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The Impact of Volatility on Economic Growth

Aurelijus Dabušinskas [*], Dmitry Kulikov and Martti Randveer [**]

Abstract

This paper investigates the impact of macroeconomic volatility on growth in a panel of 121 countries over the period 1980 to 2010. We confirm the Ramey and Ramey (1995) result that macroeconomic volatility is negatively related to economic growth using a different empirical methodology and a newer dataset. Among the issues that await further work are the interaction of financial development and volatility, potential non-linearities of the impact of macroeconomic volatility on growth, and issues related to the endogeneity of growth and volatility in the context of empirical growth regression models.

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Non-technical summary

The aim of the paper is to assess the impact of volatility on economic development. More specifically, we focus on macroeconomic volatility and its potential cost in terms of lower economic growth. We think of volatility as fluctuations in the growth rate, and distinguish between realised volatility, commonly measured by standard deviation of actual output growth, and innovation volatility, which is proxied for example by standard deviation of "unexpected" or unpredicted growth.

An oft-cited paper that galvanised the issue by demonstrating the presence of a statistically and economically significant negative relationship between volatility and growth was Ramey and Ramey (1995). Their data covered 92 countries for the period of 1962–1985; the dependent variable was per capita output growth, and volatility was measured as either realised or innovation variability in output growth. Ramey and Ramey estimation results implied that an increase in realised volatility of one standard deviation was associated with lower per capita growth of over half a percentage point in the whole sample of countries and with lower growth of about one-third of a percentage point in OECD countries.

This paper investigates the impact of macroeconomic volatility on growth in a panel of 121 countries over the period 1980 to 2010. We confirm the Ramey and Ramey (1995) result that macroeconomic volatility is negatively related to economic growth using a different empirical methodology and a newer dataset. We make a distinction between several sub-groups of countries, such as high-income OECD member countries, a group of Eastern European countries, high-growth Asian economies, and others.

Our preliminary estimates suggest that for the full sample of 121 countries, a 50-percent increase in volatility translates into 0.4-percentage-point lower annual per capita growth. The analogous estimate based on the sub-sample of OECD countries is about 10 percent smaller but is statistically indistinguishable from the whole-sample result. A similar result applies for the group of Eastern European countries, which includes the three Baltic countries.

Among the issues that await further work are the interaction of financial development and volatility, potential non-linearities of the impact of macroeconomic volatility on growth, and issues related to the endogeneity of growth and volatility in the context of empirical growth regression models.

Contents

1. Introduction

The aim of the paper is to assess the impact of volatility on economic development. More specifically, we focus on macroeconomic volatility and its potential cost in terms of lower economic growth. In empirical contexts, we will think of volatility as fluctuations in the growth rate, in which case it is useful to distinguish between *realised volatility*, commonly measured by standard deviation of actual output growth, and *innovation volatility*, proxied, for example, by standard deviation of 'unexpected' or unpredicted growth.[1] Theoretical models, in contrast, typically capture such uncertainty more fundamentally by standard deviations of structural shocks such as productivity or demand. Our focus on the link between volatility and growth is of course only one way of thinking about the consequences or costs of volatility; the choice seems justified, however, given how central economic growth is for welfare in the longer run.

In the realm of mainstream economics, the question of how volatility affects economic growth is relatively new. Prior to the emergence of the real business cycle (RBC) theory, economic growth and business cycle fluctuations were regarded as two separate issues, in, for example, the Solow growth model and the IS-LM framework. It was believed that the two phenomena had different causes and that, consequently, long-term economic growth was independent of cyclical factors. Other approaches, like the Schumpeterian paradigm of creative destruction and the Austrian school,[2] were in this sense more integrated but were not mainstream and thus were far less influential.

With the birth of RBC theory in the early 1980s (Kydland and Prescott (1982)), cyclical fluctuations and economic growth begin to be analysed in a unified modelling framework, but the previous dichotomy remains. As before, it is presumed that economic growth is driven by permanent incremental improvements in productivity through technological progress, and even though the RBC explanation that higher frequency fluctuations are caused by temporary productivity shocks is novel, the variability of these disturbances – the extent of cyclical volatility – is believed to have only second order effects on growth. One important implication of this view was shown by Lucas (1987): in an RBC world, the welfare costs of business cycle fluctuations, and thus the benefit of eliminating them, amount to only 0.06 percent of steady state consumption. Many felt the estimate was too low, but the result

[1] This distinction is very clear in Ramey and Ramey (1995).

[2] In a nutshell: monetary policy mistakes like being too accommodating in upswings foster credit booms, which, in turn, lead to over-investment and eventual busts.

was partly due to the assumption that temporary cyclical fluctuations have no first-order implications for long-term growth.

An oft-cited paper that galvanised the issue by demonstrating the presence of a statistically and economically significant *negative* relationship between volatility and growth was Ramey and Ramey (1995). Their data covered 92 countries for the period 1962–1985; the dependent variable was per capita output growth, and volatility was measured as either realised or innovation variability in output growth. The Ramey and Ramey estimation results implied that an increase in realised volatility of one standard deviation was associated with lower per capita growth of over half a percentage point in the whole sample of countries and with lower growth of about one-third of a percentage point in OECD countries (see Table 1 in Appendix). Importantly, this negative relationship was robust to controlling for the investment-to-GDP ratio, which meant that volatility was reducing growth not, or not only, by lowering investments but via some other mechanism(s) as well. More recent re-estimations of the Ramey and Ramey equations using updated data series (Aghion and Banerjee (2005)) confirm these results, though the negative volatility coefficient is no longer statistically significant for the OECD subsample (see the last two columns of Table 1 in Appendix).

It would seem natural to seek theoretical grounds for the negative relationship between volatility and growth in endogenous growth models. However, as Aghion and Banerjee (2005) explain succinctly, the two main conceptual mechanisms of endogenous growth — the AK model and the Schumpeterian paradigm — tend to suggest that volatility should affect growth positively rather than negatively. To reconcile the theoretical implications with this empirical evidence, Aghion and Banerjee (2005) argue it is necessary to modify these models by introducing an additional crucial feature of economic reality — imperfections in the functioning of financial markets.

In the AK framework,[3] the impact of volatility on economic growth is ambiguous because it depends on two counteracting effects. On the one hand, higher volatility leads to higher saving, due to precautionary motives, resulting in higher investment and thus faster growth. On the other, it reduces risk-adjusted returns, which lowers investment as well as growth. The net effect depends on the elasticity of inter-temporal substitution, which is usually also equal to the coefficient of relative risk aversion, and particularly on whether it is bigger or smaller than unity. Though there is substantial uncertainty about the true magnitude of this elasticity, Aghion and Banerjee

[3] The engine of growth in the AK model is capital accumulation, and the key element guaranteeing that this growth is everlasting is the assumption that at the aggregate level capital is not subject to diminishing returns. It is common to assume that the aggregate production function is linear in aggregate capital, hence the acronym AK.

argue that most empirical estimates for it fall in the range where the precautionary motive dominates, and the implied volatility-growth relationship is positive.

To illustrate the Schumpeterian paradigm of endogenous growth, Aghion and Banerjee assume that firms face two types of investment: capital investments that are always productive in the short run and longer-term investments that are subject to uncertainty but have the potential to generate improvements in technology through innovations. The crux of this set-up is that long-term growth becomes directly dependent on the intensity of innovative (R&D) investment in the economy. Importantly for our discussion, this model implies that R&D investments and thus long-term growth are countercyclical and that, by implication, volatility is good for growth. The main reason for this outcome is the opportunity cost effect: in recessions, when short-term projects are less profitable, it is relatively cheaper to invest for the long term. In this way, economic slumps become fertile grounds for the kinds of investment that deliver future technological advancements, the driver of long-term growth.

Since the prediction of a positive relationship between volatility and growth lacks empirical support, Aghion and Banerjee argue that a key missing element in these growth models is financial frictions, because in the real world, firms are financially constrained, and financial markets are imperfect. To demonstrate the implications that such frictions have for the Schumpeterian growth model, they introduce an additional assumption that longer-term productivity-enhancing investments are subject to interim financing requirements which are initially uncertain. Firms can meet these financing needs by drawing on their own cash flow or by borrowing, but the maximum amount that lenders are willing to lend in each case is assumed to be a fixed multiple of the financial wealth available to the firm.

If sufficiently binding, such financial constraints reverse the counter-cyclicality of longer-term innovative investments because firms' cash flows and their ability to borrow to satisfy interim liquidity needs worsen during recessions. That also changes the volatility-growth relationship from positive to negative: volatility creates uncertainty in firms' liquidity positions, and that discourages them from making productivity-enhancing investments. This characterisation is accurate not only for the extreme cases of financing constraints: if financial frictions are above a certain very-high level, innovative investments are forgone and the economy stays on a low-growth path; conversely, if financing is relatively frictionless and collateral requirements are below a certain level, productivity-enhancing investments are made and the economy grows rapidly. For intermediate levels of financing frictions, the model implies a monotonic negative relationship between volatility and growth.

In this stylised framework, the extent to which financial constraints are binding is controlled by the model parameter determining the maximum amount of credit that can be extended for a given level of financial wealth as collateral. In the real world, that should correlate with the level of financial sector development, as more advanced financial intermediation makes borrowing against future cash flows easier. The model predicts, then, that the negative effect of macroeconomic volatility on growth should be weaker in countries with more developed financial sectors.

According to Aghion and Banerjee (2005), this hypothesis is supported by the data. First they use cross-sectional growth regressions similar to those in Ramey and Ramey (1995) but modified to include the private sector credit-to-GDP ratio as a proxy for the depth of financial intermediation and an interaction of this ratio with the volatility measure to confirm that the negative volatility-growth association is weaker (less negative) when the credit ratio is higher. Moreover they show the estimated financial sector effect is substantial: it is strong enough to make the overall impact of volatility on growth positive for the countries that have the most financially advanced financial sectors. Second, similar estimations using panel data show that the terms of trade and commodity price shocks — two examples of exogenous *causes* of volatility — have a lower impact on growth in countries with more developed financial sectors, again measured by the credit-to-GDP ratio.

Today, the idea that volatility and economic growth correlate negatively is quite widely accepted.[4] Easterly et al. (2000), for example, take it as given and raise an important follow up question: if macroeconomic volatility is bad for growth, what causes it? In particular, Easterly et al. (2000) argue that, when trying to explain output volatility, macroeconomists have put too much emphasis on price and wage rigidities and labour market flexibility, and paid too little attention to the crucial role of the financial sector and financial factors in general.[5] Using panel data for a large cross-section of countries, they indeed obtain no statistically significant link between their measure of real wage flexibility (standard deviation of real wage growth) and volatility in growth. Importantly however, they find that the private credit to GDP ratio, a proxy for financial sector development, is related to volatility in a non-linear

[4] In a recent paper, Benigno et al. (2010) argue that macroeconomic volatility may increase long-term unemployment. A central theoretical mechanism that implies this result in their model is asymmetric (stronger downwards) real wage rigidity. As the realisation of strongly adverse productivity shocks becomes more likely when the variability of productivity shocks is high, firms are more reluctant to hire if lowering real wages in bad times is difficult. As a consequence, higher macroeconomic volatility leads to higher long-term unemployment. Benigno et al. (2010) show that this mechanism is important for explaining unemployment trends in the US data.

[5] Financial institutions, cash flow constraints, firm wealth effects and other balance sheet effects, etc.

way: while the credit to GDP ratio remains below a certain level, the financial sector plays a stabilising role, but as it gets deeper and more sophisticated its association with volatility becomes positive. Instead of diversifying and insuring risks, very advanced financial sectors may in fact create additional risks. In the circumstances of the recent crisis, many would find this argument particularly relevant and appealing today.[6]

As mentioned earlier, in this paper we will estimate the impact of volatility on economic growth. The earlier empirical estimates are based on data from until 2000 and therefore do not include the latest data from before the global financial crisis and the data from during the financial crisis, which might change the earlier conclusions. Although it is not included in this version of the paper, we plan an estimate of the impact of the interaction between financial constraints and volatility on economic growth and an assessment of whether the impact of volatility on economic growth is non-linear.

The paper is structured as follows. In Section 2 we present the methodology and data. In Section 3 we discuss the main empirical results. Section 4 concludes.

2. Data and econometric methodology

This section details the data collection and processing strategy used in the paper. It also provides an overview of the econometric methodology behind the empirical growth-volatility regressions in Section 3.

The empirical part of this paper uses a wide sample of countries, drawing most of the time series from the IMF's International Financial Statistics database.[7] The full sample period covers the last three decades, from 1980 to 2010. Inevitably, some of the countries are dropped out of the sample because of missing data. Out of 144 countries in the IMF's International Financial Statistics database, 23 countries are completely excluded from the sample due to their inadequate data coverage. For many of the remaining countries, the available data series start later than 1980, sometimes spanning just the last ten years of the full sample period. However, since this does not present a problem from the modelling point of view, the countries with partial data coverage are still included in the empirical growth-volatility regressions

[6] Easterly et al. (2000) also find that volatility is typically higher in developing countries and countries more open to international trade. Concerning the latter they note, however, that openness is also known to contribute to growth itself, so the overall effect is likely to be positive.

[7] See http://www.imfstatistics.org/IMF .

in Section 3 of this paper. The full sample of countries used in the empirical part of this paper is listed in Table 2 of the Appendix.

For each country in the sample the following annual data series are collected from the IMF's International Financial Statistics database: (i) real GPD per capita in PPP terms, (ii) nominal GDP, (iii) nominal gross fixed capital formation outlays, (iv) nominal government consumption expenditure, (v) nominal exports of goods and services, and (vi) population in millions. In addition, the average years of schooling over five-year periods for each country in the sample are obtained from the World Bank's EdStats database.[8]

The following data processing strategy is used to compile the set of variables used in the growth-volatility regressions in Section 3 of this paper. The full 30-year sample period is divided into six equal five-year sub-periods, starting with the first sub-period spanning the years 1980 to 1984, and ending with the last sub-period from 2005 to 2010. For each of the countries in the sample, indexed by *i*, and each of the six sub-periods, indexed by *t*, the following variables are computed: (i) Δy_{it} is the average annual growth rate of real GPD per capita in PPP terms over the corresponding sub-period in percentage points; (ii) σ_{it} is the standard deviation of the average annual growth rate of real GPD per capita in PPP terms over the corresponding sub-period; (iii) y_{it} is the average annual real GPD per capita in PPP terms over the corresponding sub-period; (iv) Δn_{it} is the average annual population growth rate over the corresponding sub-period; (v) s_{it} is the average years of schooling over the corresponding sub-period; (vi) i_{it} is the average annual investment share in GDP over the corresponding sub-period, calculated as the ratio of nominal gross fixed capital formation outlays to nominal GDP; (vii) g_{it} is the average annual government consumption share in GDP over the corresponding sub-period, calculated as the ratio of nominal government consumption expenditures to nominal GDP; and (viii) e_{it} is the average annual export share in GDP over the corresponding sub-period, calculated as the ratio of nominal exports of goods and services to nominal GDP. This data compilation strategy effectively creates a panel data set, with a cross-sectional dimension indexed by individual countries in the sample, and a time dimension given by six five-year sub-periods, over which the averages of the relevant country-specific macroeconomic indicators are computed.

The choice of econometric methodology in this paper is guided by several considerations. The growth-volatility regressions in Section 3 of this paper can be regarded as empirical models designed for measuring the impact of macroeconomic volatility on economic growth in a wide sample of heteroge-

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[8] See http://data.worldbank.org/data-catalog .

neous countries over the last three decades. They are vaguely related to growth theory, but cannot be treated as structural econometric relationships between a well-defined set of variables with well-understood structural parameters. Therefore, this paper emphasises simplicity, flexibility and robustness in its statistical assessment of the impact of volatility on growth. At the same time, given the complexity of this research question and the restrictions imposed by the limited sample scope, the issues of endogeneity and omitted variables loom large. Clearly, these two econometric issues need to be given proper attention if the empirical implications of the growth-volatility regressions in Section 3 are to be considered plausible.

This paper adopts the following linear regression view of the possible empirical link between economic growth and macroeconomic volatility in a panel of countries:

$$\Delta y_{it} = \gamma \log \sigma_{it} + \beta X_{it-1} + c_i + \delta a_t + u_{it} \qquad (1)$$

In this linear regression model the primary parameter of interest that links macroeconomic volatility to economic growth is γ. The log transform of σ_{it} is adopted for empirical reasons, as σ_{it} is non-negative by construction with a lot of statistical information concentrated in a small neighbourhood around zero, whereas the distribution of $\log \sigma_{it}$ is evened out across the real line. The set of controls in X_{it-1} consists of $\log y_{it-1}$, Δn_{it-1}, s_{it-1}, i_{it-1}, g_{it-1}, e_{it-1}, and an intercept. All variables in X_{it-1} pre-date the period over which the real per capita GDP growth Δy_{it} and the corresponding volatility σ_{it} are measured.[9] This mitigates the potential endogeneity issues in model (1), which, if present, may spill over to the estimate of γ, as well as fitting nicely into the overall framework of the empirical growth theory. In order to address the issue of sample heterogeneity and omitted variables, a set of individual country fixed effects c_i is added to the model, taking care of such potentially important factors as geography, climate, natural resources, time-invariant political effects, and so on. The impact of time-varying factors affecting economic growth on the global scale over the last three decades, such as changes in world-wide trade, energy prices, or the economic and political climate, is taken care of by a set of time dummies a_t. Finally, the idiosyncratic component of the economic growth in this panel of countries is assumed to come from a white noise term u_{it}.

The parameters of this linear regression are estimated by the fixed effects estimator (see Wooldridge (2010)). It should be recalled that the fixed effects

[9] Note that this specification implies that out of six five-year sub-periods available in the full panel dataset, only five sub-periods are actually used for the purpose of statistical inference.

estimator does not impose any assumptions on the dependence between c_i and the remaining set of explanatory variables. This is particularly important for the sample heterogeneity and omitted variables issue in an empirical investigation of growth-volatility linkages. A comparison to the bare-bones pooled OLS results is also proved, where the latter omits the country-specific fixed effects c_i.

3. Empirical results

Before going into the discussion of empirical growth-volatility regressions, it is instructive to take a closer look at the simple unconditional correlation of macroeconomic growth and volatility in the sample of 121 countries over the period of three decades from 1980 to 2010. Table 2 in the Appendix lists the corresponding sample statistics: $\overline{\Delta y_{it}}$ and $\overline{\sigma_{it}}$ are simple arithmetic averages of, respectively, Δy_{it}-s and σ_{it}-s over T_i five-year sub-periods, for which the corresponding variables are available for each particular country. Their cross plot is displayed on Figure 1, and their unconditional correlation is equal to 0.0127. A weak negative correlation of –0.0343 between $\overline{\Delta y_{it}}$ and $\overline{\sigma_{it}}$ is obtained when Armenia is excluded from the sample, but in any case the unconditional correlation between macroeconomic growth and volatility in the sample remains extremely weak. This finding is broadly in line with the corresponding empirical evidence in the literature (see Ramey and Ramey (1995)), once again highlighting a substantial heterogeneity across the sample countries.

The empirical growth-volatility regressions are summarised in Table 1, where both the pooled OLS and panel fixed effects estimates of the main parameters are listed. In addition to the reported results, time-dummy parameters δ and a time-invariant intercept are also estimated, but their estimates are not reported in the table. The total number of observations used for the statistical inference is 540, and they are split across 121 countries and five time periods, as described in Section 2. In addition, a smaller sub-sample of 155 observations from the 33 countries which were OECD members at the end of 2010 is also used for comparative purposes.

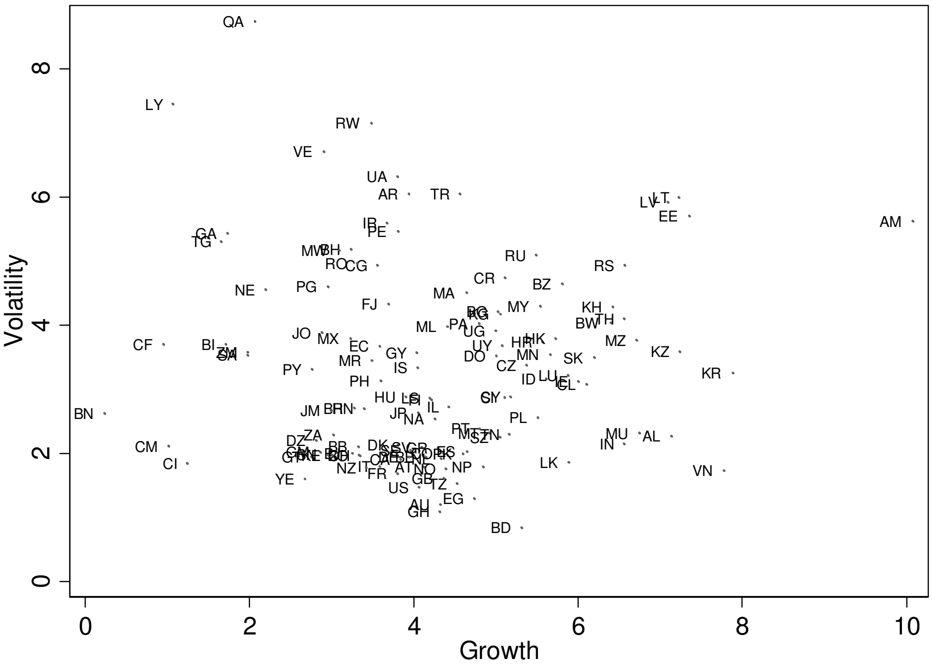

Figure 1: Cross plot of the average macroeconomic growth and its standard deviation in the sample of 121 countries over the period 1980 to 2010

Note: Country abbreviations follow the ISO 3166 standard (see Table 2 in the Appendix A).

In line with Ramey and Ramey (1995) and many others, the empirical results in Table 1 point to a negative contemporaneous link between macroeconomic volatility and growth in the sample of 121 countries over the last three decades. The negative link is statistically significant across both the pooled OLS and the panel fixed effects versions of the model, getting even stronger in the latter case, when the sample heterogeneity is accounted for by the country-specific fixed effects.

Of the six remaining control variables, only the preceding period log income level $\log y_{it-1}$ and population growth rate Δn_{it-1} retain their statistical significance across the pooled OLS and panel fixed effects versions of the model. Both of them also have the expected negative partial effect on growth, along the lines of Ramey and Ramey (1995) and Levine and Renelt (1992). Note that the effects of these two controls on Δy_{it} differ noticeably across the two sets of estimates in Table 1, implying that the unaccounted for country-specific heterogeneity in the pooled OLS version of the model can lead to some sizeable and potentially important distortions.

Table 1: Empirical growth-volatility regressions

Independent variable	Pooled OLS Full sample	Fixed effects Full sample	Fixed effects OECD sample
Log volatility ($\log \sigma_{it}$)	–0.7051**	–0.9286**	–0.8590**
	(-4.62)	(–6.14)	(–3.40)
Log income level ($\log y_{it-1}$)	–0.7305**	–7.8478**	–9.6451**
	(-5.30)	(–9.85)	(–6.52)
Population growth rate (Δn_{it-1})	–0.6156**	–0.3891**	–0.8146*
	(–6.74)	(–3.09)	(–1.84)
Education level (s_{it-1})	0.1785**	–0.1722	–0.0970
	(2.86)	(–0.93)	(–0.51)
Investment share (i_{it-1})	0.0350**	0.0124	–0.0223
	(2.07)	(0.40)	(–0.45)
Government consumption share (g_{it-1})	–0.0276	0.0136	–0.0990
	(–1.40)	(0.36)	(–1.62)
Export share (e_{it-1})	0.0154**	0.0070	0.0344**
	(3.47)	(0.58)	(2.08)
R^2	0.25	0.45	0.68
No of observations	540	540	155

*Notes: Pooled OLS and fixed effects estimation results for model (1) are shown in the table. Full sample consists of 121 countries listed in Table 2 of the Appendix. OECD sample is the 33 countries which were OECD members at the end of 2010. Estimates of the time dummies and a time-invariant intercept are not shown. Numbers in parentheses are robust t-statistics. The superscripts ** and * indicate that the corresponding coefficient is statistically significant at the 5% and 10% confidence level respectively. For the fixed effects estimator,* R^2 *refers to the within statistic*

Having said that, the previous period partial effects of education level s_{it-1}, investment share i_{it-1}, government consumption share g_{it-1}, and export share e_{it-1} on the economic growth in the following period Δy_{it} in the pooled OLS version of the model in Table 1 all have empirically plausible signs.

In a smaller sample of 33 OECD countries, the fixed effects estimator uncovers a very similar picture of the negative partial effect of volatility on growth, with the corresponding coefficient being statistically indistinguishable from its full sample counterpart. In addition, the growth-volatility regression for the OECD countries has a statistically significant positive effect on openness to world trade, as measured by the export share e_{it-1}, on economic growth in the next period.

The overall fit of the estimated growth-volatility models in Table 1 is measured by the reported R^2 statistics, and points to a substantial remaining heterogeneity still unaccounted for by the three empirical models.

4. Conclusions

Using more recent data and a broader sample of countries, we confirm the Ramey and Ramey (1995) result that macroeconomic volatility is negatively related to economic growth. Our estimates for the whole sample of 121 countries indicate that a 50-percent increase in volatility translates into 0.4-percentage-point lower annual per capita growth. The analogous estimate based on the sub-sample of OECD countries is about 10 percent smaller but statistically indistinguishable from the whole-sample result.

The similarity of our findings for a broad set of countries and the OECD sub-sample contrasts with the empirical evidence discussed by Aghion and Banerjee (2005) who argue that the negative volatility-growth relationship is harder to detect in OECD countries. According to Aghion and Banerjee, such a tendency can be explained by their theoretical model, in which the more developed financial sectors of the OECD countries can reduce the financial frictions which make volatility detrimental to growth. A recent paper by Arcand, Berkes and Panizza (2012) examines non-linear effects of financial depth, measured as the fraction of private credit to GDP, on medium-term economic growth in a panel of 133 countries over the time periood 1960 to 2010. In contrast to Aghion and Banerjee (2005), empirical results reported by Arcand, Berkes and Panizza (2012) confirm that macroeconomic volatility still retains its negative and statistically significant effect on medium-term growth even in the presence of controls for the financial sector size.

We intend to address the interaction of financial development and volatility and the potential non-linearities in their effects on economic growth in a future version of this paper.

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Appendix A: Data sources

Table 1: Relationship between average growth and volatility

Sample	Ramey and Ramey (1995) All countries 1962–1985	Ramey and Ramey (1995) OECD 1952–1988	AABM (2004)[a] All countries 1960–1995	AABM (2004)[a] OECD 1960–1995
Effect of volatility[b]	–0.21***	–0.39*	–0.22**	–0.29
Summary of variance estimates (all variance figures are multiplied by 1,000)				
Mean variance (st.dev.)	3.58 (0.06)	0.99 (0.03)		
Lowest variance (st.dev.)	0.317 (0.018) (Swed)	0.299 (0.017) (Nor)		
Highest variance (st.dev.)	28.7 (0.17) (Iraq)	2.90 (0.054) (Tur)		
US variance (st.dev.)	0.663 (0.026)	0.596 (0.024)		

Notes:
[a] *Aghion, Angeletos, Banerjee and Manova (2004) as reported in Aghion and Banerjee (2005).*
[b] *Ramey and Ramey (1995): controlling for average investment share, average population growth, initial human capital, initial per capita GDP; AABM (2004): controlling for average investment share, average population growth, secondary school enrolment, initial per capita GDP, government size, inflation, black market premium, trade openness, intellectual property rights, property rights.*

Table 2: Average economic growth and its standard deviation by country

Country	$\overline{\Delta y_{it}}$	$\overline{\sigma_{it}}$	T_i	Country	$\overline{\Delta y_{it}}$	$\overline{\sigma_{it}}$	T_i
Albania (AL)	7.13	2.27	2	Korea Republic (KR)	7.88	3.26	5
Algeria (DZ)	2.81	2.21	5	Kyrgyz Republic (KG)	5.05	4.17	3
Argentina (AR)	3.94	6.06	3	Latvia (LV)	7.10	5.92	3
Armenia (AM)	10.07	5.62	3	Lesotho (LS)	4.19	2.87	5
Australia (AU)	4.32	1.20	5	Libya (LY)	1.07	7.45	5
Austria (AT)	4.12	1.80	5	Lithuania (LT)	7.22	6.00	3
Bahrain (BH)	3.24	5.19	5	Luxembourg (LU)	5.88	3.23	5
Bangladesh (BD)	5.31	0.84	5	Malawi (MW)	3.09	5.17	5
Barbados (BB)	3.32	2.10	4	Malaysia (MY)	5.54	4.30	5
Belgium (BE)	4.15	1.95	5	Mali (ML)	4.41	3.98	5
Belize (BZ)	5.80	4.65	5	Malta (MT)	4.92	2.32	5
Benin (BJ)	3.25	2.01	5	Mauritania (MR)	3.49	3.45	4
Bolivia (BO)	3.33	1.98	5	Mauritius (MU)	6.74	2.32	5
Botswana (BW)	6.40	4.04	5	Mexico (MX)	3.23	3.80	5
Brazil (BR)	3.27	2.72	4	Mongolia (MN)	5.66	3.55	3
Brunei Darussalam (BN)	0.23	2.63	1	Morocco (MA)	4.64	4.51	5
Bulgaria (BG)	5.02	4.21	3	Mozambique (MZ)	6.71	3.77	5
Burundi (BI)	1.70	3.71	5	Namibia (NA)	4.25	2.54	3
Cambodia (KH)	6.42	4.29	4	Nepal (NP)	4.84	1.80	5
Cameroon (CM)	1.01	2.12	5	Netherlands (NL)	4.33	1.92	5
Canada (CA)	3.84	1.91	5	New Zealand (NZ)	3.42	1.78	5
Central African Republic (CF)	0.95	3.71	4	Niger (NE)	2.20	4.56	5
Chile (CL)	6.10	3.08	5	Norway (NO)	4.39	1.76	5
Colombia (CO)	4.36	2.01	5	Pakistan (PK)	4.60	1.99	5
Congo Republic (CG)	3.56	4.94	5	Panama (PA)	4.79	4.03	5
Costa Rica (CR)	5.11	4.75	1	Papua New Guinea (PG)	2.95	4.61	5
Côte d'Ivoire (CI)	1.24	1.85	5	Paraguay (PY)	2.76	3.32	5
Croatia (HR)	5.57	3.74	3	Peru (PE)	3.80	5.47	5
Cyprus (CY)	5.18	2.89	5	Philippines (PH)	3.60	3.13	5
Czech Republic (CZ)	5.37	3.38	2	Poland (PL)	5.51	2.56	5
Denmark (DK)	3.81	2.14	5	Portugal (PT)	4.80	2.39	5
Dominican Republic (DO)	5.00	3.53	5	Qatar (QA)	2.06	8.74	5
Ecuador (EC)	3.58	3.68	5	Romania (RO)	3.31	4.97	5
Egypt Arab Republic (EG)	4.74	1.30	5	Russian Federation (RU)	5.49	5.10	3
El Salvador (SV)	4.10	2.09	3	Rwanda (RW)	3.48	7.16	5
Estonia (EE)	7.35	5.71	3	Saudi Arabia (SA)	1.98	3.54	5
Fiji (FJ)	3.69	4.34	5	Senegal (SN)	2.95	1.98	5
Finland (FI)	4.21	2.84	5	Serbia (RS)	6.56	4.94	1
France (FR)	3.80	1.69	5	Slovak Republic (SK)	6.19	3.50	3
Gabon (GA)	1.73	5.44	5	Slovenia (SI)	5.10	2.87	3
Gambia (GM)	2.86	2.02	2	South Africa (ZA)	3.01	2.29	5

Germany (DE)	3.94	1.95	5	Spain (ES)	4.64	2.03	5
Ghana (GH)	4.32	1.10	4	Sri Lanka (LK)	5.88	1.87	5
Greece (GR)	4.30	2.09	5	Swaziland (SZ)	5.04	2.26	5
Guatemala (GT)	2.75	1.95	5	Sweden (SE)	3.96	2.05	5
Guyana (GY)	4.03	3.57	4	Switzerland (CH)	3.34	1.96	5
Honduras (HN)	3.39	2.70	5	Tanzania (TZ)	4.52	1.53	5
Hong Kong (HK)	5.73	3.80	5	Thailand (TH)	6.56	4.10	5
Hungary (HU)	3.90	2.89	5	Togo (TG)	1.65	5.31	5
Iceland (IS)	4.04	3.34	5	Tunisia (TN)	5.16	2.31	5
India (IN)	6.56	2.16	5	Turkey (TR)	4.56	6.05	4
Indonesia (ID)	5.61	3.16	5	Uganda (UG)	4.99	3.92	5
Iran Islamic Republic (IR)	3.67	5.60	5	Ukraine (UA)	3.80	6.33	3
Ireland (IE)	6.00	3.13	5	United Kingdom (GB)	4.36	1.61	5
Israel (IL)	4.42	2.73	5	United States (US)	4.06	1.48	5
Italy (IT)	3.59	1.80	5	Uruguay (UY)	5.07	3.69	5
Jamaica (JM)	2.99	2.67	5	Venezuela (VE)	2.90	6.71	5
Japan (JP)	4.05	2.63	5	Vietnam (VN)	7.77	1.73	3
Jordan (JO)	2.88	3.89	5	Yemen Republic (YE)	2.67	1.61	3
Kazakhstan (KZ)	7.24	3.59	3	Zambia (ZM)	1.98	3.58	5
Kenya (KE)	3.00	1.98	5				

Notes:

Listed above are the average economic growth $\overline{\Delta y_{it}}$ *and its standard deviation* $\overline{\sigma_{it}}$ *over the sample period 1980 to 2010 for each country. The corresponding sample means across all countries are 4.33 for* $\overline{\Delta y_{it}}$ *and 3.33 for* $\overline{\sigma_{it}}$ *. The number of five-year sub-periods, for which the variables in model (1) are available for each particular country, is shown in the* T_i *column.*

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