 countries with annual observations for the period 1974-2000. Using this methodology, the paper isolates and standardizes the shocks, estimates their impact on GDP, and examines how this impact depends on the domestic conditions outlined above. We find that larger trade openness magnifies the output impact of terms of trade shocks, particularly the negative ones, while financial openness reduces their impact. We find a beneficial role for labor and firm-entry flexibility, with the former dampening the impact of negative shocks and the latter magnifying the positive ones only. Domestic financial depth has a more nuanced role in stabilizing the economy. In fact, the analysis of interactions across structural determinants reveals complementarities among macroeconomic conditions (trade and financial openness and depth) and, separately, among microeconomic conditions (labor and firm-entry flexibility). Interestingly, variables belonging to these different groups tend to behave as substitutes for each other.

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Macroeconomic volatility is not only a source of business cycle uncertainty but also a major cause of low economic growth. Ramey and Ramey (1995) were the first to document this finding for a cross-section of countries. Fatás (2000) and Hnatkovska and Loayza (2005) complemented it, showing that macroeconomic volatility is particularly harmful for developing countries, where volatility is higher and its impact more pronounced.

Among the causes of macroeconomic volatility, the incidence of external shocks and, in particular, fluctuations in the terms of trade plays an important role. Across countries, about 10 percent of the variation in GDP growth and a quarter of the variation in growth volatility can be explained by the observed differences in the volatility of terms-of-trade changes (see Easterly et al. 1993 and Hnatkovska and Loayza 2005). Terms-of-trade shocks have also been documented to have a significant impact on GDP within countries (see Ahmed 2003, and Raddatz, 2007, among others), although in this regard their preeminence vis-à-vis domestic shocks is subject to debate.¹

Going beyond the average impact of external shocks, there is a rich literature that suggests the possibility that the impact of an external shock on the real side of the economy may be determined by domestic conditions that interact with the shocks to produce macroeconomic stability or volatility as outcomes. The traditional approach to analyze the domestic sources of vulnerability has stressed macroeconomic policy responses in monetary, foreign exchange, and fiscal areas. A recent example of this macroeconomic emphasis is Broda (2001), who compares the stabilization properties of different exchange rate regimes in the face of terms-of-trade shocks. New developments

in the vulnerability literature have concentrated, instead, on the role of structural characteristics related to the functioning of markets and institutions. Some studies stress the role of factor and product market rigidities for the amplification of shocks at the macroeconomic level. See, for example, Kiyotaki and Moore (1997), Bernanke and Gertler (1989), Caballero and Hamour (1994, 1996, 1998), and Caballero and Krishnamurty (2001). Others, such as Acemoglu et al. (2003) and Rodrik (1999), point to the relevance of institutional development in the control of crises and management of shocks.²

Notwithstanding these contributions, the extent to which domestic structural characteristics can account for the relative instability of aggregate output remains an open question. This paper contributes to this literature by examining how certain domestic structural characteristics influence the impact that external shocks may have on aggregate output. The broad issue under study here is whether a country's vulnerability to shocks is not purely random but linked to structural characteristics that are at least partially policy driven. Specifically, they are given by trade openness, financial depth, capital account openness, labor flexibility, and ease of firm dynamics. These are not deep institutional variables; rather, they are outcomes through which the fundamentals operate. Our purpose in using structural outcome variables is of separating and elucidating the mechanisms that drive external vulnerability.

For analytical purposes we can distinguish two aspects of output vulnerability to external shocks. The first is the frequency and strength of the shocks affecting the country. The second one is the effect that a shock of a given size and frequency can have on the country's output. This paper is dedicated to the second aspect of vulnerability.

For this purpose and working with a panel sample of 88 countries and annual observations for the period 1974-2000, the paper applies an econometric methodology that isolates and standardizes the shocks, estimates their impact on GDP, and examines how this impact depends on the domestic conditions outlined above.³

From an empirical perspective, the relevant question for the paper is whether the differential impact of a *given* external shock is related to country characteristics. Controlling for the size of the shocks is not an easy task. Most of the recent literature on this issue has relied on either indirect evidence from difference-in-difference estimation (see, for example, Braun and Larrain 2005, Caballero, Cowan, Engel, and Micco 2005, and Raddatz 2006) or calibrated macroeconomic models developed to match certain moments of developing countries' economic performance (for a survey, see Arellano and Mendoza 2004).

This paper takes a different approach and directly estimates the output impact of external shocks using semi-structural vector auto-regression analysis (VAR), as applied to a (cross-country, time-series) panel data of aggregate variables. This methodology requires the identification assumption that the relevant external variable, that is, the change in the terms of trade, does not respond to either domestic output changes or the variables that account for the country's structural characteristics. In practice, this rather uncontroversial assumption amounts to a small-open-economy condition for the countries included in the analysis. Similar applications of this methodology can be found in Broda (2004), Ahmed (2002), Uribe and Yue (2003), and Raddatz (2007). Controlling for the size of the shock, the analysis proceeds to account for its interaction with the set of country characteristics under analysis and estimate its conditional output impact.

The rest of the paper carries on as follows. Section 2 presents the econometric methodology in detail and conducts the corresponding specification tests. Section 3 introduces the data, providing information on variable definitions and sources, as well as the sample of countries and years under analysis. Section 4 presents the empirical results, including the discussion of symmetric and asymmetric (positive/negative) effects, the potential interaction between structural characteristics, and a set of robustness checks. Section 5 concludes.

I. Methodology

We estimate the impact of exogenous shocks on a country's economic performance and its relation to the country's structural characteristics using a panel vector auto-regression (panel VAR). In order to minimize the need for identification assumptions (see below), we focus exclusively on terms-of-trade shocks. Therefore, for a given country i , our semi-structural model corresponds to:

$$(1) \quad A_{i,0}x_{i,t} = \sum_{j=1}^q A_{i,j}x_{i,t-j} + \varepsilon_{it}$$

where $x_{i,t} = (\Delta tt_{i,t}, \Delta y_{i,t})'$, is a vector that contains the first difference of the log of terms-of-trade index ($\Delta tt_{i,t}$) and the log of real GDP per capita ($\Delta y_{i,t}$), both as deviations from their country-specific means.⁴ The matrices $A_{i,j}$ contain the structural coefficients for the different lags included in the model (including the contemporaneous one). The structural errors $\varepsilon_{i,t}$ are i.i.d. with zero mean and a diagonal variance-covariance matrix Σ .

The identification assumption used in the paper is that, for a given country, terms-of-trade changes are strictly exogenous. That is, we assume that $\Delta tt_{i,t}$ do not respond to $\Delta y_{i,t}$ at any lags. This assumption is equivalent to imposing the following triangular structure in all the A matrices:

$$A_{i,j} = \begin{bmatrix} a^{i,j}_{11} & 0 \\ a^{i,j}_{21} & a^{i,j}_{22} \end{bmatrix}.$$

For the developing and small developed countries included in this study, this assumption should be uncontroversial. In fact, for the sample of countries included in this study, a standard Granger causality cannot reject the hypothesis that output fluctuations do not Granger-cause terms of trade fluctuations.⁵ The relatively weak assumption required to identify the impact of a terms-of-trade shock is the reason why we focus exclusively on these shocks. We believe that it is preferable to focus on a reduced set of shocks that we can clearly identify that in a broader set of shocks that would require strong and controversial identification assumptions. This means, however, that we have to interpret our results with caution. Since our model does not account for all exogenous sources of fluctuations, it is semi-structural (as opposed to a full structural model); our terms-of-trade variable captures all strictly exogenous variables whose fluctuations are correlated with those of the terms of trade. Therefore, our statements on the role of different structural characteristics on the amplification or dampening of shocks apply directly to terms-of-trade shocks *and* indirectly to other exogenous contingencies that are correlated with these shocks, such as the world business cycle.

Our baseline model corresponds to a panel VAR in which we assume that part of the coefficients in the A matrices are common across cross-sectional units. Since we are

interested in testing how different structural characteristics of a country affect the impact of terms-of-trade shocks on output, which is captured by the $a^{i,j}_{21}$ coefficients, we permit these coefficients to vary across countries according to the specific characteristics whose role we want to determine. In particular, we assume that

$$a^{i,j}_{21} = \beta_0^j + \beta_1^j \times OPEN_i + \beta_2^j \times FDEV_i + \beta_3^j \times CAOPEN_i + \beta_4^j \times LABOR_i + \beta_5^j \times ENTRY_i$$

where $OPEN_i$, $FDEV_i$, $CAOPEN_i$, $LABOR_i$, and $ENTRY_i$ are measures of trade openness, financial development, capital account openness, labor flexibility, and firm-entry flexibility for country i that we describe below in section 3. In part of our analysis we will also allow for the possibility that the role of these characteristics on the transmission of terms-of-trade shocks may be different for an increase than for a decrease in (log) terms of trade (with respect to the mean change). In terms of the notation above, this corresponds to allowing the β^j coefficients to vary with the state of the terms-of-trade in the following way:

$$\beta = \begin{cases} \beta^+ & \text{if } \Delta t_{i,t} > 0 \\ \beta^- & \text{otherwise} \end{cases}$$

where $\beta = (\beta^0, \dots, \beta^j, \dots, \beta^q)$, $\beta^j = (\beta_0^j, \dots, \beta_5^j)$, and β^+ and β^- are similarly defined. The rest of the coefficients that capture the dynamics of the terms of trade and the lagged effect of output on itself (the $a^{i,j}_{11}$ and $a^{i,j}_{22}$ coefficients, respectively) are restricted to be the same for all countries.

The use of *panel* VARs, with the corresponding restrictions on the parameters, is common in the recent literature that estimates the impact of exogenous shocks on different macroeconomic variables (see Broda, 2004; Ahmed, 2003; Uribe and Yue,

2003) because the limited length of the time-series dimension of the data (around 25 annual observations) makes it difficult to estimate country-specific dynamics. Using a panel VAR approach increases the degrees of freedom of the estimation, and, if the common parameter restrictions are correct, provides more efficient estimators. Of course, the obvious disadvantage is that if these restrictions are not valid, the model is incorrectly specified.

A particular concern with this approach is that, as noticed by Pesaran and Smith (1995), the assumption of common coefficients may lead to obtaining parameters that underestimate (overestimate) the short (long) run impact of exogenous variables if the dynamics differ importantly across countries. However, as demonstrated by Pakes and Griliches (1984), if differences in slope coefficients are uncorrelated with the exogenous variables, the estimated parameters would be consistent estimators of the average coefficients. This is an important result for our case, as we do not see any good reason why the *marginal effect* of terms of trade in a country should be determined by the terms of trade itself. Nevertheless, in an additional exercise (and at the cost of reduced precision of the estimates), we will also estimate the VAR on a country-by-country basis, without imposing any restriction on the dynamics. We will then relate the estimated country-specific effects of the shocks to the structural characteristics under study. The results will prove to be very similar to those obtained with our panel methodology.

As mentioned above, the variables in the VAR are the first differences of the (log) terms of trade and output per capita. That is, we model the relevant series as difference-stationary. There are two reasons for this modeling choice. First, standard tests tend to suggest the presence of a unit root in the levels of both series. The results of these tests

are summarized in Table 1. Columns 1 and 2 show the results of the ADF tests performed on a country-by-country basis for, respectively, country-specific and common lag structure.⁶ It is clear that in most cases the test cannot reject the null of a unit-root for both series (about 85 percent of the time for both series when the median number of lags is used for all countries). The panel-based unit-root test suggested by Levin, Lin, and Chu (2002), augmented by the median number of lags across countries (2 lags), reported in column (3) provides a similar conclusion: The null of unit root cannot be rejected. Second, previous empirical papers in this literature (e.g. Ahmed, 2003, Broda, 2004) have estimated difference stationary models, so this specification has the advantage of being more directly comparable with existing results.⁷

Coming back to the VAR specification, we use two annual lags in the benchmark specification. This lag structure was determined using standard lag selection tests (Akaike information criterion, Schwartz information criterion, and Hannan-Quinn criterion).

Under the identification assumptions described above, we estimate the parameters of the model using a two-step procedure: we first estimate the reduced-form coefficients equation-by-equation by OLS; then, we recover the impulse-response functions (IRF) to each of the structural shocks (using the reduced-form coefficients and the variance-covariance matrices of the reduced-form errors derived from these coefficients). The confidence bands for the IRF were estimated by parametric bootstrapping assuming normally distributed reduced-form errors.⁸

II. Data

The main variables used in the paper are the following. Real GDP per-capita corresponds to the GDP per capita in constant 2000 U.S. dollars and was obtained from the WDI. The reason to use this series instead of the PPP adjusted ones, despite the reduced international comparability, is that it has more recent coverage than the measures from the Penn World Tables and longer coverage than the PPP series produced by the World Bank.⁹ The terms-of-trade index is the ratio of export prices to import prices computed using the current and constant price values of exports and imports from the national accounts component of the Penn World Tables (version 6.1) and updated using the terms-of-trade data from WDI.¹⁰ To reduce concerns about structural breaks we focus on the post Bretton-Woods period, 1974-2000.

The structural characteristics of the countries are captured in the following variables. Trade openness is measured as the (log) of the ratio of total trade to GDP. Financial development corresponds to the (log) of the ratio of the private credit provided by banks and other financial institutions to GDP, obtained from Beck, Demirguc-Kunt, and Levine (2000). When data from this source is not available, we use corresponding data from WDI. Openness in capital account transactions is captured by the Chinn-Ito (2002) index.¹¹ The index is such that a higher value indicates a higher degree of openness. The index of labor market flexibility is calculated from data in World Bank (2003) and is a weighted average of three indicators --flexibility of hiring, conditions of employment, and flexibility of firing-- as in Botero et al. (2004). We rescaled the original index to range between 0 and 1, with higher values indicating more flexible labor

markets. Finally, the index measuring the ease of firm entry was calculated from data in World Bank (2003) and O’Driscoll, Feulner, and O’Grady (2003) and is a weighted average of four indicators –registration procedures, cost of registration, days to registration, and burden entry regulations—as in Chang, Kaltani, and Loayza (2005). This index also ranges from 0 to 1, with higher values indicating less restricted firm entry.

The sample of countries used in the empirical analysis is shown in Appendix 1. The sample includes 88 countries from different regions and income levels. The largest region in the sample is Sub-Saharan Africa with 30 countries, followed by Latin America with 20, East Asia and Pacific and with 11, Middle East and North Africa and Western Europe with 10 each, and South Asia, East and Central Europe, and North America with 4, 2, and 1 countries, respectively. With respect to income, there are 35 low-income countries, 35 middle-income countries, and 18 high-income countries. The sample includes all countries where at least 15 continuous observations of both terms-of-trade and output per capita were available during the period 1974-2000 and with available measures of the structural characteristics described above. We exclude from the sample large industrial countries because of the possible endogeneity of their terms of trade. They are the United States, United Kingdom, France, Italy, Germany, and Japan. We also exclude five developing countries where the terms-of-trade data exhibited long flat periods.¹²

Appendix 1 shows some summary statistics of these variables for *each* country in the sample. Cross-sectional summary statistics and correlations among these variables are reported in Table 3. There we observe the well documented positive correlations between

the different structural characteristics and output growth, and negative correlations between the measures of volatility and growth. We also observe that the structural characteristics are positively correlated with each other, although the magnitudes of the correlations are not particularly large with the exception of that between financial development and firm-entry flexibility, which reaches 66 percent. These relatively low correlations are grounds to expect that it is indeed possible to sort out the role of the different structural characteristics in the transmission of shocks.

III. Results

Our basic results are derived from estimating the cumulative output effect of a one-standard-deviation shock to the terms of trade at different levels of a particular structural characteristic. As explained in the methodological section, we conduct this estimation in the context of a panel (cross-country, time-series) vector autoregression with (demeaned log) GDP changes as the dependent variable and (demeaned log) terms-of-trade changes as the exogenous variable. We allow the output effect of terms-of-trade shocks to vary with five country structural characteristics: trade openness, financial depth, financial (or capital-account) openness, labor market flexibility, and ease of firm entry. To analyze the effect of these structural factors, we compare the shock's cumulative output impact measured at the 25th and the 75th percentiles of the world distribution of each structural characteristic. Comparing the impact statistics at these (relatively) low and high levels for a given structural factor provides a sense for how much it contributes to amplifying or dampening the external shock.

Figure 1 and Table 3 present the cumulative effect of a one-standard-deviation shock in the terms of trade on the level of GDP per capita for low and high levels of each country characteristic. In order to indicate the accuracy of the estimated impacts, Figure 1 also presents their 90% confidence bands and Table 3 the corresponding (empirical) standard errors.¹³ In order to have a benchmark for quantitative comparison, we estimated the *median* cumulative output impact of a one-standard-deviation terms-of-trade shock (that is, the impact calculated at the median of all structural characteristics) and found it to be approximately 1 percentage point of GDP. As noted in the methodological section, the size of the shock is made the same for all countries in order to focus only on the variation in the responsiveness to a uniform shock across countries.

(Figure 1 about here)

The most noticeable result is that larger trade openness appears to increase the cumulative output impact of terms-of-trade shocks. This is likely to be a size effect in the sense that a higher volume of trade implies a larger share of economic activities that the terms of trade, as relative prices, can influence. This, however, should not be confused with a purely mechanical effect, which applies to the relation between trade prices and *nominal* GDP (or the price of GDP in terms of importable goods). Since our analysis is based on *real* GDP, mechanical price effects should not be present.¹⁴ The effect of openness is large and significant: the output impact of the shock at the third quartile of trade openness is 1.4 percentage points higher than at the first quartile. The vulnerability of open economies should not have a normative implication; it merely reflects the extent of real resource shifts in the presence of price signals and, from a methodological

perspective, highlights the need to control for openness in assessing the impact of other structural characteristics.

Conversely, higher financial depth seems to have no effect on the impact of terms-of-trade shocks. This is rather surprising given that financial depth is usually considered as an antidote to external vulnerability. This is an important issue, and we'll revisit it at several points in this paper, particularly when we consider asymmetric effects to positive and negative shocks and complementary interactions with other structural characteristics.

An increase in financial openness does appear to reduce the effect of a terms-of-trade shock, significantly but by a moderate margin: the difference in the cumulative output impact between the 25th and 75th percentiles of financial openness is -0.43 percentage points. The fact that access to international financial markets has a stabilizing effect while domestic financial depth does not is puzzling (and as mentioned above, below we examine a possible interaction between these two financial aspects).

Easing firm entry has a significant though moderate amplifying effect of terms-of-trade shocks: the output impact of the shock at the third quartile of firm-entry flexibility is 0.52 percentage points higher than at the first quartile. The entry of new firms is only one side of the firm-dynamics process, and, thus, firm exit can also be reacting to the external shocks. Moreover, the process of firm dynamics may have different characteristics under negative or positive shocks, and we shall reconsider the shock-amplifying effect of firm-entry flexibility when we analyze the case of asymmetric effects below.

Finally, of all structural characteristics considered here, improvement in labor market flexibility has the strongest effect of reducing the impact of terms-of-trade shocks on per capita GDP. The difference in the shock's cumulative output impact between the first and third quartiles of labor market flexibility is -1.23 percentage points, in absolute value almost as large as that of trade openness. The ability of firms to adjust their activities on the labor margin seems crucial for the economy to accommodate the shock.

Robustness

We examine the robustness of the basic results to changes in measurement of the terms-of-trade shock, changes in the sample of countries, the application of a longer lag structure in the estimated VARs, the inclusion of the exchange-rate regime as an additional country characteristic, and the implementation of an alternative method to estimate the effects of structural characteristics. The results on several robustness checks using the panel VAR methodology are presented in the rows of Table 4. The robustness check on the methodology itself is presented in Table 5.

The first concern is whether the amplifying effect of trade openness reflects mostly a mechanical effect. We address this issue through two robustness checks. In the first, we replace the simple terms-of-trade index with one that weighs export and import prices by the size of export and import volumes, respectively. We repeat the basic exercise using this trade-weighted shock and find that the amplifying effect of trade openness becomes even larger. This indicates that trade openness, as a mechanism for shock expansion, not only operates through trade volumes but also through domestic economic activity more generally. The second robustness check addresses the potential

shortcoming of GDP deflators in cleaning out (purely nominal) price effects from real GDP. This should be minimized if the GDP and TOT data come from the same source and GDP is adjusted for purchasing power parity. Then, at the cost of losing the most recent observations, we use GDP data from the Penn World Tables and rerun the analysis. We find that the shock-amplifying effect of trade openness remains large, though somewhat lower than in the benchmark case.

A second concern is the possibility that our results be derived only from the contrast between developing and developed countries. To consider this possibility, we exclude all high-income countries from our sample, re-estimate the model, and compute again the impact statistics. These results are qualitatively the same and quantitatively quite similar as those obtained using the full sample. This similarity is noteworthy and indicates that our results can be compared to those of studies that focus only on developing countries.

The third concern relates to the exogeneity assumption of the terms of trade shock. Although we have excluded from the sample the largest developed countries, there still remain countries like Brazil, China, and India, for whom the small-country assumption may be problematic. As a robustness check, we exclude the 10% largest countries in the sample and repeat the exercise.¹⁵ The results retain their sign and are quantitatively similar to those of the benchmark. The exogeneity assumption may also be questionable for countries whose main exports are differentiated manufacturing goods with likely endogenous prices. To dispel this doubt, we exclude from the sample countries which are mainly manufacturing exporters.¹⁶ To be specific, these are countries

whose share of manufactured products in total exports is larger than 50%. The new results are basically the same results as those of the benchmark.¹⁷

A fourth concern pertains to the correct specification of the VAR lag structure, which may be relevant in evaluating dynamic effects. In order to dispel doubts on whether pre-estimation diagnostics could have indicated a longer lag structure, we re-estimate the shock impacts from VARs with 3 lags for all countries (rather than 2 as in the benchmark). The results change little if anything: the signs of the effects remain the same and the quantitative differences with respect the benchmark are mostly small. They are also unlikely to be statistically significant, except for the case of firm-entry flexibility whose shock-amplifying effect seems stronger. A richer lag structure comes at the price of using fewer observations for estimation, particularly in countries where the time series is rather limited, and we prefer to continue working with VARs of 2 lags.

The final robustness check in the context of the panel VAR analysis concerns the role of the exchange rate regime. This was not included in the set of structural determinants since it is generally associated to standard macroeconomic policy. However, since it has received so much attention in the stabilization literature and could in principle be related to the structural characteristics considered here, we conduct an additional exercise that includes the exchange rate regime as an additional interaction variable. We follow the Gosh et al. (2000) classification to separate country-year observations with a pegged regime from those with intermediate and floating regimes. Regarding the structural variables, this exercise renders very similar results to those of the benchmark. The effect of the exchange rate regime itself is quite small and statistically insignificant. This result is, however, only tentative. The analysis of the

exchange rate regime requires a treatment of measurement issues that is out of the scope of this paper.

As explained in the methodological section, an alternative to estimating the interactions model using panel data consists of estimating the simple model country by country (VAR of output growth on terms-of-trade growth with free coefficients), and then running a cross-country regression of the resulting cumulative impacts on the five structural variables. The advantage of this method is that it allows for full country heterogeneity in (VAR) parameter estimation; this, however, comes at the cost of lower estimation efficiency and increased noise in the individual country impulse responses.

Table 5 presents these results, using two methods that eliminate the undue influence of outlying observations. The first column shows OLS estimation where three outliers are previously eliminated using the Hadi method.¹⁸ The second column shows Weighted Least Squares (WLS) estimation where the weights are inversely proportional to the corresponding squared residual.¹⁹ The results are qualitatively similar to those obtained from panel VARs. That is, the two most important country characteristics that affect the shocks' impact are trade openness and labor market flexibility, the former magnifying the impact and the latter reducing it. Both carry highly significant coefficients under OLS and WLS. Financial openness has negative coefficients under both methods, and significantly so under OLS. Similarly, firm-entry flexibility has positive coefficients under both methods, and significantly so under WLS. As in the panel VAR case, financial openness appears to stabilize the effect of shocks, whereas firm-entry flexibility appears to enlarge them. Financial depth is not statistically significant under OLS or WLS, as was the case using the panel VAR methodology.

Asymmetric effects

The analysis above allows us to determine if structural characteristics have a stabilizing (or destabilizing) effect for all shocks, whether positive or negative. In principle, however, this symmetric treatment could mask important differences on the effects of structural characteristics for positive and negative shocks. For instance, an ideal structural characteristic --one that in reality magnifies positive shocks and reduces negative ones-- could be found to be ineffectual under a symmetric analysis. We now consider separately the output response to negative and positive terms-of-trade shocks.

The results of the asymmetric analysis are presented in Table 6. We should note that the estimation of asymmetric shocks presents larger standard errors as it uses fewer observations and suffers from wide data variations associated to sign transitions. We must also clarify how the asymmetric results should be read: In the case of negative shocks, a more negative value for the cumulative impact indicates a stronger effect; conversely, for positive shocks a more positive value for the cumulative impact denotes a larger effect.

There is some evidence of asymmetric effects. Regarding trade openness, its destabilizing effect is strong and statistically significant only in the case of negative shocks. Financial depth has no significant effect on the impact of either positive or negative terms-of-trade shocks. Therefore, its lack of relevance as shock stabilizer cannot be explained by asymmetric effects. Financial openness does not seem to have a statistically significant effect either. However, the reasons in this case are different. An increase in financial openness reduces the (absolute) impact of both negative and positive

shocks and by similar magnitudes than under the case of symmetric effects (around 0.4 percentage points). It is not surprising, then, that assuming symmetry in the case of financial openness produces more efficient estimates and, thus, significant effects.

An improvement in labor market flexibility dampens the effect of both negative and positive shocks in a statistically significant way. However, the stabilizing effect for negative shocks is substantially larger (in magnitude) than that for positive shocks. Labor market flexibility is, thus, particularly important in the face of adverse shocks. Finally, firm-entry flexibility shows interesting evidence of an asymmetric effect: easing firm entry increases significantly the consequences of positive shocks only. This provides an upbeat spin to the shock-magnifying effect we found for firm-entry flexibility in the benchmark case.

Interaction Effects

Up to now we have allowed the output response to terms-of-trade shocks to vary *linearly* with the five structural characteristics. We have assessed the relevance of each of them holding the rest constant. We now augment the empirical exercise to allow for interactions across the structural determinants. That is, we allow the *effect* of each structural variable to depend on the rest. This is akin to allowing for multiplicative interactions in a regular regression context, and we will focus on the interpretation of the equivalent to the interaction coefficients in that context. Allowing for multiplicative interactions is complex enough, so that we restrict this analysis to the case of symmetric effects (of positive and negative shocks).

The presentation of results follows a similar logic to that used previously. For a given pair of structural determinants, we set the first at its 25th percentile, then vary the second one from its 25th to its 75th percentiles and compute the difference of the cumulative output impact. Next, we set the first structural determinant at its 75th percentile, then vary the second one again from its 25th to its 75th percentiles and compute the corresponding difference of the cumulative output impact. Finally, we take the difference of the previously computed differences in cumulative output impacts (always high minus low). This difference-in-difference value is the statistic of interest for us (as mentioned above, it carries analogous information to the coefficient on a regular multiplicative interaction). A negative sign for this diff.-in-diff. value reveals that the two structural determinants under consideration are complements in dampening the effects of terms-of-trade shocks: an increase in either one leads to a lower shock impact when the other one is at a high value. Conversely, a positive sign for the diff.-in-diff. value indicates that they are substitutes: an increase in either brings about a smaller shock impact when the other one is at a low value.

Table 7 presents the results of the interactions model in a summarized way: only the difference-in-difference value for each pair of structural determinants is presented, along with its corresponding (empirical) standard error and the result of its test of statistical significance. Focusing on the significant results only, the following pattern emerges. Financial depth behaves as a complement to, in turn, trade openness and financial openness. Likewise, labor flexibility and ease of firm entry behave as complements to each other. In contrast to the basic case, the interactions model indicates a relevant though nuanced role for financial depth in affecting the impact of external

shocks: Deepening domestic financial markets can reduce the impact of external shocks when international trade and financial markets are open. This result is consistent with the literature that emphasizes the complementarity between reforms in domestic and international financial markets (see Caballero and Krishnamurthy, 2001, or Edwards, 2001, among others).²⁰ In turn, labor flexibility is more effective in reducing the shock impact if firm flexibility is high in the country, a result which highlights the importance of complementary reforms for different margins of the firm dynamics process (see Eslava, Haltiwanger, Kugler, and Kugler 2005).

Other three pairs of variables behave as substitutes. They are the ease of firm entry with both financial depth and financial openness, and labor market flexibility with financial openness. Thus, deepening financial markets and opening the capital account reduce the output effect of the shock particularly when there are impediments to firm flexibility. Likewise, labor market flexibility has a larger role in reducing the shock impact when the capital account is closed. It is interesting to note that while firm and labor flexibility are complements to each other, they behave as substitutes with respect to financial market depth and openness.

IV. Concluding Remarks

What underlies a country's vulnerability to external shocks? Why do some countries suffer so much in the face of terms-of-trade shocks while others remain unscathed? With these questions in mind, in this paper we examine how certain domestic characteristics influence the impact that terms-of-trade shocks can have on aggregate output. The paper has an empirical objective but is motivated by the recent literature that

emphasizes the role of product- and factor-market rigidities as the source of macroeconomic vulnerability.

The paper applies an econometric methodology based on semi-structural vector auto-regressions to a panel of 88 countries with annual observations for the period 1974-2000. Using this methodology, the paper identifies and standardizes the terms-of-trade shocks affecting these countries, estimates their impact on (detrended) GDP per capita, and examines how this impact depends on the countries' trade and financial openness, domestic financial depth, and labor and firm-entry flexibility.

Our basic results indicate that the two most important country characteristics affecting the shocks' output impact are trade openness and labor market flexibility, the former magnifying the impact and the latter reducing it. Financial openness also shows a significant stabilizing effect, but weaker in magnitude. Firm-entry flexibility seems to magnify the shocks but in a positive sense, as revealed by the study of asymmetric effects. Financial depth, on the other hand, does not seem to directly affect the impact of terms of trade shocks, but it affects the manner in which other structural characteristics amplify or dampen these shocks, as exposed by the analysis of interaction effects. These results are robust to checking for mechanical interpretations of the trade-related results, placing stricter restrictions to guarantee shock exogeneity, concentrating exclusively on developing countries, using a longer lag structure for the VARs, controlling in addition for the exchange-rate regime, and allowing full heterogeneity in the estimation of country impulse responses.

When we allow for the possibility of asymmetric effects (from negative and positive shocks), the following taxonomy emerges. Trade openness amplifies negative

shocks, whereas ease of firm entry magnifies only positive ones. Labor market flexibility dampens both shocks but especially negative ones. Financial openness seems to reduce both shocks in a similar way. Finally, when we analyze whether the effect of a structural determinant on the shock impact is itself influenced by the others, we uncover a revealing pattern of interactions. Macroeconomic outcomes --in trade and financial openness and depth-- tend to be complements with each other in that one's improvement leads to a lower shock impact when the rest are already advanced. Likewise, microeconomic conditions --in firm and labor flexibility-- tend to be complements to each other. Interestingly, however, macro and microeconomic conditions seem to behave as substitutes in the sense that an improvement in one area brings about a smaller shock impact when the other one is poorly advanced. Regarding vulnerability, macro and micro developments seem to compensate for each other's deficiencies.

We started the paper by pointing out two aspects of output vulnerability to external shocks: The first one focuses on the strength of the shock, and the second one on the sensibility to the shock. This study has been dedicated to the second aspect, and, in conclusion, it is only fair to ask whether this is indeed quantitatively relevant in assessing a country's degree of vulnerability. Our empirical model allows us to answer that question by decomposing the variance of total predicted volatility into the portion due to the countries' sensibility to a homogeneous terms-of-trade shock and the fraction produced by the variation of these shocks across countries. A conservative estimate of the importance of the portion due to the sensibility to the shock is 30%. The estimate is conservative because it is based on homogeneous parameters across countries, as derived from our panel VAR methodology.²¹ A more liberal estimate --one based on country-

specific VAR parameters-- would assign an importance over twice as large. At any rate, the relevance of domestic structural characteristics in dealing with external vulnerability can not be ignored.

A final caveat is in order. We have focused on the role of structural characteristics on the amplification of terms-of-trade shocks only. We believe this is a relevant exercise because of the importance typically attributed to these shocks and the advantages it offers for identification purposes. To the extent that the response to other types of external shocks is similar to the response to terms-of-trade shocks, our results convey information about the general role that structural characteristics have on external vulnerability. However, we cannot disregard the possibility that their role on the transmission of other external shocks may differ from the one documented here. In particular, it is possible that financial development, which in our study seems to play a secondary role, may have a more prominent job in dampening financial shocks. Since an appropriate analysis of this possibility would require more complex and controversial identification assumptions, we leave it for future research.

Appendix 1. Sample of Countries and Summary Statistics

Country Name	Average output growth (%)	Average terms-of-trade growth (%)	Standard deviation output growth	Standard deviation terms-of-trade growth	Trade Openness	Financial Depth	Financial Openness	Labor Market Flexibility	Ease of Firm Entry
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Algeria	0.46	-0.43	2.87	23.14	3.81	-1.12	-1.41	0.54	0.66
Angola	-2.26	-3.66	9.28	18.08	4.16	-4.31	-1.55	0.22	0.22
Argentina	0.27	-0.01	5.78	8.17	2.70	-1.78	-0.13	0.34	0.69
Australia	1.86	-0.66	1.92	5.06	3.28	-0.77	1.32	0.64	0.89
Austria	2.20	-0.31	1.56	1.34	3.97	-0.25	1.68	0.70	0.74
Bangladesh	1.62	-2.08	2.27	15.78	2.91	-1.60	-1.40	0.50	0.62
Belgium	1.95	-0.12	1.66	1.59	4.83	-0.96	1.56	0.52	0.80
Benin	0.55	-1.69	3.63	14.17	3.71	-2.37	-0.24	0.48	0.69
Bolivia	-0.11	-3.12	3.00	11.29	3.73	-1.40	0.68	0.34	0.52
Botswana	5.26	1.49	3.57	8.34	4.63	-2.06	-0.21	0.65	0.62
Brazil	1.21	-1.73	3.68	9.83	2.75	-1.30	-1.64	0.22	0.45
Burkina Faso	1.19	0.77	3.43	12.52	3.17	-2.01	-0.36	0.47	0.45
Burundi	-0.61	-2.78	5.11	33.79	3.28	-2.48	-1.09	0.38	0.25
Cameroon	0.61	0.00	7.03	22.39	3.45	-1.63	-0.47	0.56	0.59
Canada	1.76	0.18	2.28	3.05	3.90	-0.37	2.68	0.66	0.94
Central African Republic	-1.42	-1.27	4.61	16.26	3.22	-2.60	-0.66	0.38	0.25
Chad	-0.56	-2.94	9.06	13.46	3.26	-2.57	-0.76	0.34	0.41
Chile	3.18	-2.54	5.75	14.51	3.73	-0.85	-1.25	0.50	0.78
China	7.35	-0.93	3.44	5.74	3.16	-0.13	-1.24	0.53	0.61
Colombia	1.34	0.54	2.30	10.19	3.21	-1.33	-1.53	0.41	0.65
Congo, Rep.	0.37	-0.79	7.02	22.26	4.27	-2.28	-0.91	0.40	0.58
Costa Rica	1.29	0.14	3.73	9.45	4.12	-1.69	-0.56	0.37	0.64
Cote d'Ivoire	-1.14	-1.95	4.94	16.36	4.05	-1.16	-0.53	0.47	0.59
Denmark	1.65	0.40	1.93	2.43	3.97	-0.89	1.13	0.75	0.91
Dominican Republic	2.27	-2.49	3.31	11.72	4.02	-1.37	-1.46	0.51	0.60
Ecuador	0.40	-1.73	3.18	13.45	3.71	-1.53	0.04	0.45	0.51
Egypt, Arab Rep.	3.55	-2.80	2.86	11.33	3.57	-1.24	-1.05	0.41	0.59
El Salvador	0.01	0.07	4.83	17.84	3.90	-2.71	-0.64	0.31	0.59
Ethiopia	-0.09	0.29	7.67	19.72	3.02	-1.82	-1.14	0.49	0.69
Finland	2.13	-0.08	3.05	3.09	3.89	-0.55	1.54	0.45	0.85
Ghana	-0.60	-2.01	5.06	15.93	3.89	-3.26	-1.39	0.65	0.55
Greece	1.42	-1.11	2.46	4.60	3.47	-0.99	-0.54	0.33	0.63
Guatemala	0.48	-1.42	2.59	25.42	3.52	-1.90	0.63	0.35	0.56
Guinea	1.38	-3.96	1.42	8.91	3.71	-3.18	-1.07	0.40	0.56
Haiti	-1.59	-4.08	4.82	12.03	3.34	-2.20	0.44	0.40	0.32
Honduras	0.53	-0.59	3.25	13.45	4.07	-1.23	0.17	0.44	0.56
Hong Kong, China	4.56	0.38	4.50	1.75	5.22	0.39	2.68	0.73	0.94
Hungary	1.69	-0.88	3.91	3.18	4.36	-1.25	-0.68	0.46	0.76
India	3.12	1.64	2.92	10.60	2.57	-1.45	-1.03	0.49	0.56
Indonesia	3.87	1.46	4.46	10.94	3.72	-1.20	2.05	0.43	0.45
Iran, Islamic Rep.	-0.64	-1.18	7.73	24.31	3.31	-1.25	-0.90	0.48	0.63
Ireland	4.35	-0.46	3.15	2.55	4.57	-0.56	0.58	0.51	0.88
Israel	1.86	0.89	1.96	4.16	4.09	-0.65	-0.39	0.62	0.83
Jamaica	-0.21	-1.60	4.19	8.67	4.17	-1.33	-0.36	0.66	0.76
Jordan	1.73	0.68	7.52	7.06	4.31	-0.49	-0.18	0.40	0.69
Kenya	0.23	-0.44	2.33	10.48	3.80	-1.24	-0.74	0.66	0.60
Korea, Rep.	5.82	-0.73	3.79	5.29	4.03	-0.30	-0.63	0.49	0.70
Lesotho	2.85	-0.98	6.64	15.82	4.79	-2.01	-0.54	0.55	0.59
Madagascar	-1.57	0.86	3.67	11.23	3.32	-1.86	-0.92	0.39	0.65
Malawi	0.56	-2.13	5.34	10.94	3.97	-2.25	-1.03	0.48	0.63
Malaysia	3.92	-0.14	4.08	6.99	4.71	-0.29	1.63	0.75	0.77
Mali	0.65	0.01	5.93	8.07	3.64	-2.03	-0.24	0.46	0.62
Mauritania	0.10	0.46	3.36	9.42	4.29	-1.16	-1.08	0.41	0.55
Mexico	1.50	-0.38	3.74	9.90	3.28	-1.67	0.92	0.23	0.66

Appendix 1. Sample of Countries and Summary Statistics (*continued*)

Country Name	Average output growth (%)	Average terms-of-trade growth (%)	Standard deviation output growth	Standard deviation terms-of-trade growth	Trade Openness	Financial Depth	Financial Openness	Labor Market Flexibility	Ease of Firm Entry
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Morocco	1.57	1.12	4.98	9.09	3.74	-1.25	-1.26	0.49	0.82
Mozambique	0.88	-3.59	7.90	10.57	3.45	-2.19	-1.32	0.26	0.40
Namibia	-0.47	-1.94	2.72	11.23	4.58	-0.97	-1.18	0.57	0.64
Netherlands	1.83	-0.14	1.50	1.00	4.52	0.08	2.53	0.46	0.80
New Zealand	0.68	0.37	2.39	5.05	3.79	-0.64	1.70	0.68	0.93
Nicaragua	-2.91	-2.46	7.85	18.30	4.01	-1.28	0.11	0.39	0.62
Niger	-1.71	0.10	6.05	17.16	3.47	-2.13	-0.53	0.41	0.57
Nigeria	-0.96	-0.03	5.59	27.87	4.11	-2.11	-1.19	0.57	0.62
Norway	3.04	-0.48	1.76	7.94	3.95	-0.22	0.54	0.59	0.82
Pakistan	2.47	-1.26	1.93	9.80	3.39	-1.48	-1.09	0.42	0.65
Panama	1.12	-0.74	4.92	10.46	3.67	-0.59	2.68	0.21	0.78
Papua New Guinea	0.07	-1.47	5.43	12.24	4.36	-1.67	-0.23	0.74	0.67
Paraguay	1.32	1.94	4.12	17.48	3.36	-1.73	-0.70	0.27	0.50
Peru	-0.42	-1.56	6.10	12.96	3.23	-1.97	0.12	0.27	0.59
Philippines	0.72	0.04	3.76	11.79	3.86	-1.13	-0.57	0.40	0.63
Portugal	2.47	0.02	3.23	4.65	3.87	-0.32	0.09	0.21	0.65
Rwanda	0.32	1.98	10.06	30.39	3.08	-2.67	-1.00	0.40	0.55
Senegal	0.19	-0.85	4.34	6.69	3.90	-1.29	-0.24	0.46	0.62
Sierra Leone	-3.35	2.57	7.15	34.08	3.52	-3.12	-0.85	0.33	0.46
Singapore	5.32	-1.24	2.56	2.08	5.67	-0.17	2.00	0.80	0.92
South Africa	-0.38	-0.79	2.30	5.61	3.75	-0.69	-1.12	0.64	0.77
Spain	1.98	0.52	1.76	5.11	3.36	-0.24	0.36	0.30	0.68
Sri Lanka	3.48	1.15	1.21	14.27	4.02	-1.73	-0.52	0.58	0.74
Sweden	1.62	-0.47	2.00	2.82	3.94	0.01	1.58	0.58	0.84
Switzerland	0.80	1.25	2.38	3.86	3.99	0.31	2.68	0.64	0.79
Syrian Arab Republic	1.57	-3.00	6.00	13.70	3.80	-2.68	-1.64	0.55	0.65
Thailand	4.66	-1.99	4.37	5.57	3.99	-0.51	-0.04	0.39	0.75
Togo	-0.49	-2.48	7.08	23.49	4.05	-1.51	-0.87	0.43	0.44
Tunisia	2.44	-1.18	2.65	4.71	4.14	-0.53	-0.92	0.43	0.78
Turkey	1.93	-0.45	4.11	6.89	3.11	-1.86	-0.95	0.45	0.77
Uganda	2.05	-0.91	3.44	20.64	3.11	-3.69	-0.47	0.58	0.60
Uruguay	1.59	-0.26	4.89	6.40	3.35	-1.29	0.87	0.61	0.68
Venezuela	-0.94	2.30	4.53	22.09	3.71	-1.07	0.64	0.25	0.55
Zambia	-2.23	-5.99	3.98	26.15	4.08	-2.78	-0.71	0.54	0.71

Notes:

- a) The different columns of the table show various summary statistics for each of the countries included in the sample, which are displayed in the corresponding rows.
- b) Average growth of real GDP per capita during the period 1974-2000 (or the sub-period for which there was available data)
 Average terms-of-trade growth (%): the average growth of the terms of trade index over the same period
 Standard deviation output growth: the standard deviation of the growth rates of real GDP per capita over the period 1974-2000
 Standard deviation terms-of-trade growth: the standard deviation of terms of trade growth over the period 1974-2000
 Trade Openness: $\text{Log}(\text{Exports} + \text{Imports}) / \text{GDP}$
 Financial Depth: $\text{Log}(\text{Private credit}) / \text{GDP}$
 Financial Openness: Chinn-Ito measure of capital account openness
 Labor Market Flexibility: 0-1 index obtained from de jure labor regulation
 Ease of Firm Entry: 0-1 index obtained combining information on number of procedures, monetary cost, and time to open a new firm

Notes:

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¹ On the one hand, Mendoza (1995), and Kose and Riezman (2001), using calibrated small-open economy models find terms-of-trade shocks to account for almost half of economic fluctuations. On the other hand, Hoffmaister, Roldós, and Wickham (1998), Ahmed (2003), and Raddatz (2005), among others, using time-series analysis find that external shocks explain a much smaller fraction of output volatility (around 20 percent).

² Another strand of the literature takes one step back and focuses on explaining the business-cycle behavior of the terms of trade. For instance, Kraay and Ventura (2006) do so by linking movements in the terms of trade to countries' endowments and resulting industrial structure.

³ An analogy can illustrate these ideas: how vulnerable people are to disease depends on the seriousness of the disease itself (first aspect) and how well prepared they are to bear a given disease (second aspect). In order to analyze the second aspect, it would be necessary to examine how people facing the same disease (in type and strength) react. This would shed light on why some people suffer so much from an attack of, say, the flu, while others remain unscathed.

⁴ Of course, this is equivalent to including a country fixed effect in the VAR.

⁵ When performed on a country-by-country basis, the test cannot reject the null in 72 of the 88 cases. The results are not materially affected by excluding the 16 countries in which the hypothesis that terms of trade are no Granger-caused by output is rejected. Those countries are Canada, Chile, Greece, India, Ireland, Jamaica, Kenya, Lesotho, Mali, Malaysia, Niger, Papua New Guinea, Senegal, Singapore, Togo, and Thailand.

⁶ The number of lags for each country was determined using Hall's (1990) methodology. The common number of lags used in column (2) corresponds to the median across countries (2 lags).

⁷ Pedroni (1999) panel cointegration test, not reported, does not reject the null of no cointegration between (log) terms of trade and output. The different statistics derived by Pedroni (1999) tend to give different results but most of them cannot reject the null of no cointegration. As the power and size trade-off of the different tests varies with the cross-sectional and time-series dimension of the panel (see Pedroni, 2004), we focused on the statistics with that have the largest size (so tend to over-reject) and highest power at short time dimensions. Those tests, corresponding to the panel and group t-statistics derive by Pedroni (1999) clearly do not reject the null of no cointegration.

⁸ The procedure can be briefly described as follows: (i) we use the estimated variance-covariance matrix of the reduced form errors to simulate a random realization of the perturbations; (ii) we use the initial values of the different variables, the baseline coefficients, and the simulated perturbations to simulate a new set of observations for the variables in the VAR; (iii) we use these simulated observations to estimate a new set of coefficients; (iv) we repeat this exercise 500 times; (v) we compute the IRF for each set

of coefficients obtained from the bootstrapping; (vi) we build a 90% confidence interval for the IRF by taking the 5th and 95th percentile of the empirical distribution of the IRF on a point-by-point basis.

⁹ However, in a robustness check presented below we also use PPP adjusted GDP. The results remain basically the same.

¹⁰ We use this index instead of the more traditional net-barter index because of its broadest coverage. However, this index has the disadvantage that it includes the service export sector (i.e. tourism and financial services), which may induce concerns because the prices of this sector are not measured as precisely as those of merchandise trade and are much less likely to be exogenous to domestic conditions (which is our main identification assumption). This is unlikely to be a problem for the average country given the typically small relevance of the export service sector, but we nevertheless addressed this concern by replacing our index by the net-barter terms of trade index in those cases where the correlation between these two indexes (based on the post 1980 data in which both are available) was smaller than 0.5, which we take as an indication of the importance of the export service sector (21 cases, or 25 percent of the sample).

¹¹ The Chinn-Ito index corresponds to the first principal components of the following 4 binary variables reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER): existence of multiple exchange rates, restrictions on current account, capital account transactions, and the existence of requirements to surrender exports proceedings.

¹² These countries are Cape Verde, Grenada, St. Lucia, St. Kitts and Nevis, and Nepal.

¹³ Critical values and corresponding confidence intervals are obtained from the empirical distribution derived through the parametric bootstrapping procedure described above.

¹⁴ Unless output deflators are incorrectly or inconsistently measured, an issue we consider in the robustness section of the paper.

¹⁵ The large countries are Australia, Brazil, Canada, China, Spain, India, Korea, Mexico, and the Netherlands.

¹⁶ The mostly manufacturing exporting countries are Canada, Switzerland, China, Finland, Hong Kong, Hungary, Ireland, Israel, Korea, Singapore, and Sweden.

¹⁷ The results are also unaffected by the exclusion of the 13 countries for which the hypothesis that terms-of-trade fluctuations are not Granger-caused by output fluctuations is rejected.

¹⁸ We applied the method using a p-value of 0.3, which resulted in 3 observations being tagged as outliers.

¹⁹ That is, using the “rreg” command in STATA.

²⁰ An alternative reading of the previous results may help clarify the positive role of financial development. First, although trade openness always increases the impact of a shock, this is considerably smaller when the expansion in openness occurs in a country with well developed local financial markets. Similarly, our findings indicate that higher financial openness in an environment of underdeveloped local financial markets may result in an increase in the impact of external shocks. In contrast, when financial openness occurs in a country with well developed financial markets the impact of the shocks is reduced.

²¹ We estimate this fraction as follows. For each country in the sample, we compute the long-run output variance in response to its own shock ($\alpha_i \sigma_i^2$) by, first, estimating the response to a common shock and, then, simulating the effect of its own shock. We use actual values of the country's structural characteristics to estimate its long-run output variance in response to a common shock ($\alpha_i \sigma^2$) and apply the country's own data to estimate the variance of its terms of trade shocks (σ_i^2). We then decompose the log of the output variance ($\log(\alpha_i \sigma_i^2)$) into the sum of log vulnerability ($\log(\alpha_i)$) and log terms-of-trade variance ($\log(\sigma_i^2)$). The cross-country variance of (log) output volatility then corresponds to the cross-country variance of (log) vulnerability, (log) terms-of-trade variance, and the covariance between them. The figure reported in the main text corresponds to the contribution of (log) vulnerability to this variance when the covariance term is imputed in proportion to the standard deviations of each component (i.e. assuming constant correlation).

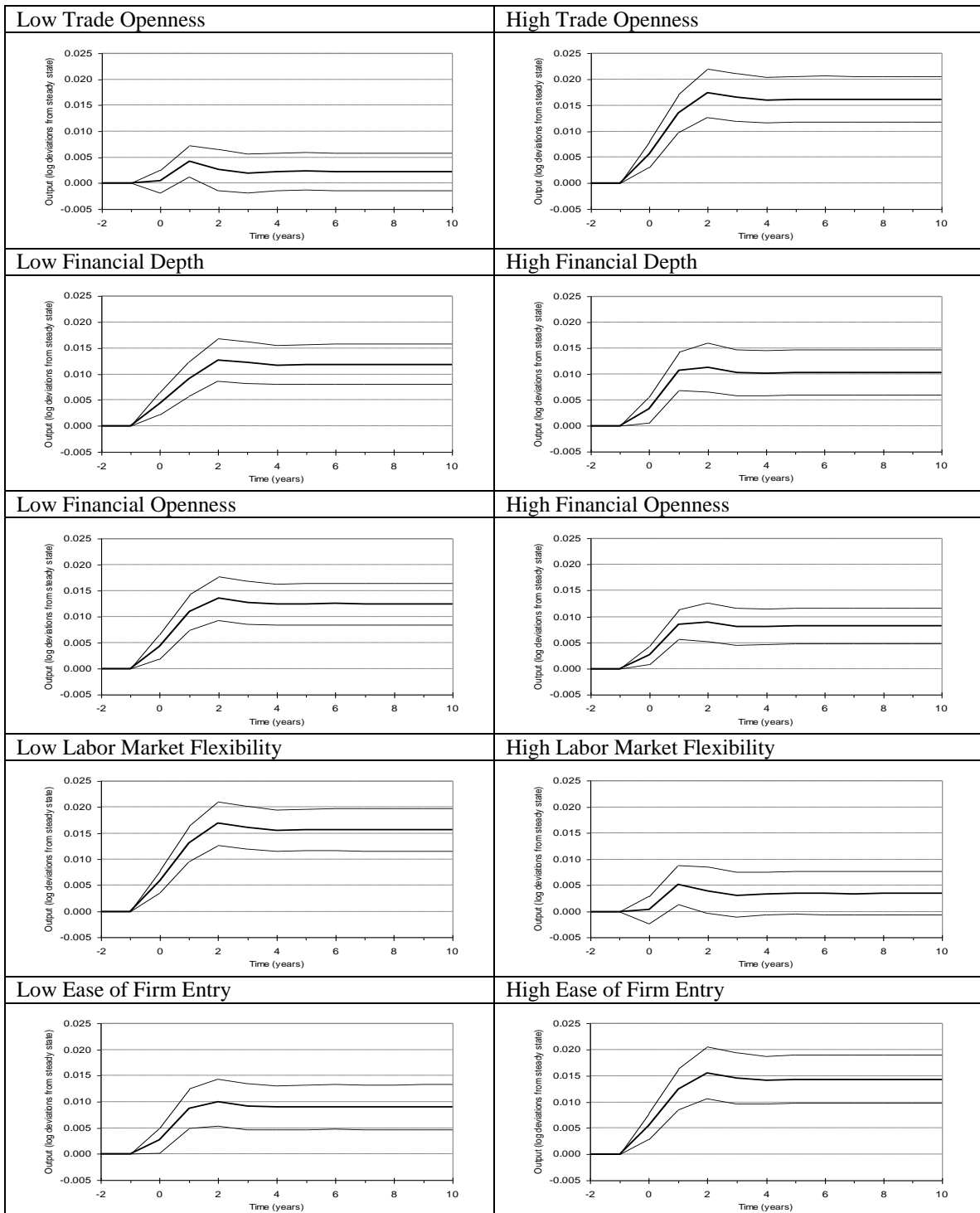
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Figure 1. Cumulative Output Impact of Terms-of-Trade Shock — Symmetric Case



Notes:

- a) See Table 1 for variable definitions.
- b) Bands are 90% confidence intervals.

Table 1. Unit Root Test

Variable	ADF by country (% cannot reject UR) (1)	ADF by country (% cannot reject UR) (2)	Levin-Lin-Chu P-value (3)
Log GDP per capita	72	86	0.987
Log terms-of-trade index	60	83	0.994

Notes:

- a) Column (1) reports the percentage of the 88 countries in the sample where the Augmented Dickey-Fuller test cannot reject the null hypothesis of a unit root when the number of lags augmenting the test is country specific, as determined by performing the Hall (1990) procedure on a country-by-country basis.
- b) Column (2) reports the same percentage for the case where for all countries the model is augmented using the median number of lags across countries (2 lags).
- c) Column (3) shows the p-value of the Levin-Lin-Chu (2002) test for panel unit roots for the case where the panel is augmented by 2 lags.

Table 2. Descriptive Statistics of Country Averages, 1974-2000

(a) Univariate (variables reported in Appendix 1)

	Mean	Std. dev.	Minimum	Maximum
Average output growth (%)	1.17	1.94	-3.35	7.35
Average terms-of-trade growth (%)	-0.75	1.55	-5.99	2.57
Standard deviation output growth	4.19	1.98	1.21	10.06
Standard deviation terms-of-trade growth	11.82	7.57	1.00	34.08
Trade Openness	3.79	0.54	2.57	5.67
Financial Depth	-1.43	0.91	-4.31	0.39
Financial Openness	-0.16	1.15	-1.64	2.68
Labor Market Flexibility	0.47	0.14	0.21	0.80
Ease of Firm Entry	0.65	0.15	0.22	0.94

(b) Bivariate Correlations: Cross-sectional correlations between the different variables reported in Appendix

	Output growth	Terms-of-trade growth	Std. dev. output growth	Std. dev. terms-of-trade gth	Trade Openness	Financial Depth	Financial Openness	Labor Market Flexibility	Ease of Firm Entry
Output growth	1.00								
Terms-of-trade growth	0.20	1.00							
Std. dev. output growth	-0.41	-0.13	1.00						
Std. dev. terms-of-trade gth	-0.57	-0.12	0.55	1.00					
Trade Openness	0.25	-0.03	-0.13	-0.29	1.00				
Financial Depth	0.52	0.30	-0.49	-0.65	0.32	1.00			
Financial Openness	0.25	0.27	-0.33	-0.47	0.35	0.56	1.00		
Labor Market Flexibility	0.31	0.09	-0.32	-0.29	0.45	0.31	0.28	1.00	
Ease of Firm Entry	0.45	0.28	-0.46	-0.60	0.40	0.66	0.51	0.56	1.00

Note:

a) Average growth of real GDP per capita during the period 1974-2000 (or the sub-period for which there was available data)

Average terms-of-trade growth (%): the average growth of the terms of trade index over the same period

Standard deviation output growth: the standard deviation of the growth rates of real GDP per capita over the period 1974-2000

Standard deviation terms-of-trade growth: the standard deviation of terms of trade growth over the period 1974-2000

Trade Openness: $\text{Log}(\text{Exports} + \text{Imports}) / \text{GDP}$ Financial Depth: $\text{Log}(\text{Private credit}) / \text{GDP}$

Financial Openness: Chinn-Ito measure of capital account openness

Labor Market Flexibility: 0-1 index obtained from de jure labor regulation

Ease of Firm Entry: 0-1 index obtained combining information on number of procedures, monetary cost, and time to open a new firm

Table 3. Basic Results under Symmetric Analysis

Cumulative output impact of a 1-std.deviation terms-of-trade shock for low and high values of 5 structural characteristics

	Trade Openness	Financial Depth	Financial Openness	Labor Market Flexibility	Ease of Firm Entry
Low	0.227 (0.222)	1.178 (0.234)	1.250 (0.244)	1.569 (0.240)	0.908 (0.262)
High	1.609 (0.266)	1.032 (0.265)	0.819 (0.207)	0.338 (0.260)	1.430 (0.281)
Difference	1.382 (0.308)	-0.147 (0.312)	-0.430 (0.236)	-1.231 (0.297)	0.523 (0.373)
Test Ho:Diff.=0 (one-tail)	**	-	**	**	*

Notes:

a) The reported impacts are given in percentage points of GDP.

b) Trade Openness: $\text{Log}(\text{Exports} + \text{Imports}) / \text{GDP}$ Financial Depth: $\text{Log}(\text{Private credit}) / \text{GDP}$

Financial Openness: Chinn-Ito measure of capital account openness

Labor market flexibility: 0-1 index obtained from de jure labor regulation

Ease of Firm Entry: 0-1 index obtained combining information on number of procedures, monetary cost, and time to open a new firm

c) "Low" and "High" correspond to the 25th and 75th percentiles of the world distribution of the respective structural characteristic.

d) Numbers in parentheses are standard errors of corresponding cumulative output impact.

e) (*) and (**) indicate 10% and 5% significance, respectively. Critical values are obtained from empirical distribution (which may have non-Gaussian properties).

Table 4. Robustness

Cumulative output impact of a 1-std.deviation terms-of-trade shock for low and high values of 5 structural characteristics

		Trade Openness	Financial Depth	Financial Openness	Labor Market Flexibility	Ease of Firm Entry	Exchange Rate Regime
Benchmark	Low	0.227	1.178	1.250	1.569	0.908	
	High	1.609	1.032	0.819	0.338	1.430	
	Diff.	1.382	-0.147	-0.430	-1.231	0.523	
Trade weighted TOT	Low	-0.526	1.018	0.890	0.996	0.264	
	High	1.470	0.522	0.435	0.290	1.571	
	Diff.	1.995	-0.496	-0.455	-0.706	1.307	
PPP GDP	Low	0.281	0.948	0.983	1.167	1.000	
	High	1.308	0.906	0.821	0.539	0.779	
	Diff.	1.027	-0.042	-0.162	-0.627	-0.221	
Only developing countries	Low	0.235	1.314	1.370	1.714	1.015	
	High	1.793	1.138	0.935	0.415	1.569	
	Diff.	1.558	-0.176	-0.435	-1.299	0.553	
Excluding 10% largest countries	Low	-0.014	1.185	1.133	1.427	0.841	
	High	1.606	0.873	0.769	0.325	1.290	
	Diff.	1.620	-0.312	-0.365	-1.102	0.448	
Excluding mainly manufacturing exporters	Low	0.207	1.273	1.275	1.638	0.935	
	High	1.701	1.052	0.912	0.359	1.522	
	Diff.	1.494	-0.220	-0.363	-1.279	0.587	
3 lags in common lag structure	Low	0.128	0.982	1.101	1.482	0.589	
	High	1.407	0.891	0.631	0.056	1.555	
	Diff.	1.279	-0.092	-0.470	-1.425	0.966	
Including exchange rate regime	Flexible	0.467	1.228	1.411	1.706	1.153	1.296
	Fixed	1.794	1.342	1.100	0.651	1.562	1.224
	Diff.	1.327	0.114	-0.311	-1.055	0.410	-0.072

Notes:

a) The reported impacts are given in percentage points of GDP.

b) Trade Openness: $\text{Log}(\text{Exports} + \text{Imports}) / \text{GDP}$ Financial Depth: $\text{Log}(\text{Private credit}) / \text{GDP}$

Financial Openness: Chinn-Ito measure of capital account openness

Labor market flexibility: 0-1 index obtained from de jure labor regulation

Ease of Firm Entry: 0-1 index obtained combining information on number of procedures, monetary cost, and time to open a new firm

c) "Low" and "High" correspond to the 25th and 75th percentiles of the world distribution of the respective structural characteristic.

d) The benchmark includes all countries and sets the common lag structure to 2 lags.

Table 5. Shock Impact and Structural Characteristics

Dependent variable: Cumulative GDP impact of a 1-std.deviation terms of trade shock

	OLS	WLS
Constant	-0.1547 (0.2086)	-0.2350 (0.2353)
Trade Openness	0.1286 ** (0.0502)	0.1187 ** (0.0513)
Financial Depth	0.0613 (0.0508)	0.0103 (0.0374)
Financial Openness	-0.0558 * (0.0301)	-0.0379 (0.0259)
Labor Market Flexibility	-0.6658 ** (0.2164)	-0.7498 ** (0.2190)
Ease of Firm Entry	0.2808 (0.2176)	0.4098 * (0.2463)
R-square	0.16	-
Number of countries	85	88

Notes:

a) Trade Openness: $\text{Log}(\text{Exports} + \text{Imports}) / \text{GDP}$ Financial Depth: $\text{Log}(\text{Private credit}) / \text{GDP}$

Financial Openness: Chinn-Ito measure of capital account openness

Labor Market Flexibility: 0-1 index obtained from de jure labor regulation

Ease of Firm Entry: 0-1 index obtained combining information on number of procedures, monetary cost, and time to open a new firm

b) Robust standard errors in parentheses below corresponding coefficient.

c) Regression is estimated using a robust procedure that reduces the influence of outliers.

d) In OLS three outliers are excluded, based on the Hadi method.

e) * : Significant at 10%

** : Significant at 5 %

Table 6. Asymmetric Effects

Cumulative output impact of 1-std.deviation terms-of-trade negative and positive shocks for low and high values of 5 structural characteristics

	Trade Openness		Financial Depth		Financial Openness		Labor Market Flexibility		Ease of Firm Entry	
	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive
Low	-0.262 (0.437)	0.427 (0.422)	-1.598 (0.418)	0.853 (0.400)	-1.791 (0.452)	0.724 (0.436)	-2.306 (0.439)	0.877 (0.422)	-1.461 (0.460)	0.210 (0.442)
High	-2.494 (0.474)	0.661 (0.453)	-1.697 (0.484)	0.386 (0.475)	-1.429 (0.375)	0.317 (0.369)	-0.637 (0.468)	0.097 (0.452)	-2.020 (0.481)	1.249 (0.476)
Difference	-2.231 (0.523)	0.234 (0.492)	-0.099 (0.509)	-0.466 (0.504)	0.362 (0.373)	-0.407 (0.370)	1.669 (0.481)	-0.781 (0.459)	-0.559 (0.557)	1.039 (0.548)
Test Ho:Diff.=0 (one-tail)	**	-	-	-	-	-	**	**	-	**

Notes:

a) The reported impacts are given in percentage points of GDP.

b) Trade Openness: $\text{Log}(\text{Exports} + \text{Imports}) / \text{GDP}$ Financial Depth: $\text{Log}(\text{Private credit}) / \text{GDP}$

Financial Openness: Chinn-Ito measure of capital account openness

Labor market flexibility: 0-1 index obtained from de jure labor regulation

Ease of Firm Entry: 0-1 index obtained combining information on number of procedures, monetary cost, and time to open a new firm

c) "Low" and "High" correspond to the 25th and 75th percentiles of the world distribution of the respective structural characteristic.

d) Numbers in parentheses are standard errors of corresponding cumulative output impact.

e) (**) indicates 5% significance. Critical values are obtained from empirical distribution (which may have non-Gaussian properties).

Table 7. Complementarities among Structural Characteristics

Differential cumulative output impact of a 1-std.deviation terms-of-trade shock for low and high values between pairs of structural Characteristics.

		Trade Openness	Financial Depth	Financial Openness	Labor Market Flexibility	Ease of Firm Entry
Trade Openness	Diff.-Diff. Test Ho=Diff-Diff=0	--	-1.679 (0.383) **	-0.489 (0.409) -	-0.468 (0.388) -	-0.074 (0.548) -
Financial Depth	Diff.-Diff. Test Ho=Diff-Diff=0		--	-1.820 (0.474) **	0.245 (0.455) -	1.353 (0.558) **
Financial Openness	Diff.-Diff. Test Ho=Diff-Diff=0			--	0.993 (0.452) **	0.936 (0.436) **
Labor Market Flexibility	Diff.-Diff. Test Ho=Diff-Diff=0				--	-2.518 (0.644) **
Ease of Firm Entry	Diff.-Diff. Test Ho=Diff-Diff=0					--

Notes:

a) The reported impacts are given in percentage points of GDP. They are the difference between a given pair of structural characteristics of the difference in the cumulative output impact of their corresponding low and high values. This is analogous to the effect of an interaction between a pair of variables.

b) Trade Openness: $\text{Log}(\text{Exports} + \text{Imports}) / \text{GDP}$

Financial Depth: $\text{Log}(\text{Private credit}) / \text{GDP}$

Financial Openness: Chinn-Ito measure of capital account openness

Labor market flexibility: 0-1 index obtained from de jure labor regulation

Ease of Firm Entry: 0-1 index obtained combining information on number of procedures, monetary cost, and time to open a new firm

c) Numbers in parentheses are standard deviations of corresponding output impact.

d) (**) indicates 5% significance. Critical values are obtained from empirical distribution (which may have non-Gaussian properties).

