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Trade Openness Reduces Growth Volatility When Countries Are Well Diversified

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Abstract

This paper addresses the mechanisms by which trade openness affects growth volatility. Using a diverse set of export diversification indicators, it presents strong evidence pointing to an important role for export diversification in reducing the effect of trade openness on growth volatility. The authors also identify positive thresholds for product diversification at which the effect of openness on volatility changes sign. The effect is shown to be positive only for a minority of countries with highly concentrated export baskets. This result is shown to be robust to both explicit accounting for endogeneity as well as the inclusion of a host of additional controls.

This paper—a product of the International Trade department, Poverty Reduction and Economic Management Network, and of the Development Prospects Group, Development Economics Vice-Presidency—is part of a larger effort to understand the relationship between export diversification and economic outcomes. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at mhaddad@worldbank.org, jlim@worldbank.org, and csaborowski@worldbank.org.

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1 Introduction

The global economic crisis erupted in the financial markets of the industrialized world, yet developing countries have not been spared. Many, including those without close financial ties to the developed world, have been driven into recession as global demand plummeted and the largest drop in global trade volumes since the Second World War ensued. Naturally, open economies heavily reliant on export revenues were among those hardest hit by the crisis. This notion has led to a renewed interest in the relative merits of export-led growth strategies for developing countries (Harrison & Rodríguez-Clare 2009; Rodrik 2009).[1]

It is widely believed that trade openness is, under suitable conditions, positively associated with growth outcomes. But does this come at the cost of a more volatile growth path due to a greater vulnerability to global shocks?[2] After all, one may reasonably expect an open economy to face a larger number of adverse shocks than one that is less reliant on trade to spark economic activity. On the other hand, the possibility of international risk sharing is enhanced in an open economy through both explicit and implicit insurance, including via joint ventures, international lending, production diversification and formal insurance contracts. Moreover, the disciplining nature of international competition and the prevalence of formal international contracts could potentially limit the risk of domestic policy mistakes. While it is therefore unclear, *ex ante*, whether the effect of openness on growth volatility should be positive or negative, it can be argued that the composition of the export basket matters in the determination of its sign.

This paper reiterates the notion that the vulnerability of countries to (some types of) external shocks should be reduced when these countries are better diversified in their exports, both across products and markets. More specifically, we hypothesize that the effect of trade openness on growth volatility—whether negative or positive on average—is likely to be exacerbated when the country in question exports either a relatively small set of products, or sells its goods to a small number of destination markets. The argument is that a higher degree of concentration in exports would imply that any idiosyncratic price shock experienced is more likely to have a substantial impact on the country's terms of trade (ToT), and this would then induce greater fluctuations in a country's growth process. Furthermore, a higher degree of diversification would likely imply that a

[1] Such strategies, in turn, are often inspired by the desire to promote superior economic growth (Sala-i-Martin 1997) or to spark growth accelerations (Jones & Olken 2008). This strategy of trade liberalization is often pursued alongside a policy that promotes export diversification, which is also believed to be a positive driver of growth (Al-Marhubi 2000; Hesse 2009).

[2] Following the pioneering work of Ramey & Ramey (1995), the literature has shown that growth volatility reduces growth rates.

country is involved in a larger number of both implicit and explicit international insurance schemes, which would similarly serve as a cushion against such fluctuations.

The channels through which openness enhances growth are well established in the theoretical literature. They include the stimulative effects that trade can have on knowledge spillovers and investments in innovation (Grossman & Helpman 1991). Moreover, productivity improvements due to intra-industry (Melitz 2003) or intra-firm (Bernard, Redding & Schott 2006) resource reallocation are likely to have a growth enhancing effect. Finally, trade openness may also lead to a reduction in a country's vulnerability to idiosyncratic sectoral shocks due to the diversification of its production and export base (Acemoglu & Zilibotti 1997).

On the empirical front, early efforts that have claimed a causal effect of trade openness on growth (Frankel & Romer 1999; Sachs & Warner 1999) have increasingly come under challenge.[3] Rodríguez & Rodrik (2000), in particular, have made a strong case against this line of literature, claiming that omitted variable biases are often inadequately addressed, and that trade policy variables are not well proxied by the measures customarily employed. Yet, advocates of openness have not been ignorant of the important caveat that market or institutional imperfections can play in moderating or even reversing the positive growth effects arising from increased integration; indeed, (Sachs & Warner 1995) and (Frankel & Romer 1999) allude to the possibility that institutional (property rights) and policy (infrastructure) choices may complicate the interpretation of earlier results.

The idea that the growth-enhancing effect of trade requires complementary institutions and policy action has been taken up in more recent work.Chang, Kaltani & Loayza (2009), using a cross-country panel, show that the growth effect of openness may indeed depend on a variety of structural characteristics, while Calderón & Fuentes (2006) consider how trade liberalization interacts with human capital policies as well as the quality of existing institutions to determine actual growth outcomes. Finally, trade openness has also been found to be a factor reducing the likelihood of a sudden stop-style crisis (Cavallo & Frankel 2008).

While the relationship between openness and growth has been investigated thoroughly, the link between openness and growth volatility is less well understood. Various studies have argued that trade openness increases macroeconomic volatility (Rodrik 1997), yet there is no clear consensus in the literature to date. In a recent paper, Raddatz (2007) applies a VAR methodology to show that external shocks—such as those transmitted to prices, foreign growth, and real interest rates—impose a substantial and significant impact

[3]The literature on the effect of financial account opening on growth is even more inconclusive (Kose, Prasad, Rogoff & Wei 2009), with recent work suggesting that the reason for this indeterminacy is due to the time-varying nature of relationship (Bussière & Fratzscher 2008).

on the volatility of real activity in low income economies. Yet, while external shocks are indisputably crucial in accounting for external sources of variation, such shocks can only explain a small fraction of the long run variance of real per capita GDP (Ahmed 2003; Becker & Mauro 2006) and the underlying institutional and policy environment cannot be ignored (Easterly, Islam & Stiglitz 2001).

Using more granular industry-level data, di Giovanni & Levchenko (2009) investigate the channels through which trade openness might affect volatility. They document that sectors more open to international trade also become more volatile. Interestingly, trade openness also appears to lead countries to become more specialized in their exports. This implies that a higher degree of openness not only exposes countries to a larger number of external shocks, but that it also makes them more vulnerable (according to the main hypothesis of the present study).[4] At the more aggregate level, (Easterly & Kraay 2000) find that ToT volatility is an important driver of growth volatility, especially for smaller states. Yet, they argue that the high income volatility typically experienced by small economies is due mainly to their openness, and that export concentration plays only a minor role.[5]

In studying the mechanisms by which the trade channel affects growth volatility, this paper asks two questions that have been neglected thus far: First, does the effect of trade openness on growth volatility vary with the degree of diversification of a country's export basket? Second, given that such conditioning exists, is there a threshold—in terms of a given export concentration measure—above which the total effect of trade openness on growth volatility changes from negative to positive? To our knowledge, these questions have not been addressed in the empirical literature. The closest study in spirit to ours is an interesting paper by Jansen (2004), which uses a cross section of countries to show, first, that export concentration determines ToT volatility, and second, that ToT volatility drives income volatility.[6]

A better understanding of these questions carries significant policy relevance, especially in the context of the current economic crisis. One of the chief arguments voiced against export-led growth strategies for developing countries is that economically-open countries are more prone to external shocks. But are they necessarily more strongly af-

[4]Finally, the authors illustrate that more open sectors also become increasingly detached from the overall economy in their growth processes, thus leading to reduced economy-wide growth volatility. However, they do find that this latter effect is smaller in magnitude relative to the earlier two.

[5]A number of papers—including Bevan, Collier & Gunning (1993), Dehn (2000), and Kose & Riezman (2001)—have documented important effects of commodity price shocks on growth volatility.

[6]However, the paper does not directly test how the link between openness and income volatility is affected by different levels of diversification, nor does it establish confidence-bound thresholds at which the total effect of openness on growth volatility changes sign. Last but not least, the author does not utilize both market and product conceptions of diversification, as we do in this study.

fected by external shocks by way of higher volatility? Given that more open economies are likely to be involved in a wider range of insurance schemes, along with the disciplinary effect of increased international competition, the total effect of openness on volatility could also go the other way. While agnostic as regards the sign of the average effect of openness on volatility, this study finds that it is likely to be negative for countries with a sufficiently diversified export basket. Moreover, a majority of the countries in our sample appear to fulfill this condition. Our results thus amount to a powerful argument in favor of open borders, when accompanied by a policy of export differentiation. The complementarity of the policies is especially important, since there is some evidence that trade openness alone may, paradoxically, lead to export concentration (di Giovanni & Levchenko 2009).

These complementary policies should be foremost on the minds of developing-country policy-makers contemplating the way forward in the aftermath of the crisis. More specifically, policymakers can encourage entrepreneurial export activity by instituting a broad-based system of tax relief and subsidies that support the discovery process, complemented by a liberal trading regime that combines export incentives while relaxing restrictions on the import of intermediates. Yet, policy measures must keep in mind that trade openness as such may lead to specialization if not coupled with an export incentive system that promotes exporting of new as opposed to existing products. One way to do this is to facilitate the costly search process for exporters by alleviating information externalities (export promotion agencies) or setting tax incentives for firms to engage in the costly trial and error process of exporting. Not only should export incentive schemes aim at promoting exports of new products, policymakers should also encourage production diversification as such. This would entail setting incentives supporting the discovery of profitable choices of products, perhaps via tax incentives, subsidized public R&D, or laws and regulations that provide greater access to high risk finance.

Our empirical strategy begins with the computation of a variety of export diversification indicators, which we use as measures of the extent of export diversification in any given country, across both products and markets. We then utilize these measures to explore the relationship between diversification, trade openness, and volatility, while controlling for important additional sources of income volatility that stem from domestic and external sources. We also obtain standard errors for the joint effect of the openness indicator and its interaction with diversification, and establish confidence-bound threshold values whereby the total effect of the openness variable on growth volatility switches sign.

One major empirical concern is the possible simultaneity in the link between growth

volatility and trade openness. While we have postulated a direct effect stemming from openness to volatility, we are aware that the converse is also possible, namely that trade policy responds to an increase in growth volatility. While endogeneity is likely to be more of an issue in regressions of growth rather than growth volatility on trade openness, we nonetheless take the charge of endogeneity seriously and use the system GMM procedure proposed by (Arellano & Bond 1991; Arellano & Bover 1995; Blundell & Bond 1998) as our benchmark specification.

Our results are generally supportive of our priors. With regard to the first question of interest—whether the effect of openness is moderated by the extent of diversification—we find strong evidence pointing to the important role that export diversification plays in reducing the vulnerability of countries to global shocks. In addition, while we were agnostic about the relative importance of product versus market diversification *ex ante*, we find that product diversification clearly moderates the effect of trade openness on growth volatility, while the market diversification measures yield much more mixed results.

For our second research question—concerning the existence and extent of a threshold level—we are able, for the most part, to identify positive thresholds in terms of our product diversification indicators at which the effect of openness on volatility changes sign. On the basis of our preferred model (the system GMM estimator), this threshold occurs at the upper part of the distribution of the respective diversification indicators. This suggests, given the current levels of diversification in the export baskets of the countries in our sample, that the majority of countries benefit from increased openness, insofar as it reduces the variability of their growth outcomes.

We conduct a battery of robustness checks to test whether our results are sensitive to changes in the sample or model specification, and we verify that our findings are indeed very robust. One interesting result arising from our robustness checks is the fact that the main findings do not change markedly when high-income economies are excluded from the analysis, even though the sample size falls substantially. In contrast, the relationship does not always hold when we exclude low-income economies from the analysis. This suggests that low- and middle-income economies are indeed responsible for our results. This is intuitive given that developing countries are likely to have only limited access to other forms of insurance against external shocks.

The rest of this paper is organized as follows. In Section 2, we describe the dataset we use and present some descriptive information for the key variables of interest; this section also outlines the econometric approach that we adopt. Section 3 reports our main results, along with a discussion of our main findings, especially pertaining to calculated threshold levels. Section 4 subjects the results in the previous section to a range of robustness

checks, and a final section concludes with some thoughts on policy implications.

2 Data and Methodology

2.1 Description of the Data

Our dataset comprises an unbalanced panel of 77 developing and developed economies over the period 1976–2005. The variables included in the data set are described in Appendix Table A.3, and the full set of countries for which data on all our variables of interest are available for at least one 5-year period is presented in Appendix Table A.5 (along with the average index values for selected key variables for the last five-year period). We compute five-year period averages (standard deviations in the case of volatility measures) for all the variables listed in Table A.3.[7]

We do so for two main reasons. First, the measures of export diversification that we employ are potentially subject to noise that is not necessarily reflective of a true diversification trend in the export basket. Other control variables such as the per capita growth rate may be subject to business cycle variations. Five-year averaging serves as a filter that would remove noise and mute cyclical elements in the data. Second, the econometric tool we employ as our benchmark (system GMM) was designed to work with data that include a large cross sectional and a short time series dimension. Taking 5-year averages yields a maximum of 6 time periods for any given country, which would then satisfy this short time-series requirement.

Due to the large number of variables included in the dataset, we limit our discussion here to the key dependent and independent variables, leaving details of the construction of other variables to the technical appendix. Our main dependent variable is output growth volatility, measured as the standard deviation of GDP per capita across each 5-year period. While it is entirely plausible to substitute *output* for growth volatility, we refrain from doing so for three main reasons. First, even a stable growth path at a constant annual rate of growth will generate a positive volatility measure, even though this is both a desirable and perfectly forecastable outcome. Second, policymakers are generally more concerned with maintaining a stable growth rate, as opposed to stable output levels, since it is the former that directly affects the planning horizon. Third, we

[7]It can be argued that using non-normalized standard deviations as measures of volatility risks overstating volatility for countries with high growth rates relative to those with low growth rates. We refrain from normalizing standard deviations for several reasons. First, the issue is likely to be less of a problem in a dynamic panel setting such as in this paper. Second, in practice the differences in standard deviations of growth typically turn out not to be driven by differences in mean levels of growth. Third, normalizing by the average may lead to large outliers when the average growth rate is close to zero.

follow the standard approach in the literature on the effects of volatility, and these papers (Easterly & Kraay 2000; Ramey & Ramey 1995) have generally focused on growth rather than output volatility.

The two main dependent variables of interest are export diversification and trade openness. Because we do not hold any *ex ante* preferences toward either product or export concentration, we include a variety of export diversification measures that capture both dimensions in any given country. These are fairly standard, and include the top five and top ten shares of products and markets (5/10 product and 5/10 market) as well as Herfindahl-Hirschman indexes for products (product Herfindahl) and markets (market Herfindahl).

We supplement these direct diversification measures with synthetic ones that we construct using principal components analysis, which extracts the first principal component of the three product (PC product) and three market (PC market) diversification measures. By capturing information common to each set of indicators—which are highly correlated with each other but not perfectly so—we will have obtained an alternative measure of diversification that captures a large share of the information common to the respective indicators.[8]

Consistent with much of the literature, we compute trade openness as the ratio of the sum of exports and imports to GDP, while financial openness is measured with an index of restrictions on cross-border transactions (Chinn & Ito 2008).[9] Both of these indicators provide measures of the actual exposure of a country to international markets. This implies that they reflect both structural and policy-related characteristics of a country.

Table 1 reports summary statistics for the key explanatory and control variables. The technical appendix reports additional descriptive statistics that may be of interest, including cross correlations between the different export diversification measures (Appendix Table A.1), as well as the n-th percentile means for the main explanatory variables of interest (Appendix Table A.2). Unsurprisingly, the three product diversification measures and the three market diversification measures are highly correlated within each of the two groups, whereas the correlation across groups is low and mostly below 50%. This correlation structure for diversification is well known, and serves as a motivation for our interest in deploying both market and product indicators to uncover whether it

[8]Both first principal components capture more than 85 percent of the variation in the underlying variables, which allows a reliance on the first principal component alone. The results of our principal components decomposition are available on request.

[9]In addition to these measures, we have explored alternative measures of trade and financial openness, such as the import share of GDP and the ratio of FDI and portfolio liabilities to GDP, respectively. Our central results were not altered, although some of the control variables fell out of statistical significance (while maintaining their directionality). These regressions are available on request.

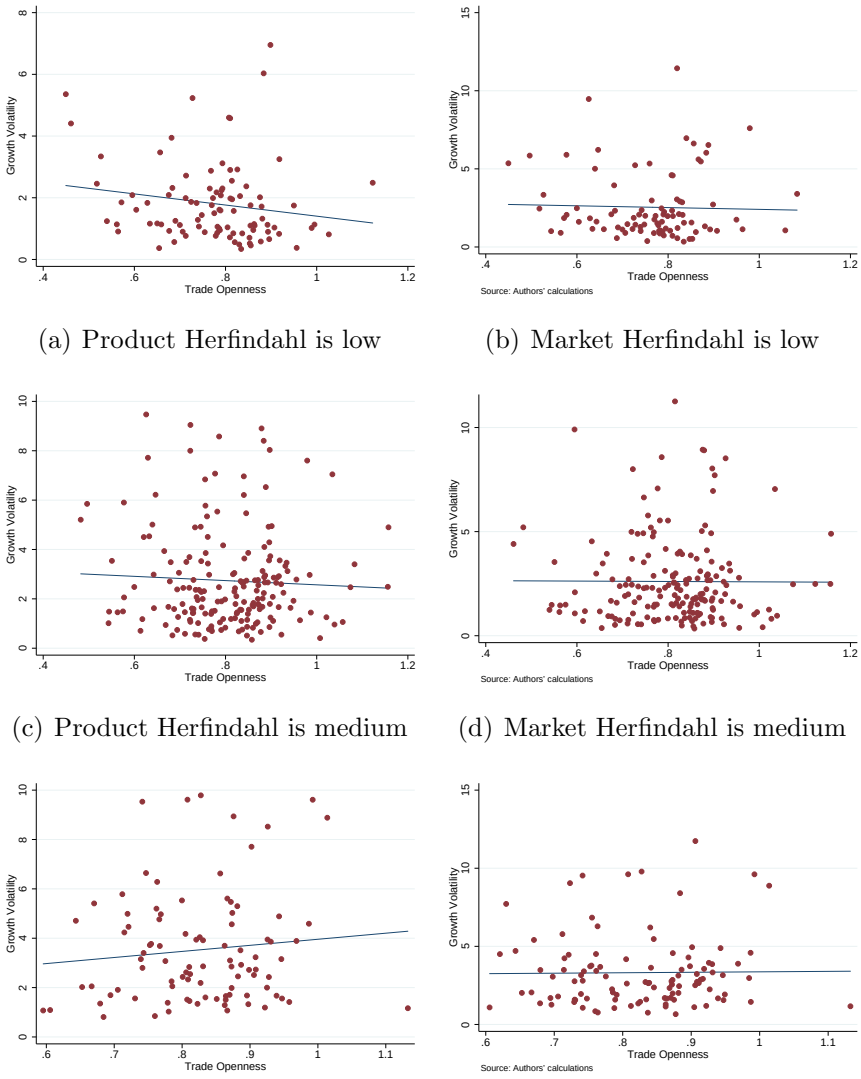
is both diversification across products and markets, or just one of the two, that matter in reducing the vulnerability of economies to external shocks.

Table 1: Summary statistics for main variables of interest

Variable	**N**	**Mean**	**Std Dev**	**Min**	**Max**
Growth volatility	380	2.791	2.17	0.340	11.740
Product diversification					
Product Herfindahl	378	0.139	0.17	0.007	0.919
5 product	378	0.504	0.25	0.100	0.987
10 product	378	0.615	0.24	0.172	0.992
PC product	378	-0.663	1.42	-2.873	3.069
Market diversification					
Market Herfindahl	364	0.167	0.15	0.046	0.944
5 market	364	0.640	0.13	0.385	0.991
10 market	364	0.787	0.10	0.566	0.996
PC market	364	-0.485	1.38	-2.816	4.354
Trade openness	380	0.803	0.11	0.450	1.157
Financial openness	380	0.198	1.53	-1.798	2.540
Capital flow volatility	380	0.199	0.59	-1.973	1.492
Foreign growth volatility	380	-0.156	0.43	-1.543	0.891
Terms of trade volatility	380	7.597	7.88	0.000	56.323
Exchange rate volatility	380	5,455.3	103,633.7	0.049	2,019,770
Inflation volatility	380	8.819	20.81	0.191	168.127
Banking crisis	380	0.030	0.06	0.000	0.182

While we defer a rigorous analysis of our key questions to the next section, it is helpful at this point to consider the plausibility of the hypotheses by examining the link between volatility and openness descriptively, contingent at different parts of the distribution of the diversification measure. We do so by plotting growth volatility against trade openness separately for observations belonging to the lower and upper quartiles (as well as the two middle quartiles jointly) of two selected diversification measures, namely the product Herfindahl and market Herfindahl indicators. The plots are shown in Figure 1.

Although awaiting formal econometric verification, the plots do appear to confirm our hypothesis in the case of the product diversification indicator: The effect of openness on growth volatility is negative when exports are well diversified across products, close to zero when product diversification is at an average level, and positive when export concentration is in the upper quartile of the distribution. Furthermore, this finding appears to be reasonably robust to alternative measures of product diversification (not reported). The same cannot be said for the market indicator. Although the evidence



(a) Product Herfindahl is low

(b) Market Herfindahl is low

(c) Product Herfindahl is medium

(d) Market Herfindahl is medium

(e) Product Herfindahl is high

(f) Market Herfindahl is high

Figure 1: Plots of standard deviation of GDP per capita growth against trade openness, with each row of the left (right) column capturing country-year observations from low, medium, and high levels of product (market) concentration, with fitted (navy) regression lines, excluding outliers identified by the Hadi (1992) multivariate detection procedure. The pattern of a negative (positive) relationship between volatility and openness when diversification is high (low) is evident for both classes of diversification measures.

is at this point only suggestive in nature, it indicates that product diversification may be more important than market diversification in shielding an economy from the adverse impact of external shocks.

2.2 Empirical Model and Estimation Strategy

The benchmark linear dynamic panel data model we estimate in this study is given by

$$\begin{aligned} GDPVOL_{i,t} = \alpha_i + \beta_1 OPEN_{i,t} + \beta_2 DIV_{i,t} + \beta_3 OPEN_{i,t} \times DIV_{i,t} \\ + \gamma \mathbf{X}_{i,t} + \epsilon_{i,t}, \end{aligned} \tag{1}$$

where the dependent variable, $GDPVOL_{i,t}$, is the standard deviation of real GDP per capita for country i for period t, $OPEN_{i,t}$ is trade openness (measured as total trade as a share of GDP), $DIV_{i,t}$ is a given measure of export diversification, $OPEN_{i,t} \times DIV_{i,t}$ is the interaction of the two previous variables, and $\mathbf{X}_{i,t}$ is a $(1 \times m)$ vector of control variables; α_i and $\epsilon_{i,t} \sim N(0, \sigma_\epsilon^2)$ are the individual-specific effects and i.i.d. disturbance terms, respectively.

Our theoretical priors suggest that, for any given country, the effect of trade openness on growth volatility is positive when export concentration is high, but that this effect decreases and eventually becomes negative as the country becomes more diversified. This implies that $\beta_1 < 0$ and $\beta_3 > 0$ are the necessary conditions to validate this hypothesis.

In addition, (1) also allows for the determination of a threshold value in terms of a given diversification measure at which the impact of openness on growth volatility changes sign. In other words, according to our model, countries with values lower than the threshold (more diversified) would be expected to benefit from a marginal increase in trade openness via a reduction in growth volatility, whereas countries above the threshold (more concentrated) would be expected to incur higher levels of volatility. Determining the threshold requires setting the total effect of openness on growth volatility to zero, followed by solving for the level of the diversification measure that is implied by the resulting equation. We then determine joint standard errors between the openness variable and the interaction term, in order to be able to draw confidence bands around the threshold.

We include a range of confounding variables in the vector $\mathbf{X}$ as controls that have been shown to be among the main sources of growth volatility in the literature. In our preferred specification, these include inflation volatility, exchange rate volatility, the volatility of capital flows to the region, an indicator for the frequency of systemic banking crises, as well as the volatility of foreign shocks, such as foreign growth volatility and ToT volatility. The robustness checks in Section 4 expand this set to include several additional controls that may also potentially affect volatility.

As discussed in the introduction, endogeneity is generally of concern in regressions of growth on trade openness, as there is little doubt that current and past realizations of growth can be important factors in driving both exports and imports—and hence trade

openness—through their influence on policy choices. Since the dependent variable in this study is not growth, but rather its second moment, this concern is alleviated but not removed. It is straightforward to think of political economy arguments that may explain why a higher level of growth volatility can lead to a less open economy. For example, this may occur if policymakers choose policies affecting trade openness as a response to large fluctuations in GDP because they regard openness as a potential source of this volatility.

A consistent estimator that does allow for the joint (weak) endogeneity of all explanatory variables including the lagged dependent variable is the GMM difference estimator derived by Arellano & Bond (1991). However, this estimator has at least two important shortcomings. First, it requires the model to be differenced, implying that information on cross-country variation is lost. Second, instrument weakness of lags of the explanatory variables can influence the asymptotic and small sample performance of the estimator. Based on the work of Arellano & Bover (1995), Blundell & Bond (1998) develop a system GMM estimator that combines the regression in differences with the regression in levels, which attenuates these shortcomings. It is this latter estimator that we use for our benchmark regressions.

3 Estimation Results and Discussion

3.1 Main Results

In this section, we estimate the empirical model defined in (1) for different choices of the diversification indicator $DIV_{i,t}$. Although our preferred estimator is the system GMM estimator, we complement it with random effects estimates, which serve a an important baseline for the purposes of comparison.[10] Estimates for (1) are reported in Tables 2 (random effects) and 3 (system GMM).

We begin the analysis trying to understand how trade openness affects growth volatility on average, in other words, independently of the diversification indicators. For this purpose, specification *R1* in Table 3 and *G1* in Table 3 estimate (1) while excluding both the diversification indicator $DIV_{i,t}$ and the interaction term $OPEN_{i,t} \times DIV_{i,t}$. Having

[10]Fixed effects estimates are available on request. The results are qualitatively and quantitatively very similar to those obtained using the random effects estimator, although some of the variables of interest become insignificant. We choose to report the random rather than the fixed effects estimates for two reasons. First, the Hausman test favors the random over the fixed effects estimator, and hence the random effects coefficients are more efficient. Second, the fact that the fixed effects estimator disregards between-group variation may be particularly problematic in our study. The reason is that between-group variation in the diversification measures may be more reliable as an actual measure of relative differences in export diversification, rather than within-group variation.

Table 2: Random effects regressions for growth volatility, openness, and product diversification[†]

	Direct	**Product diversification**			
	(*R1*)	(*R2*)	(*R3*)	(*R4*)	(*R5*)
Product		-12.179	-6.732	-5.660	-1.209
Diversification		(4.85)**	(3.69)*	(3.77)	(0.64)*
Trade	2.564	0.016	-2.664	-3.086	3.098
openness	(1.31)*	(1.25)	(2.10)	(2.50)	(1.56)**
Openness ×		15.779	9.223	8.084	1.658
diversification		(5.98)***	(4.55)**	(4.62)*	(0.79)**
Financial	-0.157	-0.166	-0.153	-0.149	-0.152
openness	(0.08)**	(0.07)**	(0.07)**	(0.07)**	(0.07)**
Terms of trade	0.052	0.043	0.041	0.040	0.040
volatility	(0.02)***	(0.02)**	(0.02)*	(0.02)*	(0.02)*
Exchange rate	0.000	0.000	0.000	0.000	0.000
volatility	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Capital flows	0.807	0.739	0.750	0.746	0.745
volatility	(0.19)***	(0.16)***	(0.16)***	(0.16)***	(0.16)***
Foreign growth	0.729	0.790	0.778	0.781	0.784
volatility	(0.37)**	(0.37)**	(0.38)**	(0.38)**	(0.37)**
Inflation	0.008	0.008	0.008	0.008	0.008
volatility	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Banking crisis	5.169	5.056	4.946	4.976	4.961
	(2.33)**	(2.34)**	(2.34)**	(2.34)**	(2.34)**
R^2	0.255	0.274	0.275	0.273	0.275
F	3758.8***	4781.0***	4817.7***	4974.4***	4934.5***
N	380	378	378	378	378

	Market diversification			
	(*R6*)	(*R7*)	(*R8*)	(*R9*)
Product	-14.591	-10.731	-14.297	-1.290
Diversification	(7.93)*	(7.30)	(8.90)	(0.76)*
Trade	-0.304	-5.529	-10.495	3.783
openness	(1.85)	(5.66)	(8.60)	(1.62)**
Openness ×	18.974	13.250	17.368	1.633
diversification	(10.56)*	(9.53)	(11.62)	(1.00)
Financial	-0.173	-0.183	-0.186	-0.182
openness	(0.07)**	(0.08)**	(0.08)**	(0.08)**
Terms of trade	0.048	0.051	0.052	0.050
volatility	(0.02)**	(0.02)**	(0.02)**	(0.02)**
Exchange rate	0.000	0.000	0.000	0.000
volatility	(0.00)	(0.00)	(0.00)	(0.00)
Capital flows	0.784	0.824	0.835	0.814
volatility	(0.18)***	(0.18)***	(0.19)***	(0.18)***
Foreign growth	0.799	0.803	0.801	0.805
volatility	(0.38)**	(0.37)**	(0.37)**	(0.37)**
Inflation	0.007	0.006	0.006	0.006
volatility	(0.01)	(0.01)	(0.01)	(0.01)
Crisis dummy	5.256	5.042	5.069	5.128
	(2.44)**	(2.40)**	(2.39)**	(2.42)**
R^2	0.253	0.246	0.247	0.249
F	3959.0***	3810.1***	3939.3***	3931.6***
N	364	364	364	364

[†] Notes: Huber-White (robust) standard errors reported in parentheses. * indicates significance at 10 percent level, ** indicates significance at the 5 percent level, and *** indicates significance at the 1 percent level. Period dummies and a constant were included, but not reported.

Table 3: System GMM regressions for growth volatility, openness, and diversification[†]

	Direct	**Product diversification**				**Market diversification**			
	(*G1*)	(*G2*)	(*G3*)	(*G4*)	(*G5*)	(*G6*)	(*G7*)	(*G8*)	(*G9*)
Lagged	-0.122	0.167	0.093	0.081	0.096	0.121	0.210	0.246	0.094
volatility	(0.18)	(0.12)	(0.15)	(0.15)	(0.14)	(0.16)	(0.17)	(0.18)	(0.17)
Product		-27.894	-20.045	-16.954	-2.320				
Diversification		(9.77)***	(8.50)**	(8.08)**	(1.34)*				
Market						-31.829	-32.601	-40.552	-3.584
Diversification						(16.42)*	(22.64)	(29.03)	(1.97)*
Trade	-0.586	-5.160	-11.804	-12.000	1.420	-4.164	-19.903	-31.768	6.502
openness	(4.13)	(2.99)*	(5.36)**	(5.86)**	(3.30)	(4.05)	(16.13)	(26.22)	(3.93)*
Openness ×		33.599	24.565	20.862	2.751	36.140	35.569	45.526	3.869
diversification		(11.30)***	(9.84)**	(9.42)**	(1.58)*	(19.26)*	(26.80)	(34.91)	(2.31)*
Financial	-0.467	-0.333	-0.380	-0.362	-0.353	-0.218	-0.225	-0.281	-0.335
openness	(0.21)**	(0.17)*	(0.18)**	(0.18)**	(0.17)**	(0.18)	(0.20)	(0.19)	(0.17)**
Terms of trade	-0.056	-0.008	-0.007	0.017	0.043	0.047	0.094	0.078	0.105
volatility	(0.06)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.09)	(0.08)	(0.07)
Exchange rate	0.000	0.000	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000
volatility	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Capital flows	0.539	0.289	0.176	0.259	0.361	1.257	1.506	1.315	1.453
volatility	(0.58)	(0.36)	(0.43)	(0.42)	(0.45)	(0.40)***	(0.59)**	(0.56)**	(0.56)***
Foreign growth	0.261	2.075	1.502	1.485	1.394	0.706	-0.344	-0.237	-0.117
volatility	(1.32)	(0.96)**	(1.00)	(0.97)	(0.93)	(0.88)	(1.02)	(1.04)	(0.99)
Inflation	0.019	0.026	0.026	0.022	0.019	-0.002	-0.011	-0.009	-0.008
volatility	(0.02)	(0.01)**	(0.01)*	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
Banking crisis	4.499	-2.290	0.227	1.995	2.946	3.245	5.671	5.242	4.539
	(11.66)	(5.94)	(5.87)	(5.50)	(4.93)	(4.36)	(5.78)	(5.88)	(5.09)
Wald χ^2	513.0***	926.2***	787.6***	730.7***	662.3***	783.2***	750.0***	860.1***	507.8***
Hansen J	16.502	37.458	32.840	34.704	37.293	40.410	45.090	41.059	43.789
AR(2) z	-0.394	0.400	0.101	0.179	0.343	0.978	1.375	1.279	1.191
N	302	302	302	302	302	289	289	289	289

[†] Notes: Heteroskedasticity and autocorrelation-robust (asymptotic) Windmeijer (2005)-corrected standard errors reported in parentheses. * indicates significance at 10 percent level, ** indicates significance at the 5 percent level, and *** indicates significance at the 1 percent level. Period dummies and a constant were included, but not reported.

excluded the interaction term, the coefficient on $OPEN_{i,t}$ now represents the average effect of trade openness on growth volatility across the entire sample, and independently of any variables that might condition it in reality.

The tables show that the coefficient is positive and significant at the 10 percent level in the random effects regression, and negative and insignificant in our preferred model, the system GMM regression. The evidence with regard to the effect of trade openness on growth volatility is thus inconclusive. It appears that an increase in trade openness has little or no effect on growth volatility on balance as the channels through which trade openness may impact growth volatility according to theory (exposure to a greater number of shocks vs. implicit and explicit insurance) cancel each other out.

To clarify how diversification comes into play, we proceed with estimates of the fully-specified model in (1). By and large, across all regressions in Tables 3 and 2, the control variables enter with the expected signs when significant. For example, volatility in the ToT is mostly positively related to growth volatility and significant, a finding that echoes others in the literature (Easterly & Kraay 2000; Raddatz 2007). Similarly, the experience of a banking crisis throughout most of the regressions is associated with increased growth volatility (which, although seemingly tautological, emphasizes the fact that the preponderance of financial crises spill over to the real economy). Moreover, both increased inflation volatility and increased volatility in capital flows to the region have a positive and mostly significant impact on growth volatility.

Of particular interest is the coefficient on financial openness, which enters with a negative sign in most regressions and is almost always statistically significant at the 5 percent level. The finding may be rationalized as follows: While trade openness, at least initially, may induce production specialization and concentration through competitive advantage, financial openness may result in *production* diversification, which reduces growth volatility. This argument is similar in spirit to the central message of our paper, namely that *export* diversification reduces growth volatility through an improved shielding of a country's exports against adverse external shocks, and a better integration of the respective country into a broader range of global value chains and implicit or explicit insurance schemes.

We now move on to considering the interaction between openness and diversification in our regressions, which address our primary questions of interest. Since the measure of diversification is central to our analysis of this question, we report results for the benchmark specification of (1) using a range of alternative product and market diversification measures to represent $DIV_{i,t}$. In the case of product diversification, these correspond to the: (a) Product Herfindahl; (b) 5 product; (c) 10 product; and (d) PC product,

and are reported in columns *R2–R5* (Table 2) and *G2–G5* (Table 3). Regressions using the analogous market indicators are presented in columns *R2–R5* (Table 2) and *G2–G5* (Table 3), respectively.

We begin by discussing the random effects estimates, and focus initially on the regressions involving product diversification indicators only (Table 2, upper half). It can be seen that he coefficient on the product diversification variable is negative throughout the specifications we run, while the interaction terms carry positive coefficients. The coefficient on the trade openness variable is, for the most part, negative. The trade openness variable is mostly not (statistically) significant, while the diversification indicator is, aside from one exception, always significant at the 10 percent level or lower. The same holds—without exception—for the interaction term. This last finding alone suggests that the effect of trade openness on growth volatility is indeed conditioned by the degree of export diversification, a result that confirms our initial hypothesis.

In addition, the point estimates are economically significant: product diversification is bound by a range $[-12.18, -1.21]$, and the interaction term has a range of $[1.66, 15.78]$. The total effect of openness on volatility is the sum of the coefficients on the openness variable and the product of the interaction term with a given level of diversification. Without further information on the level of diversification that we are considering, therefore, it is not possible to calculate the total effect that pertains to these respective variables. It is, however, illustrative to consider the effect of openness on volatility for a completely diversified economy ($DIV_{i,t} = 0$) as opposed to a totally non-diversified economy ($DIV_{i,t} = 1$). In these cases, the total effect of openness on volatility is the coefficient on the openness variable alone, versus the sum of the coefficients on the openness variable and interaction term. Since the coefficient of the latter dominates the former,[11] we can infer that openness does in fact reduce volatility in diversified economies, and it is in poorly diversified economies where openness has the opposite effect.

As discussed earlier, endogeneity is a potential concern for our estimates. We therefore treat the system GMM results in Table 3 as our favored benchmark since, as discussed in the previous section, these specifications explicitly account for possible reverse causality issues.

The results are qualitatively very similar to those reported in Table 2. The trade openness variable enters consistently with a negative sign, and only in the case of PC product is the coefficient positive. The interaction term is always positive and significant at the 10 percent level. The range of estimates consistent larger in magnitude compared

[11] With the exception of the PC product estimates; since this variables is not bound by $[0, 1]$, the discussion does not apply to this specification.

to the random effects model, but by less than an order; the coefficients for product diversification and the interaction term are $[-27.89, -2.32]$ and $[2.75, 33.60]$, respectively. Using this preferred model specification, we thus again find supportive evidence for our claim that the effect of trade openness on growth volatility falls, the more diversified a country is in its exports. Throughout all the specifications, the Hansen J test of overidentifying restrictions confirms that the (internal) instruments are valid, and the Arellano-Bond test rejects significant second-order serial correlation in the error term. Finally, while several control variables fall out of statistical significance, the volatility of foreign growth and capital flows remain influential.

We move on to consider the estimates for the regressions involving indicators of market instead of product diversification (Table 2, lower half, and Table 3). We do not maintain any *ex ante* hypothesis as to whether product or market diversification should matter more in better shielding an economy from shocks. However, while Tables 2 and 3 corroborate our claim regarding the moderating effect of product diversification, the same cannot be said of market diversification. Only in one of the four random effects regressions (specification *R6*) and two of the four GMM regressions (*G6* and *G9*) is the interaction term significant at the conventional levels. This suggests that evidence in favor of a role for market alongside product diversification in shielding an economy from shocks is limited at best. Furthermore, Wald tests (not reported) suggest that the openness variable and the interaction term are jointly insignificant in all of the market diversification regressions, implying that thresholds (at which the total effect of openness on growth volatility changes sign) in terms of the market diversification indicators cannot be established with confidence. In the case of the product diversification regression, this is not the case, as the following section demonstrates.

In sum, we find strong evidence for an important role of export diversification in reducing the vulnerability of countries to global shocks, allowing us to answer the first part of our research question—whether the effect of trade openness on growth volatility varies with the level of export diversification—with a clear affirmation. It does appear, however, that the role of product diversification is more important in this context than that of market diversification.

3.2 Threshold Analysis

Drawing further conclusions from our estimates requires us to establish thresholds in terms of the respective diversification indicators at which the effect of openness on growth volatility switches sign. In light of the findings of the previous section, namely that the

interaction term is mostly insignificant for market diversification indicators (and that the openness variable and the interaction term are always jointly insignificant), we are limited to the regressions involving product diversification indicators for this exercise. Thresholds are then established on the basis of the system GMM estimates (specifications *B2–B5*), which represent our preferred model.

The total effect of openness on volatility is the sum of the coefficients on the openness variable and the product of the interaction term and the coefficient on the interaction term. It is straightforward to determine threshold values at which the total effect of openness on growth volatility changes sign. In other words, we can identify a value for each diversification measure which, in theory, a country needs to underscore (a lower value implies a more diversified export basket) in order to benefit from a marginal increase in trade openness in terms of a reduction in growth volatility. The threshold can be identified by setting the total effect of trade openness on growth volatility to zero, that is, by taking $\beta_1 OPEN + \beta_3 OPEN \times DIV^* = 0$, and solving for the value of the critical diversification measure DIV^*, for which the relationship holds.

This yields $DIV^* = -\beta_1/\beta_3$. We apply the Wald test to determine the joint significance of the two variables forming the total effect. Moreover, we compute joint standard errors for $OPEN$ and $OPEN \times DIV$, and use these to determine confidence bands around the thresholds.

Table 4 presents the thresholds calculated for each of the four regressions, along with their corresponding 10 percent confidence intervals. It also reports Wald test results for the joint significance of the openness variable and the interaction term. The Wald test statistics (column 3, Table 4) indicate that the total effect of openness on growth volatility is statistically significant at the 90% level or higher across specifications. There is only one exception for which it is not—for the PC product indicator—and we accordingly refrain from making inferences based on that measure.

Having computed joint standard errors for the two variables in question in order to determine confidence intervals, we can plot confidence bands around the total effect of trade openness on growth volatility. Figure 2 presents the plot for the 5 product index (specification *B2*) as an example. We can see that the impact of trade openness on growth volatility is significantly lower than zero with 90 percent confidence, as long as a country scores lower than about 0.24 on the diversification variable (Table 4). The effect gradually increases and changes sign (threshold) at about 0.48. In contrast, above a value of about 0.71, the impact of trade openness on growth volatility is significantly positive. A qualitatively equivalent illustration can be made for the 10 product and the Herfindahl indicators.

Table 4: Error components and system GMM regressions for growth volatility on (independently) openness and product diversification[†]

Indicator	**Threshold**	**Joint significance**	**CI**	**Share**
Herfindahl	0.154	9.03***	[0.012, 0.271]	0.797
5 product	0.481	6.23**	[0.244, 0.710]	0.563
10 product	0.575	4.93*	[0.289, 0.905]	0.469
PC product	-0.516	3.42	[−2.761, 11.602]	0.672

[†] Notes: χ^2 values calculated from Wald tests of joint significance of coefficients of the openness and interaction terms. * indicates significance at 10 percent level, ** indicates significance at the 5 percent level, and *** indicates significance at the 1 percent level. Confidence interval reports 95 percent interval calculated from standard error of threshold level of diversification. Share reports number of countries in final period distribution falling below threshold.

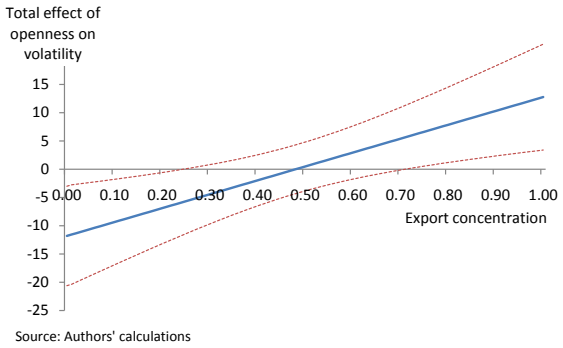


Figure 2: Effect of diversification on growth volatility, after moderating for effect on openness, based on the 5 product index. The threshold diversification value of 0.48 has a 90 percent confidence band that includes fully positive values, along with parts of the distribution significantly above and below zero. 56 percent of countries in the final five year period fall under this critical threshold level of diversification, indicating that increased openness will decrease their growth volatility.

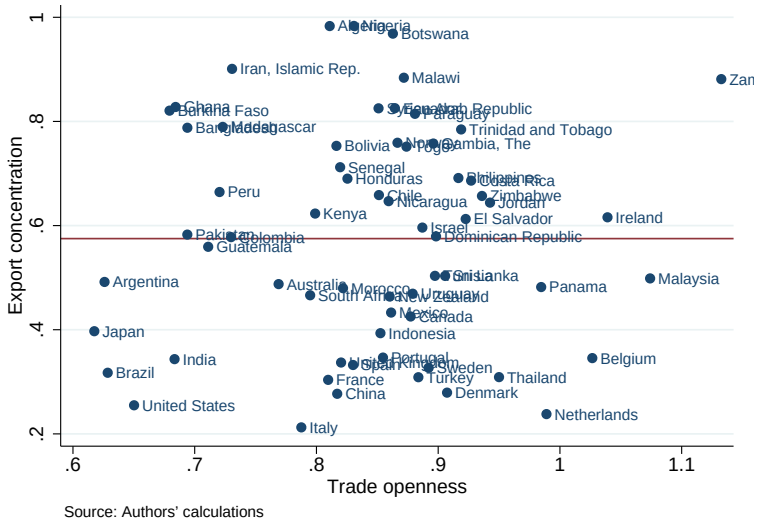
Let us put the threshold value of 0.48 into context. Based on this figure, it is straightforward to determine the share of countries in the sample whose value on the 5 product indicator lies below the threshold and the share of those whose value lies above it. We do so in Table 4 by cross-referencing the threshold with the distribution of the diversification indicator during the last 5-year period (2000–2005) in our sample, broken down into percentiles. These percentiles are also captured in Table A.4 (while the values for each individual country in the sample are in Appendix Table A.5).

Table 4 illustrates that the value of the 5 product measure lies below the threshold of 0.48 for 56 percent of all countries. The majority of countries should therefore benefit from a marginal increase in trade openness by way of a reduction in their growth volatility. In the case of the 10 product indicator, we see a similar picture emerge. The total effect of trade openness on growth volatility is again highly significant, and the system GMM estimator points to a threshold that lies at 0.58, which is underscored by about 47 percent of countries (Table 4). For the Herfindahl indicator, this share of countries is even higher, at 80 percent. This, once again, suggests that a large share of the sample of countries benefits from trade openness in the sense that it reduces its income growth volatility.

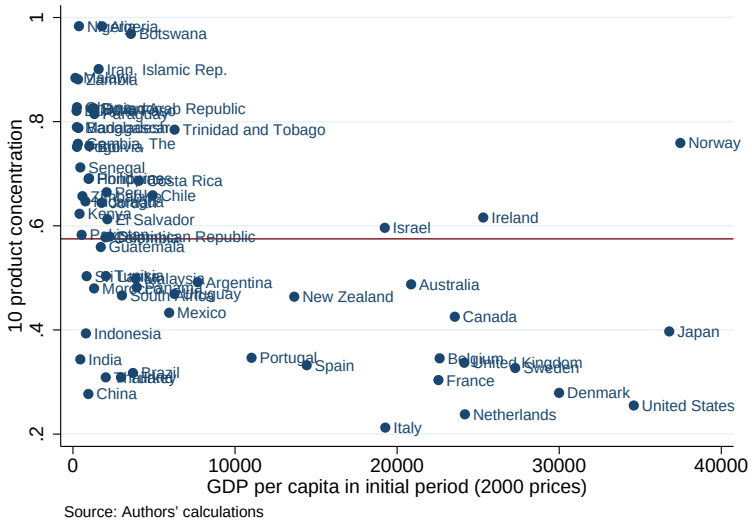
The threshold level of diversification can also be understood relative to levels of trade openness (Figure 3(a)) and income per capita (Figure 3(b)). When compared to trade openness, the distribution of countries below the diversification threshold appears to be relatively even; in contrast, countries above the threshold appear to be largely clustered around moderate levels of openness (with the exception of outliers, such as Zimbabwe). This suggests that the countries that currently experience reduced volatility as a consequence of diversification are certainly not limited to the most open economies (and, conversely that economies that do not benefit from the diversification effects of reduced volatility are not necessarily closed economies).

Naturally, countries in the lower right quadrant of the plot are in a beneficial situation in the sense that they have very open economies, but are also well diversified. According to the core hypothesis of this study, they should be well shielded against global shocks and benefit from lower levels of growth volatility. Countries in the upper right quadrant of the plot, on the other hand, are in a problematic situation. Malawi and Botswana, for instance, lie well above the threshold but have relatively open economies. According to the hypothesis of this study, their very open economies will expose them to a large number of global shocks, while their highly concentrated export baskets make them very vulnerable to these shocks.

Figure 3(b) illustrates that, as expected, all high income economies, with the exception of Norway and Ireland, have attained levels of diversification that lie substantially below



(a) Openness



(b) Income per capita

Figure 3: Distribution of countries by (10 product) diversification and (a) openness (b) initial GDP per capita. The maroon line indicates the threshold level of diversification, with countries below the line benefiting from increased openness. Open countries feature both above and below the threshold, while high income countries tend to be clustered below the threshold.

the threshold value we identified, implying that they are likely to enjoy the benefits of trade openness while being well shielded against global shocks via the participation in a large number of global value chains. Yet, we also see that the vast majority of countries above the diversification threshold are low income countries, although a large number of

low income economies also fall below the threshold. Whereas countries such as Nigeria and Botswana are troubled by extremely high export concentration, China and Nicaragua have reached levels of diversification that fall clearly below the threshold. The question then arises: can developing countries that choose to pursue a diversification path do so expediently, so that they quickly fall below the diversification threshold?

The answer is yes, and this is clearly illustrated in Figure 4, which follows the path of six developing countries toward lower levels of diversification over the sample period, using the 5 product measure. Countries such as Nicaragua, Kenya, or Colombia had very concentrated export baskets at the beginning of our sample period, yet successfully diversified to levels close to or below the threshold value we have identified. This illustrates that diversification—as a means of deriving larger benefits from trade openness and at the same time shielding the economy against global shocks—is indeed a feasible and realistic policy goal.

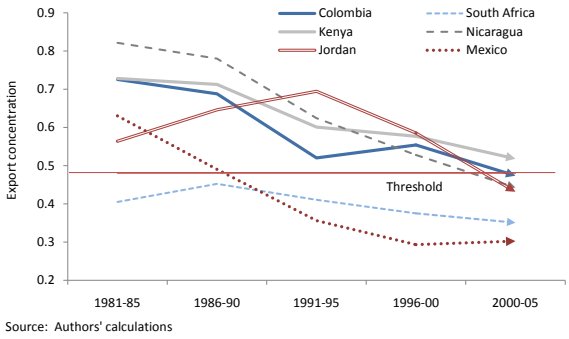


Figure 4: Example diversification paths for a selection of six developing countries between 1981–2005, and their relation to the threshold level of (5 product) diversification (maroon line). Nicaragua, Kenya, and Colombia are countries that behan with very concentrated export baskets, but which were successful in diversifying to levels close to or below the threshold diversification value, where they would benefit from reduced volatility.

4 Robustness Checks

We perform a sequence of robustness checks to ensure the stability of our results. These are: (a) the inclusion of additional controls (to the benchmark reported in Table 3) that have been identified by the literature as potential additional influences on volatility; and (b) subsample analysis of the benchmark specifications with the selective exclusion of specific time intervals and country types. In the interest of space, we report results pertaining to only two product diversification indicators—product Herfindahl and 5 product—noting

that the results obtained from the product Herfindahl and PC product indicators, and between 5 and 10 product indicators, demonstrate significant overlap. In the tables discussed in this section (Tables 5, 6, and 7), odd-numbered columns refer to regressions using the Herfindahl Products indicator, while even-numbered columns denote those using the 5 product indicator.

Table 5 systematically adds additional economic and structural control variables to the main specification. These are initial GDP (*E1–E2*), the GDP per capita growth rate (*E3–E4*), a measure of human capital (*E5–E6*), a measure of the volatility of government expenditure (*E7–E8*) and, finally, an indicator for the occurrence of natural disasters (*E9–E10*). Table 6 repeats the exercise, this time for a range of political and institutional controls, including: measures of government (*P1–P2*) and institutional quality (*P3–P4*), and indicators of political volatility (*P5–P6*), civil conflict (*P7–P8*), and assassinations of public officials (*P9–P10*).

Throughout these robustness checks, we find that the coefficients on the interaction term and the openness variable continue to carry the correct signs and are statistically and economically significant, both individually (the interaction term) and jointly (the interaction term and the openness indicator), across all specifications. The estimated threshold values (not reported) are not markedly different from those found in our preferred benchmark in Table 3.

Moreover, while the coefficients of the newly-introduced variable are statistically insignificant, they tend to carry the expected signs. For instance, a fast-growing country (specifications *E3–E4*) is more likely to experience a reduction in its growth volatility; this is reasonable, since high-growth nations are more likely to enter into the league of high-income countries, which, as discussed before, have available to them more mechanisms for smoothing growth fluctuations. Greater volatility in government spending, in contrast, is detrimental for growth stability (*E7–E8*). Superior government and institutional quality (*P1–P4*) exert a moderating effect on volatility, while the presence of civil conflict (*P7–P8*) has the opposite effect.

Our subsample analysis proceeds along two dimensions. We choose to restrict the sample from either end by deleting the final (2001–2005) (Table 7, columns *S1* (product Herfindahl) and *S2* (5 product) measures) and first (1976–1980) (*S3* and *S4*, respectively) periods from the sample. The first restriction, which deletes the most recent period, examines the importance of recent history in influencing the outcomes of the analysis. The second, which pares the earliest period of the sample, tests the robustness to the exclusion of the period of increased global trade integration in the late 1970s and early 1980s, which followed the end of the Tokyo Round and led up to the important Uruguay

Table 5: System GMM regressions for growth volatility with additional economic and structural controls[†]

	(*E1*)	(*E2*)	(*E3*)	(*E4*)	(*E5*)	(*E6*)	(*E7*)	(*E8*)	(*E9*)	(*E10*)
Lagged	0.157	0.089	0.315	0.045	0.160	0.097	0.168	0.082	0.172	0.071
volatility	(0.13)	(0.16)	(0.13)**	(0.17)	(0.12)	(0.16)	(0.14)	(0.15)	(0.13)	(0.16)
Product	-23.608	-18.128	-30.613	-19.638	-26.759	-19.780	-28.436	-18.466	-25.179	-18.020
Diversification	(8.87)***	(9.04)**	(10.90)***	(10.41)*	(8.96)***	(8.77)**	(9.95)***	(8.41)**	(10.33)**	(8.25)**
Trade	-4.250	-10.853	-6.503	-11.372	-4.257	-12.018	-5.111	-10.752	-5.204	-10.667
openness	(2.88)	(5.09)**	(3.93)*	(7.28)	(2.79)	(5.44)**	(2.98)*	(5.40)**	(3.13)*	(5.39)**
Openness ×	28.509	22.466	35.616	21.641	32.195	24.479	33.824	22.537	30.025	21.646
diversification	(10.46)***	(10.28)**	(12.99)***	(12.94)*	(10.50)***	(10.13)**	(11.24)***	(9.94)**	(11.82)**	(9.53)**
Financial	-0.314	-0.361	-0.317	-0.445	-0.318	-0.424	-0.329	-0.371	-0.379	-0.410
openness	(0.18)*	(0.20)*	(0.25)	(0.25)*	(0.16)*	(0.18)**	(0.16)**	(0.17)**	(0.17)**	(0.16)***
Terms of trade	0.298	0.153	-0.123	0.221	0.257	0.184	0.285	0.167	0.313	0.222
volatility	(0.38)	(0.44)	(0.39)	(0.41)	(0.35)	(0.42)	(0.37)	(0.43)	(0.38)	(0.44)
Exchange rate	1.638	1.353	2.856	1.741	1.866	1.578	2.020	1.421	1.843	1.243
volatility	(0.93)*	(0.97)	(0.86)***	(1.01)*	(0.90)**	(1.00)	(0.96)**	(0.99)	(0.97)*	(1.06)
Capital flows	0.013	-0.000	-0.011	0.007	-0.006	-0.004	0.001	-0.004	-0.005	0.009
volatility	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.05)
Foreign growth	-0.000	-0.000	0.000	0.000	-0.000	-0.000	0.000	-0.000	0.000	-0.000
volatility	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Inflation	0.025	0.027	0.013	0.008	0.028	0.027	0.024	0.024	0.027	0.029
volatility	(0.01)**	(0.02)*	(0.01)	(0.02)	(0.01)**	(0.01)*	(0.01)*	(0.02)	(0.01)**	(0.02)*
Banking crisis	-1.868	0.479	-1.710	-1.990	-1.823	-1.040	-2.449	0.228	-2.724	-1.079
	(5.35)	(5.78)	(5.79)	(5.65)	(5.66)	(6.16)	(5.69)	(5.26)	(5.43)	(4.91)
Initial income	0.059	0.026								
	(0.21)	(0.20)								
Growth rate			-0.149	-0.260						
			(0.19)	(0.18)						
Educational					-0.020	0.226				
level					(0.43)	(0.44)				
Government exp							0.011	0.012		
volatility							(0.02)	(0.02)		
Natural disaster									-3.450	-1.624
									(2.55)	(2.72)
Wald χ^2	941.7***	887.0***	640.9***	466.3***	1005.9***	826.1***	991.7***	805.8***	870.6***	843.2***
Hansen J	42.357	33.280	25.565	22.456	39.375	32.070	38.368	31.190	38.051	33.298
AR(2) z	0.438	0.126	0.402	-0.049	0.364	0.121	0.462	0.178	0.114	-0.012
N	302	302	238	238	302	302	302	302	302	302

[†] Notes: Heteroskedasticity and autocorrelation-robust (asymptotic) Windmeijer (2005)-corrected standard errors reported in parentheses. * indicates significance at 10 percent level, ** indicates significance at the 5 percent level, and *** indicates significance at the 1 percent level. Period dummies and a constant were included, but not reported.

Table 6: System GMM regressions for growth volatility with additional political and institutional controls[†]

	(*P1*)	(*P2*)	(*P3*)	(*P4*)	(*P5*)	(*P6*)	(*P7*)	(*P8*)	(*P9*)	(*P10*)
Lagged	0.343	0.235	0.146	0.031	0.191	0.108	0.139	0.068	0.164	0.068
volatility	(0.14)**	(0.20)	(0.12)	(0.14)	(0.13)	(0.18)	(0.13)	(0.15)	(0.12)	(0.16)
Product	-29.123	-24.271	-32.042	-11.903	-26.494	-20.324	-25.018	-16.002	-26.097	-20.927
Diversification	(10.42)***	(9.42)***	(12.89)**	(9.01)	(9.76)***	(8.75)**	(10.17)**	(7.92)**	(9.61)***	(8.76)**
Trade	-5.208	-15.151	-3.764	-5.178	-4.855	-11.853	-4.856	-9.429	-5.278	-11.972
openness	(3.87)	(6.26)**	(2.89)	(5.12)	(2.91)*	(5.38)**	(2.86)*	(4.84)*	(3.18)*	(5.46)**
Openness ×	33.410	28.066	36.393	13.208	31.826	24.824	29.463	19.091	31.456	25.365
diversification	(12.01)***	(11.01)**	(14.60)***	(10.65)	(11.33)***	(10.05)**	(11.74)**	(9.12)**	(11.15)***	(10.09)**
Financial	-0.282	-0.251	-0.131	-0.085	-0.337	-0.385	-0.318	-0.330	-0.330	-0.384
openness	(0.29)	(0.35)	(0.24)	(0.25)	(0.17)**	(0.18)**	(0.17)*	(0.19)*	(0.16)**	(0.19)
Terms of trade	-0.146	0.043	0.384	0.346	0.275	0.176	0.261	0.310	0.322	0.289
volatility	(0.40)	(0.46)	(0.36)	(0.43)	(0.36)	(0.44)	(0.42)	(0.46)	(0.36)	(0.44)
Exchange rate	2.785	2.007	1.354	0.980	1.985	1.490	2.107	1.442	1.514	1.175
volatility	(0.91)***	(0.96)**	(0.98)	(1.11)	(0.97)**	(1.01)	(0.92)**	(1.03)	(0.85)*	(0.93)
Capital flows	-0.005	-0.020	0.033	0.039	-0.007	-0.006	0.034	0.037	-0.010	-0.001
volatility	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)
Foreign growth	0.000	0.000	0.011	0.010	0.000	-0.000	-0.000	-0.000	-0.000	0.000
volatility	(0.00)	(0.00)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Inflation	0.017	0.013	0.026	0.027	0.026	0.026	0.020	0.021	0.027	0.023
volatility	(0.01)	(0.02)	(0.01)*	(0.02)*	(0.01)**	(0.01)*	(0.01)*	(0.01)	(0.01)**	(0.01)*
Banking crisis	-1.245	0.222	-5.641	-2.006	-2.961	-0.066	-3.851	-0.264	-1.899	0.251
	(5.50)	(7.12)	(5.07)	(4.05)	(5.51)	(5.29)	(5.20)	(4.90)	(5.93)	(5.98)
Government	-0.170	-0.283								
quality	(0.24)	(0.24)								
Institutional			-0.419	-0.580						
quality			(0.48)	(0.53)						
Political					-1.851	-0.940				
volatility					(2.33)	(3.10)				
Conflict							2.472	1.619		
							(2.18)	(1.85)		
Assassinations									-0.122	0.206
									(0.22)	(0.32)
Wald χ^2	581.8***	472.9***	97.3***	46.1***	1018.8***	820.5***	850.1***	725.5***	1018.1***	729.4***
Hansen J	29.776	25.755	37.067	38.329	36.424	32.517	41.199	34.925	40.490	32.788
AR(2) z	0.264	0.130	0.246	0.158	0.451	0.135	0.123	0.046	0.388	0.060
N	238	238	286	286	302	302	302	302	302	302

[†] Notes: Heteroskedasticity and autocorrelation-robust (asymptotic) Windmeijer (2005)-corrected standard errors reported in parentheses. * indicates significance at 10 percent level, ** indicates significance at the 5 percent level, and *** indicates significance at the 1 percent level. Period dummies and a constant were included, but not reported.

Round of the GATT.[12]

The results for specifications *S3* and *S4* show that excluding the first five-year period does not change the results in any noteworthy way. The coefficients of our variables of interest carry the expected signs and the interaction terms are highly significant. The threshold values (not reported) are also qualitatively unchanged. In contrast, deleting the last period increases the thresholds notably; the product Herfindahl increases from 0.19 to 0.21, while the 5 product rises from 0.47 to 0.62. Furthermore, the interaction term is insignificant at the 10 percent level in specification *S2*. Although these results do not change our main conclusions, they emphasize the importance of recent changes in the global pattern of trade liberalization and diversification since the turn of the 21st century, when the world economy experienced an extended period of economic calm.

An alternative restriction of the sample we experiment with is to limit the sample to only low and middle income economies (columns *S5* and *S6*) as well as only middle and high income economies (columns *S7* and *S8*). The restriction allows us to tease out whether the contribution of diversification and openness to growth stability is driven by patterns in the developed or developing world. As can be seen, our results do not change markedly when high income economies are excluded from the analysis, although the sample size falls substantially.

In contrast, when we exclude developing countries from the analysis, the interaction term is significant only in one of the two regressions (for the Herfindahl, in specification *S7*). Furthermore, while the variables of interest still carry the correct signs, the (statistical) significance of the relationship appears to be eroded. This suggests that much of the action driving our results indeed lies with low and middle income economies, for which export diversification matters more in shielding their economies from external shocks. A likely explanation is that developed economies have other means of insuring their economies against shocks, whereas developing countries depend more strongly on implicit insurance as represented by a more diversified structure in their exports.

5 Conclusion

This study addresses the mechanisms by which the trade channel affects growth volatility. More specifically, we have sought to ascertain whether the effect of trade openness on growth volatility varies according to the extent of export diversification, as well as to establish a threshold at which the effect changes signs. We find that the link between openness and growth volatility is indeed conditioned by the extent to which a country has

[12]Restricting the sample further by eliminating the first two periods yields qualitatively similar results.

Table 7: System GMM regressions for growth volatility for selected subsamples[†]

	1976–2000		**1981–2005**		**Low/middle income**		**High/middle income**	
	(*S1*)	(*S2*)	(*S3*)	(*S4*)	(*S5*)	(*S6*)	(*S7*)	(*S8*)
Lagged	0.329	0.126	0.175	0.113	0.251	0.300	0.074	-0.006
volatility	(0.13)**	(0.17)	(0.12)	(0.16)	(0.13)**	(0.15)*	(0.14)	(0.15)
Product	-29.447	-18.496	-27.497	-21.480	-21.973	-25.074	-37.768	-5.390
diversification	(11.23)***	(11.93)	(10.01)***	(8.36)**	(8.91)**	(9.85)**	(12.00)***	(8.65)
Trade	-7.407	-13.547	-6.545	-12.377	-5.079	-16.994	-3.776	-2.959
openness	(3.78)**	(7.54)*	(3.52)*	(5.20)**	(3.75)	(7.10)**	(3.10)	(4.80)
Openness ×	34.604	21.805	33.358	26.128	25.274	29.756	40.959	6.141
diversification	(13.26)***	(14.34)	(11.76)***	(9.69)***	(10.48)**	(11.55)**	(12.84)***	(10.81)
Financial	-0.407	-0.536	-0.303	-0.390	-0.378	-0.155	-0.550	-0.581
openness	(0.27)	(0.30)*	(0.17)*	(0.18)**	(0.19)**	(0.21)	(0.17)***	(0.17)***
Capital flows	-0.281	-0.164	0.228	0.208	0.805	0.907	0.369	0.304
volatility	(0.41)	(0.46)	(0.37)	(0.44)	(0.47)*	(0.46)**	(0.32)	(0.38)
Inflation	2.938	2.146	2.037	1.556	2.732	2.863	1.076	1.266
volatility	(0.92)***	(1.09)**	(0.94)**	(0.98)	(1.02)***	(1.08)***	(0.87)	(1.10)
Exchange rate	-0.013	-0.016	-0.005	-0.004	0.020	0.018	0.046	0.011
volatility	(0.05)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.06)	(0.05)
Terms of trade	0.000	0.000	0.000	0.000	0.000	0.000	-0.000	0.000
volatility	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Foreign growth	0.017	0.016	0.026	0.025	0.012	0.006	0.018	0.017
volatility	(0.01)	(0.02)	(0.01)**	(0.01)*	(0.01)	(0.01)	(0.01)	(0.01)
Crisis dummy	-1.119	-1.270	-2.395	-0.220	-0.970	2.857	-2.573	-5.687
	(5.64)	(6.60)	(5.85)	(6.14)	(5.55)	(5.95)	(3.85)	(3.70)
Wald χ^2	587.5***	463.1***	778.2***	806.9***	522.7***	779.3***	775.0***	830.3***
Hansen J	24.855	21.798	37.788	30.593	37.677	28.957	35.547	35.771
AR(2) z	0.470	0.267	0.421	0.154	0.881	0.814	0.935	1.028
N	238	238	283	283	207	207	231	231

[†] Notes: Heteroskedasticity and autocorrelation-robust (asymptotic) Windmeijer (2005)-corrected standard errors reported in parentheses. * indicates significance at 10 percent level, ** indicates significance at the 5 percent level, and *** indicates significance at the 1 percent level. Period dummies and a constant were included, but not reported.

diversified its export base. The results suggest that product diversification, in particular, plays an important role in shielding an economy against the detrimental impact of global shocks, while the evidence for market diversification is somewhat mixed.

What is more, we were able to identify positive thresholds for product diversification at which the effect of openness on growth volatility switches sign; with these thresholds mostly falling in the upper parts of the distributions of each respective diversification indicator, the results suggest that the majority of countries in our sample will experience reduced growth volatility should they choose to pursue increased openness to trade. These findings survive a range of additional robustness tests, both to the inclusion of additional controls and to the splitting of the sample into sub-groups of interest. Interestingly, our results fail to go through (in part) when we strip out low-income economies from the sample. This appears to imply that the importance of diversification as a means of shielding an economy against shocks coming from international markets is greater for low- and middle-income economies. The reason is likely to be the fact that industrialized countries have better access to other forms of explicit insurance schemes.

The findings of this study are of major relevance for policy makers in developing countries. The case against export-led growth strategies for developing countries is that economically-open countries are more likely to be buffeted by external shocks. This could well be true, but the relevant question is whether the combined impact of these shocks is large, and whether the effect of trade openness on volatility is indeed positive. For reasons discussed before, the theoretical case is indeterminate. This study has shown that the effect of openness on growth volatility is likely to be negative when a country possesses a sufficiently diversified export basket. This condition is fulfilled by a majority of countries in our sample. These findings amount to a powerful argument in favor of making export differentiation a first-order policy concern for developing countries as they consider exit strategies from the global financial crisis. At the same time, our research serves as an important counterargument against the recent rise in protectionist sentiment worldwide (Baldwin & Evenett 2009).

How can policy be used to enhance diversification? One way is to target the export incentive system. This is not akin to a policy of "picking winners." A strong export incentive system for firms across all sectors alike would not only support export growth, but would give hitherto domestically-oriented firms an incentive to engage in the costly trial-and-error process of exporting. Another avenue is to take measures to increase the diversification of the production base directly. The aim here will be to correct any positive (social) externalities arising from entrepreneurship and innovation which may not have been met by standard market mechanisms. This would entail setting incentives

supporting the discovery of profitable choices of products, perhaps via tax incentives for applied research, subsidized public R&D and startup incubation centers, or laws and regulations that provide greater access to risk finance.

Furthermore, our findings advocate a more phased approach toward introducing trade reform, with countries pursuing an expanded production base and export diversification strategies prior to broad tariff removal. This sequencing of liberalization efforts—especially for countries that currently have a very concentrated export base—may be important for minimizing the disruptive effects that expanded trade may imply with regard to growth volatility.

This approach does not mean protecting domestic producers with "infant industry" tariffs—a classic inward-oriented strategy—but rather an outward-oriented one where barriers to domestic market entry are removed, which would then encourage innovation and development of new markets by companies at home. There is also strong evidence that better trade facilitation (through the reduction of fixed and variable costs of moving goods across borders) can be highly effective in promoting export diversification (Dennis & Shepherd 2007). Focusing on removal of red tape affecting exports and imports, and promoting the development of trade-related infrastructure and services sectors, can therefore make a major contribution to diversifying exports and helping manage outward orientation.

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Technical Appendix

Table A.1: Correlation matrix for diversification variables

	Product Herf	5 product	10 product	Market Herf	5 market	10 market	PC product	PC market
Product Herf	1.000							
5 product	0.822	1.000						
10 product	0.748	0.984	1.000					
PC product	0.883	0.991	0.970	1.000				
Market Herf	0.240	0.226	0.233	0.243	1.000			
5 market	0.450	0.460	0.457	0.478	0.814	1.000		
10 market	0.499	0.542	0.540	0.555	0.696	0.958	1.000	
PC market	0.429	0.443	0.443	0.460	0.883	0.986	0.945	1.000

Table A.2: Percentile decompositions for diversification variables

Percentile	**Mean**	**Mean**
	Product Herfindahl	Market Herfindahl
10%	0.015	0.067
25%	0.029	0.082
50%	0.071	0.117
75%	0.190	0.184
90%	0.346	0.333
		5 product 5 market
10%	0.197	0.480
25%	0.292	0.530
50%	0.476	0.630
75%	0.707	0.723
90%	0.879	0.831
	10 product	10 market
10%	0.295	0.652
25%	0.410	0.705
50%	0.614	0.787
75%	0.825	0.869
90%	0.948	0.930
	PC product	PC market
10%	-2.328	-2.654
25%	-1.859	-2.583
50%	-0.873	0.000
75%	0.367	3.266
90%	1.281	3.378

Table A.3: Definitions and sources of variables

Variable	**Definition and construction**	**Source**
GDP per capita growth volatility	Standard deviation of log difference of GDP per capita	Authors' construction using World Bank WDI
Product Herfindahl	Herfindahl Index HS-4 Digit	World Bank diversification database
5 product	Share of 5 largest products in overall exports	World Bank diversification database
10 product	Share of 10 largest products in overall exports	World Bank diversification database
PC product	First principal component of 3 product diversification measures	Authors' construction
Market Herfindahl	Herfindahl Index for destination markets	Authors' construction with UN COMTRADE
5 market	Share of 5 largest destination markets in overall exports	Authors' construction with UN COMTRADE
10 market	Share of 10 largest destination markets in overall exports	Authors' construction with UN COMTRADE
PC market	First principal component of 3 market diversification measures	Authors' construction
Trade openness	Total trade (exports + imports) divided by GDP	Chang *et al.* (2009)
Financial openness	Restrictions on cross-border financial transactions	Chinn & Ito (2008)
Capital flow volatility	Capital flows to the region as a percentage of GDP	Calderón *et al.* (2005)
Foreign growth volatility	Standard deviation of growth rate of main trading partners	Chang *et al.* (2009)
TOT volatility	Standard deviation of terms of trade (ToT)	Chang *et al.* (2009)
Exchange rate volatility	Standard deviation of real effective exchange rate (REER)	Authors' construction based on IMF IFS
Inflation volatility	Standard deviation of annual log differences of CPI	Chang *et al.* (2009)
Banking crisis	Number of years a country underwent a banking crisis	Chang *et al.* (2009)
Initial GDP per capita	Log of the value of GDP per capita in the initial period	World Bank WDI
GDP per capita growth	Log difference of GDP per capita in constant USD	World Bank WDI
Educational level	Initial value of ratio of secondary gross enrollment	World Bank WDI
Government exp volatility	Standard deviation of government expenditures	Chang *et al.* (2009)
Natural disaster	Portion of years with natural disasters	Chang *et al.* (2009)
Government quality	Index constructed from ICRG indicators	Chang *et al.* (2009)
Institutional quality	Index of civil liberties and political rights	Freedom House (2009)
Political volatility	Number of years a country experienced political iterregna	MarshallJaggers:2008
Conflict	Number of years a country experienced conflict	Sarkees & Schafer (2000)
Assassinations	Number of attempted assassinations of government officials	Cross-National Time-Series Data Archive

Table A.4: Summary statistics for key explanatory variables in the final five-year period

	Percentile	**N**	**Mean**	**Std Dev**	**Min**	**Max**	**Percentile**	**N**	**Mean**	**Std Dev**	**Min**	**Max**
			Product Herfindahl						Market Herfindahl			
10%	0.016	64	0.120	0.17	0.008	0.819	0.067	64	0.155	0.14	0.052	0.755
25%	0.029						0.083					
50%	0.051						0.112					
75%	0.127						0.175					
90%	0.312						0.236					
			5 product						5 market			
10%	0.204	64	0.464	0.22	0.132	0.974	0.487	64	0.630	0.12	0.409	0.966
25%	0.293						0.531					
50%	0.415						0.615					
75%	0.612						0.712					
90%	0.769						0.783					
			10 product						10 market			
10%	0.309	64	0.577	0.21	0.212	0.983	0.100	64	0.777	0.10	0.566	0.989
25%	0.395						0.250					
50%	0.581						0.500					
75%	0.755						0.750					
90%	0.828						0.900					
			PC product						PC market			
10%	-2.305	64	-0.882	1.29	-2.706	2.788	-1.997	64	-0.604	1.30	-2.765	3.256
25%	-1.885						-1.560					
50%	-1.082						-0.767					
75%	-0.139						0.120					
90%	0.951						0.704					
			Openness									
10%	0.684	64	0.841	0.11	0.618	1.133						
25%	0.791											
50%	0.857											
75%	0.898											
90%	0.950											

Table A.5: Average diversification index values in final 5-year period†

Country	Product Herfindahl	5 Product	10 Product	Market Herfindahl	5 Market	10 Market
Algeria	0.444	0.958	0.983	0.119	0.695	0.894
Argentina	0.035	0.355	0.492	0.072	0.509	0.651
Australia	0.035	0.326	0.488	0.078	0.536	0.707
Bangladesh	0.088	0.616	0.788	0.154	0.683	0.837
Belgium	0.024	0.279	0.345	0.099	0.637	0.779
Bolivia	0.105	0.583	0.753	0.151	0.735	0.890
Botswana	0.632	0.935	0.969	0.643	0.966	0.989
Brazil	0.016	0.197	0.317	0.073	0.442	0.595
Burkina Faso	0.396	0.753	0.821	0.245	0.819	0.938
Canada	0.033	0.338	0.425	0.738	0.914	0.941
Chile	0.108	0.538	0.659	0.071	0.487	0.683
China	0.012	0.180	0.277	0.102	0.607	0.720
Colombia	0.068	0.474	0.578	0.206	0.653	0.759
Costa Rica	0.127	0.598	0.686	0.236	0.650	0.794
Denmark	0.013	0.204	0.279	0.071	0.504	0.711
Dominican Rep	0.051	0.398	0.579	0.205	0.764	0.878
Ecuador	0.246	0.769	0.825	0.209	0.694	0.836
El Salvador	0.069	0.485	0.613	0.153	0.783	0.917
France	0.016	0.230	0.304	0.065	0.512	0.687
Gambia, The	0.127	0.609	0.758	0.214	0.820	0.931
Ghana	0.202	0.681	0.828	0.096	0.588	0.780
Guatemala	0.042	0.392	0.559	0.175	0.720	0.846
Honduras	0.081	0.503	0.690	0.201	0.728	0.849
India	0.028	0.256	0.344	0.057	0.409	0.566
Indonesia	0.027	0.292	0.393	0.090	0.568	0.724
Iran	0.691	0.882	0.901	0.199	0.844	0.914
Ireland	0.057	0.447	0.616	0.112	0.658	0.834
Israel	0.142	0.508	0.596	0.162	0.584	0.721
Italy	0.008	0.132	0.212	0.058	0.484	0.618
Japan	0.032	0.294	0.397	0.103	0.573	0.726
Jordan	0.051	0.432	0.644	0.117	0.623	0.761
Kenya	0.080	0.518	0.623	0.069	0.507	0.672
Madagascar	0.112	0.637	0.789	0.225	0.777	0.887
Malawi	0.312	0.811	0.884	0.075	0.540	0.732
Malaysia	0.043	0.365	0.499	0.093	0.585	0.761
Mexico	0.029	0.303	0.433	0.755	0.919	0.944
Morocco	0.030	0.298	0.480	0.153	0.669	0.807
Netherlands	0.010	0.167	0.238	0.095	0.598	0.738
New Zealand	0.031	0.320	0.464	0.084	0.555	0.686
Nicaragua	0.055	0.443	0.647	0.160	0.716	0.879
Nigeria	0.819	0.974	0.983	0.168	0.666	0.823
Norway	0.256	0.699	0.759	0.097	0.603	0.812
Pakistan	0.050	0.396	0.583	0.084	0.492	0.644
Panama	0.052	0.382	0.482	0.255	0.690	0.812
Paraguay	0.170	0.682	0.815	0.155	0.707	0.848
Peru	0.077	0.528	0.664	0.105	0.537	0.694
Philippines	0.132	0.590	0.691	0.111	0.629	0.863
Portugal	0.019	0.231	0.347	0.115	0.669	0.839
Senegal	0.095	0.556	0.712	0.114	0.603	0.789
South Africa	0.031	0.351	0.466	0.052	0.444	0.589
Spain	0.029	0.265	0.332	0.083	0.590	0.725
Sri Lanka	0.041	0.351	0.503	0.163	0.635	0.755
Sweden	0.017	0.230	0.327	0.055	0.443	0.680
Syria	0.431	0.772	0.825	0.147	0.667	0.821
Thailand	0.016	0.212	0.309	0.075	0.516	0.682
Togo	0.109	0.637	0.752	0.092	0.594	0.742
Trinidad & Tobago	0.173	0.723	0.785	0.327	0.737	0.828
Tunisia	0.037	0.357	0.503	0.175	0.747	0.884
Turkey	0.015	0.198	0.309	0.055	0.445	0.620
United Kingdom	0.017	0.238	0.337	0.067	0.508	0.694
United States	0.011	0.177	0.255	0.086	0.521	0.671
Uruguay	0.040	0.349	0.469	0.088	0.527	0.703
Zambia	0.255	0.766	0.881	0.194	0.762	0.892
Zimbabwe	0.093	0.541	0.657	0.096	0.539	0.724

† Notes: 5-year period beginning 2001–2005, inclusive.