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Uncertainty and growth: evidence of emerging and developed countries

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Abstract

This letter aims to investigate the relationship between uncertainty and economic growth in economies with different stages of development. We use monthly data on industrial production during the period of 1961 to 2014 from OECD's Main Economic Indicators database. We estimate the relationship between industrial production growth and its volatility from 14 countries using EGARCH in mean and panel GARCH in mean models. Our results suggest that the correlation between economic growth and its own volatility is positive in developed countries but ambiguous in emerging economies. This facts support both theories of precautionary savings, in the case of developed countries, and irreversible investments, in the case of some emerging economies.

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1. Introduction

There are a number of different theories that associate uncertainty and economic growth. Some of them assume a positive relationship between those two variables, while other assume a negative relationship. Black (2010) says that moments of high growth volatility are followed by high rates of growth, since riskier investments will be realized only if expected returns are high. Mirman (1971) and Aiyagari (1994) argue that precautionary savings may play an important role in this relationship, since risk averse agents tend to increase savings in moments of uncertainty, generating future long-term investments and higher growth. But according to Bernanke (1983) and Pindyck (1991), uncertainty may affect growth negatively, since economic agents face a trade-off between investing in the short term or waiting to gather new information. Assuming that these decisions are irreversible and that information about long-term investment projects are distributed over time, the result is that long-term investments are postponed until past deviations are taken into account, generating business cycles, and that uncertainty about future prices means uncertainty about firm's profits. However, Aghion et al. (2010) offer a different explanation. The authors argue that credit constraints play a key role in how uncertainty impacts economic growth. The stylized facts derived from Aghion et al. (2010) can imply that the relationship between volatility and growth may be positive in developed countries and negative in emerging economies. Furthermore, the assumptions made by theories of irreversible investments and precautionary savings are conformable with these facts. In this letter we seek to test this conjecture empirically.

Previous empirical literature in this subject found mixed evidences. Ramey and Ramey (1995) find negative correlation between volatility and economic growth in two samples including emerging and developed countries with panel data methods, supporting the hypothesis of irreversible investments. A negative correlation is also observed by Lin and Kim (2013) and Jetter (2014). However, the findings of Fountas and Karanasos (2006) and Imbs (2007) suggest a positive correlation. In addition, some research argue that the correlation depends on the origin of uncertainty shocks (Blackburn and Pelloni, 2004; Jetter, 2014).

The main goal of this letter is to analyze the relationship between uncertainty and economic growth in emerging and developed countries, where our measure of uncertainty is a volatility based estimate of deviations from the mean growth rates with autoregressive components. The main hypothesis is that the correlation between volatility and growth is negative for emerging countries and positive for developed countries in our sample.

2. Data and Methods

Our data source is the *Main Economic Indicators* database from OECD. The data are in monthly frequency and it spans from January 1961 to December 2014. The Industrial Production Index is used as a proxy variable for economic growth. The monthly index of production is log-transformed and the first-difference is taken in order to ensure stationarity. Two groups of countries are extracted from the database: the first group contains emerging economies (Brazil, Chile, Estonia, India, Mexico, Russian Federation and Turkey). The second one contains the members of G7 (Canada, France, Germany, Italy, Japan, UK and the United States).

After ensuring that the monthly industrial production growth rate series are stationary through Augmented Dickey-Fuller unit root tests, we estimate an EGARCH-M(1,1) model for each country to infer about the relationship of volatility and growth. The equations are as follow:

$$IP_t = \mu + \sum_{p=1}^{P} \phi_p IP_{t-p} + \delta\sigma_t + u_t, \quad \text{with} \quad u_t \sim N(0, \sigma_t^2), \quad \text{and} \tag{1}$$

$$\ln(\sigma_t^2) = \omega + \alpha \left(\frac{u_{t-1}}{\sigma_{t-1}} - E\left[\frac{u_{t-1}}{\sigma_{t-1}}\right] \right) + \gamma \frac{u_{t-1}}{\sigma_{t-1}} + \beta \ln(\sigma_{t-1}^2), \tag{2}$$

where, in equation (1), IP_t is the monthly growth of the industrial production index; μ is the unconditional mean; ϕ_t are the autoregressive terms; δ is the GARCH in mean parameter, which measures the relationship between volatility and growth; σ_t is the conditional standard deviation and u_t is the error term, which we suppose is normally distributed [1]. In equation (2), ω is the unconditional variance; α is the GARCH coefficient, which determines the rate of reversal to mean volatility; β is the ARCH coefficient and γ is the EGARCH parameter, which measures the asymmetry of the impact of shocks in volatility.

We estimate this model for each country individually. We chose the EGARCH-M(1,1) model because of parsimony. The number of autoregressive components in equation (1) is determined by the Akaike information criteria, in order to completely remove residual autocorrelation from the mean equation. Our main parameter of interest is δ, since it measures the relationship between volatility and industrial production growth, our proxy measure for economic growth.

We also estimate two GARCH in mean long panel data models with country fixed effects. These models are based in Cermeño and Grier (2006). The first panel contains four developed countries (Germany, Japan, UK and USA), and the second panel contains four emerging countries (Brazil, Chile, Mexico and Russian Federation). The choice of developed countries follows their importance in the global scenario, and the choice of emerging countries was the one that maximized our sample, since we had fewer observations for emerging countries. The reduced number of countries included in the two panels reflects the fact that the number of correlations and variances that has to be estimated increases with the country group size. So we chose only four countries in each panel for parsimony.

In the panel GARCH in mean model, the mean growth rate of industrial production is determined by the following equation:

$$IP_{it} = \mu_i + \sum_{p=1}^{12} \phi_p IP_{i,t-p} + \delta\sigma_{it} + u_{it}, \quad u_{it} \sim N(0, \sigma_{it}^2), \tag{3}$$

where μ_i is the fixed-effect term, ϕ_p are the autoregressive parameters, and δ is the parameter that measures the overall impact of volatility on the growth of industrial production for the countries included in the panel. The mean growth rate of industrial production for every country is determined by an AR(12) model, following Cermeño and Grier (2006). We suppose that the vector of residuals follows a multivariate normal distribution with zero mean and symmetric variance-covariance matrix, given by $\mathbf{\Omega}_t$. The variances and covariances of the residuals are given by a GARCH(1,1) process shown in the equations below.

[1] Nelson (1991) suggests that the residuals of the EGARCH model are distributed following a GED distribution, optimal for heavier-tailed residuals. We opt for the normal residuals, as no excess kurtosis was found on preliminary tests.

$$\sigma_{i,t}^2 = \omega_i + \alpha\sigma_{i,t-1}^2 + \beta u_{i,t-1}^2, \quad (4)$$

$$\sigma_{ij,t} = \eta_{ij} + \lambda\sigma_{ij,t-1} + \rho u_{i,t-1}u_{j,t-1} \quad \text{for} \quad i \neq j. \quad (5)$$

This model is more restricted than standard multivariate GARCH models in the sense that the coefficients of variances and covariances are common to all countries within a panel, therefore they follow the same dynamics, as well as the autoregressive coefficients for the mean growth rates. Two specifications of this model will be used:

1. The first specification assumes that there is no covariance between the growth rates of different countries in the panel, such that $\sigma_{ij,t} = 0$, for all i, j, with $i \neq j$. In this case, the matrix $\mathbf{\Omega}_t$ will be diagonal.

2. The second specification is the full model described in equations (4) and (5), where we allow covariances between growth rates of different countries, including uncertainty spillovers among countries in the same development stage.

3. Results

Table I shows the main results of the EGARCH in mean model for all countries in the sample. The autoregressive coefficients for the mean growth rates were omitted for simplicity. The interpretation of the coefficient δ is that a volatility shock of 1% in σ_t causes a variation of approximately δ% in the industrial production index.

For developed countries, the results were significantly different than zero in 6 out of 7 countries. In all cases we observed positive values for δ, implying that periods of high volatility tend to be related with positive economic growth. The size of the effect was similar for United States and Canada, and for Germany and United Kingdom, while the greatest magnitude of the effect was in Japan. According to theory, smaller credit constraints allow developed countries to sustain long-term investments in times of greater uncertainty, leading to greater economic growth in the long run. Notoriously, the case of Japan reveals greater risk aversion of economic agents. This behavior is predicted by theories that describe the mechanism of precautionary savings.

For emerging countries, we found that the volatility coefficient was significantly different than zero in 5 out of 7 countries, but the sign of the effect was positive for Chile, India and Turkey, and negative for the other countries. This negative relationship, as discussed earlier, can be related to greater risk preference in decisions which involve consumption or savings, as well as irreversible investments. Also, the propagation mechanism studied by Aghion et al. (2010) supports the idea that tighter credit can lead to both higher volatility and lower mean growth. Our results, in general, supports the theoretical model of Aghion et al. (2010), except for the cases of Chile, India and Turkey, which experience similar credit constraints than the other emerging countries but at the same time does not seem to be negatively affected by growth volatility. The political and institutional environment, as pointed by Acemoglu et al. (2003), could be responsible for this effect, since a bad institutional framework makes it harder to calculate expected returns for investments. Since our measure of volatility may also capture differences in precautionary saving rates and institutional frameworks, we believe that the financial reforms of Chile in the 1985-1990s (Hernandez and Parro, 2004) and the Banking Sector Restructuring Program of 2001 in Turkey (Banking Regulation and Supervision Agency, 2010)

Table I: Impact of growth volatility in economic growth from EGARCH-M models

	Developed countries						
	Germany	Canada	USA	France	Italy	Japan	UK
Volatility (δ)	0.1445*	1.7613*	1.7959*	0.6266*	0.0343	2.9698*	0.1479*
	(0.0092)	(0.1180)	(0.2499)	(0.0735)	(0.1135)	(0.1076)	(0.0283)
Constant (ω)	-2.9448*	-0.2966*	-1.5089*	-0.6047*	-0.2152	-0.1645*	-3.7082*
	(0.6561)	(0.0034)	(0.0128)	(0.1868)	(0.1379)	(0.0001)	(0.6490)
ARCH term (α)	-0.0931‡	-0.0434‡	-0.2455*	0.2579*	0.0114	-0.1449*	-0.0815†
	(0.0434)	(0.0216)	(0.0309)	(0.0455)	(0.0311)	(0.0008)	(0.0488)
GARCH term (β)	0.6455*	0.9678*	0.8520*	0.9122*	0.9723*	0.9801*	0.5814*
	(0.0788)	(0.0000)	(0.0000)	(0.0272)	(0.0170)	(0.0000)	(0.0729)
Asymmetry (γ)	0.4283*	0.0617*	0.0972*	0.6260*	0.3096*	0.0261*	0.8177*
	(0.0804)	(0.0132)	(0.0207)	(0.0912)	(0.0558)	(0.0072)	(0.0904)
Sample	647	647	647	647	647	647	647
	Emerging countries						
	Brazil	Chile	Estonia	India	Mexico	Russian	Turkey
Volatility (δ)	-0.1944*	0.4878*	-0.6500*	0.3289*	-0.0186	-0.1250	0.2573‡
	(0.0249)	(0.0000)	(0.1376)	(0.0402)	(0.0339)	(0.0996)	(0.1156)
Constant (ω)	-3.3985*	-0.4011*	-0.6965	-0.9047*	-0.5452*	-1.9004*	-3.3090*
	(0.9719)	(0.0000)	(0.4878)	(0.0162)	(0.1797)	(0.5967)	(1.0123)
ARCH term (α)	-0.1792*	-0.0972*	-0.0967†	-0.1758*	-0.1475*	-0.4832*	-0.0464
	(0.0690)	(0.0000)	(0.0508)	(0.0460)	(0.0430)	(0.0947)	(0.0758)
GARCH term (β)	0.5466*	0.9477*	0.9035*	0.8909*	0.9387*	0.7588*	0.4737*
	(0.1277)	(0.0000)	(0.0676)	(0.0019)	(0.0198)	(0.0722)	(0.1591)
Asymmetry (γ)	0.7739*	-0.0837*	0.0752	0.3056*	0.4537*	1.0037*	0.5507*
	(0.1085)	(0.0000)	(0.0982)	(0.0436)	(0.0810)	(0.1252)	(0.1586)
Sample	479	287	203	248	419	263	359

Notes: Standard errors are in parentheses. *: $p < 0.01$; ‡: $p < 0.05$; †: $p < 0.10$.
Data source: Author's calculations.

may help to explain why industrial growth are not negatively affected by growth uncertainty. In the particular case of India, the Gross savings rate as percentage of the GDP was 32% in 2015, according to the World Bank, which is substantially higher than the other emerging countries included in the sample. A higher rate of savings in moments of uncertainty may generate future long-term investments and higher growth according to Mirman (1971) and Aiyagari (1994).

The results found in Table I show that theories such as precautionary savings are more applicable to developed countries instead of emerging economies. Also, the tendency of capital to go to developed countries in periods of crisis may also explain why uncertainty is good for them and bad for emerging economies in terms of growth.

Table II shows the estimates from the two different specifications of the panel GARCH-M model. Model 1 considers that there is no volatility spillovers among countries in the same development stage, while Model 2 allows for covariance between the growth rates of different countries in the panel. For the sake of simplicity, we omitted unconditional variances and covariances (coefficients ω_i and η_{ij}, respectively), as well as the fixed effects and autoregressive terms (μ_i and ϕ_p, respectively). For developed and emerging countries, the test of no individual effects, with null hypothesis $H_0 : \mu_1 = \mu_2 = ... = \mu$, was rejected at 1% level of significance. This shows heterogeneous effects persist even among countries in the same stage of development.

Table II: Impact of growth volatility in economic growth from panel GARCH-M models

	Developed countries		Emerging countries	
	Model 1	Model 2	Model 1	Model 2
Volatility				
δ	$0.4619^{\ddagger}$	0.5458^{*}	-0.2892	$-0.3311^{\dagger}$
	(0.2135)	(0.0339)	(0.1844)	(0.1860)
Variances				
α	$0.0969^{\ddagger}$	0.0848^{*}	0.1591^{*}	0.1593^{*}
	(0.0419)	(0.0083)	(0.0139)	(0.0254)
β	0.3373^{*}	0.3222^{*}	0.6691^{*}	0.6816^{*}
	(0.0291)	(0.0170)	(0.0903)	(0.0985)
Covariances				
λ	-	0.0431	-	0.0828
		(0.0896)		(0.2931)
ρ	-	0.0921^{*}	-	0.0709
		(0.0208)		(0.0700)
Sample	634	634	247	247
$L(\hat{\boldsymbol{\theta}}, \hat{\boldsymbol{\Omega}}_t)$	7678.42	7708.98	2602.05	2438.37
$Q(12)$	804.47^{*}	536.04^{*}	297.58^{*}	281.56^{*}

Notes: Standard errors in parentheses. *: $p < 0.01$; ‡: $p < 0.05$; $\dagger$: $p < 0.10$.
Data source: Author's calculations.

Both models 1 and 2 show significant and positive impacts of volatility on growth for developed countries, but for emerging countries we found negative coefficients and less significance of the results, probably due to the distinct nature of emerging economies. These results are consistent with the EGARCH-M model estimates in Table I. In all models of Table II the hypothesis of joint residual autocorrelation is rejected using a multivariate version of the Ljung-Box Q test.

For developed countries, we found that an increase in volatility of 1% is related with an increase of about 0.55% in industrial production. This result is similar to the one found in Lee (2010). For emerging countries, our results show that there is a negative effect of around -0.33%, but the estimates did not exhibit statistically significance. This lack of significance is probably due to the very distinct results for each emerging country, as shown in Table I. Another interesting fact is that the persistence of volatility is smaller in developed countries. This suggests that these countries experience smaller periods of greater uncertainty.

4. Discussion

In this letter we have shown that uncertainty may enhance economic growth in developed countries, supporting the results found in the literature (Lee, 2010; Imbs, 2007). But this does not apply to emerging economies, where the effects of uncertainty are more ambiguous. This results contribute to the literature by showing that the effect of uncertainty on growth is heterogeneous and dependent on the stage of development of countries. Also, we contribute to the literature by accounting for each country's macroeconomic conditions while observing interactions within groups. In the EGARCH-M model, we observed the dynamics of uncertainty in each country. The panel GARCH-M model made possible treating the problem as an integrated process among countries with similar characteristics. In both approaches, we verified the validity of our hypothesis of different signs in the volatility-growth correlation.

Theoretically, our findings imply that different approaches for the subject can coexist. While some cases can be treated from the perspective of precautionary savings, credit constraints matters especially for emerging countries. Our findings are in line with the results found by Aghion et al. (2010), in the sense that the uncertainty increases the probability of postponement of long-term investment projects due to lower supply of credit to private sector, thus affecting sustained economic growth. Future research can investigate the effects that country-specific characteristics have in the relationship between uncertainty and growth, in order to understand the ambiguous results found for emerging economies.

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