Response of Garey and Valerie Ramey

to

"Are Average Growth Rate and Volatility Related?" by Partha Chatterjee and Malik Shukayev

September 13, 2006

In a recent paper, Chatterjee and Shukayev argue that growth and volatility are not related when growth rates are defined as percent changes. The paper replicates the Ramey and Ramey (AER, 1995) results using alternative definitions and alternative data sets. The paper concludes that there is no significant relationship between volatility and growth.

Unfortunately, the paper's premise is built on a bad definition of growth rates. Contrary to the authors' suggestion, the *standard* definition of growth rates in empirical applications of growth theory is log differences, not percent changes. Why does everyone use log differences? As explained in textbooks and lecture notes, percent changes have the undesirable quality that they are not symmetric whereas log changes are (i.e. see http://home.uchicago.edu/~hgarduno/gsb33040logs.ppt). For example, if a house price goes up 20% this year and falls 20% next year, the average percent change is 0, but the ending price of the house is lower than the starting price. Stated another way, taking averages of percent changes can be very misleading about overall growth because:

$$\frac{1}{T}\sum_{t=1}^{T}\frac{Y_t - Y_{t-1}}{Y_{t-1}} \neq \left(\frac{Y_T}{Y_0}\right)^{1/T} - 1$$

The expression on the right hand side is the correct measure of growth rates when growth is geometric, which is the type of growth assumed by virtually every paper in the growth literature. The asymmetry of percent changes leads to biases in average growth rates when stated as percent changes.

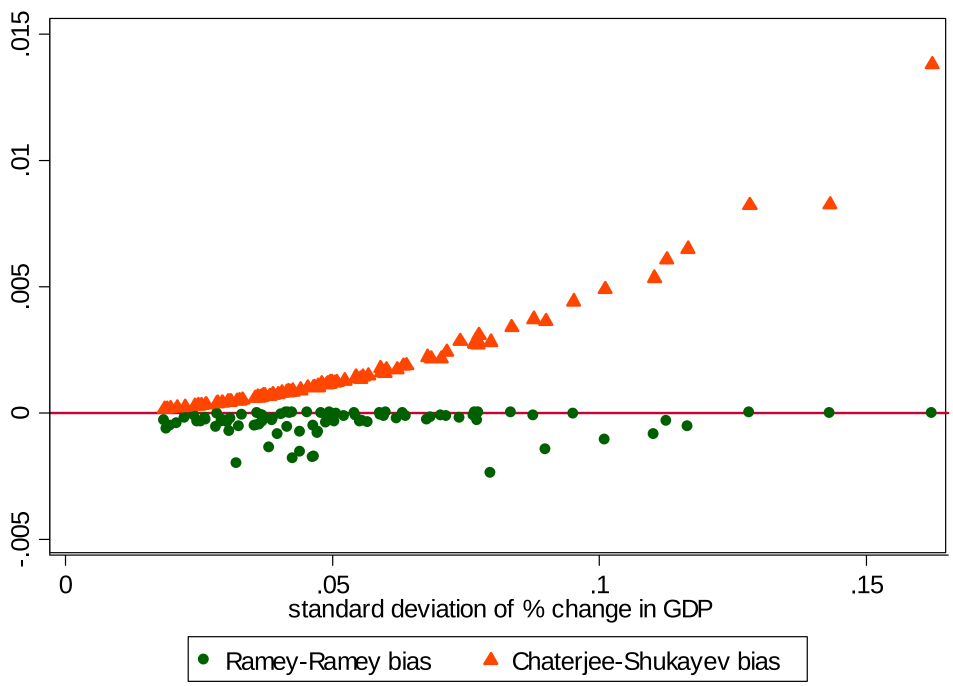
Take the example of El Salvador (Country 54 in the Summers-Heston data set). On the last page of this note are given the level of per capita GDP, the percent change, and the log change. The average percent change is 0.02265, whereas the average log difference is 0.0088. The correct measure of average annual growth rates (assuming geometric growth) is $\left(\frac{Y_{1985}}{Y_{1961}}\right)^{1/24} - 1$ = 0.0088, which is much smaller than the average percent change. If one used the average percent change and the initial value of GDP to calculate GDP 24 years later, the answer would be far from the truth: the estimate would be 4,861 compared to the actual value of 3,508. The reason that these two numbers deviate so much is that El Salvador is very volatile and experiences periods of significant declines in GDP. *The asymmetry inherent in percent change calculations leads to very biased estimates of growth rates.*

Note that the bias in the percent change measure is not so great for low volatility countries like the U.S. because significant downturns in GDP are rare. In general, for a given growth rate, the more volatile the country, the more significant and frequent the decreases of GDP, *and thus the more upward biased is the percent change calculation relative to true* *growth.* Thus, the true bias is the reverse of what the authors claim: the percent change measure has an upward bias for exactly those countries with the most volatility.

Figure 1 shows the biases for percent changes and log differences in approximating the compound growth rate, measured as $g = \left(\frac{Y_T}{Y_0}\right)^{1/T} - 1$. The biases are plotted against the standard deviation of the average annual percent change in GDP. The data are for the 92 countries in the Ramey-Ramey data set, from 1962 to 1985.

Note the strong positive relationship between Chatterjee and Shukayev's measure's bias and volatility. Note also the lack of a relationship between the bias using the log change and volatility. It is no wonder that the authors find an insignificant relationship between volatility and growth when measured this way.

Fig. 1: Growth Estimate Bias vs. Volatility
Ramey-Ramey 92 Country Dataset



$$\text{Ramey-Ramey Bias} = \Delta \log y - \left\{\left(\frac{Y_T}{Y_0}\right)^{1/T} - 1\right\}$$

$$\text{Shaterjee-Shukayev Bias} = \frac{1}{T}\sum_{t=0}^{T}\frac{Y_t - Y_{t-1}}{Y_{t-1}} - \left\{\left(\frac{Y_T}{Y_0}\right)^{1/T} - 1\right\}$$

Chatterjee and Shukayev also argue that the *standard deviation* of log growth rates is a biased measure of volatility relative to the standard deviation of percent changes. To investigate the importance of this bias in the Ramey-Ramey data, consider the simple cross-country regression of average log differences on volatility in the 92-country sample. If volatility is measured as the standard deviation of log differences, the coefficient is -0.15 with a heteroscedastic-consistent standard error of 0.06. If volatility is instead measured as the standard deviation of percent changes, the coefficient is -0.13 with a heteroscedastic-consistent standard error of 0.06. Thus, the type of bias that Chatterjee and Shukayev highlight has minimal effects on the estimates. The advantage of using the Ramey-Ramey measure of volatility (based on logs) is that it can be estimated within the model using maximum likelihood methods, so the coefficient estimates are more precise.

In conclusion, Chatterjee and Shukayev's finding of no relationship between growth and volatility is due to their badly biased measure of average growth. The standard measure used by Ramey and Ramey, which is log differences, does not suffer from this bias.

Data from El Salvador

YEAR	GDP	Percent Change	Log Change
1961	2840	.	.
1962	2791	-0.017254	-0.017404
1963	2517	-0.098173	-0.10333
1964	2907	0.15495	0.14405
1965	3237	0.11352	0.10753
1966	3252	0.0046339	0.0046232
1967	2886	-0.11255	-0.11940
1968	3206	0.11088	0.10515
1969	3181	-0.0077979	-0.0078284
1970	3127	-0.016976	-0.017122
1971	3254	0.040614	0.039811
1972	3327	0.022434	0.022186
1973	3428	0.030358	0.029906
1974	4423	0.29026	0.25484
1975	5038	0.13905	0.13019
1976	4958	-0.015879	-0.016007
1977	5119	0.032473	0.031957
1978	5986	0.16937	0.15646
1979	7598	0.26930	0.23846
1980	6176	-0.18715	-0.20721
1981	3503	-0.43280	-0.56705
1982	2891	-0.17471	-0.19202
1983	3721	0.28710	0.25239
1984	3578	-0.038431	-0.039188
1985	3508	-0.019564	-0.019758