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Output Volatility and Openness to Trade: A Reassessment

by

Eduardo A. Cavallo

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Inter-American Development Bank
1300 New York Avenue, N.W.
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Abstract[1]

Many economists believe that, while openness to trade increases average GDP growth rates, it also raises output volatility by exposing countries to terms-of-trade shocks. This view does not take into account that, as suggested by a recent strand of the financial fragility literature, commercial trade might also reduce financially related volatility. Once this is taken into account, the relationship between exposure to trade and output volatility is still an open question. Trade therefore is not necessarily a destabilizing force in countries that are exposed to volatile capital flows.

This paper presents new empirical evidence that suggests that the net effect of trade openness on output volatility is stabilizing. The methodology employed seeks to correct for the likely endogeneity of trade in this setting using gravity estimates as instrumental variables. The results confirm that exposure to trade raises output volatility through the terms-of-trade channel, as previously documented in the literature, but also shows that this is counteracted by a quantitatively larger stabilizing effect. Additional evidence is presented showing that the latter effect comes (at least in part) through the financial channel. Splitting the sample into countries that are more exposed to capital flows and countries that are less exposed, the paper shows that the stabilizing effect of commercial trade predominates in the first sub-sample.

JEL Classification: F36, F40.
Keywords: openness to trade, output volatility, financial crises, gravity equation.

[1] I am thankful to Norman Loayza and Viktoria Hnatkovska, who kindly shared their dataset for this paper. I am indebted to José De Gregorio for spurring my interest in this topic and for very stimulating comments and suggestions. I also thank my academic advisors at Harvard University: Dani Rodrik, Jeffrey Frankel and Andrés Velasco for their generous guidance and continued support. Part of this study was undertaken while I was visiting the Research Department of the Federal Reserve Bank of Atlanta. Juan Camilo Chaparro provided excellent research assistance. All errors are mine.

1. Introduction

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

Why openness to trade?[5] As Easterly et al. (2001a) argue, output volatility naturally relates to the frequency and the size of the shocks that affect an economy and to the manner in which the economy handles the shocks. It is therefore not surprising that openness to trade is commonly associated with *greater* output volatility: presumably, the more exposed to trade a country is, the more vulnerable it is to shocks coming from abroad.[6] In spite of this, 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 et al. (2004) 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" (p. 2). To the extent that external and internal shocks are not negatively correlated, then more vulnerability to external shocks implies more output volatility. The "consensus" that these authors allude to is summarized in Figure 1.

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[2] Ramey and Ramey (1995) and Hausmann and Gavin (1996), Fatas and Mihov (2003).

[3] Hnatkovska and Loayza (2003) 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 a significant impact of volatility on growth exists even after the simultaneity of growth and volatility are accounted for.

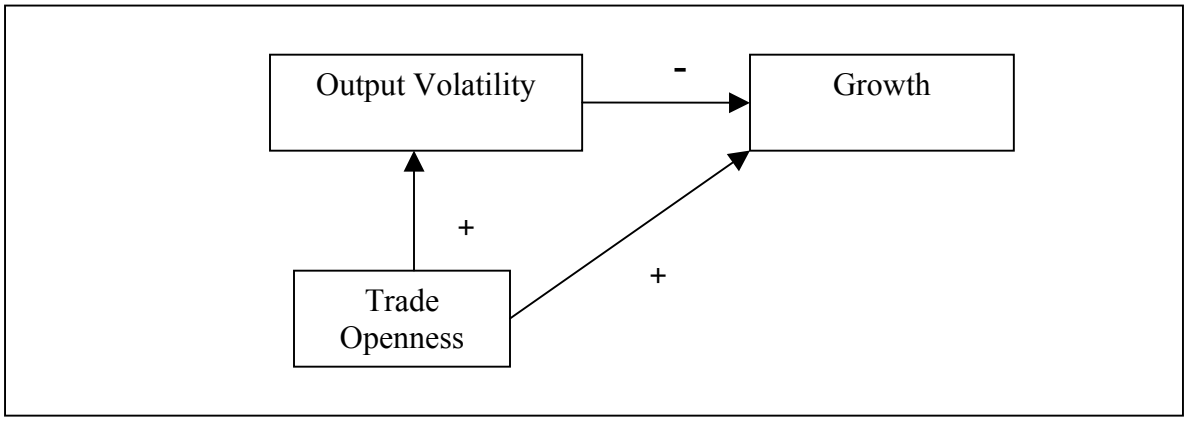
[4] Easterly, Islam and Stiglitz (2001); Buch, Dopke, and Pierdzioch (2002); Kose, Prasad and Terrones (2003) and Fatas and Mihov (2003) and Mobarak (2005) are among the few ones.

[5] I shall use the words "openness to trade" and "exposure to trade" interchangeably. In either case I am always referring to trade quantities, not to a particular stance of commercial trade policy.

[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) and Easterly, Islam and Stiglitz (2001).

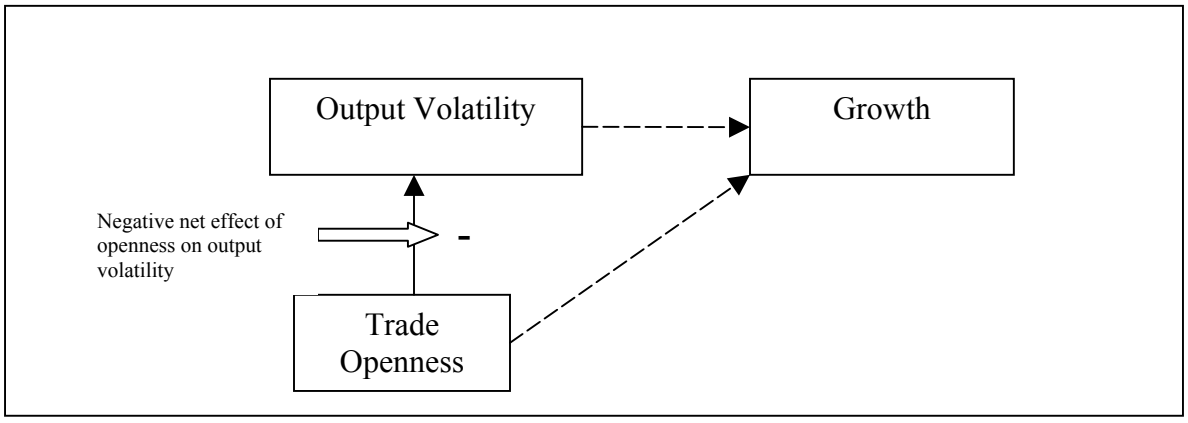
[7] See Frankel and Romer (1999) for pioneering work on this topic, and Rodriguez and Rodrik (2000) for a more skeptical assessment of the evidence. More recently, Lee, Ricci and Rigobón (2004) apply the novel technique of identification through heteroskedasticity to estimate the effect of openness on growth. Their results suggest that openness has a small positive effect on growth (despite the reverse causality).

Figure 1. "Consensus" on the Relationship between Trade, Volatility and Growth per Kose et al. (2004)



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 suggests that the latter is likely to be the case. In particular, I show in a single cross-section of 77 countries (21 of which are OECD) that the effect of trade openness on output volatility is negative rather than positive.

Figure 2. New Evidence Reported in this Paper



Error! Reference source not found. Figure 2 summarizes the new evidence presented in this paper. I do not deal with the direct link between trade openness and growth, and for that reason the arrow connecting these two variables appears as broken. As for the link between output volatility and growth, to the extent that I touch upon it, I rely on the research undertaken by Hnatkovska and Loayza (2003), which uses the same dataset. Leaving these issues beyond the scope of this paper, I deal with the link between trade openness and growth volatility and present new evidence that points towards a negative causal link. This new result is consistent with recent research by Calvo et al. (2003), Cavallo (2005), and Cavallo and Frankel (2004) showing that openness to trade reduces vulnerability to some forms of external crises, such as sudden stops and currency crashes (i.e., financial crises), and with research by Sachs (1985) and, more recently, by Guidotti et al. (2003) showing that openness to trade reduces the ex post output costs of crises that occur and smoothes adjustment in the aftermath of external shocks. On both accounts, openness to 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 (i.e., terms-of-trade shocks).

The previous empirical attempts that either directly or indirectly assessed the impact of openness to trade on income volatility did not test whether trade exerts an independent effect on volatility once the terms-of-trade related risk is accounted for. I do so by introducing in all the regressions the de facto trade openness variable (Trade/GDP) 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 has remained ignored in the related literature is the one associated to the probable endogeneity of trade in this setting. It is clear that if trade is endogenous to output levels (because, for example, richer countries tend to liberalize trade barriers, in part because their mode of public finance shifts from tariff revenue to income or VAT taxes), then it is likely to be endogenous to output volatility as well, because output levels and output volatility are different moments of the same distribution.[8] A formal Hausman-type test corroborates the probable endogeneity of trade openness and provides justification for the

[8] Hnatkovska and Loayza (2003) show that output volatility depends on income levels.

instrumental variables procedure used in this paper. I use gravity estimates to construct an instrumental variable for trade openness. This methodology was developed by Frankel and Romer (1999) in the context of the effect of trade on growth and was later applied to a variety of settings in which trade and some other variable could potentially be jointly determined.[9] Basically, this methodology consists of aggregating up across a country's partners the prediction of a gravity equation that explains trade with distance, population, language, land-border, land-area, and landlocked status. Gravity estimates are a good instrumental variable because they are based on geographical variables which are plausibly exogenous and yet, when aggregated across all bilateral trading partners, highly correlated with a country's overall trade. If trade still appears to be a significant 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 there is a statistically significant and robust stabilizing effect of commercial trade. This is in spite of the fact that, as presumed, openness raises exposure to terms-of-trade related volatility. In OLS estimates, the net effect is small and stabilizing only in countries that are less prone to terms-of-trade fluctuations. Instead, when instrumental variables are used, the results are more impressive, and the net effect is stabilizing for all countries, irrespective of how vulnerable they are to terms-of-trade risk. Apparently, there is a positive non-causal association between trade openness and output volatility that distorts the OLS estimates and that comes 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. Splitting the sample into countries that are more exposed to capital flows and countries that are less exposed, I show that that the stabilizing effect of openness to trade predominates in the first sub-sample.

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;

[9] For example, Frankel and Rose (2002) shows that currency unions may raise output, via trade. For a survey of the gravity model in general, and applications and extensions, see Chapters 4 and 6 of Frankel (1997).

countries with a history of misaligned exchange rates and inflation (macroeconomic instability), and countries with less democratic political regimes have more volatile growth rates.[10]

2. Empirical Strategy

Using a cross-section of 77 countries (21 of which are OECD) of country averages over the period 1960-2000, I estimate a set of OLS regressions of the following form:

$$sd\_gr_i = c + \alpha\,(Trade/GDP)_i + \theta(Trade/GDP)_i*(sdtotgr)_i + \beta\,X + \varepsilon_i \qquad (1)$$

where *sd_gr* 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 (country averages 1960-2000), *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 *X* are a set of other potential determinants of output volatility which include:

- *Real Exchange Rate Misalignment* (*lnmis*), from Loayza and Hnatkovska (2003), calculated as the absolute deviation of the real exchange rate overvaluation from the equilibrium real exchange rate (set to 1).[11]
- *Initial* (1960) *GDP per capita* (*lnyo*) from World Bank World Development Indicators (WDI).
- *Average (1960-2000) GDP per capita* (*avgGDPpc*) from WDI.
- *Index Autocracy-Democracy Political Regimes* (*Democracy*), from Marshall and Jaggers (2002).
- *Index of Institutional Development* (*icrg*), from the International Country Risk Guide (Average 1960-2000).
- *Government Consumption / GDP* (*lngovc*), from Loayza and Hnatkovska (2003) who, in turn, use data from Summer, Heston and Aten (2002) (Average 1960-2000).
- *Gross Secondary-school enrollment* (*lnsec2*), from WDI (Average 1960-2000).

[10] 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 lower volatility, while volatility itself reduces growth.

[11] The extent of real exchange rate disequilibrium is defined as the difference between actual real effective exchange rate and its equilibrium level, given by cross-country purchasing power parity comparisons.

- *The natural log of area in sq. kilometers* (*lnarea*) from WDI.
- *Dummy for landlocked* (*landl*).
- *Dummy for Island* (*island*)
- *Latitude above the Equator* (*lat*)*,* from Andrew Rose's dataset.[12]
- *The natural log of average (1960-2000) population* (*lnpop*), from WDI.
- *Total Number of Sudden Stops* (*numSS1*), author's calculation with data from Cavallo (2004) and Cavallo and Frankel (2004).
- *Volatility of inflation* (*sdinlf*), from Loayza and Hnatkovska (2003).
- *Volatility of capital flows* (*sdcapflows*), author's calculation with data from IMF International Financial Statistics (IFS).
- *Discretionary Fiscal Policy* (*FiscalVol*), from Fatas and Mihov (2003).[13]
- *Volatility of Private Credit Gorwth* (*sdgrpcred*), from Loayza and Hnatkovska (2003)
- *Regional Dummies*.
- *Exports Concentration Index* (*xHFI*): Average Herfindahl-Hirschman Index (1980-2000) of country's exports,[14] from the United Nations Conference on Trade and Development (UNCTAD) Handbook of Statistics Online.

Note that in equation (1), *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 (1998) provides a formal justification for the use of this variable as a proxy for terms-of-trade risk. The *Trade/GDP* term by itself seeks to capture any additional effect of trade openness on output volatility coming from other channels. The inclusion of both terms simultaneously means that the net effect depends on the estimated coefficients α and θ, and on the level of *stdtotgr*. In particular:

[12] http://faculty.haas.berkeley.edu/arose/RecRes.htm

[13] Fatas and Mihov (2003) 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 time trend.

[14] The index can take any value between 0 and 1. Countries with exports concentrated in a few products will have a higher index value.

$$\Delta sd\_gr_i = [\alpha + \theta*(sdtotgr)_i]*\Delta(Trade/GDP)_i \quad (2)$$

where Δ is the "change" symbol. Equation (2) says that any change in openness (i.e., Δ (*Trade/GDP*)) might affect output volatility directly via *α*, or by changing the exposure to terms-of-trade risk.

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 interrelationships. In this case I only include *Trade/GDP* because when *sdtotgr* is also included, the standard errors of all three point estimates (i.e., the two variables and the interaction) increase considerably. This might be due to multicollineality between some of these variables. In particular, the problem seems to be between the interaction term and *sdtotgr*, which have a correlation coefficient of 0.80. I deal with this problem by dropping *sdtotgr* from the main specification. In order to decide which of the two variables to drop without falling into specification bias, I go back to theory (i.e., Rodrik, 1998) and look for the correct variable to control for terms-of-trade risk.[15]

I also report the results from regressions that use instrumental variables (IV) to account for the endogeneity of trade. I instrument *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' geographical (and cultural) characteristics. I use the Frankel and Rose (2002) dataset to compute OLS regressions of the following form:[16]

$$\text{Log}\,(T_{i,j} / Y_i) = c + \tau_1\,\text{logdist}_{i,j} + \tau_2\,\text{logpop}_j + \tau_3\,\text{comlang}_{i,j} + \tau_4\,\text{border}_{i,j} + \tau_5\,\text{areap}_{i,j} + \tau_6\,\text{landlock} + \mu \quad (3)$$

where $T_{i,j}$ is the bilateral trade value between countries *i* and *j*; Y_i is the real GDP of country *i*; *c* is a constant term; $logdist_{i,j}$ is the log of the distance between the economic centers of countries *i* and *j*; *comlang* is a dummy variable that takes a value of one if *i* and *j* share a common language and is zero otherwise; *border* is a dummy variable that takes a value one if *i* and *j* share a border and is zero otherwise; $areap_{i,j}$ is the log of the product of the areas (in km^2) of countries *i* and *j*;

[15] See Rodrik (1998), p. 1014.

[16] The data set 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 data set. The trade data are taken from the World Trade Database, a consistent recompilation of the U.N. trade data presented in Feenstra, Lipsey, and Bowen (1997), supplemented with data from the United Nations' *International Trade Statistics Yearbook*. This data set is estimated to cover at least 98 percent of all trade.

and "*landlock*" takes a value of two if *i* and *j* are both landlocked, a value of one if either *i* or *j* are landlocked, and zero otherwise; and μ 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,[17] it is a good instrument, because it is less likely that geography is related to economic outcomes through any channel other than trade.[18] In other words, geography is quite plausibly exogenous.

3. Results

Table 1 summarizes the OLS and IV results for some variants of equation (1). The fit of the regressions is very good, with an adjusted R^2 of approximately 0.65. The coefficient of trade openness (α) enters the regressions with a negative sign (i.e., trade stabilizes output) and it is always statistically significant at standard confidence levels. The interaction term (θ) is positive and statistically significant. As argued before, the interaction variable seeks to capture the effect of openness to trade on output volatility that goes through greater exposure to risk coming 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 α.

[17] The actual correlation between the variable "trade openness" and the instrument used in this paper is 0.50.

[18] Rodriguez and Rodrik (2000) have challenged this underlying assumption. They fear that geographically constructed measures of "trade openness" might be incorrectly appropriating effects that really go through institutions rather than trade. I deal with this critique by introducing a proxy for institutional quality as a separate repressor and testing whether the results change. They do not.

Table 1. The Effect of Trade on Volatility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	IV	OLS with sq. trade term	OLS without lnarea	IV without lnarea	OLS with geography controls	IV with geography controls
	Dependent Variable sd_g						
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)*(sdtotgr)	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
	(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)

Robust t statistics in parentheses // * significant at 10%; ** significant at 5%; *** significant at 1%

Table 1. (continued), The Effect of Trade on Volatility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS Cont.	IV Cont.	OLS with sq. trade term Cont.	OLS without lnarea Cont.	IV without lnarea Cont.	OLS with geography controls Cont.	IV with geography controls Cont.
Lnarea	0.083	-0.028	0.059			0.106	0.018
	(0.83)	(-0.20)	(0.58)			(0.87)	(0.12)
Lnyo	-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)
(Trade/GDP)^2			0.000				
			(1.61)				
Lat						0.005	0.007
						(0.69)	(0.85)
Landl						-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	6.750	15.714
	(1.94)*	(1.71)*	(2.26)**	(2.17)**	(1.98)*	(1.94)*	(1.87)*
Observations	74	73	74	74	73	74	73
R-squared	0.68	0.62	0.69	0.68	0.64	0.69	0.61

Robust t statistics in parentheses // * significant at 10%; ** significant at 5%; *** significant at 1%

Interestingly, the Trade/GDP and the interaction term are still significant determinants of output volatility with IV estimates, and the point estimate α increases in absolute value. This suggests that there is a positive non-causal correlation between openness and volatility that dampens the OLS estimates.[19] Instrumental variables are important in this setting because trade is likely to be endogenous. Countries differ in the level of openness to trade for basically two reasons. One of these is geography: larger and more isolated countries will naturally trade less. Geography is quite plausibly exogenous. Another set of reasons is commercial trade policy. It is harder to believe that trade policy is also exogenous. Trade liberalization could be part of a more general reform strategy driven by pro-globalization philosophy or "Washington Consensus" forces. Other aspects of such a reform program, such as privatization, financial liberalization, or macroeconomic stabilization might affect output volatility as well, and yet an OLS regression analysis might inappropriately attribute those effects to trade. Another way that trade openness could be endogenous is because experience with large fluctuations in output—the dependent variable—may itself cause liberalization, via an IMF program. Or it might have the opposite effect, if a country's response to output volatility is disenchantment with globalization and the Washington Consensus. The Trade/GDP ratio compounds these two determinants (i.e., geography and policy) raising the problem of endogeneity. Formal Hausman-type tests reject the null hypothesis that trade is exogenous.[20]

It is important to note that the negative sign and the statistical significance of the openness coefficient prevail in spite of including in the regressions controls for country size. This is verified by comparing the results in columns (4) and (5) (regressions without controls for country size) to those in columns (1) and (2) (the same regressions with controls for country size) in Table 1. This is important because a potential criticism is that larger countries, which naturally trade less, are more stable for reasons other than trade (i.e., they have more possibilities of diversification). Also, in columns (6) and (7) it is shown that the negative correlation between openness and output volatility survives the inclusion of other geographical characteristics such as latitude above the equator or dummy variables for being landlocked or for island states.[21] Also, all the reported regressions include controls for institutional quality. Geographic and institutional

[19] Or there is an omitted third variable that simultaneously causes more output volatility and more openness.
[20] The p-values for the different tests I conducted fall in the 0.05 to 0.1 range. Further details are available upon request.
[21] Below, it will be shown that the results are also robust to the inclusion of another control for the diversification of exports.

controls are important because another potential criticism of the current framework could be that trade (even after it is instrumented) is incorrectly appropriating effects on output volatility that really go through institutions or geography. In column (3), the square of the term of Trade/GDP is included in the OLS regression to test for plausible non-linearities, but it turns out not to be significant and not to affect the significance of α.[22]

As for the other variables, the results are intuitive and consistent with previous research: greater real exchange rate misalignment and more inflation (i.e., more macroeconomic instability) lead to more instability of growth rates. More democratic countries have more stable growth rates,[23] and so do more populated countries (which presumably have more options for diversification) and OECD countries. The only seemingly counterintuitive result is the one on the coefficient for institutional quality *icgr*, which 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 the inclusion or exclusion of them from the regressions do not affect the results. These additional variables include: size of the government (not reported), initial GDP per capita, average GDP per capita (not reported), volatility of capital flows (not reported), regional dummies, number of sudden stops, volatility of private credit, and geographical controls. 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. As a matter of fact, the effects of openness on output volatility are identified even when no additional controls variables are included in the regression.

The point is made formally in Table 2, where the OLS and IV variants of equation (1) are estimated without including additional controls.

[22] The point estimate of α increases considerably (in absolute) value when the square term is included in the regression. The probable cause is the fact that the square term, in spite of being almost negligible, is positive.

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

Table 2. Openness and Volatility without Controls

	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
	Dependant Variable sd_gr			
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)***
Observations	77	77	76	76
R-squared	0.038	0.41	n.a.	0.35

Robust t statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%

Column (1) in Table 2 shows that there is no significant effect of openness 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 the destabilizing effects of openness which appear to even out in OLS estimates, as will be discussed below. When the control for terms-of-trade risk is included in the regression in column (2) through the interacted term, the stabilizing and destabilizing effects of openness are separately identified as in Table 1. 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 when the terms-of-trade risk is unaccounted for (i.e., column (3)). This is consistent with the observation made in this section about the positive non-causal correlation between openness and volatility that dampens the OLS estimates, and 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.

4. Quantitative Significance and Implications

The results reported in Table 1 and Table 2 indicate that there are two effects of openness to trade on output volatility: a destabilizing effect ($\theta>0$) coming from increased exposure to terms-of-trade risk, and a stabilizing effect ($\alpha<0$) that has to come from other routes. What is the estimated net effect? And what are the implications of this for long-run growth?

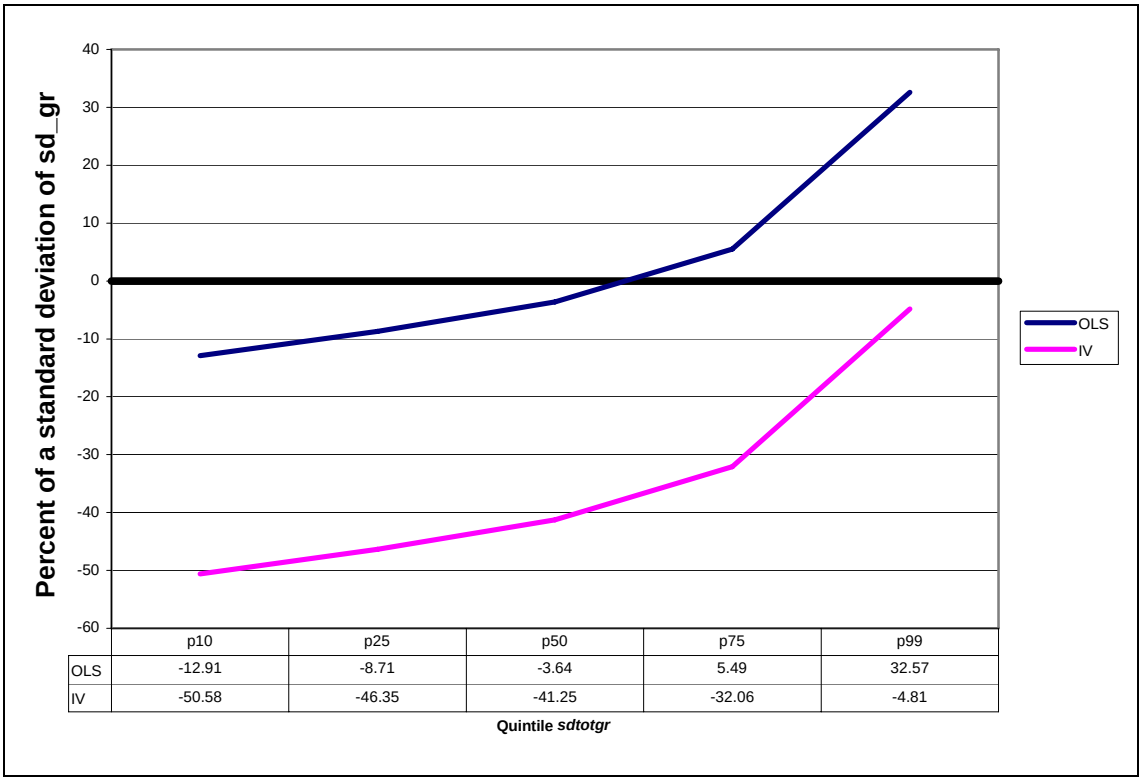
We begin with the first question, which is the primary focus of this paper. The net effect of openness on output volatility depends on the sign and size of the estimated coefficients, and on the level of *sdtotgr*. In particular, recall from the previous section that:

$$\Delta sd\_gr_i = [\alpha + \theta*(sdtotgr)_i]*\Delta(Trade/GDP)_i \qquad (2)$$

where Δ is the "change" symbol. Given that $\alpha<0$ and $\theta>0$, it is clear that countries that are prone to more volatile terms-of-trade (i.e., high levels of *sdtotgr*) will 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*. Also, note that the estimated value of θ is the same in all the regressions reported in Table 1. Therefore, we use the value θ=0.001 throughout all the simulations. Finally, I take α= -0.012 as the benchmark OLS estimate (column (1) in Table 1) and α=-0.038 as the corresponding IV estimate (column (2) in Table 1). What is the estimated net effect on output volatility of increasing Trade/GDP one standard deviation above the sample mean (i.e., from 60 percent to 85 percent)?

Figure 3 plots the results for the OLS and IV cases:

Figure 3. The Estimated Effect on Volatility of Increasing Trade/GDP by 25 pp



	p10	p25	p50	p75	p99
OLS	-12.91	-8.71	-3.64	5.49	32.57
IV	-50.58	-46.35	-41.25	-32.06	-4.81

In the OLS case, a country that is at the median (p50) of the distribution of *sdtotgr* (countries in this range include Jamaica, Kenya, Colombia, Egypt and Brazil), does not benefit greatly in terms of more output stability from more openness to trade (the volatility falls just 3.64 percent of a standard deviation), and countries that are above the median level of *sdtotgr*, such as Chile, Argentina, Indonesia, Pakistan, Algeria, Bangladesh and Venezuela, are even hurt by openness.[24] IV estimates, however, present a different picture. In the IV case, a country that is at the median of the distribution of *sdtotg*r sees output volatility fall by more than 40 percent of a standard deviation when the Trade/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 more exposure to terms-of-trade risk.

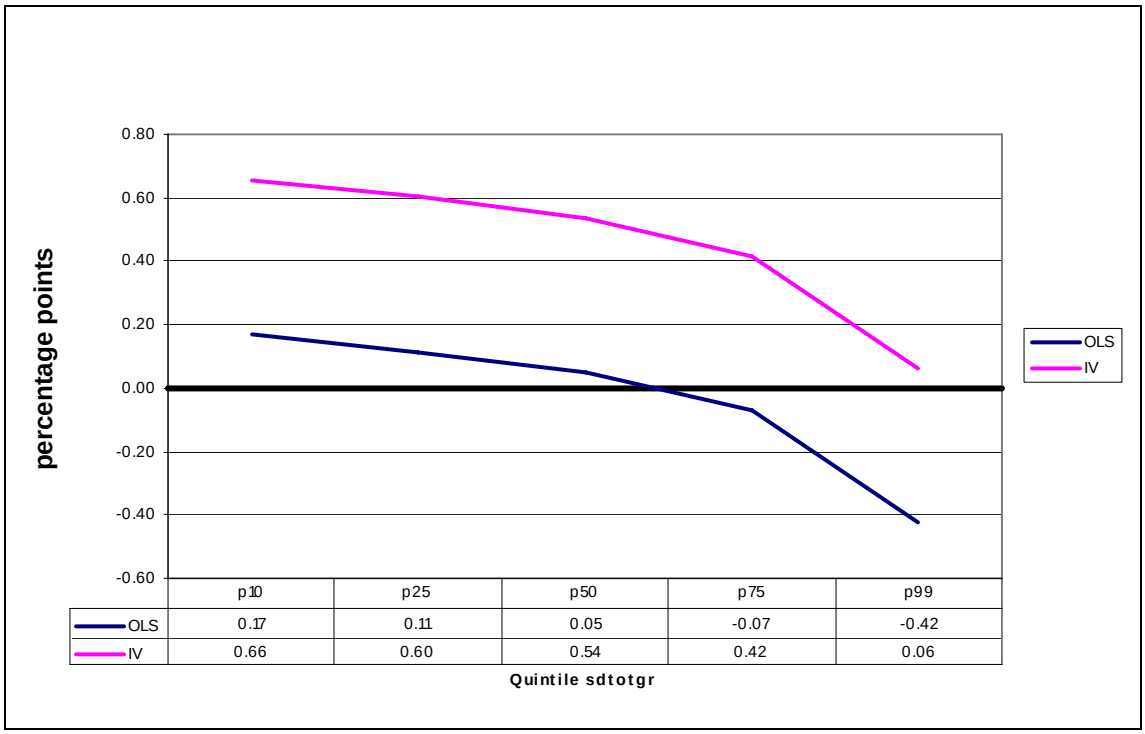
To get a better sense of the relevance of this number, it is worth noting that Hnatkovska and Loayza (2003), using this same dataset, have estimated that a one standard deviation increase in output volatility leads to a 1.3 percentage-point drop in the annual growth rate.[25] Taking this estimate as the benchmark, what is the effect on growth, coming *exclusively* through output stability, of raising the Trade/GDP ratio one standard deviation above the mean?

Figure 4 plots the results.

[24] See the appendix for a complete list of countries ranked by increasing level of sdtotgr

[25] Mobarak (2005) using a different dataset finds a stronger effect of volatility on growth. He finds that a one standard deviation increase in volatility decreases growth by about 2percentage points, which is over 0.8 standard deviations.

Figure 4. The Estimated Growth Effect of Increasing the Trade/GDP Ratio by 25pp



In the OLS case, a country that is at the median of the distribution of *sdtotgr* does not benefit greatly (an increase of only 0.05 percentage points in the annual growth rate), and countries that are above the median level of *sdtotgr* are even hurt by openness (because volatility increases with openness for these countries). But once again, the picture is different in the IV case: a country that is at the median of the distribution of *sdtotgr* sees annual growth increase by ½ percentage points when the Trade/GDP ratio increases by 25 percentage points. Furthermore, in the IV case, all countries appear to benefit from more openness to trade. Given that trade is likely to be endogenous in this setting, IV estimates are my preferred specification. Whether the estimated net effects are large or not is debatable, but the fit of the estimation is quite good.[26]

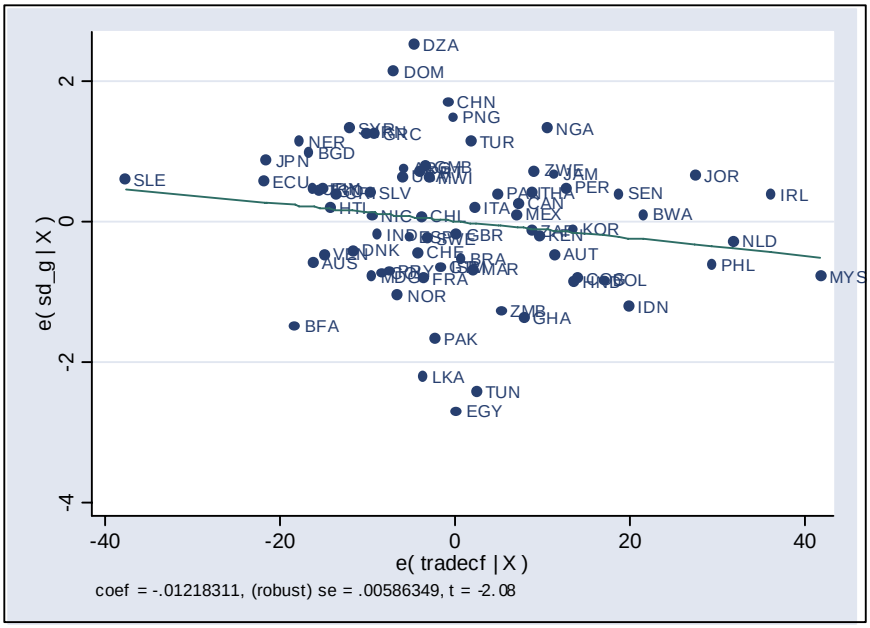
5. Robustness Checks

To obtain a visual understanding of the results and to ensure that they are not driven by outliers, consider the following figure, which plots the partial correlation between trade and output

[26] Since I only generate and use a single instrument, I have no over-identifying restrictions to test.

volatility (partial in the sense that other determinants of output volatility are controlled for) drawn from OLS regression (1) in Table 1. Country codes are included to give the reader a sense of where different countries stand.

Figure 5. The Relationship between Openness and Volatility



The plot shows a clear negative correlation between openness to trade and output volatility that does not appear to be driven by outliers. In the Appendix the exercise is replicated for all the variables included in the benchmark regression in Table 1. It can be readily verified that no obvious outliers appear to be driving any of the results reported here.

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. Fatas and Mihov (2003) are among the few papers that study the determinants of output volatility per se. While their main focus is on the effects of discretionary fiscal policy on volatility (and economic growth), they include Trade/GDP as a control variable that does not appear as significant in their regressions. In columns (1) and (2) of Table 3, I replicate their regressions using my dataset. Their measure of discretionary fiscal policy (borrowed from them) also enters

the regressions with a positive and statistically significant sign. Also, just as in their regressions, the control variables, including Trade/GDP, are not statistically significant.[27]

Table 3. Fatas and Mihov (2003): Output Volatility and Fiscal Policy

	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	IV
	Dependent Variable sd_gr			
FiscalVol	1.269	1.200	0.830	0.749
	(0.200)***	(0.217)***	(0.230)***	(0.250)***
avgGDPpc	-0.151	-0.093	0.007	0.057
	(-0.177)	(-0.192)	(0.186)	(0.202)
Trade/GDP		**0.002**	**-0.011**	**-0.021**
		(0.005)	**(-0.006)***	**(-0.012)***
lngovc		0.464	0.179	0.259
		(0.484)	(0.444)	(0.407)
(Trade/GDP)*(sdtotgr)			**0.002**	**0.002**
			(0.000)***	**(0.001)*****
Constant	2.663	0.880	1.434	1.327
	(1.852)	(2.462)	(2.197)	(2.229)
Observations	74	72	72	71
R-squared	0.468	0.456	0.542	0.533

Robust standard errors in parentheses.
*significant at 10%; ** significant at 5%; *** significant at 1%

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-of-trade risk. Note that in these cases openness appears to exert an independent negative effect on output volatility, just as in my benchmark regressions. Also note that the fit of the regressions improves considerably.

Another paper that tests the relationship between openness and output volatility is Rodrik (1998). He uses a specification similar to (1) but without including the Trade/GDP ratio as a separate regressor. 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), Table 4, I replicate Rodrik's regression using my dataset and obtain similar results to those reported in his paper.[28] 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 goodness of fit increases considerably. In

[27] The comparable table in that paper is Table 1.
[28] Table 7, page 1022.

columns (3) and (4) I repeat the regressions using IV instead of OLS. The results are very similar: just as in the regressions reported in Table 1, trade openness is shown to have a significant negative effect on output volatility that is independent from the terms-of-trade risk.

Table 4. Replicating Rodrik (1998)

	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
	Dependant Variable sd_gr			
Trade/GDP		**-0.0190**		**-0.0192**
		(-0.0067)* **		**(-0.0083)** **
(Trade/GDP)*(sdtotgr)	**0.0012**	**0.0018**	**0.0015**	**0.0020**
	(0.0004)* **	**(0.0004)*** **	**(0.0005)*** **	**(0.0005)*** **
Lnyo	-0.45	-0.37	-0.45	-0.37
	(-0.21)**	(-0.19)*	(-0.22)**	(-0.21)*
Oecd	-0.87	-0.94	-0.72	-0.87
	(-0.49)*	(-0.44)**	(-0.52)	(-0.47)*
Latinamerica	-0.36	-0.68	-0.36	-0.68
	(-0.47)	(-0.46)	(-0.46)	(-0.47)
Africa	-0.49	-0.66	-0.57	-0.75
	(-0.59)	(-0.57)	(-0.62)	(-0.59)
Southasia	-2.36	-2.72	-2.28	-2.67
	(-0.86)***	(-0.77)***	(-0.89)**	(-0.78)***
Constant	7.18	7.50	6.92	7.34
	(1.70)***	(1.62)***	(1.78)***	(1.64)***
Observations	77	77	76	76
R-squared	0.533	0.583	0.527	0.581

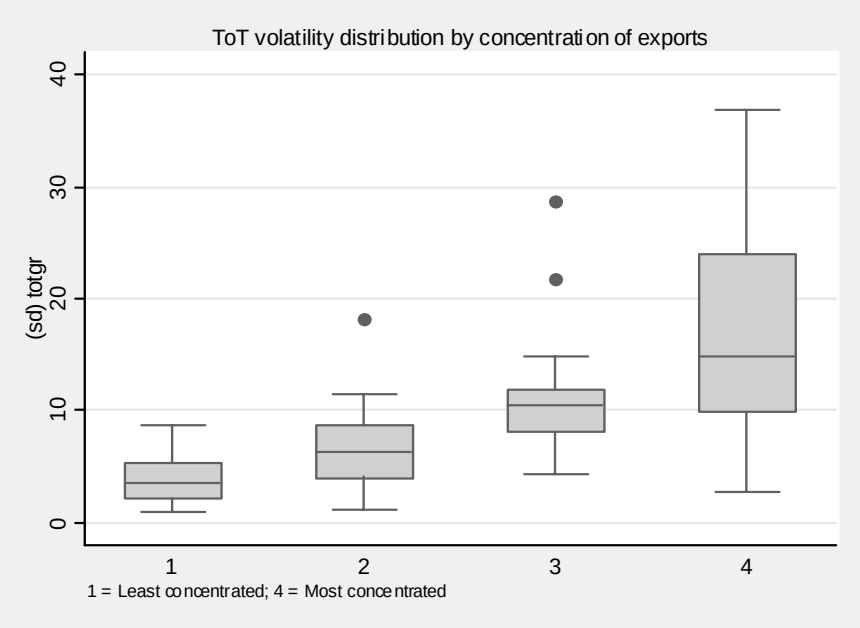
Robust standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Another possibility that has not 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 leads to more 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. In particular, Koren and Tenreyro (2005) show that the correlation of sectoral shocks between low-trade and high-trade countries is very high, suggesting that more open economies do not face different exposure.

In spite of this, it is possible that the relation between terms-of-trade shocks, trade openness and output volatility could depend on the basket of products and services exported.

Figure 6 shows the distribution of terms of trade volatility by groups of countries based on export concentration level.[29] Those countries with a wider portfolio of exports have experienced, on average, less volatile terms of trade shocks (box on the left side of the figure).

Figure 6. Terms of Trade Volatility by Export Concentration Index[30]



Therefore, a positive relation between terms of term volatility and output volatility could 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 exports concentration levels in the regressions. The results are reported in Table 5.

[29] Based on the average Herfindahl-Hirschman Index (1980-2000) of country's exports. *Source:* UNCTAD.
[30] Each box gives information on basic distributional statistics: p(5), p(25), p(50), p(75), p(95) and outliers.

Table 5. Controlling for Export Concentration

	(1)	(2)	(3)	(4)
	OLS	OLS with xHFI	IV	IV with xHFI
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)
Lnyo	-0.291	-0.251	-0.448	-0.422
	(-1.31)	(-1.02)	(-1.49)	(-1.39)
xHFI		**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)
Observations	74	74	73	73
R-squared	0.68	0.69	0.62	0.63

Robust standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%

The table shows that controlling for export concentration levels does not change the benchmark results of Table 1. Even though the coefficient of the export concentration index is positive, it is not statistically significant, and the point estimates of the openness and the volatility of terms of trade coefficients are not affected. In other words, there does not appear to be an independent effect of export concentration on output volatility.

6. Openness to Trade, Capital Flows and Output Volatility

A recent branch of the extensive literature on financial fragility has provided evidence that openness to trade reduces countries' vulnerability to some forms of costly financial crises.[31] The main idea behind these studies hinges on the intuition put forward by Bulow and Rogoff (1989) 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.[32] In other words, more open economies might be less credit constrained and might therefore be able to smooth output fluctuations more easily.

In order to test whether the computed stabilizing effects of openness to trade operate (at least in part) through this channel, I run the regressions in two sub-samples: (i) countries that are, on average, more exposed to capital flows; and (ii) 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 presence of volatile capital flows, then the effect of openness to trade on output volatility should be more pronounced in the first sub-sample. This is indeed what the results, reported below, indicate.

In order to split the sample I use two different variables. In the first case I use data from Klein (2003) on open capital accounts.[33] In particular, I use the variable $Share_{76\text{-}95}$. This variable, which reflects the proportion of years in the period 1976-1995 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 the median values of $Share_{76\text{-}95}$ and split the sample according to whether the individual country values fall above or below each of these cut-offs. This method provides two splits: one given by the mean and another given by the median value of $Share_{76\text{-}95}$. The first split produces 28 countries that are more exposed to capital flows and for which I have data vs. 46 that are less exposed. The second split produces 39 vs. 35 countries with complete data, respectively.

Alternatively, I split the sample using de facto capital flows. I compute the median value of *sdcapflows* (a measure of the de facto volatility of capital flows) and split the sample

[31] For example Rose (2002), Calvo et al. (2004), Cavallo (2005), and Cavallo and Frankel (2004).
[32] Bulow and Rogoff (1989) argue that countries that trade more are subject to more harmful trade-related retaliation in the aftermath of default and therefore are less likely to default.
[33] I thank Jeffrey Frankel for kindly providing me the data.

according to whether countries lie above or below this cut-off. The two sub-samples consist of 37 countries each.[34] The appendix includes a list of the countries in to each sample.

The results are reported in Table 6. The first column in Table 6 is column (1) in Table 1, which is included here for comparison purposes. The second and third columns replicate the benchmark OLS regression on the first two sub-samples: countries with more exposure to capital flows (column 2) and countries with less exposure to capital flows (column 3), where the cut-off point is given by the mean value of $Share_{76\text{-}95}$. The results indicate that openness to trade has a statistically significant effect on output volatility only in the first sub-sample (countries with more exposure to capital flows). Note that the point estimate of Trade/GDP in column (2) increases in absolute value with respect to the full sample counterpart, and so does the statistical significance of the point estimate. The fourth and fifth columns of Table 6 show the same pattern for the IV regressions: trade openness reduces output volatility in countries that are more exposed to capital flows. The next two columns show similar results in the OLS regressions when the sample split is based on the median value of $Share_{76\text{-}95}$. Finally, the last two columns report the results of the OLS regressions when the split is based the median value of *sdcapflows*.[35] Once again, the results suggest that the stabilizing effect of openness to trade on volatility is statistically significant only in the sub-sample of countries that are more exposed to volatile capital flows. These results are broadly consistent with the aforementioned research on the impact of openness to trade on vulnerability to financial crises.

[34] I do not use the mean value of *sdcapflows* as an alternative cut-off because it leaves too few observations in one of the sub-samples.

[35] The corresponding IV estimates for the latter regressions (which are not reported here but available upon request), do not show a statistical significant effect of the trade coefficient in either split, but the point estimates remain consistent with those of the OLS counterparts.

Table 6. Sample Splits: Does Openness to Trade Reduce Volatility through the Financial Channel?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	(OLS)	(OLS)	(OLS)	(IV)	(IV)	(OLS)	(OLS)	(OLS)	(OLS)
	Full Sample	Open K-Account (> mean $Share_{76-95}$)	Closed K-Account (< mean $Share_{76-95}$)	Open K-Account (> mean $Share_{76-95}$)	Closed K-Account (< mean $Share_{76-95}$)	Open K-Account (> median $Share_{76-95}$)	Closed K-Account (< median $Share_{76-95}$)	High Volatility of K-Flows	Low Volatility of K-Flows
	Dependent Variable sd_g								
Trade/GDP	-0.012	-0.025	-0.010	-0.035	-0.018	-0.015	-0.009	-0.015	-0.012
	(-2.08)**	(-4.20)***	(-1.03)	(-2.45)**	(-0.70)	(-1.86)*	(-0.62)	(-1.92)*	(-0.86)
(Trade/GDP)*(sdtotgr)	0.001	0.000	0.001	0.000	0.001	0.000	0.001	0.001	0.001
	(2.87)***	(0.39)	(2.05)**	(0.62)	(1.57)	(0.65)	(2.15)**	(1.17)	(0.60)
Lnmis	0.924	0.607	0.815	0.435	0.781	1.111	0.463	1.332	0.422
	(3.43)***	(2.26)**	(2.03)**	(1.37)	(1.56)	(3.45)***	(0.87)	(3.78)***	(1.02)
Democracy	-0.143	-0.130	-0.128	-0.132	-0.138	-0.151	-0.113	-0.092	-0.212
	(3.22)***	(-2.10)*	(-2.25)**	(-2.52)**	(-2.13)**	(-3.38)***	(-1.83)*	(-1.74)*	(-2.72)**
Icrg	0.384	0.720	0.240	0.897	0.309	0.531	0.099	0.304	0.269
	(2.12)**	(4.20)***	(0.77)	(2.48)**	(0.92)	(3.46)***	(0.28)	(1.26)	(0.79)
Sdinf	0.009	0.014	0.008	0.016	0.006	0.012	0.003	0.007	0.001
	(1.88)*	(1.53)	(1.26)	(1.62)	(0.91)	(2.51)**	(0.27)	(1.06)	(0.10)

Robust t statistics in parentheses // * significant at 10%; ** significant at 5%; *** significant at 1%

Table 6 (continued). Sample Splits: Does Openness to Trade Reduce Volatility through the Financial Channel?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	(OLS)	(OLS)	(OLS)	(IV)	(IV)	(OLS)	(OLS)	(OLS)	(OLS)
	Full Sample Cont.	Open K-Account (> mean $Share_{76-95}$) Cont.	Closed K-Account (< mean $Share_{76-95}$) Cont.	Open K-Account (> mean $Share_{76-95}$) Cont.	Closed K-Account (< mean $Share_{76-95}$) Cont.	Open K-Account (> median $Share_{76-95}$) Cont.	Closed K-Account (< median $Share_{76-95}$) Cont.	High Volatility of K-Flows Cont.	Low Volatility of K-Flows Cont.
Lnpop	-0.257	-0.233	-0.314	-0.274	-0.299	-0.233	-0.351	-0.389	0.086
	(-2.06)**	(-1.45)	(-1.31)	(-1.40)	(-0.63)	(-1.42)	(-1.06)	(-2.02)*	(0.40)
Oecd	-0.601	-1.095	-0.872	-1.307	-0.904	-0.675		-0.493	-0.905
	(-1.49)	(-1.61)	(-1.36)	(-1.52)	(-1.34)	(-1.56)		(-0.71)	(-1.20)
Africa	-0.409	0.387	-0.423	0.266	-0.509	0.171	-0.495	-0.536	-0.074
	(-0.83)	(1.03)	(-0.65)	(0.71)	(-0.75)	(0.53)	(-0.66)	(-0.71)	(-0.10)
Lnarea	0.083	-0.062	0.106	-0.149	0.038	0.054	0.144	-0.022	0.048
	(0.83)	(-0.48)	(0.55)	(-0.85)	(0.17)	(0.43)	(0.59)	(-0.15)	(0.31)
Lnyo	-0.291	-0.783	-0.081	-0.928	-0.053	-0.591	0.014	-0.605	0.155
	(-1.31)	(-3.34)***	(-0.29)	(-2.86)**	(-0.16)	(-2.98)***	(0.04)	(-1.92)*	(0.43)
Constant	6.879	13.973	6.254	17.858	7.116	9.030	6.726	11.786	0.091
	(1.94)*	(4.14)***	(1.18)	(2.45)**	(0.71)	(2.56)**	(0.97)	(2.74)**	(0.01)
Observations	74	28	46	28	45	39	35	37	37
R-squared	0.68	0.89	0.60	0.89	0.60	0.90	0.48	0.72	0.67

Robust t statistics in parentheses // * significant at 10%; ** significant at 5%; *** significant at 1%

Next, consider splitting 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 mean (42 countries) or the median (37 countries) of the sample, while initially rich countries are all the rest. 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 are the ones that stand to benefit more from capital inflows because they are capital scarce. So an interesting question is whether the stabilizing effects of trade openness predominate in one sub-sample over the other. The answer is provided in Table 7.

Table 7. Sample Splits by Level of Per Capita Income

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV
	Full Sample	1960 poor (< mean GDPpc)	1960 rich (> mean GDPpc)	1960 poor (< median GDPpc)	1960 rich (> median GDPpc)	Full Sample	1960 poor (< mean GDPpc)	1960 rich (> mean GDPpc)	1960 poor (< median GDPpc)	1960 rich (> median GDPpc)
	Dependent Variable sd_g									
Trade/GDP	-0.012	-0.021	-0.008	-0.022	-0.008	-0.038	-0.064	-0.019	-0.111	-0.008
	(-2.08)**	(-2.43)**	(-0.94)	(-1.82)*	(-0.79)	(-1.68)*	(-1.99)*	(-1.07)	(-1.79)*	(-0.36)
(Trade/GDP)*(sdtotgr)	0.001	0.002	-0.000	0.001	0.001	0.001	0.002	-0.000	0.001	0.001
	(2.87)***	(3.07)***	(-0.82)	(3.05)***	(1.03)	(1.92)*	(2.31)**	(-0.88)	(0.99)	(0.94)
Lnmis	0.924	1.046	0.676	1.027	0.715	1.038	1.251	0.611	1.773	0.771
	(3.43)***	(2.75)***	(2.20)**	(2.41)**	(1.54)	(3.26)***	(2.51)**	(1.88)*	(1.89)*	(1.74)*
Democracy	-0.143	-0.162	-0.018	-0.125	-0.187	-0.164	-0.189	-0.009	-0.089	-0.189
	(-3.22)***	(-2.84)***	(-0.47)	(-1.90)*	(-3.48)***	(-3.08)***	(-2.61)**	(-0.22)	(-0.97)	(-2.95)***
Icrg	0.384	0.761	-0.102	0.784	0.021	0.615	1.240	0.003	1.015	0.040
	(2.12)**	(3.21)***	(-0.50)	(2.89)***	(0.09)	(2.17)**	(2.89)***	(0.01)	(2.09)**	(0.08)
Sdinf	0.009	0.006	0.010	0.009	0.006	0.006	0.003	0.011	0.002	0.005
	(1.88)*	(1.11)	(1.96)*	(1.75)*	(0.76)	(1.39)	(0.45)	(2.21)**	(0.13)	(0.69)

Robust t statistics in parentheses// * significant at 10%; ** significant at 5%; *** significant at 1%

Table 7 (continued). Sample Splits by Level of Per Capita Income

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV
	Full Sample Cont.	1960 poor (< mean GDPpc) Cont.	1960 rich (> mean GDPpc) Cont.	1960 poor (< median GDPpc) Cont.	1960 rich (> median GDPpc) Cont.	Full Sample Cont.	1960 poor (< mean GDPpc) Cont.	1960 rich (> mean GDPpc) Cont.	1960 poor (< median GDPpc) Cont.	1960 rich (> median GDPpc) Cont.
Lnpop	-0.257	-0.240	-0.228	-0.141	-0.220	-0.499	-0.466	-0.321	-1.045	-0.235
	(-2.06)**	(-1.07)	(-1.98)*	(-0.55)	(-1.53)	(-1.66)	(-1.05)	(-2.09)**	(-1.05)	(-1.07)
Oecd	-0.601	0.420	-0.553		-0.136	-0.744	-0.514	-0.480		-0.180
	(-1.49)	(0.71)	(-1.75)*		(-0.24)	(-1.57)	(-0.52)	(-1.45)		(-0.33)
Africa	-0.409	-0.416	-0.168	-0.118	-0.069	-0.661	-0.588	-0.065	-0.171	-0.156
	(-0.83)	(-0.59)	(-0.39)	(-0.16)	(-0.10)	(-1.21)	(-0.70)	(-0.14)	(-0.15)	(-0.24)
Lnarea	0.083	0.013	0.072	-0.093	0.089	-0.028	-0.203	-0.018	-0.078	0.095
	(0.83)	(0.06)	(0.74)	(-0.39)	(0.66)	(-0.20)	(-0.76)	(-0.11)	(-0.19)	(0.43)
Lnyo	-0.291	-0.140	-0.404	-0.192	-0.087	-0.448	0.100	-0.583	-0.320	-0.122
	(-1.31)	(-0.31)	(-1.29)	(-0.38)	(-0.26)	(-1.49)	(0.18)	(-1.89)*	(-0.35)	(-0.21)
Constant	6.879	6.600	8.402	6.668	5.574	14.599	13.652	13.155	25.195	5.965
	(1.94)*	(1.20)	(2.23)**	(1.13)	(1.14)	(1.71)*	(1.36)	(2.15)**	(1.29)	(0.56)
Observations	74	42	32	37	37	73	41	32	36	37
R-squared	0.68	0.58	0.88	0.55	0.85	0.62	0.44	0.86		0.85

Robust t statistics in parentheses* significant at 10%; ** significant at 5%; *** significant at 1%

Columns (1) and (6) in Table 7 replicate the full sample OLS and IV regressions in Table 1. Note that the point estimates of the effect of initial GDP per capita (i.e., *lny0*) on output volatility are negative (although not statistically significant), implying that initially richer countries tend to be more stable. Yet, when the sample is split between initially poor and initially rich countries, it is shown that the stabilizing effects of trade predominate in the first sub-sample. In other words, the data reveal that it is precisely in countries that (at least in theory) stand to benefit more from capital inflow where openness to trade helps to stabilize output fluctuations.

It is important to stress that 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 while the volatility of the terms-of-trade is measurable over a time-span, the proclivity to financial crisis is not uniquely linked to, for example, the volatility of capital flows.[36] The proposed sample splits provide one operational way out of this conundrum.

7. 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 (i.e., terms-of-trade shocks). But the current consensus does not take into account that openness to trade might reduce financial-related volatility. A recent branch of the extensive financial fragility literature 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), and that it reduces the ex post output costs of crises that occur and smoothes the subsequent adjustment. Once this is taken into account, the empirical relationship between openness to trade and output volatility is still an open question.

[36] For example, volatile capital flows are a necessary but not a sufficient condition for sudden stops in capital flows, as these occur when there is a fall in net capital inflows that is greater than 2 standard deviations below each country's own volatility. See Cavallo (2005) for details.

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 tradeoffs related to opening up to trade. The estimated relationships are long-run, cross-sectional effects. Therefore many interesting dynamics related to the process of trade integration are 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, it does not appear to be the case that more open economies are necessarily more volatile, as is commonly thought.

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Appendix

Figure 7. All the Partial Relationships for the Benchmark Regression

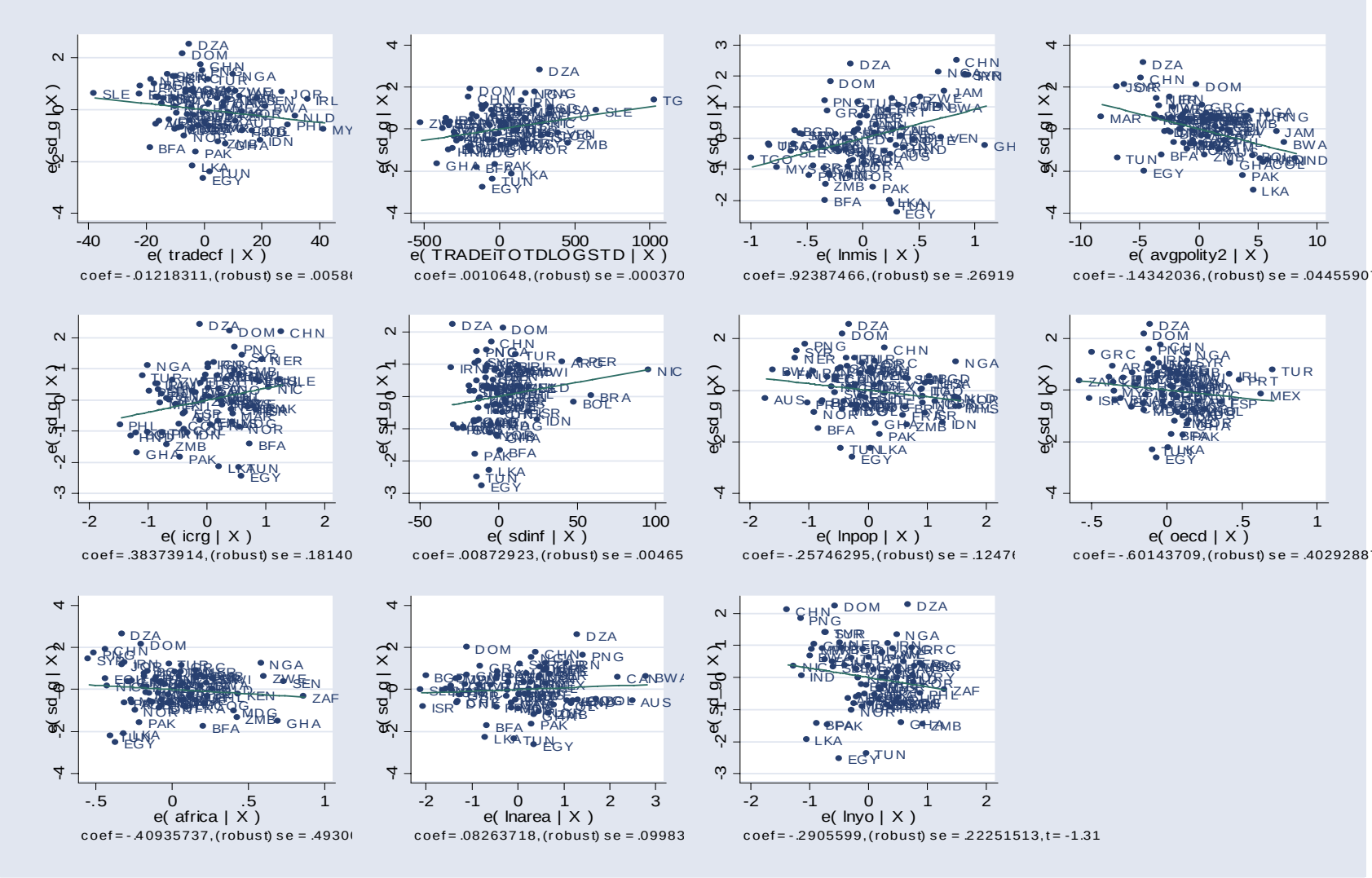

Table 8. List of All Countries and Country Groupings for Sample Splits

Country	1960 Poor	1960 Poor	Closed K-acc.	Closed K-acc.	Volatile K-flows	1960 Rich	1960 Rich	Open K-acc.	Open K-acc.	Stable K-Flows
			$Share_{76-95}$	$Share_{76-95}$	sdcapflow			$Share_{76-95}$	$Share_{76-95}$	sdcapflow
	(<median)	(<mean)	(< mean)	(< median)	(>median)	(>median)	(>mean)	(> mean)	(> median)	(< median)
Algeria		x	x	x		○				○
Argentina			x		x	○	○		○	
Australia						○	○	○	○	○
Austria						○	○	○	○	○
Bangladesh	x	x	x	x						○
Bolivia	x	x			x			○	○	
Botswana	x	x	x	x	x					
Brazil			x	x		○	○			○
Burkina Faso	x	x	x	x						○
Canada						○	○	○	○	○
Chile			x	x	x	○	○			
China	x	x						○	○	○
Colombia		x	x	x		○				○
Congo, Rep.	x	x	x	x	x					
Costa Rica			x			○	○		○	○
Cote d'Ivoire	x	x	x	x	x					
Denmark						○	○	○	○	○
Dominican Republic	x	x	x	x	x					
Ecuador	x	x			x			○	○	
Egypt, Arab Rep.	x	x	x	x	x					
El Salvador			x	x		○	○			○
Finland					x	○	○	○	○	
France						○	○	○	○	○
Gambia, The	x	x			x			○	○	
Ghana	x	x	x	x						○
Greece			x	x		○	○			○
Guatemala	x	x						○	○	○
Haiti	x	x						○	○	○
Honduras	x	x						○	○	○

Table 8 (continued). List of All countries and Country Groupings for Sample Splits

Country	1960 Poor	1960 Poor	Closed K-acc.	Closed K-acc.	Volatile K-flows	1960 Rich	1960 Rich	Open K-acc.	Open K-acc.	Stable K-Flows
			$Share_{76-95}$	$Share_{76-95}$	sdcapflow			$Share_{76-95}$	$Share_{76-95}$	sdcapflow
	(<median)	(<mean)	(< mean)	(< median)	(>median)	(>median)	(>mean)	(> mean)	(> median)	(< median)
Iceland			x	x		○	○			○
India	x	x	x	x						○
Indonesia	x	x			x			○	○	
Iran, Islamic Rep.	x	x	x		x				○	
Ireland			x		x	○	○		○	
Israel			x	x	x	○	○			
Italy						○	○	○	○	○
Jamaica			x	x	x	○	○			
Japan						○	○	○	○	○
Jordan		x	x	x	x	○				
Kenya	x	x	x	x						○
Korea, Rep.			x	x		○	○			○
Madagascar	x	x	x	x	x					
Malawi	x	x	x	x						○
Malaysia		x			x	○		○	○	
Mexico						○	○	○	○	○
Morocco	x	x	x	x	x					
Netherlands						○	○	○	○	○
Nicaragua	x	x	x		x				○	
Niger	x	x	x		x				○	
Nigeria	x	x	x	x	x					
Norway			x		x	○	○		○	
Pakistan	x	x	x	x						○
Panama					x	○	○	○	○	
Papua New Guinea	x	x	x	x	x					
Paraguay	x	x	x		x				○	
Peru					x	○	○	○	○	
Philippines	x	x	x	x	x					
Portugal			x		x	○	○		○	
Senegal	x	x	x	x						○
Sierra Leone	x	x	x	x	x					
South Africa			x	x		○	○			○
Spain			x			○	○		○	○

Table 8 (continued). List of All countries and Country Groupings for Sample Splits

Country	1960 Poor	1960 Poor	Closed K-acc.	Closed K-acc.	Volatile K-flows	1960 Rich	1960 Rich	Open K-acc.	Open K-acc.	Stable K-Flows
			$Share_{76-95}$	$Share_{76-95}$	sdcapflow			$Share_{76-95}$	$Share_{76-95}$	sdcapflow
	(<median)	(<mean)	(< mean)	(< median)	(>median)	(>median)	(>mean)	(> mean)	(> median)	(< median)
Sri Lanka	x	x	X	x						○
Sweden			x			○	○		○	○
Switzerland					x	○	○	○	○	
Syrian Arab Republic	x	x	x	x	x					
Thailand	x	x	x	x	x					
Togo	x	x	x	x	x					
Trinidad and Tobago			x		x	○	○		○	
Tunisia	x	x	x	x						○
Turkey		x				○		○	○	○
United Kingdom						○	○	○	○	○
United States						○	○	○	○	○
Uruguay					x	○	○	○	○	
Venezuela, RB					x	○	○	○	○	
Zambia	x	x	x	x	x					
Zimbabwe	x	x						○	○	○

Table 9. List of All Countries Ranked by Increasing Level of Terms-of-Trade Volatility (*sdtotgr*)

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	Cote 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		