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How do trade and financial integration affect the relationship between growth and volatility?

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Abstract

The influential work of Ramey and Ramey [Ramey, G., Ramey, V.A., 1995. Cross-country evidence on the link between volatility and growth. American Economic Review 85, 1138–1151 (December).] highlighted an empirical relationship that has now come to be regarded as conventional wisdom—that output volatility and growth are negatively correlated. We reexamine this relationship in the context of globalization—a term typically used to describe the phenomenon of growing international trade and financial integration that has intensified since the mid-1980s. Using a comprehensive new data set, we document that, while the basic negative association between growth and volatility has been preserved during the 1990s, both trade and financial integration significantly weaken this negative relationship. Specifically, we find that, in a regression of growth on volatility and other controls, the estimated coefficient on the interaction between volatility and trade integration is significantly positive. We find a similar, although less robust, result for the interaction of financial integration with volatility.

Keywords: Globalization; International trade and financial linkages; Macroeconomic volatility and growth

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In an influential paper, Ramey and Ramey (1995) documented an empirical relationship that has now come to be regarded as conventional wisdom—that volatility and growth are negatively correlated. This is an important result since it suggests that policies and exogenous shocks that affect volatility can also influence growth. Thus, even if volatility is considered intrinsically a second-order issue, its relationship with growth indicates that volatility could indirectly have first-order welfare implications.

How do trade and financial integration affect the relationship between growth and volatility? This paper attempts to answer this question, which has taken on increasing importance in view of the significant increases in the volumes of international trade and financial flows over the last four decades (see Lane and Milesi-Ferretti, 2001; Kose et al., 2005, in press-b). Cross-country trade linkages have of course been rising steadily during the past four decades. Cross-border capital flows, on the other hand, began to surge only in the mid-1980s. While the spread of trade linkages has been broad-based, only a relatively small group of developing economies, often referred to as "emerging markets," has undergone significant financial integration, as measured by gross capital flows across their borders. Many of these economies have experienced rapid growth but have also been subject to high volatility, most prominently in the form of severe financial crises that befell many of them during the last decade and a half.

These developments naturally lead to the question of whether, in a more integrated global economy, the relationship between growth and volatility has changed. The changes over time in the relative vulnerability of industrial and developing economies to external crises also raises questions about whether the growth–volatility relationship is influenced by the "growing pains" seemingly associated with rising trade and financial integration. In other words, are the level of a country's development and the extent of its integration into international markets important in determining the conditional validity of this relationship?

The Ramey and Ramey results are based on a data set that ends in 1985, just when the pace of globalization began to pick up and enveloped a number of developing countries as well. As we discuss later in the paper, some recent studies show that the negative relationship between growth and volatility has persisted into the 1990s. However, none of these papers provides a rigorous analysis of the role of rising trade and financial linkages in influencing this relationship. Thus, a central contribution of this paper is a comprehensive analysis of the roles of both trade and financial integration in driving the growth–volatility relationship.

In Section 1, we provide a brief overview of the theoretical and empirical literature examining the effects of globalization on growth and volatility. 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 vulnerability to external shocks. The effects of financial integration on both growth and volatility are far less obvious. Thus, the question addressed in this paper is essentially an empirical one. This survey also indicates that neither existing theoretical studies nor empirical ones have rigorously examined the effects of increased trade and financial linkages on the growth–volatility relationship. Our analysis does not take a position on whether trade and financial integration affect growth and/or volatility independently but is more narrowly focused on the question of whether integration itself affects the marginal relationship between volatility and growth, after controlling for other factors.

In Section 2, we describe the data set used in the analysis. An important feature of the data set, which covers the period 1960–2000, is that it includes a comprehensive set of measures of trade and financial integration. In Section 3, we provide a variety of stylized facts about the changes in the dynamics of growth and volatility over time and across countries. We find that the growth–volatility relationship varies across different country groups and, more importantly, has been changing over time. This sets the stage for the more formal empirical analysis in Section 4, where we use various regression models to analyze the determinants of the growth–volatility relationship.

Our regression results indicate that the basic result of a negative cross-sectional association between volatility and growth holds up even in the 1990s. More importantly, however, we find that the result is sensitive to the choice of country groups. For example, the results indicate that, while there is a significant positive relationship among industrial countries, the relationship is significantly negative among developing countries. Moreover, the association between growth and volatility in developing countries depends on the extent of financial integration. In more financially integrated economies, the relationship appears to be positive, whereas in less financially integrated ones it is negative.

We then use cross-section and panel regressions to conduct a more formal analysis of the growth–volatility relationship, including an examination of how the evolutions of trade and financial linkages may have affected this relationship. Using measures of average growth and volatility in each decade, we find that the negative relationship between growth and volatility survives when we include standard controls from the growth literature and account for the interaction between volatility and different measures of global integration.

Our main result is that trade and financial integration weaken the negative growth–volatility relationship. Specifically, in regressions of growth on volatility and other control variables, we find that the estimated coefficients on interactions between volatility and trade integration are significantly positive. We find a similar, although less robust, result for the interaction of financial integration with volatility.

In Section 5, we report a variety of robustness checks of our main results. We consider different regression frameworks to further examine the robustness of our results. In particular, we employ fixed effects regressions to capture country-specific effects, least absolute deviation regressions to check the role of outliers in driving the main findings, and instrumental variables regressions to account for the possible endogeneity of the integration variables. The results indicate that our main findings are robust to potential problems associated with fixed effects, the presence of outliers, and endogeneity issues. We then study the impact of other control variables, representing various possible channels linking volatility to growth. Section 6 concludes with a brief summary of the main results and possible directions for future research.

1. Review of economic theory and prior empirical research

It is useful to begin by reviewing the extensive literature that analyzes the effects of globalization separately on growth and volatility. Various theoretical models

emphasize the importance of trade openness in promoting economic growth. Similarly, in theory, there are various direct and indirect channels through which increased financial flows can enhance growth.[1] On the empirical front, however, recent research has been unable to establish a clear link between financial integration and economic growth (e.g., Edison et al., 2002). Although there is a large literature suggesting that openness to trade has a positive impact on growth (e.g., Sachs and Warner, 1995; Frankel and Romer, 1999; Dollar and Kraay, 2003; Wacziarg and Welch, 2003), some of the findings have been challenged by Rodriquez and Rodrik (2000), who raise questions about the measures of trade openness and the econometric methods employed in these studies.[2]

The theoretical impact of increased trade and financial flows on output volatility depends on various factors, including the composition of these flows, patterns of specialization, and the sources of shocks. For instance, financial integration could help lower the volatility of macroeconomic fluctuations in capital-poor developing countries by providing access to capital that can help these countries diversify their production base. Rising financial integration could, however, also lead to increasing specialization of production based on comparative advantage considerations, thereby making economies more vulnerable to industry-specific shocks (Kalemli-Ozcan et al., 2003). In addition, sudden changes in the direction of capital flows could induce boom–bust cycles in developing countries which do not have deep financial sectors to cope with volatile capital flows (Aghion et al., 1999).

Recent empirical work has been unable to establish a clear link between stronger trade or financial linkages and macroeconomic volatility. Most studies find that an increase in the degree of trade openness leads to higher output volatility, especially in developing countries (Easterly et al., 2001; Kose et al., 2003), although there are some exceptions (Buch et al., 2002). Bekaert et al. (2002a,b) find that domestic equity market liberalizations are associated with lower volatility of output growth. IMF (2002) also provides evidence that financial openness is associated with lower output volatility in developing countries. By contrast, Kose et al. (2003) find that financial integration does not significantly affect output volatility.

Whether volatility and growth should be investigated independently, rather than studied as related phenomena, has also been the subject of some debate. Papers in the stochastic dynamic business cycle literature have propounded the view that the distinction between trend and cycles is an artificial one, since both growth and fluctuations are driven by the same set of shocks. However, as discussed in Jones et al. (2000), it is hard to derive a clear implication from these models about the relationship between volatility and growth. In their models, Mendoza (1997) and Jovanovic (2004) show that, under certain assumptions, macroeconomic volatility can have a negative effect on growth. Other authors have argued

[1] Prasad et al. (2003) provide a review of theoretical and empirical studies that analyze the effects of financial integration on economic growth.

[2] Baldwin (2003) and Winters (2004) provide extensive surveys of the literature on trade liberalization and economic growth. Winters (2004) concludes that "while there are serious methodological challenges and disagreements about the strength of the evidence, the most plausible conclusion is that liberalization generally induces a temporary (but possibly long-lived) increase in growth."

that macroeconomic volatility could have a beneficial impact on economic growth (e.g., Blackburn, 1999; Ranciere et al., 2003; Tornell et al., 2004).

Direct empirical examinations of the relationship between output volatility and growth date back to contributions by Kormendi and Meguire (1985) and Grier and Tullock (1989), who suggest that the relationship is positive. The paper by Ramey and Ramey (1995; henceforth referred to as RR) established the benchmark result that growth and volatility are negatively related. Using a data set comprising 92 countries and covering the period 1950–1985, they show that the relationship is robust after introducing various control variables, including the share of investment in GDP, population growth, human capital, and initial GDP.

More recent work using different methodologies and data sets broadly tends to confirm the negative relationship between volatility and growth. This set of papers includes Martin and Rogers (2000), Fatás (2002), Hnatkovska and Loayza (in press).[3] The latter two papers also examine the role of trade openness and conclude that it has no significant impact on the relationship between volatility and growth. None of these authors looks at the effects of financial openness on this relationship.

In summary, there are four major points to be taken from our brief survey. First, economic theory suggests that globalization should have a positive impact on growth, but does not provide strong predictions about its impact on volatility or on the relationship between growth and volatility. Second, a large body of empirical research suggests that, subject to certain caveats, increasing trade openness tends to be associated with both higher growth and more volatility. In contrast, recent studies indicate that the effects of financial openness on growth and volatility are far less clear. Third, several recent empirical studies appear to confirm the negative relationship between growth and volatility, both in unconditional terms and controlling for a variety of standard determinants of growth. Fourth, neither theoretical studies nor empirical ones have rigorously examined the effects of increased trade and financial linkages on the growth–volatility relationship. In our view, rising global linkages, especially financial linkages, constitute one of the key economic phenomena over the last two decades in terms of understanding how macroeconomic volatility and growth are related. This provides a point of departure for our paper from the existing literature.

2. Data set

We study the relationship between growth and volatility using a large data set that includes industrial as well as developing countries. A full description of the data set–including the list of countries and descriptions of the variables and their sources–is provided in the data appendix of the working paper version of our paper (Kose et al., 2005).

[3] In related research, Catão and Kapur (2004) find that the volatility of output plays a major role in determining the sovereign risk rating of several developing countries. For a summary of several recent studies, see Kose et al. (in press-b) and Aizenman and Pinto (in press).

While the basic data set we use is the latest version of the Penn World Tables (Heston et al., 2002), we supplement that with data from various other sources, including databases maintained by the World Bank and IMF. Our data set comprises annual data over the period 1960–2000 for a sample of 85 countries—21 industrial and 64 developing. It is possible to employ a more comprehensive country coverage for the basic growth–volatility regressions used in RR. However, our main objective is to analyze how trade and financial openness affect this basic relationship and the data on financial openness turned out to be a major constraint to expanding the coverage of the data set any further.

For the descriptive analysis in the next two sections, we divide developing countries into two coarse groups—more financially integrated (MFI) economies and less financially integrated (LFI) economies. There are 23 MFI and 41 LFI economies in our sample. The former essentially constitute the group of "emerging markets" and account for a substantial fraction of net capital flows from industrial to developing countries in recent decades as we document in the next section. The group of industrial countries corresponds to a subsample of the OECD economies for which data used in the empirical analysis are available.

In our analysis, we use two measures of trade integration. The first is a binary measure–based on the dates of trade liberalization–taken from Wacziarg and Welch (2003), who extend the data set constructed by Sachs and Warner (1995). This measure takes a value of one when a country's trade regime is liberalized, and zero otherwise. The trade liberalization dates were based on a detailed examination of country case studies. Sachs and Warner (1995) have another binary measure of openness, which is based on the extent of restrictiveness of a country's trade policies. Both Rodriquez and Rodrik (2000) and Wacziarg and Welch (2003) have identified some major shortcomings of this latter measure. Hence, we use the former measure in our empirical analysis since the liberalization dates capture major changes in trade policy and, as noted by Wacziarg and Welch (2003), these are more reliable than the restrictiveness measure.[4] The second measure of trade integration is a continuous one used widely in the literature—the ratio of the sum of imports and exports to GDP.

To measure the degree of financial integration, we again employ both a binary and a continuous measure. Our binary measure takes a value of one when the equity market is officially liberalized and zero otherwise. The majority of the dates of official financial liberalization for individual countries are taken from Bekaert et al. (2002a,b) and Kaminsky and Schmukler (2003).[5] The former paper documents a chronology of official liberalizations of stock markets based on the dates of regulatory changes and the dates on which foreigners were granted access to the local market. The latter provide a

[4] We also experimented with using the restrictiveness measure in place of the measure based on liberalization dates in our regressions. The main results were mostly preserved.

[5] As these dates are not available on a consistent basis for some countries in our sample, we use various IMF sources to complete the set of dates of liberalizations. We also experimented with other binary measures of financial integration that are associated with current account and capital account restrictions. These include payment restrictions for current and capital account transactions, export surrender requirements, and multiple exchange rates. The use of alternative binary measures did not qualitatively affect our main findings.

chronology of financial liberalizations based on the dates of deregulation of the capital account, the domestic financial sector, and the stock market. Our second financial integration measure–the ratio of gross capital flows to GDP–is analogous to the trade openness ratio.

Our binary indicators can be considered as measures of de jure trade and financial integration while the continuous measures capture de facto integration. The distinction between de jure and de facto measures is of particular importance in understanding the effects of financial integration since many economies that have maintained controls on capital account transactions have found them ineffective in many circumstances, particularly in the context of episodes of capital flight.[6] The continuous measures also capture variations over time in the degree of trade and financial integration better than the binary ones as they reflect the changes in annual trade and financial flows.

3. Dynamics of growth and volatility

This section first discusses some stylized facts about the evolution of growth and volatility over time and across different groups of countries, followed by a brief descriptive analysis of growth–volatility dynamics before and after financial and trade liberalizations.

The first column of Table 1 presents, for different country groupings, the cross-sectional medians of the level and volatility of the growth rate of output over the past four decades. Volatility is measured as the standard deviation of output growth. Over the full sample period, output growth is highest on average for industrial countries, followed by MFI economies and then the LFI economies. The order is reversed for output volatility. Thus, at a very coarse level, there are signs of a negative cross-sectional relationship between growth and volatility.

This is confirmed by a cross-sectional plot of growth against volatility (Fig. 1a). In effect, this is the updated version of the basic RR regression. The relationship is, however, different across the three groups of countries. Like RR, we find a positive relationship between growth and volatility among industrial countries and a negative one among developing countries (Figs. 1b and c). But the relationship also differs among the developing countries. While it is strongly negative for LFI economies, it is positive among the group of MFI economies (Figs. 2a and b). These results suggest the need to take into account the extent of trade and financial integration while studying the relationship between growth and volatility.

An examination of changes in patterns of macroeconomic volatility over time (columns 2–5 of Table 1) reveals that average output growth and volatility have both been declining in industrialized countries over the past two decades.[7] Both MFI and

[6] See Prasad et al. (2003) for a discussion of the relationship between these two concepts of financial integration and the implications of measuring them separately.

[7] It has been extensively documented that there has been a steady decline in the volatility of macroeconomic aggregates of industrialized countries since the 1970s (see, e.g., Stock and Watson, 2004; Kose et al., 2004).

Table 1
Medians for each group of countries

	Full sample	Decade			
	1961–2000	1960s	1970s	1980s	1990s
Growth					
Industrial countries	2.80 [0.24]	3.75 [0.49]	2.75 [0.38]	2.09 [0.17]	1.88 [0.26]
Developing countries	1.57 [0.21]	2.46 [0.22]	2.06 [0.40]	0.32 [0.36]ψ	1.39 [0.38]
MFIs	2.61 [0.41]	3.06 [0.53]	2.80 [0.99]	1.76 [1.18]ψ	2.45 [0.70]
LFIs	1.23 [0.25]	2.25 [0.36]	1.77 [0.56]	−0.27 [0.36]ψ	0.83 [0.67]ψ
Volatility					
Industrial countries	2.59 [0.36]	2.18 [0.27]	2.78 [0.26]	2.12 [0.22]	1.79 [0.28]
Developing countries	4.90 [0.30]	4.62 [0.46]	4.83 [0.58]	3.89 [0.24]	3.39 [0.30]
MFIs	4.07 [0.42]	3.29 [0.57]	3.35 [0.43]	3.56 [0.64]	3.27 [0.51]
LFIs	5.38 [0.61]	4.82 [0.56]	6.40 [0.52]	4.05 [0.31]	3.39 [0.37]

Standard errors are in brackets. The symbol ψ indicates that the value is not significantly different from zero. All other values (unmarked) are statistically significant at the 1% level.

LFI economies saw a decline in their average output growth rates in the 1980s and a subsequent rebound in the 1990s, although growth remained below the corresponding levels in the 1970s. The evolution of volatility is less similar across these two groups, with MFI economies experiencing a small increase in volatility in the 1980s while LFI economies had a significant decline in their volatility in each of the last two decades. From this very broad perspective, it is difficult to detect a stable time-series relationship between growth and volatility that is consistent across different groups of countries.[8]

A different approach to exploring the effects of globalization on the growth–volatility relationship is to examine if it has shifted during the period of globalization for the group of MFI economies, which have faced the most dramatic shifts in openness to trade and financial flows during the past 20 years. For example, 20 out of 23 MFI economies in our sample implemented trade and/or financial liberalization reforms after 1985. In addition, anecdotal evidence suggests that these economies faced the largest shift in the growth–volatility relationship during the 1990s as periods of high growth were followed by periods of severe financial crises in some MFI economies. Figs. 3a and b show the relationship for this group of economies before and after trade and financial liberalization, respectively. The relationship is strongly negative in the period before trade liberalization and positive after that. The difference between the pre- and post-financial liberalizations periods follows a similar, but a somewhat less striking pattern. These plots suggest that trade and financial

[8] In order to examine whether the results discussed above could be influenced by the use of decade averages, we plotted the average level and volatility of output growth for different groups of countries using 10-year rolling windows. The qualitative features of the results in Table 1 are generally preserved, indicating that the use of decade averages is not driving or distorting these broad patterns in the data. These results are available from authors upon request. Kose et al. (in press-b) examine the evolution of growth and volatility of various macroeconomic aggregates over time.

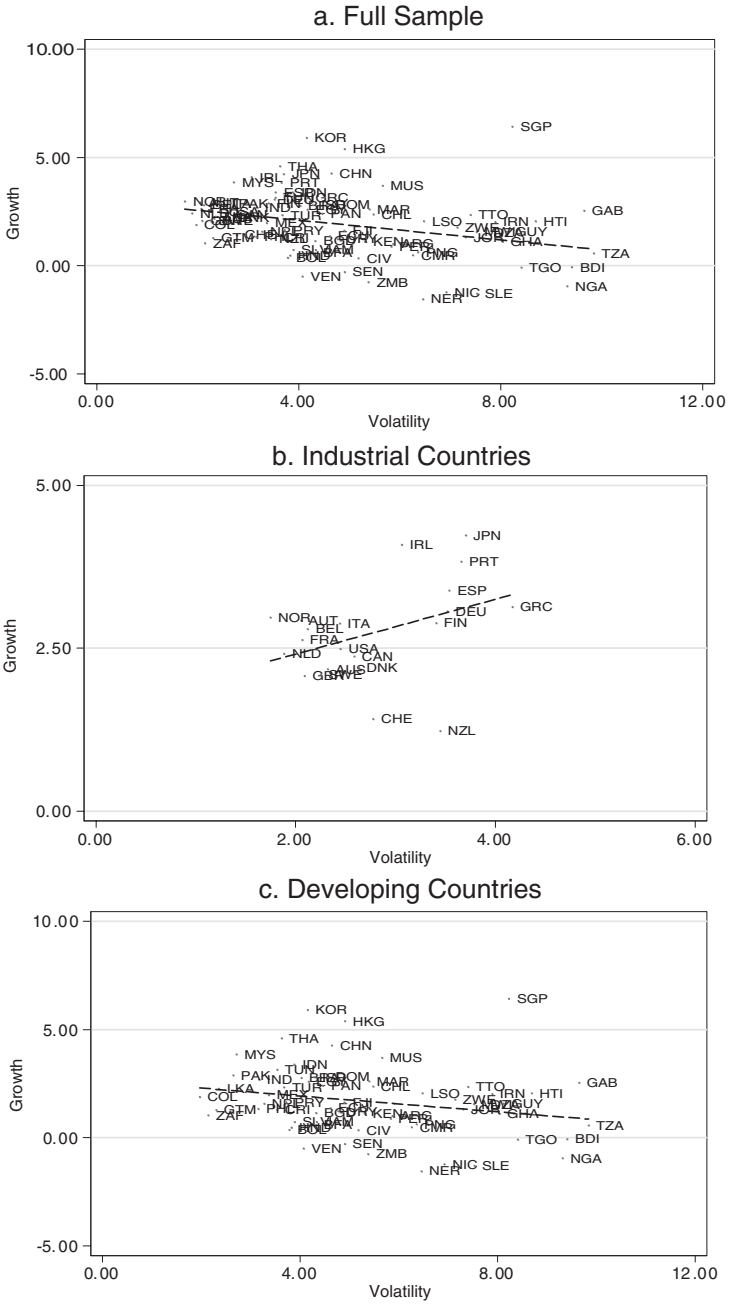

Fig. 1. Growth and volatility (simple correlation, 1960–2000).

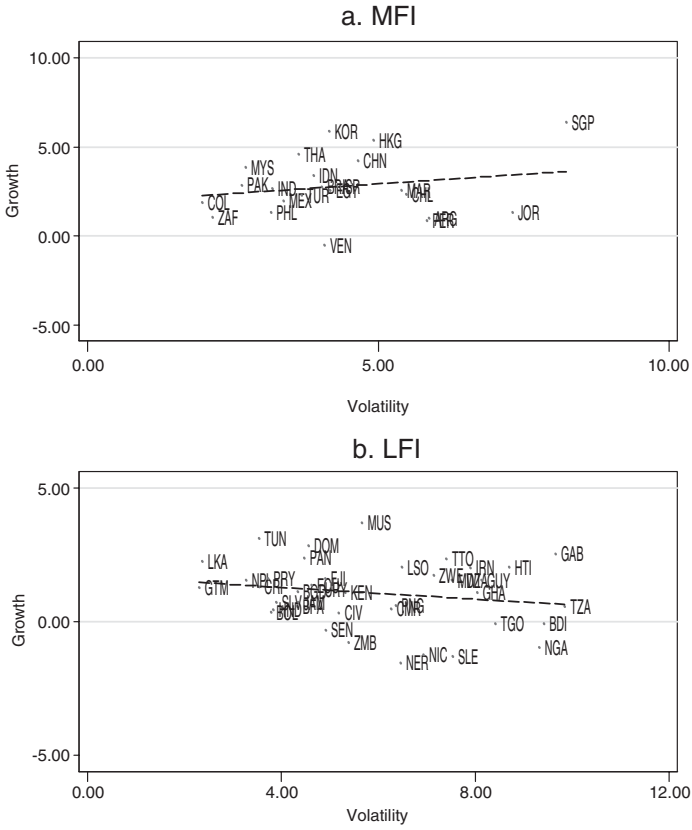

Fig. 2. Growth and volatility (simple correlation, MFI and LFI countries, 1960–2000).

integration might have a considerable effect on how volatility and growth are associated.[9]

The descriptive analysis in this section indicates that the unconditional relationship between volatility and growth has been changing over time and across different country groups in response to increased trade and financial flows, but it does not take into account some important considerations. First, the coarse country grouping used in the descriptive analysis so far does not capture differences in and changes over time in the degree of trade and financial integration of different countries. Second, this is a static classification of countries, which is unable to take into consideration other country characteristics that could influence both growth and volatility. Third, this is an ex-post classification that

[9] For these plots, we used country-specific dates of trade and financial liberalizations for the MFI economies. Since we did not have similar liberalization dates for industrial and LFI economies, we attempted a similar exercise for different groups of countries using 1985 as a break point, notwithstanding the problems associated with using a common date to capture liberalizations for all countries. Those results did not show a sharp shift in the relationship across the two periods.

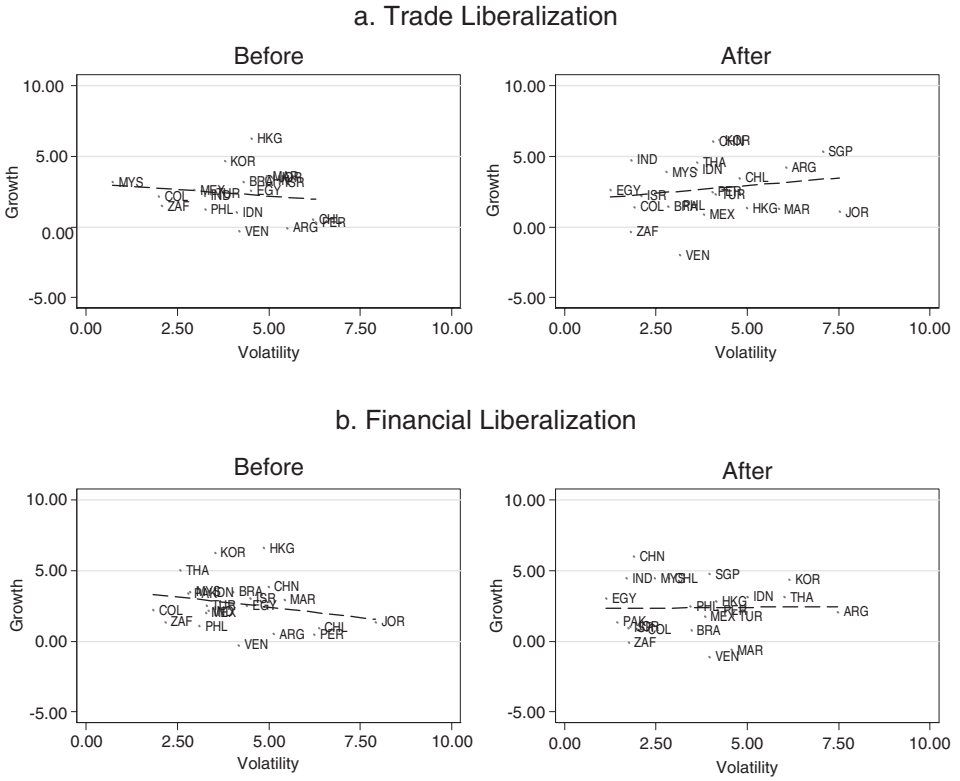

Fig. 3. Growth and volatility in MFI countries (simple correlation, before and after liberalizations).

ignores changes over time in the degree of development of countries (for instance, many OECD countries may not have been classified as industrial countries in the 1960s). Moreover, trade and financial liberalization programs are often accompanied by other reforms and policy measures that could have an impact on the relationship between growth and volatility. To address these issues, we turn to a more formal regression analysis that dispenses with these classifications and instead looks directly at measures of trade and financial integration.

4. The effects of integration on the growth–volatility relationship

We now undertake a more formal analysis of the relationship between growth and volatility using a variety of cross-sectional and panel regression techniques. After characterizing the unconditional relationship, we examine its sensitivity to the inclusion of various controls, taken mainly from the empirical growth literature. In order to examine the impact of trade and financial integration on this relationship, we then take a simple approach of interacting volatility with the measures of integration in our regressions.

4.1. Cross-sectional analysis

We begin by examining the cross-sectional relationship between volatility and growth. The first regression that RR report in their paper is a cross-sectional regression of mean output growth on the standard deviation of output growth for a 92-country sample over the period 1962–1985. They report that the coefficient on output volatility is significantly negative. We reestimate the basic RR regression with our sample of 85 countries for the period 1960–2000. As shown in Table 2 (column 1), we get a statistically significant coefficient of −0.23, confirming that the basic RR result is preserved in our sample.

We then examine this relationship within different country groups. A similar regression for the 21 industrial countries yields a significantly positive coefficient of 0.42 (column 2). RR find that, in their sample of 24 OECD economies, the coefficient on volatility is positive, but not significantly different from zero. One potential explanation of the difference between these two results is that the positive association between volatility and economic growth among industrial countries might have become stronger over time.[10]

In the case of the developing country subsample, we find a negative and statistically significant relationship between growth and volatility (column 3). We then analyze how the growth–volatility relationship differs across industrial, MFI, and LFI countries. To do this, we interact volatility with dummies for the three groups of countries. We again find a statistically significant positive relationship between volatility and growth for industrial countries (column 4). The results suggest that there is a weak positive association between volatility and growth (borderline significant at the 10% level) for MFI countries, whereas it is negative (but not statistically significant) for LFI countries. In addition, the coefficient associated with LFI countries appears to be different than those of other countries.

In short, the unconditional negative relationship between growth and volatility documented by RR is preserved in our sample, but it is sensitive to the choice of country groups. In particular, while the relationship is significantly positive for industrial countries, it is significantly negative for developing countries. Within the group of developing countries, the association differs across MFI and LFI economies. These results suggest that the levels of trade and financial integration have an influence on the growth–volatility relationship.

4.1.1. The effects of additional controls on the basic relationship

A problem with the regressions reported in Table 2 is that they ignore other variables that could explain growth. To address this issue, we draw upon the growth literature and include a set of standard controls including the log level of initial per capita income, the fraction of the population with at least a primary education, the share of investment in GDP, and the average population growth rate.

We present the results of regressions with additional controls in Table 3 (column 2). The results indicate that the additional controls are statistically significant with their

[10] Other reasons could be the difference in sample coverage (21 industrial countries in ours versus 24 in theirs) and data revisions in the Penn World Tables (PWT).

Table 2
Cross-section regressions

	Full sample [1]	Industrial countries [2]	Developing countries [3]	Full sample with interaction terms [4]
Volatility	−0.228 [0.076]***	0.420 [0.210]*	−0.182 [0.094]*	
Volatility × Industrial				0.363 [0.162]**
Volatility × MFI				0.239 [0.146]
Volatility × LFI				−0.112 [0.074]
Number of observations	85	21	64	85
Adjusted R-squared	0.09	0.11	0.04	0.32
Is the volatility coefficient equal across country groups? (p-values)				
H0: Industrial=MFI				0.257
H0: Industrial=LFI				0.000
H0: MFI=LFI				0.001
H0: Industrial=MFI=LFI				0.000

The dependent variable is the growth rate of GDP per capita. "Industrial," "MFI," and "LFI" denote country group dummy variables. Robust standard errors are reported in brackets. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. All regressions include an intercept.

expected signs. For instance, the education variable–a measure of investment in human capital–has a significantly positive impact on growth and initial per capita income has a significant and negative impact, which has been interpreted as evidence of conditional convergence. The coefficient on volatility now becomes smaller but retains its statistical significance.[11]

These results, while apparently stable, leave open the possibility that the true growth–volatility relationship is more subtle than can be captured by a simple linear specification. For instance, the RR result that the unconditional correlation between volatility and growth is negative for developing countries and positive for industrial countries would generate a type of nonlinearity. Our findings in Table 2 also indicate that there could be such a nonlinear relationship between growth and volatility. In a similar vein, Fatás (2002) finds that, for countries with high levels of per capita GDP, the relationship between growth and volatility turns positive. We now pursue this possibility but, instead of simply linking the nonlinearity to just a country's stage of development, we specifically examine whether trade and financial linkages have any impact on this relationship.

4.1.2. The roles of trade and financial integration

We now add different measures of integration to the cross-sectional regression to analyze how individual aspects of globalization affect the growth–volatility

[11] For the OECD subsample (results not shown here), the coefficient on the volatility of output turns negative, just as in the RR regressions with controls. The estimated coefficient is in our regression is almost the same as that estimated by RR (−0.385 in RR and −0.379 in our regression; both coefficients are statistically significant). These results are available from authors upon request.

Table 3
Cross-section regressions with control variables

	[1]	[2]	[3]	[4]	[5]	[6]
Volatility	−0.228 [0.076]***	−0.157 [0.073]***	−0.152 [0.077]*	−0.232 [0.089]**	−0.090 [0.087]	−0.230 [0.086]***
Volatility × Trade Integration				0.119 [0.044]**		0.162 [0.052]***
Volatility × Financial Integration					−0.128 [0.588]	−0.637 [0.318]**
Trade Integration (Binary)			0.012 [0.004]***	0.011 [0.005]*	0.012 [0.005]**	0.012 [0.004]***
Financial Integration (Binary)			0.013 [0.011]	0.003 [0.011]	0.005 [0.013]	0.009 [0.010]
Trade Integration (%GDP)			0.009 [0.003]***			
Financial Integration (%GDP)			−0.026 [0.009]***			
Initial Income (Log)		−0.009 [0.002]***	−0.010 [0.002]***	−0.010 [0.002]***	−0.010 [0.002]***	−0.010 [0.002]***
Primary Education		0.022 [0.005]***	0.024 [0.006]	0.024 [0.005]***	0.025 [0.006]***	0.023 [0.005]***
Investment Rate (%GDP)		0.111 [0.028]***	0.055 [0.027]**	0.063 [0.026]***	0.083 [0.030]***	0.056 [0.027]**
Population Growth		−0.005 [0.002]***	−0.004 [0.002]**	−0.004 [0.002]**	−0.003 [0.002]*	−0.004 [0.002]**
Number of observations	85	85	85	85	85	85
Adjusted R-squared	0.09	0.54	0.62	0.60	0.56	0.62

The dependent variable is the growth rate of GDP per capita. Robust standard errors are reported in brackets. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. For the interaction terms, trade integration is defined as the ratio of total trade to GDP, and financial integration is defined as the ratio of capital flows to GDP. All regressions include an intercept.

relationship.[12] When we introduce the two measures each of trade and financial integration, the coefficient on volatility remains negative and statistically significant. Interestingly, the coefficients on the trade openness indicators are positive, indicating that trade integration has a positive impact on economic growth, after controlling the effect of volatility (column 3). The coefficient on the financial openness variable is negative, however.[13]

Next, we interact volatility with the continuous measures of trade and financial integration variables to examine if the relationship between growth and volatility is linked to the degree of integration. Column 4 of Table 3 shows that the interaction between volatility and trade integration is significantly positive. The coefficient on volatility is also significant and negative. The positive interaction term indicates that, the greater the degree of trade integration, the weaker the negative relationship between volatility and growth. Column 5 reports results with the interaction of volatility and financial integration. The basic relationship between growth and volatility is no longer statistically significant and only the binary measure of trade integration has a positive and statistically significant coefficient. This result echoes that of Fatás and Mihov (2003), although in their sample the coefficient on volatility becomes smaller and insignificant when they include the basic RR set of control variables.[14]

In order to better understand the respective roles played by trade and financial integration in influencing the relationship between growth and volatility, we then include both sets of integration variables and interaction terms (column 6). The coefficient on volatility is statistically significant as before and so are the coefficients on trade integration and its interaction with volatility. These results indicate that accounting for trade integration and the interaction terms is essential for uncovering the negative conditional relationship between growth and volatility.

The coefficient on the financial integration interaction term turns negative and significant in this specification. This result is similar and could be related to the sign of the coefficient on the continuous financial integration variable in column 3. In other words, once one accounts for trade integration, financial integration appears to have a negative impact on the growth–volatility relationship. Does this result imply that the adverse impact of macroeconomic volatility is further exacerbated in more financially integrated economies? Such a strong conclusion, however, may not be warranted simply based on the cross-sectional regressions, which do not utilize the marked variation over time in the measures of integration. Hence, we now turn to a panel analysis of the relationship

[12] The binary measures are averaged over the full sample for each country and can, therefore, take values between 0 and 1.

[13] As discussed in Edison et al. (2002), the large body of literature analyzing the impact of financial integration on growth is not conclusive. There are several papers suggesting that there is no robust correlation between financial integration and economic growth and, in some of these, the coefficient on financial openness has a negative sign, similar to the result we report here.

[14] Fatás and Mihov (2003) note that the significance of the coefficient is quite sensitive to the coverage of countries. Martin and Rogers (2000) find that there is a significant negative relationship between growth and the amplitude of business cycles in developed countries. However, they do not find a statistically significant relationship for the group of developing countries. Imbs (2004) attempts to reconcile the positive relationship between growth and volatility at the sectoral level with the negative relationship at the country level.

between volatility and growth to capture the role of temporal changes in trade and financial flows.

4.2. Panel analysis

For the panel analysis, we break the data set into four separate decades. This means that, for each country, we have a maximum of four observations. For some countries, we were unable to get data on the financial openness variable for the 1960s, so we lose a few observations in that decade. We use average growth rates and the standard deviation of growth over each decade of the sample and corresponding transformations for the other variables in the regressions. For initial conditions such as the level of initial per capita income, we use the data at the beginning of each decade. All of the panel regressions below include time effects (dummies for three of the four decades).

The first column of Table 4 shows that, in the panel, the correlation between volatility and growth is similar to that in the cross-section in that it is negative and statistically significant, but smaller in absolute value (cf. Table 2, column 1). While the panel OLS regressions also suggest that there is a positive association between growth and volatility for industrial countries and a negative one for developing countries, these coefficients are not statistically significant (columns 2 and 3). However, when we interact volatility with country group dummies, we find that all of the coefficients have the same signs as in our cross-sectional regressions and the coefficients of volatility interacted with industrial and LFI country dummies become significant (column 4). These findings also point to the existence of a nonlinearity in the growth–volatility relationship.

Table 5 examines this relationship in the panel when additional controls are included. When we augment the basic regression with the same core set of controls for growth as in

Table 4
Panel regresssions

	Full sample [1]	Industrial countries [2]	Developing countries [3]	Full sample with interaction terms [4]
Volatility	−0.169 [0.071]**	0.158 [0.193]	−0.131 [0.079]	
Volatility × Industrial				0.256 [0.131]*
Volatility × MFI				0.139 [0.098]
Volatility × LFI				−0.155 [0.069]**
Number of observations	340	84	256	340
Adjusted R-squared	0.14	0.37	0.11	0.21
Is the volatility coefficient equal across country groups? (p-values)				
H0: Industrial=MFI				0.257
H0: Industrial=LFI				0.000
H0: MFI=LFI				0.000
H0: Industrial=MFI=LFI				0.000

The dependent variable is the growth rate of GDP per capita over each 10-year period. “Industrial,” “MFI,” and “LFI” are country group dummy variables. Robust standard errors are reported in brackets. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. All regressions include decade dummies.

Table 5
Panel regressions with control variables

	[1]	[2]	[3]	[4]	[5]	[6]
Volatility	−0.169 [0.071]**	−0.095 [0.073]	−0.103 [0.075]	−0.210 [0.103]**	−0.102 [0.076]	−0.221 [0.107]**
Volatility × Trade Integration				0.158 [0.054]***		0.137 [0.058]**
Volatility × Financial Integration					0.411 [0.200]**	0.307 [0.172]*
Trade Integration (Binary)			0.013 [0.003]***	0.011 [0.003]***	0.013 [0.004]***	0.012 [0.003]***
Financial Integration (Binary)			0.004 [0.004]	0.004 [0.004]	0.003 [0.004]	0.004 [0.004]
Trade Integration (%GDP)			0.005 [0.003]*			
Financial Integration (%GDP)			0.008 [0.007]			
Initial Income (Log)		−0.005 [0.002]**	−0.008 [0.003]**	−0.007 [0.002]***	−0.008 [0.003]**	−0.008 [0.003]**
Primary Education		0.020 [0.006]***	0.024 [0.007]***	0.021 [0.006]***	0.023 [0.007]***	0.022 [0.007]***
Investment Rate (%GDP)		0.108 [0.018]***	0.075 [0.021]***	0.078 [0.019]***	0.084 [0.020]***	0.072 [0.020]***
Population Growth		−0.004 [0.001]***	−0.002 [0.002]	−0.002 [0.002]	−0.002 [0.002]	−0.002 [0.002]
Number of observations	340	338	315	334	316	315
Adjusted *R*-squared	0.14	0.33	0.37	0.38	0.37	0.38

The dependent variable is the average growth rate of GDP per capita over each 10-year period. Robust standard errors are reported in brackets. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. For the interaction terms, trade integration is defined as the ratio of total trade to GDP, and financial integration is defined as the ratio of capital flows to GDP. All regressions include decade dummies.

the cross-sectional regressions, the coefficient on volatility remains negative but is no longer statistically insignificant (column 2). This remains the case when the trade and financial integration variables are included (column 3), although the indicators of trade openness are positive and significant. Once the term capturing the interaction of volatility with trade openness is included (column 4), however, the results become more interesting. The coefficient on volatility is now negative and the coefficients on trade openness and its interactions with volatility are both positive. In other words, the conditional relationship between growth and volatility is still negative, but trade integration makes this relationship less negative. The result with only the financial integration interaction term included (column 5) also yields an insignificant conditional relationship between volatility and growth. However, the interaction term is significantly positive, implying that financial integration also allows for higher volatility and higher growth to coexist.

Finally, we include both sets of integration variables and interaction terms in order to characterize how different aspects of globalization influence the growth–volatility relationship (column 6). These results indicate that the negative relationship between growth and volatility reemerges when we control for both trade and financial integration. The trade integration variable is positive and, as in the previous two specifications, the interaction terms are both significantly positive, suggesting that both trade and financial integration attenuate the negative relationship between growth and volatility. We regard this regression as our benchmark specification for capturing the full effects of globalization and now discuss its conceptual and empirical implications in more detail.

5. Robustness of the results

Our main result is that trade and financial integration attenuate the negative growth–volatility relationship. While the role of trade integration in dampening the adverse impact of volatility on growth is significant and robust, the role of financial integration is often significant but tends to be less robust. In this section, we examine the overall robustness of our main results. We first consider alternative regression frameworks to take into account some potential misspecification problems that could be associated with our earlier regressions. We then study the impact of adding various other control variables.

5.1. Alternative regression frameworks

We now turn to a number of potential concerns regarding our regression specification, starting with the omission of country fixed effects (FE). FE regressions help account for country-specific characteristics that may not be captured by the explanatory variables in our models. On the other hand, they eliminate cross-country variation in growth and volatility, which is much larger than the time-series variation and is also of greater interest for the main question of interest in this paper. In any case, column 2 of Table 6 presents the results of our benchmark specification with country fixed effects included. These results are encouraging in the sense that they are consistent with our main findings, which are reproduced in column 1; in fact, the coefficients on the interactions of volatility with both trade and financial integration become even larger.

Table 6
Robustness regressions

	Benchmark [1]	Fixed effects [2]	Weighted [3]	LAD [4]	IV [5]
Volatility	-0.221 [0.107]**	−0.233 [0.092]**	−0.222 [0.101]**	−0.295 [0.054]***	−0.402 [0.158]**
Volatility × Trade Integration	0.137 [0.058]**	0.204 [0.088]**	0.143 [0.053]***	0.203 [0.034]***	0.336 [0.157]**
Volatility × Financial Integration	0.307 [0.172]*	0.390 [0.220]*	0.310 [0.172]*	0.109 [0.157]	0.137 [0.187]
Trade Integration (Binary)	0.012 [0.003]***	0.010 [0.005]**	0.012 [0.003]***	0.010 [0.003]***	0.009 [0.004]***
Financial Integration (Binary)	0.004 [0.004]	0.005 [0.005]	0.005 [0.004]	0.009 [0.004]**	0.006 [0.004]
Initial Income (Log)	−0.008 [0.003]**	−0.004 [0.003]	−0.008 [0.003]**	−0.011 [0.001]***	−0.009 [0.002]***
Primary Education	0.022 [0.007]***	0.023 [0.014]*	0.023 [0.006]***	0.023 [0.005]***	0.023 [0.006]***
Investment Rate (%GDP)	0.072 [0.020]***	0.081 [0.031]***	0.072 [0.020]***	0.076 [0.016]***	0.061 [0.024]***
Population Growth	−0.002 [0.002]	−0.002 [0.003]	−0.002 [0.002]	−0.002 [0.001]*	−0.004 [0.002]**
Observations	315	315	315	315	308
R-squared	0.38	0.27	0.39	0.28	
R-squared first stage					0.60
Hansen J statistic (p-value)					0.45

The dependent variable is the average growth rate of GDP per capita over each 10-year period. Robust standard errors are reported in brackets. The symbols *, **, and *** indicate statistical significance at 10%, 5% and 1% levels, respectively. All regressions include decade dummies. The benchmark regression in column 1 corresponds to column 6 in Table 5. For the fixed effects regressions, the R-squared within is reported. In weighted OLS regressions, countries are weighted by their average GDP. For the Least Absolute Deviation (LAD) regression, the pseudo-R-squared is reported. The IV regressions use terms of trade volatility, the interaction of volatility with relative income, initial level of M2/GDP, and a gravity variable as instruments for the volatility * trade integration interaction term.

In our analysis, we treat a country as the unit of analysis. To check if large countries may be driving the results, we reestimated the benchmark regression using weighted OLS, with average log GDP as the weights (column 3). The main results are not affected.

A potential problem with our results is that they could be driven by outliers. To check this, we reestimate our main specification using LAD regressions, which use the median as a measure of central tendency. The interaction term for trade integration is still statistically significant while that for financial integration becomes insignificant (column 4). In other words, trade integration once again has a robust impact on the growth–volatility relationship while financial integration appears to play a less important role.[15]

Another key concern is related to potential endogeneity of the integration variables. There has of course been a substantial literature dealing with the endogeneity of trade openness in growth regressions (see, e.g., Frankel and Romer, 1999). The endogeneity of volatility itself is also a potential concern. We used a GMM technique to test for the endogeneity of each of the volatility and integration terms as well as their interactions (see Hayashi, 2000; Baum et al., 2003). The only variable that appears to be endogenous in our regressions is the interaction between volatility and trade openness. We reestimate our benchmark specification using terms-of-trade volatility, country size and gravity variables to instrument for this interaction term (column 4).[16] The coefficient on this variable remains significantly positive while the coefficient associated with financial integration interaction turns insignificant. The remaining coefficients are largely unaffected.

In summary, the main findings of our paper are generally robust to potential concerns about misspecification associated with fixed effects, the presence of outliers, and endogeneity of regressors. While the role of trade integration in dampening the negative association between volatility and growth is significant across all these robustness tests, the role of financial integration tends to be less robust and is insignificant in some instances.

5.2. Other control variables

A key concern, related to our earlier results showing differences between industrial and developing countries in terms of the growth–volatility relationship, is that our results may be misspecified due to omission of interactions of volatility with income level and country size. We therefore include these variables and their interactions with volatility in Table 7 (columns 2 and 3; with column 1 showing our benchmark result to facilitate comparison). Our main results appear robust to the inclusion of these interactions.[17]

[15] We also ran additional LAD regressions using the different subsamples of countries and find that our results are still valid for the developing country and MFI subsamples.

[16] These are valid instruments in the sense that R-squared from the first-stage regression in the IV estimation is 0.60 and they satisfy the orthogonaility condition as evidenced by J Statistic of Hansen.

[17] The new results reported in this table build upon those in Table 6 by using GMM techniques to instrument for the volatility * trade openness interaction terms and also to correct for heteroskedasticity (in any case, all of the standard errors reported in earlier tables are also robust standard errors that correct for heteroskedasticity).

Table 7
Panel regressions with additional controls

	Benchmark (IV) [1]	Income [2]	Size (population) [3]	Credit (%GDP) [4]	Growth of terms-of-trade [5]	Real exchange rate overvaluation [6]	Agricultural sector (%GDP) [7]	Property rights [8]	Executive constraints [9]	Political instability [10]
Volatility	−0.402	−0.407	−0.314	−0.381	−0.409	−0.690	−0.497	0.013	−0.620	−0.458
	[0.158]**	[0.160]**	[0.155]**	[0.135]***	[0.153]***	[0.232]***	[0.224]**	[0.415]	[0.193]***	[0.188]**
Volatility × Trade Integration	0.336	0.357	0.285	0.352	0.343	0.522	0.409	0.321	0.425	0.376
	[0.157]**	[0.171]**	[0.147]*	[0.162]**	[0.153]**	[0.205]**	[0.171]**	[0.164]*	[0.219]*	[0.209]*
Volatility × Financial Integration	0.137	0.127	0.206	0.014	0.141	−0.124	0.110	0.160	0.058	0.091
	[0.187]	[0.200]	[0.174]	[0.196]	[0.190]	[0.260]	[0.215]	[0.184]	[0.249]	[0.242]
Trade Integration (Binary)	0.009	0.009	0.010	0.010	0.009	0.007	0.008	0.009	0.009	0.010
	[0.004]***	[0.004]**	[0.003]***	[0.003]***	[0.003]***	[0.004]*	[0.004]**	[0.004]***	[0.004]**	[0.004]***
Financial Integration (Binary)	0.006	0.005	0.004	0.006	0.006	0.008	0.005	0.004	0.007	0.006
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]*	[0.004]	[0.005]	[0.004]*	[0.004]
Initial Income (Log)	−0.009	−0.008	−0.008	−0.015	−0.009	−0.012	−0.007	−0.008	−0.008	−0.007
	[0.002]***	[0.004]*	[0.002]***	[0.002]***	[0.002]***	[0.002]***	[0.003]**	[0.002]***	[0.002]***	[0.002]***
Primary Education	0.023	0.021	0.021	0.027	0.022	0.021	0.024	0.025	0.022	0.022
	[0.006]***	[0.006]***	[0.006]***	[0.006]***	[0.006]***	[0.007]***	[0.007]***	[0.006]***	[0.006]***	[0.006]***
Investment Rate (%GDP)	0.061	0.060	0.067	0.081	0.062	0.067	0.061	0.051	0.051	0.057
	[0.024]***	[0.024]**	[0.023]***	[0.023]***	[0.024]***	[0.027]**	[0.025]**	[0.027]*	[0.026]**	[0.025]**
Population Growth	−0.004	−0.004	−0.003	−0.006	−0.004	−0.006	−0.004	−0.003	−0.005	−0.005
	[0.002]**	[0.002]*	[0.002]*	[0.002]***	[0.002]**	[0.002]***	[0.002]**	[0.002]	[0.002]**	[0.002]**
Additional Control			0.000	0.004	0.000	0.000	0.012	0.005	−0.003	−0.001
			[0.000]***	[0.007]	[0.001]	[0.000]**	[0.026]	[0.005]	[0.001]**	[0.000]**
Additional Control × Volatility		0.000	−0.001	−0.014	−0.001	0.002	0.176	−0.101	0.030	0.009
		[0.000]	[0.001]	[0.280]	[0.012]	[0.001]	[0.505]	[0.131]	[0.024]	[0.007]
Number of observations	308	315	315	293	308	294	305	305	305	305

The dependent variable is the average growth rate of GDP per capita over each 10-year period. Robust standard errors are reported in brackets. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Column 1 is our IV regression specification, and corresponds to column 5 in Table 6. Additional control in each column is specified above the column number. All regressions include decade dummies.

A potentially important channel linking volatility to growth is financial market development (see Denizer et al., 2002; Rajan and Zingales, 1998). We measure the level of financial market development by the ratio of total credit to the private sector to GDP. We also interact the credit ratio with volatility to analyze whether the growth–volatility relationship changes in countries with more developed financial markets. The interaction term is positive but not significant. The coefficients on volatility itself and on its interaction with trade integration are still statistically significant and positive. This suggests that the impact of trade integration on the growth–volatility relationship is above and beyond the role played by the depth of domestic financial markets.

We also examined other indicators that others have found to influence growth, including changes in the terms of trade, a measure of real exchange rate overvaluation and the share of the agricultural sector in GDP (see Sachs and Warner, 1995; Sala-i-Martin, 1997). None of these variables affects our main conclusions (columns 4–6).

Some recent studies argue that the quality of institutions plays an important role in (separately) determining the dynamics of growth and of volatility (see Acemoglu et al., 2003). We introduce various measures of institutional quality and political stability into our regressions to assess the robustness of our findings to such common factors that may affect both growth and volatility. For example, we experiment with measures of property rights, which indicates the degree of legal protection given to the ownership of private property; constraints on the executive branch of government, reflecting institutional and other limits placed on presidents and other political leaders; and political instability, which captures the likelihood that the government will be overthrown by unconstitutional or violent means. As one might expect, weak institutions have a negative effect on growth. But none of these variables has a major impact on our key results.[18] The results of this section suggest that our findings are robust to the introduction of other major control variables.

5.3. Discussion

As emphasized earlier, our reduced-form regression framework does not necessarily imply a causal relationship between volatility and growth. Nevertheless, it is interesting to note that our result about the effects of trade integration is consistent with several recent studies documenting the positive impact of trade integration on growth and a related literature suggesting that economies that are more open to trade tend to be more vulnerable to external shocks. The finding that the coefficient on the financial integration interaction term is of a similar sign but less robustly significant than that for trade integration is consistent with recent studies showing that the direct causal effects of financial integration on growth are not strongly and robustly positive but that its effects on volatility are more apparent. This result also has some intuitive appeal in terms of relating it to the experiences of emerging markets that, during the

[18] We also tried other variables, including those which captures a country's legal origin and the degree of ethnolinguistic fractionalization. Our main results were not affected.

late 1980s and 1990s, experienced relatively high growth but also higher volatility.[19] In addition, it ties in nicely with the basic RR result that, among industrial economies, which tend to be more open to financial flows, the relationship between growth and volatility is positive.

Next, we examine the significance of the results in terms of economic magnitudes using the IV specification in Table 6 column 5. The marginal relationship between volatility on growth is determined by the coefficients on volatility and the two interactions terms. At the sample means of the integration variables, this marginal effect is −0.183, with a standard error of 0.082. This suggests, for instance, that going from the mean of the volatility measure for industrial economies (0.024) to that of developing economies (0.048)–and assuming that both sets of economies have the mean levels of trade and financial integration corresponding to the full sample average–is associated with lower growth of about 0.44 percentage points (0.0044). We would of course not ascribe the lower growth of developing economies relative to industrial countries to the higher volatility of the former based simply on our reduced-form regressions. But it is still interesting, based on this purely mechanical exercise, to note that the figure amounts to 40% of the observed difference in mean growth rates across the two groups. When we perform this comparative exercise for the 1990s (at the mean of the data for the 1990s), using the same coefficients, the implied effect of going from the average volatility level of industrial countries to that of developing countries (0.022 to 0.042) drops to about 0.28 percentage points of growth, which is about 55% of the observed mean difference in growth across the two groups (1.9% for industrialized versus 1.4% for developing countries).

6. Conclusions and extensions

In this paper, we have documented that the negative relationship between volatility and growth has survived into the 1990s, but with some important qualifications. Our main finding is that trade and financial integration appear to weaken the negative growth–volatility relationship. Specifically, we find that, in regressions of growth on volatility and other controls, the estimated coefficients on interactions between volatility and trade integration are significantly positive, suggesting that countries that are more open to trade appear to be able to tolerate higher volatility without adverse consequences for long-term growth. A related but alternative interpretation of this result is that, in economies that are intrinsically more volatile, the beneficial effect of trade integration on growth may be stronger. We find a similar but much less robust result for the interaction of financial integration with volatility.

[19] Trade integration could help a developing economy to export its way out of a recession since a given exchange rate depreciation could have a larger impact on its export revenues than a less open economy. In addition, this could help service its external debt, which is quite substantial in a number of developing countries (see Catão, 2002). These factors also suggest that openness to trade flows could make developing countries less vulnerable to sudden stops of international capital flows (see Cavallo and Frankel, 2004). Kose et al. (in press-a) analyze the impact of NAFTA on the dynamics of volatility and growth in Mexico and argue that trade integration has made the Mexican economy more resilient to shocks and may have contributed to its faster recovery from the 1994–1995 peso crisis than from the 1982 debt crisis.

Some recent empirical studies have analyzed how the relationship between growth and volatility is affected by a variety of shocks stemming from terms of trade, macroeconomic policy variables, and financial flows. For example, Fatás and Mihov (2003) find that the volatility of measures of fiscal policy reduces economic growth. Mendoza (1997) and Turnovsky and Chattopadhyay (2002) document the negative impact of terms of trade volatility on growth. Some other papers emphasize the importance of external shocks in explaining economic growth in developing countries (see Deaton and Miller, 1996; Calderón et al., 2004; Bleaney and Greenaway, 2001).[20] To analyze the robustness of our results, we have examined the impact of volatility associated with composite measures of external and domestic shocks, respectively. In particular, in our baseline regression specifications, we replaced the volatility of output growth with volatility of each of these sources of shocks.[21]

The results of these additional experiments suggest that, in general, both trade and financial integration weaken the growth–volatility relationship, but the significance and magnitude of their impact depend on the particular source of volatility as presented in Table 8. For example, the negative coefficient on volatility and the positive coefficients on the trade integration and volatility * trade integration interaction variables were significant when we experimented with volatility of external and domestic shocks (columns 2 and 3). However, the coefficients on the interaction variables were not significant when we used the volatility of domestic shocks.[22] These preliminary results suggest that further research is necessary to provide a better understanding of the roles played by various shocks in driving the relationship between volatility and growth.

Our findings should be seen in the context of a rapidly burgeoning literature examining the effects of globalization on volatility and growth. Controversies still abound in this literature, even about basic issues such as whether trade and financial integration contribute to higher growth. We do not assess the evidence on these issues within our framework since they are not directly relevant to our more narrowly focused question about whether integration affects the growth–volatility relationship. Furthermore, there is still not a well-developed theoretical framework for addressing the nature of the growth–volatility relationship in a general setting. While our empirical approach analyzes only a particular dimension of the relationship between volatility and growth, our view is that it is nevertheless a useful empirical exercise that could set the stage for a richer theoretical investigation of this relationship.

In future work, we plan to explore in more detail the relationship between growth and the volatility of the components of output in particular, consumption and investment. This

[20] Judson and Orphanides (1996) find evidence of a negative relationship between inflation volatility and economic growth.

[21] The volatility of external shocks is proxied by the predicted volatility from a regression of the volatility of output growth on terms of trade volatility, volatility of trade flows, and volatility of financial flows. Volatility of domestic shocks is measured by the predicted volatility from a regression of volatility of output growth on the volatility of government consumption and inflation volatility.

[22] The results regarding the positive coefficients on integration and interaction variables did not change when we experimented with separate measures of volatility of the terms of trade, fiscal policy, and monetary policy. Since this is not the main focus of our paper and we need to conserve space, we have only summarized our main findings here. Tables with detailed results are available from the authors upon request.

Table 8
Robustness regressions with sources of volatility

	Benchmark [1]	External shocks [2]	Domestic shocks [3]
Volatility	−0.221 [0.107]**	−0.394 [0.170]**	−0.510 [0.156]***
Volatility × Trade Integration	0.137 [0.058]**	0.132 [0.072]*	0.081 [0.067]
Volatility × Financial Integration	0.307 [0.172]*	0.280 [0.234]	0.313 [0.206]
Trade Integration (Binary)	0.012 [0.003]***	0.011 [0.003]***	0.012 [0.004]***
Financial Integration (Binary)	0.004 [0.004]	0.003 [0.004]	0.005 [0.005]
Initial Income (Log)	−0.008 [0.003]**	−0.008 [0.003]**	−0.008 [0.003]**
Primary education	0.022 [0.007]***	0.026 [0.007]***	0.024 [0.007]***
Investment rate (%GDP)	0.072 [0.020]***	0.069 [0.022]***	0.071 [0.022]***
Population growth	−0.002 [0.002]	−0.002 [0.002]	−0.002 [0.002]
Number of observations	315	315	315
Adjusted *R*-squared	0.38		

The dependent variable is the average growth rate of GDP per capita over each 10-year period. Terms in brackets are biased corrected errors. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All regressions include decade dummies. The benchmark regression in column 1 corresponds to column 6 in Table 5. The volatility of external shocks is proxied by the predicted volatility from a regression of the volatility of output growth on terms of trade volatility, volatility of trade flows, and volatility of financial flows. Volatility of domestic shocks is measured by the predicted volatility from a regression of volatility of output growth on the volatility of government consumption and inflation volatility.

would allow us to relate our results to two strands of theoretical work. The first links overall macroeconomic volatility to investment growth and, by extension, to output growth. In this context, a characterization of the predictable and unpredictable components of volatility and the relationships of these components with growth would be useful. The second is related to how the volatility of consumption growth reflects the availability of consumption smoothing opportunities that could divorce the growth of output from its volatility. This is of particular importance in understanding the welfare implications of volatility because, ultimately, it is the growth and volatility of consumption rather than output that matter for welfare.

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