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Is Higher Volatility Associated with Lower Growth? Intranational Evidence from South Korea

Karin Tochkov

Department of Psychology, Texas A&M University – Commerce
Texas, USA

Email: Karin_Tochkov@tamu-commerce.edu

Kiril Tochkov

Department of Economics, Texas Christian University
Fort Worth, Texas, USA

Abstract: This paper examines the relationship between output volatility and growth using regional data from South Korea over the period 1985-2003. The estimation is conducted using volatility that varies across regions as well as across time. The findings indicate that provinces with higher volatility have lower growth, but this is largely due to common shocks across provinces.

Keywords: Growth; Volatility; South Korea

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1. Introduction

Business cycle fluctuations have long been considered to be independent of economic growth. Since the emergence of endogenous growth models and the real business cycle theory in the 1980s, the validity of this dichotomy has been tested by a number of empirical studies using cross-country data. Kormendi and Maguire (1985) and Grier and Tullock (1989) find that output volatility is positively related to growth, whereas Ramey and Ramey (1995) and Kneller and Young (2001) provide evidence for a negative relationship. Another group of studies examine the link between growth and volatility at the regional level within a country, but the results are similarly ambiguous. Dawson and Stephenson (1997) use data from 48 US states, and find no evidence of an empirical relationship. Martin and Rogers (2000) show that volatility is negatively associated with growth for a sample of 90 European regions. Based on data from 10 Canadian provinces, Dejuan and Gurr (2004) find a positive but statistically insignificant link between volatility and growth.

This study is an empirical analysis of the relationship between growth and volatility at the regional level in South Korea. The first goal of the study is to contribute to the existing

literature by providing cross-regional evidence from a newly industrialized East Asian economy. South Korea is one of the fastest growing economies in the world with an average annual growth rate close to 6 percent over the past 40 years. During the same period, output volatility as measured by the standard deviation of average annual growth was 4 percent. This combination of high growth and volatility makes South Korea at the same time an exception among the OECD member countries and a representative example of a group of East Asian economies including Singapore, Hong Kong, and Taiwan.

The second goal of the paper is to examine whether measuring volatility over different periods and controlling for common output shocks across regions affects the growth-volatility relationship and is responsible for the ambiguous findings in the empirical literature. For this purpose, the paper follows at first the approach adopted in previous studies which assume that output volatility varies across regions but not across time. Next, a time-varying measure of volatility is introduced, and the link between growth and volatility is estimated via a panel regression. Furthermore, the robustness of the estimate to any conceivable controls that vary across time or across regions is tested by including fixed effects in the model.

2. **Cross-Regional Evidence on Volatility and Growth**

The panel data set includes 10 South Korean provinces over the period 1985-2003. Gwangju, Daejeon, and Ulsan are treated as parts of the provinces Jeonnam, Chungnam, and Gyeongnam, respectively, due to the lack of data for the years before they became separate administrative regions. Real provincial per capita GDP is measured in 2000 constant prices. The data was provided by the Korean National Statistical Office.

The basic model used in the empirical literature to estimate the relationship between volatility and growth is a cross-sectional specification given by:

$$\overline{\Delta y_i} = \alpha_0 + \alpha_1 \sigma_i + \varepsilon_i \qquad (1)$$

The dependent variable, $\overline{\Delta y_i}$, is the average annual growth rate of real per capita GDP of province *i* over the sample period, expressed as a log difference. The independent variable, σ_i, is the standard deviation of annual growth of real per capita GDP in province *i*.

The results of the regression given in Eq. (1) for the South Korean provinces are:

$$\overline{\Delta y_i} = \underset{(3.98)}{0.103} - \underset{(1.88)}{0.832}\sigma_i$$

with t-statistics given in parentheses. As the regression shows, there is a negative and statistically significant (albeit at the 10 percent level) relationship between growth and

volatility. In particular, the estimate suggests that a 1 percent increase in the volatility of provincial GDP growth leads to a 0.8 percent decrease in the average growth of provincial GDP. When compared to previous cross-regional studies that use the same specification, this finding is similar to Dawson and Stephenson (1997) and Martin and Rogers (2000), but contradicts the positive relationship found by Dejuan and Gurr (2004).

Following Ramey and Ramey (1995), the link between growth and volatility has also been estimated as follows:

$$\Delta y_{it} = \beta_0 + \beta_1 \sigma_i + \beta_2 y_{i,1985} + \beta_3 \Delta n_{it} + \omega_{it} \quad (2)$$

$$\omega_{it} \sim N(0, \sigma_i^2) \quad (3)$$

where volatility, σ_i, is measured as the standard deviation of the residuals, ω_{it}. The log of the initial real per capita GDP, $y_{i,1985}$, and the population growth rate, Δn_{it}, are included as control variables.

Equation (2) and (3) are estimated jointly using a maximum likelihood procedure and produce the following results:

$$\Delta y_{it} = \underset{(0.27)}{0.135} - \underset{(0.58)}{0.456}\sigma_i - \underset{(0.12)}{0.004} y_{i,1985} - \underset{(0.84)}{0.284}\Delta n_{it}$$

Similarly to Dawson and Stephenson (1997), the standard deviation enters the estimated equation with a negative coefficient that is not significantly different from zero. The coefficients for the initial level of output and the population growth rate have the expected signs but are not statistically significant as well.

In Eqs. (1)-(3), volatility is measured over the entire sample period, and therefore varies across provinces but not across time. However, Kneller and Young (2001) have shown for a sample of OECD countries that the sign of the estimated coefficients reverses depending on whether volatility is measured over longer or shorter periods. To examine whether the results for South Korea are sensitive to the length of the period over which volatility is measured, three different time-varying measure of volatility are introduced. These are calculated as standard deviations of the 3-, 5-, and 7-year central moving averages of real provincial per capita GDP.

The regression of annual provincial GDP growth on the time-varying measure of volatility takes the form:

$$\Delta y_{it} = \gamma_{1i} + \gamma_{2t} + \gamma_3 \sigma_{it} + u_{it} \quad (4)$$

An advantage of this specification is that the region-fixed effects, γ_{1i}, control for the effect of *every* region-specific variable that could possibly affect the growth-volatility

relationship. The time-fixed effects, γ_{at}, remove any correlation between growth and volatility that arises from aggregate output shocks common to all provinces. Time-fixed effects are potentially much more important for cross-regional than for cross-country studies due to the common effects of fiscal and monetary policy of the central government across regions.

The results from estimating Eq. (4) for the sample of South Korean provinces are presented in Table 1. From the first row it is evident that without any fixed effects there is a negative and statistically significant relationship between growth and volatility at the regional level. It is also the case that the estimated effect of volatility changes only slightly across the three time-varying volatility measures. When region-fixed effects are included, the estimates remain significantly negative and nearly identical in magnitude indicating that unobserved regional characteristics are not responsible for the negative correlation between growth and volatility.

When Eq. (4) is estimated with time-fixed and no region-fixed effects, the coefficients remain negative, but their magnitude falls by about two thirds and they are no longer significant at conventional levels. This suggests that common output shocks across provinces are the main driving force behind the negative growth-volatility relationship. With both region- and time-fixed effects included in the regression, the estimated effects of volatility remain statistically insignificant and negative, except for the coefficient of the 7-year measure which has a positive sign.

Table 1: Relationship between Annual GDP Growth and Time-varying Volatility across South Korean Provinces, 1985-2003

MA periods	**k=3**	**k=5**	**k=7**
Fixed Effects:			
None	-0.710	-0.634	-0.665
	(-6.57)	(-4.78)	(-3.38)
Region-fixed	-0.730	-0.661	-0.680
	(-6.70)	(-4.54)	(-3.30)
Time-fixed	-0.085	-0.235	-0.296
	(-0.64)	(-1.34)	(-1.29)
Region and Time	-0.008	-0.071	0.212
	(-0.06)	(-0.34)	(0.68)

Note: k denotes the central moving average periods in years used in calculating time-varying volatility. Values of heteroscedastic-consistent t-statistics appear in parentheses.

3. Conclusions

This paper shows that higher output volatility is associated with lower economic growth across provinces in South Korea. However, the negative relationship is largely due to aggregate shocks common to all regions within the country. Once these shocks are controlled for, there is no evidence that growth and volatility are empirically related at the regional level. Previous cross-regional studies neither allow volatility to vary across time nor include time-fixed effects in their empirical specification. Thus the ambiguous results in the literature might simply reflect the fact that common shocks across regions have a different impact on the growth-volatility relationship in different countries, depending for instance on the fiscal and monetary policy of the respective central governments.

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