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Output Volatility and Openness to Trade: A Reassessment

Output volatility has been shown to be negatively correlated with economic growth across countries.[1] Recent studies document that the correlation is not only robust to alternative samples and estimation techniques, but that the direction of causality goes from volatility to growth.[2] Given the robustness and the policy relevance of these results, it is surprising that so few attempts have been made to identify the causes of output volatility to date.[3] This paper bridges that gap by studying the empirical determinants of volatility, with a particular focus on the role of openness to commercial trade.[4]

Output volatility naturally relates to the frequency and size of the shocks that affect an economy and to the manner in which the economy handles the shocks.[5] Openness to trade is thus commonly associated with greater output volatility: presumably, the more exposed to trade a country is, the more

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1. Ramey and Ramey (1995); Hausmann and Gavin (1996); Fatás and Mihov (2003).

2. Hnatkovska and Loayza (2004) find that the negative link between volatility and growth is exacerbated in countries that are poor, institutionally underdeveloped, undergoing intermediate stages of financial development, or unable to conduct countercyclical fiscal policies; Mobarak (2005) provides evidence that volatility has a significant impact on growth even after the simultaneity of growth and volatility are taken into account.

3. Easterly, Islam, and Stiglitz (2001a); Buch, Döpke, and Pierdzioch (2005); Kose, Prasad, and Terrones (2003); Fatás and Mihov (2003); Mobarak (2005); Calderón, Loayza, and Schmidt-Hebbel (2005); Loayza and Raddatz (2006) are among the few.

4. Throughout the paper, I use the terms *openness to trade* and *exposure to trade* interchangeably. In both cases, I am always referring to trade quantities, not to a particular stance of commercial trade policy.

5. Easterly, Islam, and Stiglitz (2001a, 2001b).

vulnerable it is to shocks coming from abroad.[6] Nevertheless, economists believe that trade openness promotes economic growth.[7] The combination of these results has led some observers to identify a general consensus on the interrelationship between openness to trade, output volatility, and growth. As Kose, Prasad, and Terrones state, "While there appears to be a general consensus that openness to trade flows stimulates domestic growth, it is also the case that such openness increases the vulnerability to external shocks."[8] To the extent that external and internal shocks are not negatively correlated, a greater vulnerability to external shocks implies more output volatility. If openness to trade increases output volatility and growth, but output volatility hurts growth, then either the direct effect of trade on growth outweighs the indirect effect, or there is something wrong with one of the presumed links. In this paper I present new evidence that the latter is likely to be the case. In particular, I show in a single cross-section of seventy-seven countries—twenty-one of which are members of the Organization for Economic Cooperation and Development (OECD)—that the effect of trade openness on output volatility is negative rather than positive.

In the paper, I do not deal with the direct link between trade openness and growth, and to the extent that I touch on the link between output volatility and growth, I rely on research by Hnatkovska and Loayza, who use the same dataset.[9] Exploring these issues in depth is beyond the scope of this paper, however. Here, I present new evidence that points toward a negative causal link between trade openness and output volatility. This new result is consistent with research showing that openness to trade reduces vulnerability to some forms of financial crises and that openness to trade smooths the adjustment in the aftermath of external shocks.[10] On both accounts, openness to

6. In other words, trade openness raises exposure to trade-transmitted volatility in world goods markets. For empirical evidence that supports this claim, see Rodrik (1998); Easterly, Islam, and Stiglitz (2001a).

7. See Frankel and Romer (1999) for pioneering work on this topic and Rodríguez and Rodrik (2001) for a more skeptical assessment of the evidence. Lee, Ricci, and Rigobon (2004) apply the novel technique of identification through heteroskedasticity to estimate the effect of openness on growth. Their results suggest that openness has a small positive effect on growth (despite the reverse causality).

8. Kose, Prasad, and Terrones (2006, p. 2).

9. Hnatkovska and Loayza (2004).

10. On reduced vulnerability, see, for example, Calvo, Izquierdo, and Mejía (2004); Edwards (2004); Cavallo and Frankel (2008); Martin and Rey (2006); on adjustment following external shocks, see Sachs (1985); Calvo and Talvi (2005); Guidotti, Sturzenegger, and Villar (2004).

trade might reduce output volatility. This effect counteracts the effect that goes from trade openness to exposure to trade-transmitted volatility in world goods markets (that is, terms-of-trade shocks). This is also consistent with Calderón, Loayza, and Schmidt-Hebbel, who find evidence that trade openness provides the means for the domestic economy to diversify away some external sources of risk.[11]

The previous empirical attempts that either directly or indirectly assess the impact of openness to trade on income volatility do not test whether trade exerts an independent effect on volatility once the terms-of-trade risk is taken into account. I do so by introducing in all the regressions the de facto trade openness variable (the trade-to-GDP ratio), along with an interacted variable to account for the possibility that more open economies are naturally more prone to terms-of-trade risk. The underlying hypothesis is that, to the extent that the latter effectively controls for that risk, any other effect of trade on volatility should manifest itself through the point estimate of the openness coefficient.

Another relevant issue that is largely ignored in the related literature is the probable endogeneity of trade in this setting. If trade is endogenous to output levels (because, for example, richer countries tend to liberalize trade barriers, as their mode of public finance shifts from tariff revenue to income or value added taxes), then it is also likely to be endogenous to output volatility, since output levels and output volatility are different moments of the same distribution.[12] A formal Hausman test corroborates the probable endogeneity of trade openness and provides justification for the instrumental variables procedure used in this paper. I use gravity estimates to construct an instrumental variable for trade openness.[13] This methodology was developed by Frankel and Romer in the context of the effect of trade on growth, and it was later applied to a variety of settings in which trade and some other variable could potentially be jointly determined.[14] If trade still appears to be a significant

11. Calderón, Loayza, and Schmidt-Hebbel (2005) find even stronger evidence in favor of the stabilizing effects of financial openness. This is an interesting result, as trade and financial openness are likely to be jointly determined (see Aizenman, 2008).

12. Hnatkovska and Loayza (2004) show that output volatility depends on income levels.

13. Basically, this methodology consists of aggregating across a country's partners the prediction of a gravity equation that explains trade with distance, population, language, a shared border, land area, and landlocked status. Gravity estimates are a good instrumental variable because they are based on geographic variables that are plausibly exogenous and yet, when aggregated across all bilateral trading partners, highly correlated with a country's overall trade.

14. Frankel and Romer (1999). Frankel and Rose (2002) show that currency unions may raise output, via trade. For a survey of the gravity model and its applications and extensions, see Frankel (1997, chaps. 4 and 6).

determinant of output volatility with instrumental variables estimates, then the estimated effect of trade on volatility is plausibly causal.

The results reported here show that commercial trade has a statistically significant and robust stabilizing effect, despite the fact that, as presumed, openness raises exposure to trade-related volatility. In ordinary least squares (OLS) estimates, the net effect is small and stabilizing only in countries that are less prone to terms-of-trade fluctuations. The results are more impressive when instrumental variables are used: the net effect is stabilizing for all countries, irrespective of how vulnerable they are to terms-of-trade risk. A positive noncausal association between trade openness and output volatility apparently distorts the OLS estimates; it stems from either simultaneous causation from third variables or a positive feedback from output volatility to trade openness. Once the positive link is removed, the negative causal effect is identified. Additional evidence is presented showing that the stabilizing effect of openness comes (at least in part) through the financial channel. By splitting the sample into countries that are more exposed to capital flows and countries that are less exposed, I show that the stabilizing effect of openness to trade dominates in the first subsample.

The negative association between trade openness and output volatility is robust to the inclusion of other plausible determinants of output volatility in the regressions, and the estimated coefficient on these additional determinants enters the regressions with the expected signs; countries with a history of misaligned exchange rates and inflation (macroeconomic instability) and countries with less democratic political regimes have more volatile growth rates.[15]

A Simple Framework

Consider a simple economy with a production stream (y_t) that is exposed to three types of shocks: domestic (δ_t), terms-of-trade (τ_t), and external financial (ϕ_t). Assume, for simplicity, that the three shocks are uncorrelated, and that the parameters (α_i) measure the vulnerability of y_t, such that for a given country

$$y_t = \alpha_\delta \delta_t + \alpha_\tau \tau_t + \alpha_\phi \phi_t, \tag{1}$$

15. Mobarak (2005) studies the interrelationship between democracy, volatility, and growth. He explores the determinants of average growth and its volatility in a two-equation system, finding that higher levels of democracy decrease volatility, while volatility itself reduces growth.

and, therefore, output volatility (σ_y) is

$$\sigma_y = \alpha_\delta^2 \sigma_\delta + \alpha_\tau^2 \sigma_\tau + \alpha_\phi^2 \sigma_\phi, \tag{2}$$

where $\sigma_i = \text{var}(i)$. Assume that the parameters (α_i) are a function of trade openness (X), so that the level of exposure to trade affects the economy's sensitivity to the different shocks. The overall effect of trade openness (∂X) on output volatility is thus

$$\frac{1}{2}\frac{\partial \sigma_y}{\partial X} = \alpha_\delta \frac{\partial \alpha_\delta}{\partial X}\sigma_\delta + \alpha_\tau \frac{\partial \alpha_\tau}{\partial X}\sigma_\tau + \alpha_\phi \frac{\partial \alpha_\phi}{\partial X}\sigma_\phi. \tag{3}$$

The argument made in much of the related literature is that trade openness (∂X) increases the vulnerability to trade-related shocks ($\partial \alpha_\tau / \partial X > 0$). If τ_t is the only shock hitting the economy, then trade openness unambiguously raises volatility ($\partial \sigma_y / \partial X > 0$). With other possible shocks, however, the overall effect hinges on the signs of ($\partial \alpha_\phi / \partial X$) and ($\partial \alpha_\delta / \partial X$).

From this framework it is clear that if one had good measures of the three shocks (δ_t, τ_t, ϕ_t), then one could directly estimate all the coefficients and the overall effect of trade openness on output volatility. In the absence of these measures, the task is elusive. The only shock that has been unambiguously characterized in the related literature is τ_t, which is typically measured as the standard deviation of the log difference in the terms of trade.[16] In this paper, rather than try to characterize the other two types of shocks, I follow a different strategy, in which I estimate variants of the following equation:

$$\sigma_y = \beta_1 X \sigma_\tau - \beta_2 X + \varepsilon, \tag{4}$$

where X is a measure of trade openness and, following the convention in the literature, σ_τ is defined as the standard deviation of the log differences in the terms of trade. In this setting, β_1 measures the effect of trade openness on output volatility associated with the terms-of-trade channel, and β_2 captures the effect coming through the other channels.[17] The evidence presented in this paper indicates that while β_1 is positive (that is, terms-of-trade shocks increase output volatility), β_2 is negative—in other words, the effect of trade openness on output volatility originating in the nontrade channels is stabilizing.

16. See, for example, Rodrik (1998); Loayza and Raddatz (2006).

17. This is true under the assumption of uncorrelated shocks and also if there are no other omitted shocks.

The next step is to try to disentangle whether the stabilizing effects of trade are generated through the financial stability channel, as suggested by one strand of the literature. I approach this task through a two-pronged strategy. First, some variants of equation 4 control for possible domestic shocks, such as natural disasters. I thus estimate variants of the following equation:

$$\sigma_y = \beta_1 X\sigma_\tau - \beta_2 X + \beta_3 X\sigma_\delta + \varepsilon. \tag{5}$$

The objective of equation 5 is to test whether β_2 is still significant even after controlling for possible domestic shocks. If so, then the stabilizing effect of trade openness estimated via β_2 could be coming from the financial channel.

Second, given that the proposed measure for domestic shocks is neither flawless nor comprehensive, I explore whether β_2 in equation 4 is more negative and statistically significant in the sample of countries that are most exposed to financial shocks (that is, countries whose sensitivity to financial shocks, α_ϕ, is suspected to be highest). If openness to trade reduces output volatility by reducing the likelihood of financial crises that are prevalent in the presence of volatile capital flows or financial integration, then the effect of openness to trade on output volatility should be more pronounced in the subsample of countries that are most exposed. Independently of the methodology used, the evidence presented in this paper is that the stabilizing effect of trade seems to come, at least in part, from the financial channel.

Empirical Strategy

Using country averages for a cross-section of seventy-seven countries (twenty-one of which are OECD members) over the period 1960–2000, I estimate a set of OLS regressions of the following form:

$$\begin{aligned} \text{SDGR}_i = {} & c + \beta_1 \left(\text{Trade}/\text{GDP}\right)_i \left(\text{SDTOTGR}\right)_i + \beta_2 \left(\text{Trade}/\text{GDP}\right)_i \\ & + \beta_3 \left(\text{SDTOTGR}\right)_i + \theta \mathbf{X} + \varepsilon_i, \end{aligned} \tag{6}$$

where SDGR represents output volatility and is measured as the standard deviation of per capita GDP growth rates between 1960 and 2000, Trade/GDP represents the ratio of exports plus imports to GDP, SDTOTGR is the volatility of terms-of-trade shocks (computed as the standard deviation of the log difference of terms of trade), ε is the error term, i indexes countries, and $\mathbf{X}$ is a vector of other potential determinants of output volatility. The appendix

includes a list of the twenty-one components of the vector, together with their summary statistics.

In equation 6, Trade/GDP and (Trade/GDP)*(SDTOTGR) are included as separate regressors. The interacted term intends to capture the intuitive fact that more open economies are naturally exposed to greater terms-of-trade risk. Rodrik provides a formal justification for the use of this variable as a proxy for terms-of-trade risk.[18] The Trade/GDP term by itself seeks to capture any additional effect of trade openness on output volatility through other channels. The inclusion of both terms simultaneously means that the net effect depends on the estimated coefficients β_1 and β_2 and on the level of SDTOTGR. In particular,

$$\Delta \mathrm{SDGR}_i = \left[\beta_2 + \beta_1 * (\mathrm{SDTOTGR})_i\right] * \Delta(\mathrm{Trade/GDP})_i, \tag{7}$$

where Δ symbolizes change. Equation 7 says that any change in openness—that is, Δ(Trade/GDP)—might affect output volatility either directly via β_2 or indirectly through a change in the exposure to terms-of-trade risk.

I also report the results from regressions that use instrumental variables (IV) to account for the possible endogeneity of trade. I instrument Trade/GDP and (Trade/GDP)*(SDTOTGR) with the predicted Trade/GDP and the predicted (Trade/GDP)*(SDTOTGR), respectively. The predicted Trade/GDP for each country *i* is computed from gravity estimates and is based on countries' geographic (and cultural) characteristics. I use Frankel and Rose's dataset to compute OLS regressions of the following form:[19]

$$\log(T_{ij}/Y_t) = c + \tau_1 \log \mathrm{DIST}_{ij} + \tau_2 \log \mathrm{POP}_j + \tau_3 \mathrm{COMLANG}_{ij} + \tau_4 \mathrm{BORDER}_{ij} + \tau_5 \mathrm{AREAP}_{ij} + \tau_6 \mathrm{LANDLOCK} + \mu, \tag{8}$$

where T_{ij} is the bilateral trade value between countries *i* and *j;* Y_i is the real GDP of country *i; c* is a constant term; $\log\mathrm{DIST}_{ij}$ is the log of the distance between the economic centers of countries *i* and *j;* $\log\mathrm{POP}_j$ is the log of the

18. Rodrik (1998).

19. Frankel and Rose (2002). The dataset consists of 41,678 bilateral trade observations spanning six different years (1970, 1975, 1980, 1985, 1990, and 1995). All 186 countries, dependencies, territories, overseas departments, colonies, and other political units for which the United Nations Statistical Office collects international trade data are included in the dataset. The trade data are taken from the World Trade Database, a consistent recompilation of the United Nations trade data presented in Feenstra, Lipsey, and Bowen (1997), supplemented with data from the *International Trade Statistics Yearbook* published by the United Nations. This dataset is estimated to cover at least 98 percent of all trade.

population size in country *j;* COMLANG is a dummy variable that takes a value of one if *i* and *j* share a common language and zero otherwise; BORDER is a dummy variable that takes a value one if *i* and *j* share a border and zero otherwise; $AREAP_{ij}$ is the log of the product of the areas (in square kilometers) of countries *i* and *j;* and LANDLOCK is a dummy variable that takes a value of two if *i* and *j* are both landlocked, a value of one if either *i* or *j* is landlocked, and zero otherwise; and ϵ is the error term. The gravity estimates are generated by taking the exponent of fitted values and summing across bilateral partners *j*. The underlying hypothesis is that, to the extent that the predicted Trade/GDP is highly correlated with the actual Trade/GDP, it is a good instrument, because it is less likely that geography is related to economic outcomes through any channel other than trade.[20] In other words, geography is quite possibly exogenous.

Results

Table 1 summarizes the OLS and IV results for some variants of equation 6. The fit of the regressions is very good, with an adjusted *R* squared of approximately 0.65. The results suggest that there is no robust effect of trade openness on output volatility in these specifications. While the coefficient of trade openness (β_2) enters the regressions with a negative sign, it is (weakly) statistically significant in only one of the four regressions. In contrast, the coefficient on the interaction term (β_1) is positive but always statistically insignificant. Finally, the coefficient of the terms-of-trade shocks (β_3) is always insignificant.

Despite these results, a potential problem with these regressions is that it may not be possible to disentangle the effects of terms-of-trade volatility in levels (that is, SDTOTGR) from the interaction term with these data. This might be due to multicollinearity between these variables. In particular, the interaction term and SDTOTGR have a correlation coefficient of 0.80. In general, when an interaction term is included in the regression, both components of the interaction should also be included to account for all possible

20. The actual correlation between the trade openness variable and the instrument used in this paper is 0.50. Rodríguez and Rodrik (2001) challenge the underlying assumption, arguing that geographically constructed measures of trade openness might be incorrectly appropriating effects that really operate through institutions rather than trade. I deal with this critique by introducing a proxy for institutional quality as a separate regressor and testing whether the results change. They do not.

TABLE 1. The Effect of Trade on Volatility[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
Trade/GDP	−0.008	−0.032*	−0.005	−0.034
	(−0.92)	(−1.71)	(−0.55)	(−1.38)
(Trade/GDP)*(SDTOTGR)	0.001	0.0003	0.0004	0.0001
	(0.89)	(0.10)	(0.60)	(0.06)
SDTOTGR	0.041	0.043	0.046	0.050
	(0.87)	(0.27)	(0.93)	(0.32)
lnMIS	0.851***	1.068***	0.905***	1.085***
	(3.09)	(2.82)	(3.26)	(2.87)
DEMOCRACY	−0.149***	−0.162***	−0.142***	−0.165***
	(−3.23)	(−3.15)	(−3.17)	(−3.01)
ICRG	0.435**	0.615**	0.386**	0.645**
	(2.44)	(2.19)	(2.10)	(2.10)
SDINF	0.010**	0.006	0.008*	0.006
	(2.31)	(1.13)	(1.84)	(1.16)
lnPOP	−0.202	−0.540	−0.256**	−0.568
	(−1.64)	(−1.31)	(−2.08)	(−1.40)
OECD	−0.629	−0.696	−0.558	−0.714
	(−1.51)	(−1.52)	(−1.32)	(−1.43)
Africa	−0.360	−0.623	−0.381	−0.634
	(−0.72)	(−1.08)	(−0.76)	(−1.08)
$\ln y_0$	−0.291	−0.467	−0.290	−0.489
	(−1.27)	(−1.36)	(−1.28)	(−1.40)
lnAREA			0.094	−0.021
			(0.92)	(−0.14)
Constant	6.850*	14.580	6.266	15.564
	(1.91)	(1.64)	(1.65)	(1.60)
Summary statistic				
No. observations	74	73	74	73
R squared	0.68	0.62	0.69	0.6

*Statistically significant at the 10 percent level.
**Statistically significant at the 5 percent level.
***Statistically significant at the 1 percent level.

a. The dependent variable is SDGR. Columns 1 and 3 are estimated using OLS; columns 2 and 4 use IV. In the IV regressions, the endogenous variables are Trade/GDP and (Trade/GDP)*(SDTOTGR), with the predicted Trade/GDP and predicted (Trade/GDP)*(SDTOTGR), respectively. The predicted Trade/GDP for each country *i* is computed from gravity estimates and is based on countries' geographic (and cultural) characteristics. Robust *t* statistics are in parentheses.

interrelationships. When variables are so highly correlated, however, it is necessary to go back to the theory and rethink the model. I deal with this problem by dropping SDTOTGR from the main specification. Rodrik provides a theoretical framework showing that the interaction term is the correct variable to control for terms-of-trade risk.[21] In particular, the terms-of-trade volatility

21. Rodrik (1998).

affects output volatility only through the interaction with the level of openness to trade. Therefore, there is no omitted variable bias associated with excluding SDTOTGR from the main specification. I thus estimate a set of regressions of the following form:

$$\text{SDGR}_i = c + \beta_1 \left(\text{Trade}/\text{GDP}\right)_i * \left(\text{SDTOTGR}\right)_i + \beta_2 \left(\text{Trade}/\text{GDP}\right)_i + \theta \mathbf{X} + \varepsilon_i. \tag{9}$$

Table 2 summarizes the OLS and IV results for some variants of equation 9. The fit of the regressions is still very good, with an adjusted *R* squared of approximately 0.65. The coefficient of trade openness (β_2) enters the regressions with a negative sign (that is, trade stabilizes output), and it is always statistically significant at standard confidence levels. The interaction term (β_1) is positive and statistically significant. The interaction variable seeks to capture the effect of openness to trade on output volatility that operates through the increased exposure to risk from world goods markets. The underlying hypothesis is that to the extent that this variable captures that effect, any independent effect of openness to trade on output volatility should be reflected through the sign (and statistical significance) of β_2.

If the problem with the regressions in table 1 is multicollinearity between some of the variables, as conjectured, then once the problem is solved, the magnitude of the coefficients (in this case β_1 and β_2) should not change much, and only the standard errors should change. This is indeed what happens: a set of *F* tests (two-sided tests) was performed on the null hypothesis that β_1 and β_2 are equal to the corresponding coefficients in table 1, and the null hypothesis is never rejected.[22]

Interestingly, Trade/GDP and the interaction term are still significant determinants of output volatility with IV estimates, and the point estimate β_2 increases in absolute value. This suggests that a positive noncausal correlation between trade openness and output volatility is dampening the OLS estimates.[23] Instrumental variables are important in this setting because trade is likely to be endogenous. Countries differ in their level of openness to trade for

22. I compared the coefficients in column 1 of table 2 with the coefficients in column 3 of table 1; the coefficients in column 2 of table 2 with the coefficients in column 4 of table 1; and the coefficients in column 4 of table 2 with the coefficients in column 1 of table 1. Finally, I compared the coefficients in column 5 of table 2 with the coefficients of column 2 of table 1. All the tests are available on request.

23. Alternatively, there is an omitted third variable that simultaneously causes more output volatility and more openness.

TABLE 2. The Effect of Trade on Volatility Revisited[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
Trade/GDP	−0.012**	−0.038*	−0.043**	−0.014**	−0.034*	−0.012**	−0.039*
	(−2.08)	(−1.68)	(−2.16)	(−2.40)	(−1.96)	(−2.04)	(−1.77)
(Trade/GDP)*	0.001***	0.001*	0.001***	0.001***	0.001**	0.001**	0.001
(SDTOTGR)	(2.87)	(1.92)	(2.84)	(2.87)	(2.15)	(2.41)	(1.15)
lnMIS	0.924***	1.038***	0.940***	0.874***	1.025***	0.947***	1.121***
	(3.43)	(3.26)	(3.43)	(3.30)	(3.31)	(3.29)	(3.09)
DEMOCRACY	−0.143***	−0.164***	−0.148***	−0.150***	−0.160***	−0.131***	−0.155***
	(−3.22)	(−3.08)	(−3.38)	(−3.24)	(−3.17)	(−2.91)	(−2.76)
ICRG	0.384**	0.615**	0.373**	0.428**	0.581**	0.340*	0.560*
	(2.12)	(2.17)	(2.06)	(2.42)	(2.47)	(1.75)	(1.89)
SDINF	0.009*	0.006	0.008*	0.010**	0.006	0.009**	0.008*
	(1.88)	(1.39)	(1.74)	(2.29)	(1.41)	(2.24)	(1.78)
lnPOP	−0.257**	−0.499	−0.310**	−0.209*	−0.474*	−0.276*	−0.599*
	(−2.06)	(−1.66)	(−2.31)	(−1.73)	(−1.72)	(−1.99)	(−1.90)
OECD	−0.601	−0.744	−0.547	−0.661	−0.716	−0.728	−0.876*
	(−1.49)	(−1.57)	(−1.38)	(−1.64)	(−1.65)	(−1.50)	(−1.69)
Africa	−0.409	−0.661	−0.394	−0.388	−0.642	−0.230	−0.367
	(−0.83)	(−1.21)	(−0.78)	(−0.79)	(−1.18)	(−0.45)	(−0.62)
lnAREA	0.083	−0.028	0.059			0.106	0.018
	(0.83)	(−0.20)	(0.58)			(0.87)	(0.12)
$\ln y_0$	−0.291	−0.448	−0.280	−0.291	−0.427	−0.284	−0.463
	(−1.31)	(−1.49)	(−1.26)	(−1.30)	(−1.52)	(−1.27)	(−1.59)
$(\text{Trade/GDP})^2$			0.0002				
			(1.61)				
LAT						0.005	0.007
						(0.69)	(0.85)
LANDLOCK						−0.189	−0.486
						(−0.54)	(−1.45)
ISLAND						−0.430	−0.417
						(−0.91)	(−0.76)
Constant	6.879*	14.599*	8.895**	7.343**	13.503*	6.75*	15.714*
	(1.94)	(1.71)	(2.26)	(2.17)	(1.98)	(1.94)	(1.87)
Summary statistic							
No. observations	74	73	74	74	73	74	73
R squared	0.68	0.62	0.69	0.68	0.64	0.69	0.61

*Statistically significant at the 10 percent level.

**Statistically significant at the 5 percent level.

***Statistically significant at the 1 percent level.

a. The dependent variable is SDGR. Columns 1, 3, 4, and 6 are estimated using OLS; columns 2, 5, and 7 use IV. In the IV regressions, the endogenous variables are Trade/GDP and (Trade/GDP)*(SDTOTGR), with the predicted Trade/GDP and predicted (Trade/GDP)*(SDTOTGR), respectively. The predicted Trade/GDP for each country *i* is computed from gravity estimates and is based on countries' geographic (and cultural) characteristics. Robust *t* statistics are in parentheses.

two basic reasons: geography, in that larger and more isolated countries will naturally trade less, and commercial trade policy. Geography is quite plausibly exogenous, whereas trade policy may not be. Trade liberalization could be part of a more general reform strategy driven by a proglobalization philosophy or Washington Consensus forces. Other aspects of such a reform program, such as privatization, financial liberalization, or macroeconomic stabilization, might also affect output volatility, yet an OLS regression analysis might inappropriately attribute those effects to trade. Another way that trade openness could be endogenous is that experience with large fluctuations in output—the dependent variable—may itself cause liberalization, via an IMF program. It could also have the opposite effect, if a country's response to output volatility is disenchantment with globalization and the Washington Consensus. The trade-to-GDP ratio compounds these two determinants (that is, geography and policy), raising the problem of endogeneity. Formal Hausman tests reject the null hypothesis that trade is exogenous.[24]

A potential criticism of this framework is that larger countries, which naturally trade less than smaller countries, are more stable for reasons other than trade (for example, they have more possibilities for diversification). However, the negative sign and statistical significance of the openness coefficient prevail even when the regressions include controls for country size. This is verified by comparing the results in columns 4 and 5 (regressions without controls for country size) with those in columns 1 and 2 (the same regressions with controls for country size) in table 2. Another potential criticism is that trade (even after it is instrumented) is incorrectly appropriating effects on output volatility that really operate through other geographic characteristics or institutions. Columns 6 and 7 show that the negative correlation between openness and output volatility survives the inclusion of geographic characteristics such as latitude above the equator or dummy variables for being landlocked or an island state.[25] All the reported regressions also include controls for institutional quality. In column 3, the square of Trade/GDP is included in the OLS regression to test for plausible nonlinearities, but it is not significant and does not affect the significance of β_2.[26]

24. The *p* values for the different tests I conducted fall in the 0.05 to 0.10 range. Further details are available on request.

25. Below, I show that the results are also robust to the inclusion of another control for the diversification of exports.

26. The point estimate of β_2 increases considerably in (absolute) value when the square term is included in the regression. The probable cause is the fact that the square term, although almost negligible, is positive.

As for the other variables, the results are intuitive and consistent with previous research: greater real exchange rate misalignment and higher inflation (that is, more macroeconomic instability) increase the instability of growth rates. More democratic countries have more stable growth rates, as do more populated countries (which presumably have more options for diversification) and OECD countries.[27] The only seemingly counterintuitive result is that the coefficient for institutional quality, ICGR, enters all regressions with a positive sign.

The rest of the explanatory variables tried in both the OLS and IV variants of equation 1 are not statistically significant, and their inclusion in or exclusion from the regressions does not affect the results. These additional variables include the size of the government, initial GDP per capita, average GDP per capita, the volatility of capital flows, regional dummies, the number of sudden stops, the volatility of private credit, and geographic controls.[28] These variables were selected after some experimentation to achieve the best possible fit for the regression, but without regard to the coefficient on openness per se. In fact, the effects of openness on output volatility are identified even when no additional control variables are included in the regression.

Table 3 presents the OLS and IV variants of equation 9 without including additional controls. Column 1 shows that openness has no significant effect on output volatility when the trade-to-GDP ratio is used as the single measure of openness. This is not surprising since the single measure compounds the stabilizing and destabilizing effects of openness, which appear to even out in OLS estimates, as discussed below. When the control for terms-of-trade risk is included in the regression through the interacted term (column 2), the stabilizing and destabilizing effects of openness are separately identified as in table 2. When gravity estimates are used to instrument for the trade-to-GDP ratio in columns 3 and 4, the coefficient on openness is negative and statistically significant even after accounting for the terms-of-trade risk (column 3). This is consistent with the observation made earlier about the positive noncausal correlation between openness and output volatility that dampens the OLS estimates. It is also consistent with evidence to be presented in the next section on how, in the IV case, openness to trade appears to stabilize output even in countries that are more exposed to terms-of-trade risk.

27. For a discussion on the role of democracy in output stability and for results that support the presumption that democracy lowers volatility, see Mobarak (2005).

28. The results of regressions with some of these control variables are not reported to save space, but they are available on request.

TABLE 3. Openness and Volatility without Controls[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
Trade/GDP	0.004	–0.020***	–0.048***	–0.039***
	(0.54)	(–3.16)	(–2.66)	(–3.13)
(Trade/GDP)*(SDTOTGR)		0.003***		0.003***
		(7.03)		(7.04)
Constant	3.887***	3.677***	6.928***	4.734***
	(7.84)	(8.76)	(6.37)	(5.68)
Summary statistic				
No. observations	77	77	76	76
R squared	0.04	0.41	n.a.	0.35

***Statistically significant at the 1 percent level.

n.a. Not available.

a. The dependent variable is SDGR. Columns 1 and 2 are estimated using OLS; columns 3 and 4 use IV. In the IV regressions, the endogenous variables are Trade/GDP and (Trade/GDP)*(SDTOTGR), with the predicted Trade/GDP and predicted (Trade/GDP)*(SDTOTGR), respectively. The predicted Trade/GDP for each country *i* is computed from gravity estimates and is based on countries' geographic (and cultural) characteristics. Robust *t* statistics are in parentheses.

Quantitative Significance and Implications

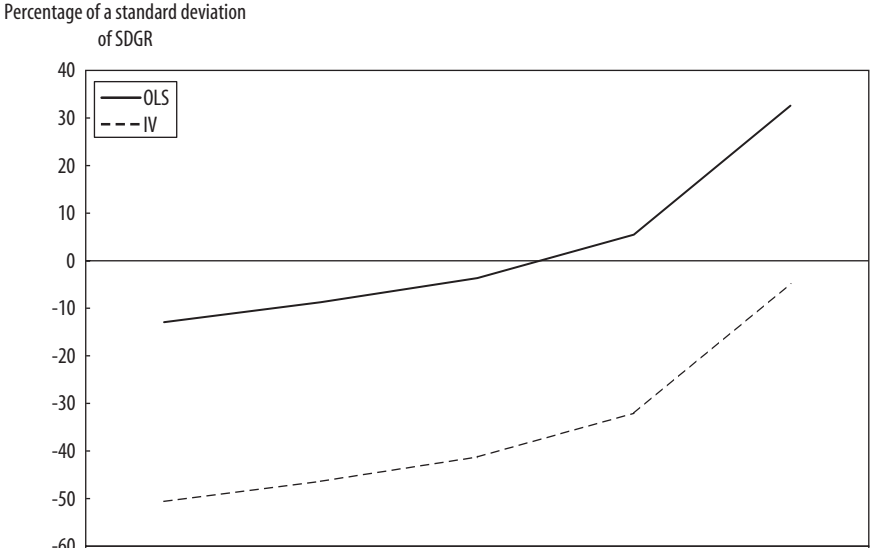
The results reported in tables 2 and 3 indicate that openness to trade has two effects on output volatility: a destabilizing effect ($\beta_1 > 0$) coming from increased exposure to terms-of-trade risk and a stabilizing effect ($\beta_2 < 0$) that has to come from other routes. The net effect of openness on output volatility depends on the sign and size of the estimated coefficients and on the level of SDTOTGR. In particular, recall from equation 7 that

$$\Delta \mathrm{SDGR}_i = \left[\beta_2 + \beta_1 * (\mathrm{SDTOTGR})_i\right] * \Delta(\mathrm{Trade/GDP})_i .$$

Given that $\beta_2 < 0$ and $\beta_1 > 0$, countries that are prone to more volatile terms of trade (that is, high levels of SDTOTGR) will clearly tend to benefit less from greater openness to trade. In the computations that follow, I estimate the net effects of openness on output volatility at different levels of SDTOTGR. Since the estimated value of β_1 is the same in all the regressions reported in table 2, I use the value $\beta_1 = 0.001$ throughout all the simulations. Finally, I take $\beta_2 = -0.012$ as the benchmark OLS estimate (column 1 in table 2) and $\beta_2 = -0.038$ as the corresponding IV estimate (column 2 in table 2).

What is the estimated net effect on output volatility of increasing Trade/GDP one standard deviation above the sample mean (that is, from 60 percent to 85 percent)? Figure 1 plots the results for the OLS and IV cases. In the OLS

FIGURE 1. The Estimated Effect on Volatility of Increasing the Trade-to-GDP Ratio

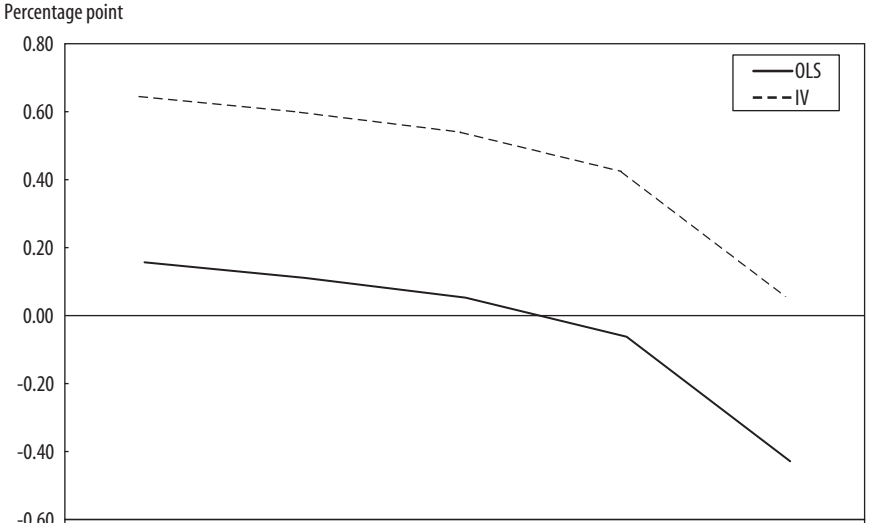


	10th	25th	50th	75th	99th
OLS	-12.91	-8.71	-3.64	5.49	32.57
IV	-50.58	-46.35	-41.25	-32.06	-4.81

case, a country that is at the median (or fiftieth percentile) of the distribution of SDTOTGR (for example, Brazil, Colombia, Egypt, Jamaica, and Kenya) does not benefit greatly from increased openness to trade in terms of output stability (the volatility falls just 3.64 percent of a standard deviation), and countries that are above the median level of SDTOTGR (such as Algeria, Argentina, Bangladesh, Chile, Indonesia, Pakistan, and Venezuela) are even hurt by openness.[29] IV estimates, however, present a different picture. In the IV case, a country that is at the median of the distribution of SDTOTGR sees output volatility fall by more than 40 percent of a standard deviation when the trade-to-GDP ratio increases 25 percentage points. Furthermore, all countries benefit from more openness. The stabilizing effect of openness completely outweighs the destabilizing effect arising from increased exposure to terms-

29. See table A-1 in the appendix for a complete list of countries ranked by increasing level of SDTOTGR.

FIGURE 2. The Estimated Effect on Growth of Increasing the Trade-to-GDP Ratio[a]



	10th	25th	50th	75th	99th
OLS	0.17	0.11	0.05	-0.07	-0.42
IV	0.66	0.60	0.54	0.42	0.06

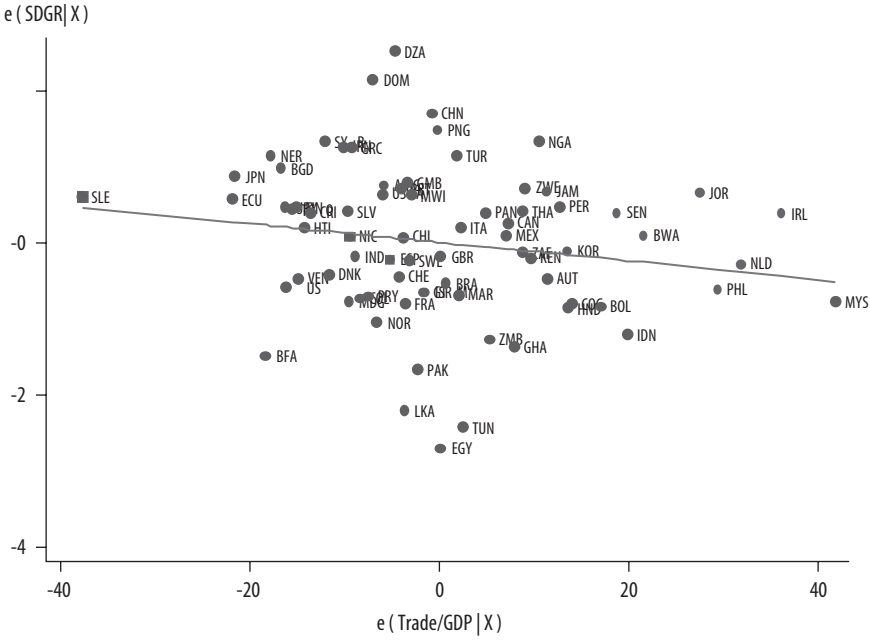
a. Based on Hnatkovska and Loayzas (2003) baseline estimation.

of-trade risk. Hnatkovska and Loayza, using this same dataset, estimate that a one-standard-deviation increase in output volatility leads to a 1.3 percentage point drop in the annual growth rate.[30]

Taking this estimate as the benchmark, I next explore the effect on growth, coming exclusively through output stability, of raising the Trade/GDP ratio one standard deviation above the mean. Figure 2 plots the results. In the OLS case, a country that is at the median of the distribution of SDTOTGR does not benefit greatly (with an increase of only 0.05 percentage point in the annual growth rate), and countries that are above the median level of SDTOTGR are hurt by openness (because volatility increases with openness for these countries). A different picture again emerges in the IV case: a country that is at the median of the distribution of SDTOTGR sees annual growth increase by

30. Hnatkovska and Loayza (2004). Mobarak (2005) uses a different dataset and finds a stronger effect of volatility on growth: a one-standard-deviation increase in volatility decreases growth by about 2 percentage points, which is over 0.8 standard deviations.

FIGURE 3. The Relationship between Openness and Volatility[a]



a. Coefficient: –0.012; robust standard error: 0.006; *t* statistic: –2.08.

0.5 percentage point when the trade-to-GDP ratio increases by 25 percentage points. Furthermore, in the IV case, all countries appear to benefit from increased openness to trade. Given that trade is likely to be endogenous in this setting, IV estimates are the preferred specification. Whether the estimated net effects are large is debatable, but the fit of the estimation is quite good.[31]

Robustness Checks

In testing the robustness of the above results, the first step is to ensure that the results are not driven by outliers. Figure 3 plots the partial correlation between trade and output volatility (partial in the sense that the exercise controls for other determinants of output volatility) drawn from the OLS regression 1 in table 2. The plot shows a clear negative correlation between openness to trade

31. Since I only generate and use a single instrument, I have no overidentifying restrictions to test.

TABLE 4. Output Volatility and Fiscal Policy[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
FISCALVOL	1.270***	1.200***	0.830***	0.750***
	(6.35)	(5.53)	(3.61)	(2.99)
AVGGDPPC	−0.150	−0.090	0.010	0.060
	(−0.85)	(−0.49)	(0.04)	(0.28)
Trade/GDP		0.002	−0.011*	−0.021*
		(0.40)	(−1.83)	(−1.75)
lnGOVC		0.460	0.180	0.260
		(0.96)	(0.40)	(0.64)
(Trade/GDP)*(SDTOTGR)			0.002***	0.002***
			(2.00)	(2.00)
Constant	2.660	0.880	1.430	1.330
	(1.44)	(0.36)	(0.65)	(0.59)
Summary statistic				
No. observations	74	72	72	71
R squared	0.47	0.46	0.54	0.53

*Statistically significant at the 10 percent level.

***Statistically significant at the 1 percent level.

a. The regressions replicate the estimations in Fatás and Mihov (2003), using my dataset. The dependent variable is SDGR. Columns 1, 2, and 3 are estimated using OLS; column 4 uses IV. In the IV regressions, the endogenous variables are Trade/GDP and (Trade/GDP)*(SDTOTGR), with the predicted Trade/GDP and predicted (Trade/GDP)*(SDTOTGR), respectively. The predicted Trade/GDP for each country *i* is computed from gravity estimates and is based on countries' geographic (and cultural) characteristics. Robust *t* statistics are in parentheses.

and output volatility that does not appear to be driven by outliers.[32] As additional robustness checks, I consider other attempts to measure the effect of openness to trade on output volatility and try to disentangle the difference in the results. Fatás and Mihov are among the few researchers who study the determinants of output volatility per se.[33] While their main focus is on the effects of discretionary fiscal policy on volatility (and economic growth), they include the ratio of trade to GDP as a control variable, and it is not significant in their regressions. In columns 1 and 2 of table 4, I replicate their regressions using my dataset. Their measure of discretionary fiscal policy enters the regressions with a positive and statistically significant sign. Also, the control variables, including Trade/GDP, are not statistically significant, as in their regressions.[34] In columns 3 and 4, I repeat the exercise but introduce the interacted term in the OLS and IV regressions, respectively, to control for terms-

32. I also replicated the exercise for all the variables included in the benchmark regression in table 2. No obvious outliers appear to be driving any of the results. The corresponding figure is available in the working paper version of this paper or directly on request.

33. Fatás and Mihov (2003).

34. The comparable table in that paper is table 1.

TABLE 5. Replicating Rodrik[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
Trade/GDP		−0.019***		−0.019**
		(−2.84)		(−2.31)
(Trade/GDP)*(SDTOTGR)	0.001***	0.002***	0.002***	0.002***
	(3.00)	(4.50)	(3.00)	(4.00)
$\ln y_0$	−0.450**	−0.370*	−0.450**	−0.370*
	(−2.14)	(−1.95)	(−2.05)	(−1.76) *
OECD	−0.870*	−0.940**	−0.720	−0.870
	(−1.78)	(−2.14)	(−1.39)	(−1.85)
Latin America	−0.360	−0.680	−0.360	−0.680
	(−0.77)	(−1.48)	(−0.78)	(−1.45)
Africa	−0.490	−0.660	−0.570	−0.750
	(−0.83)	(−0.57)	(−0.62)	(−0.59)
South Asia	−2.360***	−2.720***	−2.280**	−2.670***
	(−2.74)	(−3.53)	(−2.56)	(−3.42)
Constant	7.180***	7.500***	6.920***	7.340***
	(4.22)	(4.63)	(3.88)	(4.48)
Summary statistic				
No. observations	77	77	76	76
R squared	0.53	0.58	0.53	0.58

*Statistically significant at the 10 percent level.
**Statistically significant at the 5 percent level.
***Statistically significant at the 1 percent level.

a. The regressions replicate the estimations in Rodrik (1998), using my dataset. The dependent variable is SDGR. Columns 1 and 2 are estimated using OLS; columns 3 and 4 use IV. In the IV regressions, the endogenous variables are Trade/GDP and (Trade/GDP)*(SDTOTGR), with the predicted Trade/GDP and predicted (Trade/GDP)*(SDTOTGR), respectively. The predicted Trade/GDP for each country *i* is computed from gravity estimates and is based on countries' geographic (and cultural) characteristics. Robust *t* statistics are in parentheses.

of-trade risk. In these cases, openness appears to exert an independent negative effect on output volatility, as in my benchmark regressions. The fit of the regressions also improves.

Rodrik tests the relationship between openness and output volatility using a specification similar to equation 9 but without the trade-to-GDP ratio as a separate regressor.[35] In other words, Rodrik does not allow for the possibility that openness has an independent effect on volatility that does not come from greater exposure to terms-of-trade risk. In column 1 of table 5, I replicate Rodrik's regression using my dataset and obtain similar results to those reported in his paper.[36] In column 2, I augment the regression by including Trade/GDP as a separate explanatory variable. The coefficient on Trade/GDP enters the regression with a negative and statistically significant sign, and the

35. Rodrik (1998).
36. Rodrik (1998, p. 1022, table 7).

goodness of fit increases considerably. In columns 3 and 4, I repeat the regressions using IV instead of OLS. The results are very similar: trade openness is shown to have a significant negative effect on output volatility that is independent from the terms-of-trade risk, as in table 2.

Another possibility that has not yet been explored in this paper is that openness to trade could affect output volatility through the pattern of sectoral specialization. For example, if openness to trade increases specialization, the economy might become more vulnerable to external shocks that are idiosyncratic to specific sectors. While this is an interesting theoretical possibility, the existing empirical evidence does not support it. Koren and Tenreyro show that sectoral shocks are highly correlated between low-trade and high-trade countries, suggesting that more open economies do not face different exposure.[37] Nevertheless, the relation between terms-of-trade shocks, trade openness, and output volatility could potentially depend on the basket of products and services exported. Figure 4 shows the distribution of terms-of trade-volatility by groups of countries based on export concentration levels.[38] Countries with a wider portfolio of exports have experienced, on average, less volatile terms-of-trade shocks than countries with more concentrated exports (see the box on the left side of the figure). A positive relation between terms-of-trade volatility and output volatility could thus be hiding a relation between export concentration and output volatility. Furthermore, if exposure to trade affects the pattern of export diversification, the estimated negative effect of trade on volatility could arise from the relation between export concentration and output volatility.

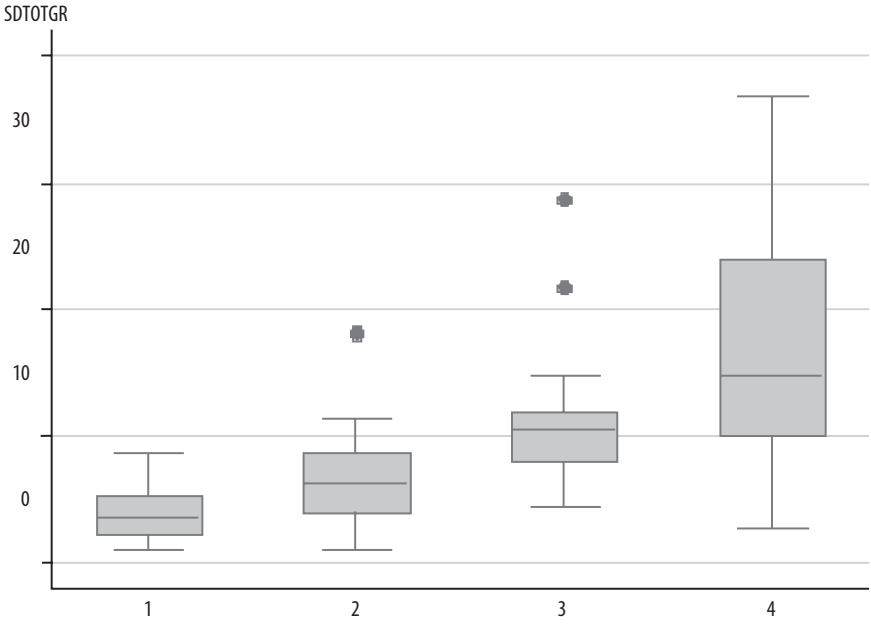
These possibilities can be formally tested by controlling for export concentration levels in the regressions. The results are reported in table 6. The table shows that controlling for export concentration levels does not change the benchmark results of table 2. Although the coefficient of the export concentration index is positive, it is not statistically significant, and the point estimates of the coefficients on openness and terms-of-trade volatility are not affected. In other words, export concentration does not appear to have an independent effect on output volatility.[39]

37. Koren and Tenreyro (2005).

38. Based on the average Herfindahl-Hirschman index (1980–2000) of each country's exports, using data from the United Nations Conference on Trade and Development (UNCTAD).

39. A potential criticism of the analysis so far is that while trade openness is treated as an endogenous variable, the volatility of terms-of-trade growth (SDTOTGR) is not. To deal with this problem, I instrument SDTOTGR using the oil exporting dummy and the export concentration index, two variables that are highly correlated to the volatility of the terms of trade, while also being possibly exogenous. The results (available on request) do not change.

FIGURE 4. Terms of Trade Volatility, by Export Concentration Index[a]



a. Each box gives information on basic distributional statistics: $p(5)$, $p(25)$, $p(50)$, $p(75)$, $p(95)$, and outliers. In the concentration index, one represents the least concentrated and four the most concentrated.

Finally, the measure of trade openness used in this paper could be working as a proxy for other structural characteristics of the economy, such as the level of financial development. For example, Loayza and Raddatz use an econometric methodology based on semi-structural vector autoregressions on a panel of ninety countries to examine empirically how domestic structural characteristics related to trade and financial openness, financial development, and labor market flexibility influence the impact that terms-of-trade shocks have on aggregate output.[40] They find, consistent with the results reported in this paper, that greater trade openness magnifies the output impact of terms-of-trade shocks. They also find that financial depth plays a nuanced role in stabilizing the economy by helping to reduce the impact of terms-of-trade shocks, particularly when trade openness is high. This raises the question of

40. Loayza and Raddatz (2006).

TABLE 6. Controlling for Export Concentration[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
Trade/GDP	−0.012**	−0.011*	−0.038*	−0.036*
	(−2.08)	(−1.84)	(−1.68)	(−1.67)
(Trade/GDP)*(SDTOTGR)	0.001***	0.001**	0.001*	0.001
	(2.87)	(2.46)	(1.92)	(1.23)
lnMIS	0.924***	0.836***	1.038***	0.975***
	(3.43)	(2.70)	(3.26)	(2.91)
DEMOCRACY	−0.143***	−0.151***	−0.164***	−0.169***
	(−3.22)	(−3.25)	(−3.08)	(−3.13)
ICRG	0.384**	0.403**	0.615**	0.628**
	(2.12)	(2.18)	(2.17)	(2.20)
SDINF	0.009*	0.010**	0.006	0.008
	(1.88)	(2.27)	(1.39)	(1.63)
lnPOP	−0.257**	−0.188	−0.499	−0.446
	(−2.06)	(−1.31)	(−1.66)	(−1.55)
OECD	−0.601	−0.564	−0.744	−0.704
	(−1.49)	(−1.35)	(−1.57)	(−1.47)
Africa	−0.409	−0.431	−0.661	−0.665
	(−0.83)	(−0.88)	(−1.21)	(−1.24)
lnAREA	0.083	0.037	−0.028	−0.056
	(0.83)	(0.37)	(−0.20)	(−0.38)
$\ln y_0$	−0.291	−0.251	−0.448	−0.422
	(−1.31)	(−1.02)	(−1.49)	(−1.39)
XHHI		1.090		0.970
		(0.79)		(0.51)
Constant	6.879*	5.995	14.599*	13.801
	(1.94)	(1.59)	(1.71)	(1.67)
Summary statistic				
No. observations	74	74	73	73
R squared	0.68	0.69	0.62	0.63

*Statistically significant at the 10 percent level.
**Statistically significant at the 5 percent level.
***Statistically significant at the 1 percent level.

a. The dependent variable is SDGR. Columns 1 and 2 are estimated using OLS; columns 3 and 4 use IV. In the IV regressions, the endogenous variables are Trade/GDP and (Trade/GDP)*(SDTOTGR), with the predicted Trade/GDP and predicted (Trade/GDP)*(SDTOTGR), respectively. The predicted Trade/GDP for each country *i* is computed from gravity estimates and is based on countries' geographic (and cultural) characteristics. Robust *t* statistics are in parentheses.

whether trade openness is really working as a proxy for financial development. To test this hypothesis, I run the regressions again including the interaction between two proxies of financial depth and SDTOTGR. The measures of financial depth are defined by Levine, Loayza, and Beck and constructed using data from the IMF's *International Financial Statistics*.[41] The two

41. Levine, Loayza, and Beck (2000).

TABLE 7. IV Estimates Including Interaction with Financial Development[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
Trade/GDP	−0.040**	−0.040***	−0.058***	−0.044**
	(−2.22)	(−3.42)	(−3.68)	(−2.52)
(Trade/GDP)*(SDTOTGR)	0.003***	0.003***	0.002***	0.003**
	(5.76)	(3.39)	(4.62)	(2.40)
(Private credit)*(SDTOTGR)	−0.001		−0.004**	
	(−0.88)		(−2.13)	
(COM-CENT)*(SDTOTGR)		−0.0001		−0.001
		(−0.14)		(−0.95)
Constant	5.351***	4.777***	6.572***	5.063***
	(5.80)	(6.28)	(5.40)	(4.76)
Summary statistic				
No. observations	39	76	23	47
R squared	0.36	0.35	0.14	0.13

*Statistically significant at the 10 percent level.
**Statistically significant at the 5 percent level.
***Statistically significant at the 1 percent level.

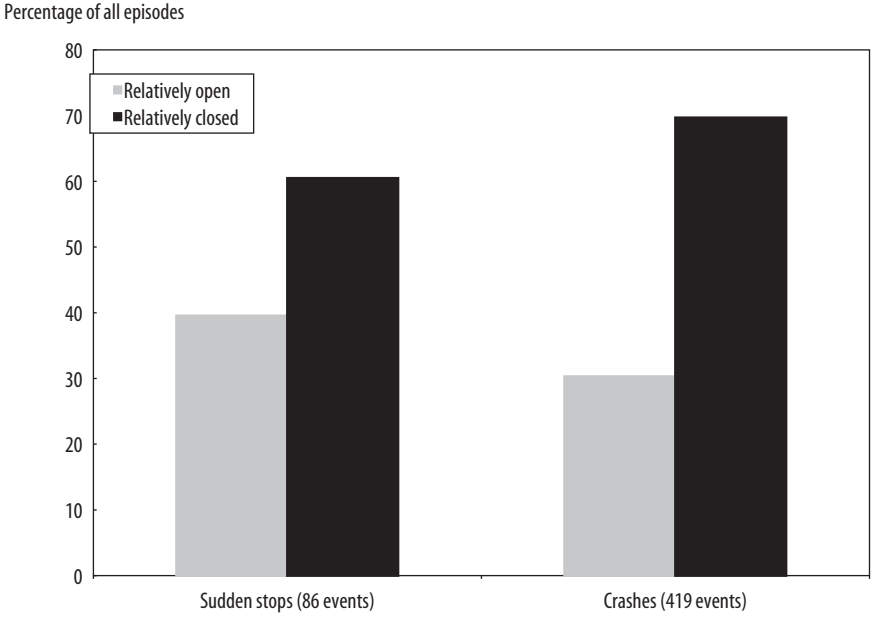
a. The dependent variable is SDGR. All four regressions are estimated using IV. In columns 1 and 2, the endogenous variables are Trade/GDP and (Trade/GDP)*(SDTOTGR), while the instruments are the predicted Trade/GDP and predicted (Trade/GDP)*(SDTOTGR). In column 3, the endogenous variables are Trade/GDP, (Trade/GDP)*(SDTOTGR), and (Private Credit/ GDP), while the instruments are the predicted Trade/GDP, predicted (Trade/GDP)*(SDTOTGR), and legal origin dummies. In column 4, the endogenous variables are Trade/GDP, (Trade/GDP)*(SDTOTGR), and the ratio of commercial bank assets to commercial plus central bank assets (COM-CENT), while the instruments are the predicted Trade/GDP, predicted (Trade/GDP)*(SDTOTGR), and legal origin dummies. Robust *t* statistics are in parentheses.

variables are as follows: private credit, which equals the value of loans by financial intermediaries to the private sector divided by GDP (average 1960–2000); and COM-CENT, which equals the ratio of commercial bank assets to total commercial bank plus central bank assets (average 1960–2000). The results are reported in table 7.[42] Columns 1 and 2 treat the measures of financial development as exogenous, while in the regression reported in columns 3 and 4, they are instrumented using the legal origin dummies as in Levine, Loayza and Beck.[43] The results show that the identified effects of trade openness are robust to the inclusion of the additional interaction. In other words, trade openness does not appear to be working as a proxy for financial development.

42. Because of data limitations, the regressions do not include the full set of controls.

43. Levine, Loayza, and Beck (2000). Comparative legal scholars place countries into four major legal families: English, French, German, or Scandinavian. The rationale for using legal origin as an instrument for financial depth can be traced back to the work of La Porta and others (1997) who show that national legal origin (which is possibly exogenous) strongly influences the legal and regulatory environment governing financial sector transactions.

FIGURE 5. Distribution of Sudden Stops and Currency Crises, by Level of Trade Openness[a]



Source: Author's calculations, based on Cavallo and Frankel (2008)

a. "Sudden stops" are defined following Cavallo and Frankel (2008); "currency crises" (crashes) are defined following Frankel and Wei (2004).

Openness to Trade, Capital Flows, and Output Volatility

A recent branch of the extensive literature on financial fragility provides evidence that openness to trade reduces countries' vulnerability to some forms of costly financial crises.[44] One possible explanation as to why more open economies are less prone to crises hinges on the intuition that openness to trade increases the creditworthiness of countries and therefore makes them less likely to be subject to costly crises driven by sudden stops in capital inflows.[45] The puzzle that these papers document and explain is summarized in figure 5. The figure plots the frequency of occurrence of two types of exter-

44. For example, Rose (2002); Calvo, Izquierdo, and Mejía (2004); Cavallo (2006); Cavallo and Frankel (2008); Martin and Rey (2006).

45. Bulow and Rogoff (1989) argue that countries that trade more are subject to more harmful trade-related retaliation in the aftermath of default and are therefore less likely to default.

nal crises—sudden stops and currency crises—across different levels of trade openness. These crises happen disproportionately more frequently in relatively closed economies (that is, in countries whose trade-to-GDP ratio is below the mean level of openness).[46] This result still holds after controlling for other determinants of these crisis episodes.[47]

The connection between trade openness and the propensity for financial crises is important because crises affect growth and output volatility. Although there is some debate in the literature on whether crises affect long-run growth, there is more consensus on the fact that they have an important short-term effect on output levels and that they raise volatility.[48] The reason is that output typically collapses after these shocks and then tends to recover to precrisis levels. For example, Calvo, Izquierdo, and Talvi document that, in their sample of countries, output falls by as much as 10 percent of GDP, on average, following a sudden stop and that recovery to the precrisis level is rather fast (two years, on average).[49]

In related work, Calvo and Talvi study the differential responses of Chile (a very open economy) and Argentina (a very closed economy) to the liquidity crunch following the Russian default in 1998.[50] They conclude that while both economies were affected, Argentina suffered more because the size of the real exchange rate depreciation that it had to engineer to close the external financing gap was much bigger than what Chile faced. This, compounded with a greater degree of domestic liability dollarization, resulted in a worse outcome.[51]

To the extent that trade openness helps to mitigate the effect of financial crises either by preventing them or by smoothing their consequences, it should also help to mitigate output volatility through the financial stability channel. To test whether the computed stabilizing effects of openness to trade operate (at least in part) through this channel, I follow a two-pronged strategy. First,

46. This is also true for other forms of external crises. For example, Edwards (2004) documents that more open economies are less prone to current account reversal.

47. See Cavallo and Frankel (2008); Edwards (2004).

48. For example, Rancière, Tornell, and Westermann (2005) argue that while crises are costly, they are a necessary bump in the road toward development. In the long run, countries that experience crises grow more. In contrast, Cerra and Saxena (2005) argue that countries never fully recover from some forms of external crises.

49. Calvo, Izquierdo, and Talvi (2006).

50. Calvo and Talvi (2005).

51. Both Argentina and Chile lost financing for their current account deficits in 1998. The real exchange rate depreciated by 185 percent in Argentina between January 1998 and December 2002 and only 47.5 percent in Chile.

TABLE 8. Controlling for Natural Disasters[a]

Independent variable	*(1)*	*(2)*	*(3)*	*(4)*
Trade/GDP	−0.020***	−0.019**	−0.048***	−0.043**
	(−3.26)	(−2.45)	(−2.76)	(−2.61)
(Trade/GDP)*(SDTOTGR)	0.003***	0.003***	0.003***	0.003***
	(6.95)	(6.89)	(6.10)	(5.77)
(Trade/GDP)*(ND)	0.0001	−0.002	−0.010	−0.030
	(0.01)	(−0.29)	(−1.25)	(−0.77)
ND		0.001		0.006
		(0.21)		(0.48)
Constant	3.672***	3.600***	5.743***	5.557***
	(9.50)	(6.85)	(4.16)	(3.96)
Summary statistic				
No. observations	76	76	75	75
R squared	0.40	0.40	0.22	0.16

*Statistically significant at the 10 percent level.
**Statistically significant at the 5 percent level.
***Statistically significant at the 1 percent level.

a. The dependent variable is SDGR. Columns 1 and 2 are estimated using OLS; columns 3 and 4 use IV. In the IV regressions, the endogenous variables are Trade/GDP and (Trade/GDP)*(SDTOTGR), with the predicted Trade/GDP and predicted (Trade/GDP)*(SDTOTGR), respectively. The predicted Trade/GDP for each country *i* is computed from gravity estimates and is based on countries' geographic (and cultural) characteristics. Robust *t* statistics are in parentheses.

in the absence of good measures of financial shocks in a cross-sectional setting, I augment regression 9 to include a control for plausible domestic shocks.[52] The objective of these new regressions is to test whether the coefficient of trade openness is still significant after controlling for domestic shocks. If so, then the stabilizing effect of trade openness could be coming from the financial channel, which is the only other possible source of risk in the economy. One source of exogenous domestic shocks (that is, shocks that are not the outcome of output volatility per se) is natural disasters (ND).[53] The results of these regressions are reported in table 8. Columns 1 and 3—OLS and IV regressions, respectively—include the interaction term between trade openness and natural disasters, while columns 2 and 4 also include the natural disasters variable separately. The coefficient of trade openness itself is still negative and significant even after accounting for the effect of trade openness that operates through the potential mitigation of domestic shocks.

52. The problem is that while the volatility of the terms of trade is measurable over a time span, the proclivity to financial crisis is not uniquely linked, for example, to the volatility of capital flows.

53. The total number of natural disasters between 1960 and 2000 is from the OFDA/CRED international disaster database (EM-DAT). For a discussion of the incidence of natural disasters, see Borensztein, Cavallo, and Valenzuela (forthcoming).

The second part of the strategy to identify whether the estimated stabilizing effects of trade openness come from the financial channel consists of doing sample splits. In particular, I run the regressions in two subsamples: countries that are, on average, more exposed to capital flows; and countries that are, on average, less exposed to capital flows. If openness to trade reduces output volatility by reducing the likelihood of financial crises that are prevalent in the context of greater exposure to financial flows, then the effect of openness to trade on output volatility should be more pronounced in the first subsample.[54] This is indeed what the results indicate, as reported below.

I use three different variables to split the sample. First, I use Klein's data on open capital accounts, particularly the variable $SHARE_{76–95}$.[55] This variable, which reflects the number of years in the period 1976–95 in which countries had no de jure capital account restrictions, is constructed using the information available from the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER). I compute the mean and median values of $SHARE_{76–95}$ and split the sample according to whether the individual country values fall above or below each of these cutoffs. This method provides two splits, given by the mean and median values of $SHARE_{76–95}$. The first split produces twenty-eight countries that are more exposed to capital flows and for which I have data versus forty-six that are less exposed. The second split produces thirty-nine versus thirty-five countries with complete data, respectively.

Second, I split the sample using a quantity-based measure of financial openness that provides an alternative measure of a country's integration with international financial markets.[56] The preferred measure is the sum of gross stocks of foreign assets and liabilities as a ratio of GDP. Using data from Lane and Milesi-Ferretti, I construct the average value for 1970–2000 of each country's sum of gross stocks of foreign assets and liabilities as a ratio of GDP (AVGFO).[57] I then compute the median value of this variable and split the sample according to whether an individual country falls above or below the median. The two subsamples consist of thirty-nine countries each.

Finally, I split the sample using de facto capital flows. I compute the median value of SDCAPFLOWS (a measure of the de facto volatility of

54. Martin and Rey (2006) show, in a general equilibrium model, that when emerging markets start opening their financial account but are closed to trade in goods, they are more prone to financial crises because profits and dividends depend on volatile domestic demand.

55. Klein (2003).

56. Kose and others (2006).

57. Lane and Milesi-Ferretti (2007).

TABLE 9. Sample Splits: Open versus Closed Capital Account[a]

Explanatory variable	*Full sample* (1)	*Open capital account* (2)	*Closed capital account* (3)	*Open capital account* (4)	*Closed capital account* (5)
Trade/GDP	−0.012**	−0.025***	−0.010	−0.035**	−0.018
	(−2.08)	(−4.20)	(−1.03)	(−2.45)	(−0.70)
(Trade/GDP)*	0.001***	0.0002	0.001**	0.0003	0.001
(SDTOTGR)	(2.87)	(0.39)	(2.05)	(0.62)	(1.57)
lnMIS	0.924***	0.607**	0.815**	0.435	0.781
	(3.43)	(2.26)	(2.03)	(1.37)	(1.56)
DEMOCRACY	−0.143***	−0.130*	−0.128**	−0.132**	−0.138**
	(−3.22)	(−2.10)	(−2.25)	(−2.52)	(−2.13)
ICRG	0.384**	0.720***	0.240	0.897**	0.309
	(2.12)	(4.20)	(0.77)	(2.48)	(0.92)
SDINF	0.009*	0.014	0.008	0.016	0.006
	(1.88)	(1.53)	(1.26)	(1.62)	(0.91)
lnPOP	−0.257**	−0.233	−0.314	−0.274	−0.299
	(−2.06)	(−1.45)	(−1.31)	(−1.40)	(−0.63)
OECD	−0.601	−1.095	−0.872	−1.307	−0.904
	(−1.49)	(−1.61)	(−1.36)	(−1.52)	(−1.34)
Africa	−0.409	0.387	−0.423	0.266	−0.509
	(−0.83)	(1.03)	(−0.65)	(0.71)	(−0.75)
LnAREA	0.083	−0.062	0.106	−0.149	0.038
	(0.83)	(−0.48)	(0.55)	(−0.85)	(0.17)
lny_0	−0.291	−0.783***	−0.081	−0.928**	−0.053
	(−1.31)	(−3.34)	(−0.29)	(−2.86)	(−0.16)
Constant	6.879*	13.973***	6.254	17.858**	7.116
	(1.94)	(4.14)	(1.18)	(2.45)	(0.71)
Summary statistic					
No. observations	74	28	46	28	45
R squared	0.68	0.89	0.6	0.89	0.60

*Statistically significant at the 10 percent level.
**Statistically significant at the 5 percent level.
***Statistically significant at the 1 percent level.

a. The dependent variable is SDGR. Columns 1, 2, and 3 are estimated using OLS; columns 4 and 5 use IV. An open (closed) account is defined as being above (below) the mean share. Robust *t* statistics are in parentheses.

capital flows) and split the sample according to whether countries lie above or below this cutoff. The two subsamples consist of thirty-seven countries each.[58]

The results are reported in table 9. For brevity, I report the results for the sample splits based on the first measure only (mean $SHARE_{76–95}$), but the

58. I do not use the mean values of AVGFO or SDCAPFLOWS as an alternative cutoff because they leave too few observations in one of the subsamples. A table listing all the countries in each subsample is available in the working paper version of this paper or directly on request.

results are consistent across all the other sample splits.[59] The first column is the same as column 1 in table 2; it is included here for comparison purposes. The second and third columns of table 9 replicate the benchmark OLS regression on the first two subsamples: countries with more exposure to capital flows (column 2) and countries with less exposure to capital flows (column 3), where the cutoff point is given by the mean value of $SHARE_{76–95}$. The results indicate that openness to trade has a statistically significant effect on output volatility only in the first subsample (countries with more exposure to capital flows). The point estimate of Trade/GDP in column 2 increases in absolute value with respect to the full sample counterpart, as does the statistical significance of the point estimate. The fourth and fifth columns of table 9 show the same pattern for the IV regressions: trade openness reduces output volatility in countries that are more exposed to capital flows. I find similar results when the sample split is based on the median value of $SHARE_{76–95}$, SDCAPFLOWS, or AVGFO. Once again, these unreported results suggest that the stabilizing effect of openness to trade on output volatility is statistically significant only in the subsample of countries that are more exposed via greater de facto or de jure financial openness. These results are broadly consistent with the research on the impact of openness to trade on vulnerability to financial crises.

The next task is to split the sample between initially poor and initially rich countries. Initially poor countries are those whose level of GDP per capita in 1960 was below the sample mean (forty-two countries) or median (thirty-seven countries), while the GDP per capita of the initially rich countries was above the cutoffs. Irrespective of actual capital flow patterns, or even the de jure capital flow restrictions in every country, it is a standard result in the development literature that relatively poor countries stand to benefit the most from capital inflows because they are capital scarce. An interesting question, therefore, is whether the stabilizing effects of trade openness predominate in one subsample over the other. The answer is provided in table 10. Columns 1 and 6 replicate the full sample OLS and IV regressions in table 1. For brevity, I report only the results for the case in which the sample split is based on the mean level of initial GDP.[60] The point estimates of the effect of initial GDP per capita (that is, $\ln y_0$) on output volatility are negative (although not statistically significant), implying that initially richer countries tend to be more stable. Yet, when the

59. The other tables are available in the working paper version of this paper or directly on request.

60. The results do not change when we use the median value to split the sample. These results are available in the working paper version of the paper or directly on request.

TABLE 10. Sample Splits: Level of per Capita Income[a]

Explanatory variable	*Full sample (1)*	*Poor (2)*	*Rich (3)*	*Full sample (6)*	*Poor (7)*	*Rich (8)*
Trade/GDP	−0.012**	−0.021**	−0.008	−0.038*	−0.064*	−0.019
	(−2.08)	(−2.43)	(−0.94)	(−1.68)	(−1.99)	(−1.07)
(Trade/GDP)*	0.001***	0.002***	−0.0004	0.001*	0.002**	−0.0004
(SDTOTGR)	(2.87)	(3.07)	(−0.82)	(1.92)	(2.31)	(−0.88)
lnMIS	0.924***	1.046***	0.676**	1.038***	1.251**	0.611*
	(3.43)	(2.75)	(2.20)	(3.26)	(2.51)	(1.88)
DEMOCRACY	−0.143***	−0.162***	−0.018	−0.164***	−0.189**	−0.009
	(−3.22)	(−2.84)	(−0.47)	(−3.08)	(−2.61)	(−0.22)
ICRG	0.384**	0.761***	−0.102	0.615**	1.24***	0.003
	(2.12)	(3.21)	(−0.50)	(2.17)	(2.89)	(−0.01)
SDINF	0.009*	0.006	0.01*	0.006	0.003	0.011**
	(1.88)	(−1.11)	(1.96)	(−1.39)	(−0.45)	(2.21)
lnPOP	−0.257**	−0.24	−0.228*	−0.499	−0.466	−0.321**
	(−2.06)	(−1.07)	(−1.98)	(−1.66)	(−1.05)	(−2.09)
OECD	−0.601	0.42	−0.553*	−0.744	−0.514	−0.48
	(−1.49)	(−0.71)	(−1.75)	(−1.57)	(−0.52)	(−1.45)
Africa	−0.409	−0.416	−0.168	−0.661	−0.588	−0.065
	(−0.83)	(−0.59)	(−0.39)	(−1.21)	(−0.70)	(−0.14)
lnAREA	0.083	0.013	0.072	−0.028	−0.203	−0.018
	(−0.83)	(−0.06)	(−0.74)	(−0.20)	(−0.76)	(−0.11)
$\ln y_0$	−0.291	−0.14	−0.404	−0.448	0.1	−0.583*
	(−1.31)	(−0.31)	(−1.29)	(−1.49)	(−0.18)	(−1.89)
Constant	6.879*	6.6	8.402**	14.599*	13.652	13.155**
	(1.94)	(−1.20)	(2.23)	(1.71)	(−1.36)	(2.15)
Summary statistic						
No. observations	74	42	32	73	41	32
R squared	0.68	0.58	0.88	0.62	0.44	0.86

*Statistically significant at the 10 percent level.
**Statistically significant at the 5 percent level.
***Statistically significant at the 1 percent level.
a. The dependent variable is SDGR. Columns 1 through 5 are estimated using OLS; columns 6 through 10 use IV. Poor (rich) countries are defined as being below (above) the mean of 1960 GDP per capita. Robust *t* statistics are in parentheses.

sample is split between initially poor and initially rich countries, the stabilizing effects of trade predominate in the first subsample. In other words, the data reveal that trade openness helps stabilize output fluctuations precisely in countries that (at least in theory) stand to benefit the most from capital inflows.

While the results in this paper are consistent with the hypothesis that openness to trade attenuates output volatility through the financial stability route, they are not irrefutable proof that this is the only stabilizing channel. Indeed, one potential criticism of this framework is that while it utilizes interactive

terms to capture one source of risk (terms of trade), it resorts to sample splits to isolate the other source (proneness to financial crisis). The problem is that although the volatility of the terms of trade is measurable over a time span, the propensity for financial crisis is not uniquely linked, for example, to the volatility of capital flows.[61] The proposed sample splits provide one operational way out of this conundrum.

Conclusions

Some economists believe that openness to trade increases the average growth rates of GDP at the expense of raising output volatility. This belief is grounded on the intuition that more open economies can reap the static and dynamic benefits of trade diversification, but only at the expense of exposing themselves to trade-related volatility (namely, terms-of-trade shocks). The current consensus, however, does not take into account that openness to trade might reduce financial volatility. A recent branch of the extensive literature on financial fragility has suggested that openness to trade reduces countries' vulnerabilities to some forms of costly financial crises (such as sudden stops in capital flows and currency crashes), while also reducing the ex post output costs of crises that occur and smoothing the subsequent adjustment. Once this is taken into account, the empirical relationship between openness to trade and output volatility remains an open question.

In this paper, I present new empirical evidence that suggests that, after appropriately accounting for the likely endogeneity of trade, the net effect of trade openness on output volatility is stabilizing. This result should not be interpreted as meaning that there are no trade-offs related to opening up to trade. The estimated relationships are long-run, cross-sectional effects. Many interesting dynamics related to the process of trade integration are thus beyond the scope of this paper. Nevertheless, the evidence presented here should raise doubts on the current consensus regarding the relationship between openness to trade and output volatility. In particular, more open economies are not necessarily more volatile, as is commonly thought.

61. For example, volatile capital flows are a necessary but not sufficient condition for sudden stops in capital flows, as these occur when net capital inflows fall more than two standard deviations below each country's own volatility. See Cavallo (2006) for details.

Appendix: Sample Data

This appendix presents additional information on the dataset I use, which encompasses a cross-section of seventy-seven countries (twenty-one of which are OECD members). Table A-1 provides a list of all the countries in the sample, ranked by increasing level of terms-of-trade volatility (SDTOTGR). Table A-2 presents the summary statistics for SDGR, Trade/GDP, and the individual components of **X** from equation 6. Recall that **X** is a vector of other potential determinants of output volatility, which include the following twenty-one variables:

—Real exchange rate misalignment (lnMIS), from Loayza and Hnatkovska, calculated as the absolute deviation of the real exchange rate overvaluation from the equilibrium real exchange rate (set to one);[62]

—Initial (1960) GDP per capita ($\ln \boldsymbol{y}_0$) from the World Bank's *World Development Indicators* (WDI);

—Average (1960–2000) GDP per capita (AVGGDPPC), from WDI;

—An index of autocratic-democratic political regimes (DEMOCRACY), from Marshall and Jaggers;[63]

—An index of institutional development (ICRG), from the International Country Risk Guide (average 1960–2000);

—The ratio of government consumption to GDP (lnGOVC), averaged over 1960–2000, from Loayza and Hnatkovska, who, in turn, use data from Summer, Heston, and Aten;[64]

—Gross secondary-school enrollment (lnSEC2), averaged over 1960–2000, from WDI;

—The natural log of area in square kilometers (lnAREA), from WDI;

—A dummy for whether a country is landlocked (LANDLOCK);

—A dummy for whether a country is an island (ISLAND);

—A dummy for whether a country is an oil exporter (OIL);

—Latitude above the equator (LAT), from Andrew Rose's dataset;[65]

—The natural log of average (1960–2000) population (lnPOP), from WDI;

—The total number of sudden stops (NUMSS1);[66]

62. Hnatkovska and Loayza (2004). The extent of real exchange rate disequilibrium is defined as the difference between the actual real effective exchange rate and its equilibrium level, given by cross-country purchasing power parity comparisons.

63. Marshall and Jaggers (2002).

64. Hnatkovska and Loayza (2004); Summers, Heston, and Aten (2002).

65. Available online at faculty.haas.berkeley.edu/arose/RecRes.htm.

66. Own calculation based on data from Cavallo (2006).

TABLE A-1. List of All Countries Ranked by Increasing Level of Terms-of-Trade Volatility

Rank	*Country*	*Rank*	*Country*	*Rank*	*Country*	*Rank*	*Country*
1	Netherlands	21	Portugal	41	Egypt, Arab Rep.	61	Niger
2	Austria	22	South Africa	42	India	62	El Salvador
3	Sweden	23	Norway	43	Madagascar	63	Côte d'Ivoire
4	Finland	24	Panama	44	Papua New Guinea	64	Haiti
5	Denmark	25	Morocco	45	Jordan	65	Ghana
6	Canada	26	Japan	46	Malawi	66	Paraguay
7	Greece	27	Malaysia	47	Sri Lanka	67	Congo, Rep.
8	United Kingdom	28	Thailand	48	Israel	68	Trinidad and Tobago
9	Switzerland	29	Mexico	49	Tunisia	69	Nicaragua
10	France	30	Guatemala	50	Uruguay	70	Algeria
11	United States	31	Philippines	51	Bolivia	71	Venezuela, RB
12	Ireland	32	Zimbabwe	52	Burkina Faso	72	Bangladesh
13	Dominican Republic	33	Costa Rica	53	Peru	73	Zambia
14	Italy	34	Honduras	54	Gambia, The	74	Iran, Islamic Rep.
15	Iceland	35	Senegal	55	Pakistan	75	Nigeria
16	China	36	Botswana	56	Indonesia	76	Togo
17	Korea, Rep.	37	Jamaica	57	Chile	77	Sierra Leone
18	Turkey	38	Kenya	58	Argentina		
19	Spain	39	Colombia	59	Ecuador		
20	Australia	40	Brazil	60	Syrian Arab Republic		

TABLE A-2. Summary Statistics

Variable	*No. observations*	*Mean*	*Std. deviation*	*Minimum*	*Maximum*
SDGR	77	4.13	1.71	1.61	8.29
Trade/GDP	77	58.73	25ò.24	16.17	133.22
lnMIS	77	3.18	0.55	2.00	4.86
DEMOCRACY	75	2.65	6.02	–8.82	10.00
ICRG	77	0.20	1.82	–3.07	3.47
SDINF	77	16.90	25.54	2.10	129.95
lnPOP	77	16.30	1.49	12.35	20.69
OECD	77	0.27	0.44	0.00	1.00
Africa	77	0.23	0.42	0.00	1.00
lnAREA	77	12.59	1.65	8.54	16.05
$\ln y_0$	77	7.16	1.43	4.55	10.18
LAT	77	17.58	25.57	–34.00	65.00
LANDLOCK	77	0.14	0.35	0.00	1.00
ISLAND	77	0.10	0.30	0.00	1.00
SDTOTGR	77	10.75	6.69	1.35	32.16
ND	77	55.68	78.02	4.00	447.00

—Volatility of inflation (SDINLF), from Loayza and Hnatkovska;[67]

—Volatility of capital flows (SDCAPFLOWS), own calculation with data from *International Financial Statistics* (IFS), published by the International Monetary Fund (IMF);

—Discretionary fiscal policy (FISCALVOL), from Fatás and Mihov;[68]

—Volatility of private credit growth (SDGRPCRED), from Loayza and Hnatkovska;[69]

—Regional dummies;

—An exports concentration index (XHHI), calculated as the average Herfindahl-Hirschman index (1980–2000) of a country's exports, from the United Nations Conference on Trade and Development (UNCTAD) *Handbook of Statistics Online;*[70]

—Natural disasters (ND), defined as the total number of natural disasters between 1960–2000, from the EM-DAT International Disaster Database.[71]

67. Hnatkovska and Loayza (2004).

68. Fatás and Mihov (2003). These authors define *discretionary fiscal policy* as changes in fiscal policy that do not represent reactions to economic conditions. They make the term operational by computing the variance of the residuals from the regression of changes in government spending on real income, controls for government spending, and deterministic components such as a time trend.

69. Hnatkovska and Loayza (2004).

70. The index can take any value between 0 and 1, with a higher number indicating that the country's exports are concentrated in a few products.

71. A disaster must fulfill at least one of the following criteria to be entered in the database: ten or more people reported killed, a hundred people reported affected, declaration of a state of emergency, or call for international assistance. The data are available online at www.em-dat.net.