Appalachian
STATE UNIVERSITY

Department of Economics Working Paper

Number 14-08 | June 2014

The Empirical Volatility-Growth Relationship: Is Economic Freedom the Missing Link?

John W. Dawson
Appalachian State University

Department of Economics
Appalachian State University
Boone, NC 28608
Phone: (828) 262-2148
Fax: (828) 262-6105
www.business.appstate.edu/economics

June, 2014

The Empirical Volatility-Growth Relationship: Is Economic Freedom the Missing Link?

John W. Dawson*
Department of Economics
Appalachian State University
Boone, NC 28608-2051
dawsonjw@appstate.edu
828-262-6128

Abstract

This paper examines the role of economic freedom in the empirical relationship between business cycle volatility and long-run growth across countries. In a diverse sample of 99 countries, it is shown that accounting for economic freedom's influence on volatility mitigates or even eliminates the negative impact of volatility on growth. It is also possible that the impact of volatility on growth is not homogeneous across countries with different levels of freedom. In particular, volatility appears more likely to have a negative impact on growth in countries at low levels of economic freedom. These findings are consistent with "circumstantial" evidence available in other studies, but there was no clear evidence that economic freedom was the missing link.

***JEL* classifications:** E32, O43
Keywords: business cycles, volatility, growth, economic freedom

*I am grateful to Jim Gwartney, Mark Strazicich, and session participants at the 2014 annual meetings of the Association for Private Enterprise Education in Las Vegas for helpful comments on earlier drafts of this paper. Any remaining errors are my own.

1. Introduction

Ramey and Ramey (1995) is widely regarded as the benchmark empirical study of the relationship between business cycle volatility and long-run economic growth. The Rameys report a negative relationship between volatility and growth in a broad cross-section of countries. A number of more recent studies confirm the finding of a negative volatility-growth relationship, including Martin and Rogers (2000), Fatas and Mihov (2003), Mobarak (2005), Baldinger (2010), and Furceri (2010). Other recent studies, however, report a positive relationship; see, for example, Stastny and Zagler (2007) and Lee (2010). Two studies which predate Ramey and Ramey—often ignored in this literature—also examine the volatility-growth relationship. In their broad search for determinants of cross-country growth, Kormendi and Meguire (1985) and Grier and Tullock (1989) find evidence of a positive relationship between volatility and growth.

At first glance, it seems that the available evidence on the empirical relationship between volatility and growth is contradictory. A closer look at the evidence, however, reveals some interesting patterns in the data. First, Ramey and Ramey's finding of a negative relationship in a 92-country sample becomes positive and statistically insignificant when their sample is restricted to OECD countries. Similarly, Kormendi and Meguire's positive relationship is obtained in a sample of 47 mostly developed countries and the positive relations found in the studies by Stastny and Zagler and Lee are obtained in samples restricted to OECD and G7 countries. In addition, Dawson and Stephenson (1997) find no evidence of a volatility-growth relationship across the U.S. states. All of this suggests that the generally accepted negative relationship between volatility and growth may not be an accurate description of the process at work in more developed economies.

It is interesting to consider what characteristic of more developed economies drives this pattern. Specifically, this paper considers whether the volatility-growth relationship varies with levels of economic freedom across countries or whether volatility is serving as a proxy for economic freedom in studies of the volatility-growth relationship. It is well known that economic freedom is an important determinant of growth across countries; see, for example, studies by Dawson (1998) and Gwartney,

Lawson, and Holcombe (1999), among others.[1] More recently, Lipford (2007) and Dawson (2010) have shown that economic freedom is also related to business cycle volatility across countries. It is possible, then, that volatility is serving as a proxy for economic freedom in studies of the volatility-growth relationship that do not explicitly control for differences in freedom across countries. It is also possible that volatility and growth are positively related or unrelated in countries with higher levels of economic freedom and negatively related in countries with lower levels of freedom. Such possibilities could explain why volatility and growth are negatively related in diverse samples of countries, but found to be positively related or insignificant in samples restricted to more developed countries where freedom is at a higher and more uniform level. It can also explain why volatility and growth are not related across the U.S. states where freedom is also at a higher and more uniform level.

Evidence provided by Grier and Tullock also supports this conjecture, where a positive volatility-growth relation is found in a large, diverse sample of countries using a specification that includes a number of institutional proxies and the size and significance of the volatility coefficient is reduced when an explicit measure of institutions is included. Studies that find a negative relationship between volatility and growth in broad samples of countries may also be consistent with the idea that economic freedom matters in the volatility-growth relationship. If such studies ignore the role of freedom in growth, the analysis may attribute to volatility the influence that is really due to freedom.

This paper explores the possibility that economic freedom is the missing link in the relationship between macroeconomic volatility and economic growth. The next section of the paper provides a brief theoretical perspective on the volatility-growth relationship. The third section then discusses the empirical model, methodology, and data in detail. A discussion of the empirical results appears in the following two sections and the final section offers some concluding remarks.

2. Volatility and Growth: A Brief Theoretical Perspective

In terms of theory, relatively little attention has been paid to the effect of business cycle volatility on long-run economic growth. Indeed, the literatures on business cycles

[1]DeHaan, Lundstrom, and Sturm (2006) provide a survey of the large literature on economic freedom and growth.

and economic growth have existed largely in isolation from one another. There are reasons, however, to believe that volatility and growth may be related. For example, economic uncertainty and credit constraints during periods of increased macroeconomic volatility may reduce investment, capital accumulation, and presumably growth. Along similar lines, if investment is to some extent irreversible, increased volatility can lead to lower investment and thus lower growth; see, e.g., Bernanke (1983). Both of these channels suggest a negative relationship between volatility and growth.

There are also reasons to suspect a positive relationship between volatility and growth. Black (1987) suggests that economies face a positive risk-return tradeoff where riskier technologies (that ultimately lead to higher volatility) are adopted only if they are expected to pay a higher return and hence produce higher growth rates. Separately, Sandmo (1970) and Mirman (1971) hypothesize that more variable income streams lead to higher savings, more investment, and presumably more growth. These channels both imply a positive volatility-growth relationship.

Clearly, there are different possible channels through which volatility may affect growth, some with positive and some with negative predicted relationships. In addition, different channels may be dominant in different economies, causing different estimated relationships in different groups of countries. Which channel dominates in an economy may well depend on certain characteristics in that economy. In particular, different institutional arrangements may determine which channel is dominant. For instance, economies with more market-oriented institutions (i.e., more economic freedom) may be able to adjust to volatility more readily, thus mitigating the negative effect of volatility on investment. This may, in turn, result in a statistically insignificant or positive estimated volatility-growth relationship in high freedom countries. Similarly, myopic behavior in countries with low levels of economic freedom may dampen precautionary saving motives even in times of high volatility, thus reducing the positive influence of volatility on growth. This could leave a negative volatility-growth relationship at work in these countries.

While the preceding theoretical discussion is obviously far from complete, the point is to illustrate that theory alone cannot settle the debate over the relationship between volatility and growth. Moreover, the question of which theoretical relationship emerges in an economy may depend on the institutional framework. Ultimately, it is an

empirical issue. The analysis in the remainder of the paper addresses this empirical question.

3. Empirical Model, Methodology, and Data

The following empirical specification is typical of that used in studies of the volatility-growth relationship:

$$\Delta \ln y_i = \alpha + \lambda \sigma_i + \Sigma_j \beta_j X_{ji} + \varepsilon_i.$$

The dependent variable, $\Delta \ln y$, is the average annual growth rate of real GDP per capita. X_j represents a common set of conditioning variables found by Levine and Renelt (1992) to be robustly related to growth. These conditioning variables include the initial income level, the investment share of GDP, and population growth. σ is the volatility measure and λ is the coefficient of interest. This basic specification is used as a starting point in the analysis that follows.

The explanatory variable of interest, macroeconomic volatility, is measured using the standard deviation of annual growth rates of real GDP per capita. This is a standard measure of business cycle volatility that has been used in a number of recent studies, including the pure cross-section specification in Ramey and Ramey. This volatility measure implicitly assumes the trend growth rate is constant and equal to the mean for each country.[2]

To determine whether the volatility-growth relationship varies across countries with different institutional environments, measures of economic freedom are added as explanatory variables in the specification above. In regressions that include economic freedom, both the initial level of freedom and the change in freedom over the sample period is included. Changes in economic freedom have been shown to be important along with the level of freedom in explaining long-run growth experiences across countries in a number of studies (see, e.g., Dawson, 1998).

[2] An alternative measure of volatility is the standard deviation of the output "gap" measured as the difference between actual and trend real GDP per capita, where the trend is obtained using a smoothing method such as the Hodrick-Prescott filter. This method allows for a time-varying trend for each country, whereas the standard deviation of growth rates implies a constant trend. Each method has benefits and costs depending on the exact nature of a given country's growth path. In practice, however, the two volatility measures are highly correlated and provide qualitatively similar results in the analysis below. Thus, only the results using the standard deviation of annual growth rates are reported below.

In addition, Pitlik (2002) shows that a measure of the volatility of economic freedom over time is negatively related to long-run growth rates across countries even after controlling for other factors related to growth, including the level and changes in freedom. This result shows that volatile liberalization policies depress growth even when they generally tend toward increased levels of economic freedom. It seems particularly important to control for volatility in the path toward freedom in the analysis that follows, given that the focus of the analysis is on macroeconomic volatility more generally. Thus, a measure of the volatility of economic freedom over the sample period is also included (along with the initial level and change in freedom) in regressions that explicitly control for economic freedom. Pitlik shows that the appropriate measure of volatility is the standard deviation of the time series of changes in economic freedom over the sample period. More specifically, for the time period 0, …, T in a given country, define:

$$SDEF = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\Delta EF_t - \frac{1}{T}\sum_{t=1}^{T}\Delta EF_t\right)^2},$$

Where EF_t is a measure of economic freedom and $\Delta EF_t = EF_t - EF_{t-1}$. This measure of the volatility of freedom is used in the analysis that follows whenever measures of freedom are included as explanatory variables.

The data on economic freedom used in the analysis is the *Economic Freedom of the World* (EFW) index from Gwartney, Lawson, and Hall (2011). The EFW index is based on the classical conception of individual liberty, which emphasizes personal choice, private property, and freedom of exchange. The EFW index encompasses five areas of freedom which are aggregated into a single summary index of economic freedom.[3] Within each area, various underlying components are equally weighted to construct an area index. Then, equal weight is given to each of the five area indexes to construct the summary EFW index (i.e., the five area indexes are averaged). The index is available for a large number of countries in five-year intervals from 1975-1995, and annually since 1995.[4] The analysis below uses the EFW "chain" index, which is

[3]The five major areas of the index are (1) size of government; (2) legal structure and security of property rights; (3) access to sound money; (4) freedom to trade internationally; and (5) regulation of credit, labor, and business. The underlying data that comprise each area are listed in Table 1. All underlying data are converted to a scale from 0 (representing the least free) to 10 (most free).

[4]The most current version of the EFW index is available at http://freetheworld.com.

suggested by Gwartney, Lawson, and Hall to be the most consistent version of the index over time.

The empirical methodology used in this paper is cross-country regression analysis. The analysis is strictly cross-section, with only one observation for each country. The sample includes 99 countries over the period 1980-2009. The analysis also controls for the possibility that macroeconomic volatility is endogenous. As discussed above, the volatility of growth has been shown to be systematically related to levels of economic freedom across countries. In order to identify causation running from economic freedom to volatility, instrumental variables that isolate the exogenous variation in volatility are used. The instrumental variables are selected in light of the recent literature on the determinants of volatility (see, for example, Dawson (2010)). They include distance from the equator, dummy variables for diversified exporters and land-locked countries, the other exogenous explanatory variables in the analysis (the initial income level, investment share, and population growth rate), and the various measures (initial level, change, and volatility) of economic freedom (when included as explanatory variables in the primary regression). Distance from the equator and the dummies for diversified exporters and land-locked countries are from the World Bank Global Development Network's growth database.

Underlying data on real GDP per capita, population, and investment shares are from the Penn World Tables (Version 7.0). Johnson, Larson, Papageorgiou, and Subramanian (2013) show that Penn World Table (PWT) data vary substantially across different versions of the PWT and that the methodology used to estimate growth rates leads to systematic variation in PWT data. They further show that these problems matter in the empirical growth literature. More specifically, they show that Ramey and Ramey's finding of a negative volatility-growth relationship is not robust across different versions of the PWT. Previously, Dawson, DeJuan, Seater, and Stephenson (2001) also found that Ramey and Ramey's negative volatility coefficient was not robust after controlling for data quality within the version of the PWT used by Ramey and Ramey. However, Johnson et al. show that this issue only applies to studies that use high-frequency (particularly annual) data in general and to Ramey and Ramey's panel analysis using annual data in particular—and that studies using low-frequency data remain robust to data revisions in the PWT. As such, the pure cross-section analysis that follows is not

subject to the problems identified in these studies. Thus, pure cross-section analysis remains a useful and valid technique for uncovering fundamental relationships in the underlying data and the results reported below are comparable to Ramey and Ramey's pure cross-section results. In addition, since the Johnson et al. analysis leaves Ramey and Ramey's finding of a significantly negative volatility-growth relationship in their pure cross-section analysis intact, it seems the perfect setting to explore the role of economic freedom in the volatility-growth relationship.

4. Empirical Results

This section discusses the empirical results for the model discussed above. After including the measures of economic freedom, the specification to be estimated is:

$$\Delta \ln y_i = \alpha + \lambda \sigma_i + \Sigma_j \beta_j X_{ji} + \gamma_1 EF_{0i} + \gamma_2 \Delta EF_i + \gamma_3 SDEF_i + \varepsilon_i,$$

where $\Delta \ln y$ is the average annual growth rate, σ is the standard deviation of annual growth, X_j are conditioning variables found by Levine and Renelt (1992) to be robustly related to growth (initial income, investment share, and population growth), EF_0 is the initial level of freedom, ΔEF is the change in freedom, and $SDEF$ is the volatility of freedom. Investment shares and population growth rates are averages over the period 1980-2009. Initial income and initial freedom are 1980 values entered as natural logarithms. The change in freedom is the change in the EFW chain index over the 1980-2009 period. The volatility of freedom is the standard deviation of changes in freedom (as defined in the previous section) over the 1980-2009 period.

Estimation of all variations of this model is by ordinary least squares (OLS) and, for the instrumental variables (IV) analysis, two-stage least squares. Reports of statistical significance are based on White heteroskedasticity-consistent standard errors. The sample of 99 countries used in the analysis is the largest sample for which data are currently available for all variables. Table 2 lists the 99 countries included in the analysis.

Estimates of the model are provided in Table 3. Column (1) provides the results when the volatility measure alone is included as an explanatory variable in the OLS regression. The coefficient on volatility is found to be negative and statistically significant when no other correlates of growth are included. When the common set of control variables (initial income, investment share, and population growth) are included

in the regression, as reported in column (2), the coefficient on volatility remains significantly negative. The coefficients on the control variable all have the expected sign and are statistically significant. To allow for the possibility that the volatility measure is endogenous, the model is estimated using two-stage least squares. The results of the IV analysis are reported in column (3). The coefficient on volatility remains negative, but is only marginally significant in the IV analysis. The first-stage *F*-statistic suggests the instruments are sufficiently strong, but a version of the Hausman specification test proposed by Davidson and MacKinnon (1989, 1993) suggests endogeneity is not a problem in the OLS specification. Thus, the results in column (2) appear to be valid for this specification. The finding of a significantly negative volatility coefficient in this broad sample of countries is consistent with numerous results in the literature.

Next, the initial level of economic freedom, the change in freedom, and the volatility of freedom are added to the specification as explanatory variables. The OLS results are reported in column (4). Both initial freedom and the change in freedom are significantly positive, as expected. The volatility of freedom is negative, but statistically insignificant. All of the control variables remain significant and of the expected sign. However, the coefficient on volatility becomes statistically insignificant with the addition of the economic freedom variables to the model. One possible explanation for the insignificance of volatility when the freedom variables are added as regressors is that volatility is serving as a proxy for freedom in specifications that do not explicitly control for differences in freedom across countries. To account for the possibility that volatility is endogenous, the model is also estimated via IV analysis. The results are reported in column (5). Volatility remains statistically insignificant in the IV analysis, but the Hausman test again suggests that the OLS estimates are valid. Thus, it appears that including economic freedom variables in the analysis mitigates the estimated impact of volatility on growth.[5]

[5]It is possible that volatility's effect on growth operates primarily through an effect on investment. If so, volatility's estimated impact on growth should increase in size and significance if investment is removed as an explanatory variable in the analysis. Removing investment as a regressor generally has little effect on the estimated coefficients on volatility reported here, but it does increase the estimated size and significance of the economic freedom variables in explaining growth. This effect is consistent with results reported in Dawson (1998) which suggest that economic freedom affects growth at least in part through an indirect effect on investment. Thus, investment is included as an explanatory variable in all remaining results.

For volatility to proxy for economic freedom in specifications that ignore the role of freedom in the growth process, volatility and freedom must be systematically related. Lipford (2007) and Dawson (2010) show that volatility and freedom are indeed related in broad samples of countries even after controlling for other factors that are important in explaining output volatility across countries. Figure 1 shows median volatility levels by EFW index quartile for the 99-country sample used here.[6] Additional descriptive statistics for the volatility measure by EFW quartile are provided in Table 4. Volatility is clearly lower in countries with higher freedom ratings and vice versa.

It is also interesting to explore the possibility that the volatility-growth relationship is not homogeneous across countries with different levels of freedom. A first step in this direction is provided in Figure 2, which shows scatter plots of average annual growth rates and output volatility by EFW index quartile. The simple regression lines show that volatility and growth are positively related in the top two quartiles (high-freedom countries) and negatively related in the bottom two quartiles (low-freedom countries). The negative relationship is statistically significant in the bottom quartile (the least free countries) and marginally significant in the third quartile. The positive relationships in the top two quartiles are statistically insignificant. Closer examination of the plots for the top two quartiles reveals that the positive relations might be stronger if not for a few high-volatility countries in those quartiles. Notwithstanding, the plots are at least suggestive that volatility's impact on growth may well vary across countries with different freedom characteristics.

To determine if the volatility-growth relationship varies across subsamples with different freedom levels, the regression model is re-estimated with dummy variables for the EFW quartiles. The results are reported in Table 5. The impact of volatility on growth in each of the EFW quartiles is given by the coefficient on Qi × volatility for i = 1, 2, 3, and 4, respectively, where the Qi are dummies for the first (most free), second, third, and fourth (least free) EFW quartiles. Thus, this analysis allows for a distinct volatility-growth relationship within each EFW quartile.

[6]Quartiles are determined from the 141 countries around the world for which EFW data are available, thus explaining why there are different numbers of countries in each quartile used here. The results are not dependent on how quartiles are selected.

The first column in Table 5 reports the results when only the volatility measures are included. The estimated coefficients suggest a pattern such that volatility has a larger negative impact in countries with lower levels of freedom. However, volatility is significantly negative only in the fourth (least free) EFW quartile. Thus, even when no other correlates of growth are included in the specification, there is evidence that the volatility-growth relationship varies across countries with different institutional arrangements. The four volatility coefficients are also jointly significant in explaining growth across countries in this specification.

The second column in Table 5 reports the results when the common set of conditioning variables is included in the growth regression. All of the conditioning variables are individually significant with the expected signs. The volatility coefficients continue to indicate the same pattern with volatility in lower-freedom countries having a larger negative impact on growth. Indeed, volatility is now significantly negative in the third and fourth EFW quartiles. An *F*-test also indicates that the full set of volatility variables is jointly significant. Column (3) reports on the same specification estimated using the IV approach. The same pattern generally holds with respect to the volatility-growth relationship across EFW quartiles. The fourth EFW quartile remains negative and significant at the 5% level. The third quartile is marginally significant (at the 10% level) and the second quartile nearly so. The set of volatility measures as a whole remain jointly significant. The first-stage *F*-statistic for the IV regression suggests the instruments are sufficiently strong and the Hausman test suggests the OLS estimates in column (2) may be invalid due to endogeneity. Thus, based on the results in column (3), volatility is estimated to have a significantly negative impact on growth in countries at the lowest levels of freedom, but this effect diminishes as the level of freedom increases and disappears altogether in countries at the highest levels of freedom in the world. But will this pattern hold up once levels of freedom are explicitly included in the model?

The results reported in columns (4) and (5) add measures of economic freedom to the specification. Diagnostic measures again suggest endogeneity may be a problem in the OLS analysis, so attention is restricted to the IV results in column (5). The results suggest that controlling for freedom eliminates the previously suggested pattern of volatility's impact on growth across countries with different levels of freedom. More specifically, volatility is no longer statistically significant in any of the EFW quartiles and

the set of volatility measures as a whole is no longer jointly significant. The measures of economic freedom are also individually insignificant, a result owing to the use of EFW quartile dummies that implicitly account for some degree of the variation in freedom across countries. Nonetheless, the role of economic freedom in the growth process is well established and the results suggest that controlling for differences in freedom across countries attenuates or even eliminates the estimated impact of volatility on growth.[7]

Taken together, the analysis suggests that findings of a negative volatility-growth relationship in diverse samples of countries may be driven by a failure to account for differences in economic freedom across countries. Once the analysis controls for differences in freedom, it is questionable as to whether volatility is a statistically significant determinant of cross-country growth at all. If a negative volatility-growth relationship does exist, it appears to dominate primarily in countries at lower levels of economic freedom and this effect diminishes with higher levels of freedom. There is no evidence of a positive relationship between volatility and growth, even in countries at the highest levels of freedom. While this result contradicts findings in several studies which use samples of highly developed countries, visual inspection of the top two (most free) EFW quartiles in Figure 2 leaves open the possibility of finding a positive relationship in certain restricted samples of these countries. Overall, these findings help to explain the range of different results in the literature with regard to the empirical volatility-growth relationship. In particular, it appears that economic freedom may be the missing link in reconciling the contrasting results.

5. Analysis of the Underlying Areas of Freedom

This section takes a closer look at the five underlying areas of freedom that make up the EFW index. Recall that the EFW index is a composite of five individual areas of freedom: (1) size of government; (2) legal structure and security of property rights; (3) access to sound money; (4) freedom to trade internationally; and (5) regulation of credit,

[7]Similar results are obtained by dividing the 99-country sample into subsamples of low-freedom (bottom two EFW quartiles) and high-freedom (top two EFW quartiles) countries and running separate regressions on each subsample. Specifically, volatility is generally insignificant in the high-freedom subsample and significantly negative in the low-freedom subsample, but volatility becomes insignificant in the IV analysis when measures of economic freedom are included in the model. Similarly, dividing the sample into high-, medium-, and low-freedom subsamples provides qualitatively similar results. Thus, the results suggested in Table 5 are robust to difference groupings of countries.

labor, and business. The analysis in this section will allow a determination of whether the different areas of freedom have a different impact on the volatility-growth relationship. For example, it may be argued that "unsound money" policies that lead to high and variable rates of inflation in an economy cause more macroeconomic volatility which is contemporaneously associated with lower growth. As such, volatility will be found to be a determinant of growth in regressions that do not control for this aspect of economic freedom. Likewise, if the composite EFW index is sufficiently correlated with the sound money area of freedom, use of the broad composite in empirical analysis (such as in the previous section of this paper) may proxy for the role that is actually attributable to the more narrow area of freedom. In other words, the desire is to determine which, if any, areas of freedom are driving the results discussed above.

To analyze the role of the underlying areas of freedom, the regression analysis considered above is repeated using the individual areas of freedom in place of the composite EFW index. More specifically, the initial level and change in each underlying area of freedom is included individually in volatility-growth regressions analogous to those reported in the previous section. To be clear, each regression includes the initial level and change in one of the five underlying area of freedom. All regressions control for the volatility of the composite EFW index using the same *SDEF* measure as defined above (i.e., the volatility of each underlying area of freedom is not included). For convenience, the specification to be estimated here is:

$$\Delta \ln y_i = \alpha + \lambda \sigma_i + \Sigma_j \beta_j X_{ji} + \gamma_1 \text{AREA}n_{0i} + \gamma_2 \Delta \text{AREA}n_i + \gamma_3 SDEF_i + \varepsilon_i,$$

where AREAn_i, for $n = 1, 2, \ldots, 5$, is one of the five underlying areas of freedom in country i and all other variables are as defined above.

Table 6 reports the results using the five underlying areas of freedom individually and a uniform effect of macroeconomic volatility on growth (i.e., with EFW quartile dummies not included).[8] Note that each column in the table reports results using a different area of freedom. Among the areas of freedom, Area 2 (legal structure and security of property rights) and Area 4 (freedom to trade internationally) are found to be statistically significant. When these areas of freedom are included in the model, volatility is found to be statistically insignificant. In the specification that includes Area 3 (access

[8]Regression diagnostics from IV analysis suggest that OLS estimates of these specifications are valid, so only the OLS results are reported in Table 6.

to sound money), changes in that area of freedom are found to be marginally significant and volatility is insignificant (but very nearly significant at the 10% level). However, volatility remains significantly negative in the specification that includes Area 5 (regulation of credit, labor, and business) where none of the measures of freedom in that area are significant. Volatility is marginally significant in the model that includes Area 1 (size of government) and none of the measures of freedom in that area are significant (although volatility of the composite EFW index is marginally significant).

Taken together, the results in Table 6 are consistent with the notion that controlling for differences in economic freedom mitigates the estimated impact of macroeconomic volatility on growth. However, the results in Table 6 allow a finer distinction as to which particular aspects of freedom are most important in explaining growth and, thus, rendering the volatility measure insignificant as a determinant of growth. The results suggest Area 2 and Area 4 are the most important in this respect, and possibly Area 3 to a lesser extent. Area 1 and Area 5 are less important in explaining growth and rendering volatility insignificant.

Table 7 reports results for a similar analysis using the individual areas of freedom with EFW quartile dummies included to allow for a varying effect of volatility on growth in countries at different levels of freedom.[9] Recall that analysis using the composite EFW index with quartile dummies (results in Table 5) indicated a pattern where volatility's impact on growth was more pronounced in countries at lower levels of freedom. However, this pattern vanished—with none of the volatility measures statistically significant—when broad measures of freedom were included in the model. The pattern where volatility in countries with lower levels of freedom is an important factor explaining growth emerges in Table 7 when Area 3 and Area 5 are used (separately) in the analysis. In these specifications, volatility in quartile 4 (least free) countries is statistically significant and volatility in quartile 3 is marginally significant—both indicating the familiar negative impact on growth in those countries. Volatility is significantly negative in quartile 4 countries when Area 1 is used in the analysis, but only marginally significant when Area 2 is used. None of the volatility measures are significant when Area 4 is used. These results are consistent with those in Table 6 in

[9]Regression diagnostics from IV analysis suggest that OLS estimates of these specifications may be invalid due to endogeneity, so only IV estimates are reported in Table 7.

suggesting that Area 4 and, to a lesser extent, Area 2 are most important in rendering volatility insignificant in cross-country growth regressions. Area 3 and Area 5 appear to be the least important in affecting the suggested pattern of significance of volatility. Once again, these results are consistent with the notion that any negative impact of volatility on growth occurs primarily in countries at low levels of economic freedom and that this effect is mitigated or even eliminated by controlling for the relevant areas of freedom.

6. Conclusion

This paper takes a new look at the empirical relationship between macroeconomic volatility and long-run growth across countries. The emphasis is on the role of economic freedom in explaining the mixed results on the volatility-growth relationship in the existing literature. In particular, the goal is to determine whether a reported relationship between volatility and growth is really a reflection of differences in economic freedom across countries when such differences are not explicitly accounted for in the analysis. In addition, the question of whether the volatility-growth relationship itself differs across countries at different levels of economic freedom is also considered. The analysis considers both a broad measure of economic freedom, measured by the composite *Economic Freedom of the World* index, and its underlying component areas of freedom.

First, broad measures of economic freedom are included in cross-country growth regressions that are typical of those used in the literature to assess the role of volatility on growth. The results suggest that a negative and statistically significant coefficient on volatility becomes insignificant after controlling for freedom in a diverse sample of countries. This helps to reconcile previous findings of a negative relationship in broad samples of countries alongside positive or insignificant relationships in samples of developed countries or U.S. states where freedom is at a higher, more uniform level.

The analysis also reveals, as shown elsewhere in the literature, that volatility varies systematically with the level of freedom across countries. Countries with higher levels of freedom experience markedly less volatility in their growth rates, and vice versa. To determine if the volatility-growth relationship is heterogeneous with respect to levels of freedom, dummy variables are included to determine whether the volatility-growth relationship varies across countries divided into quartiles based on levels of

economic freedom. The results suggest a negative relationship between volatility and growth among low-freedom countries when measures of economic freedom are not explicitly included in the analysis. Including measures of freedom in the analysis, however, leaves volatility insignificant in explaining growth across countries at all levels of economic freedom.

When the underlying areas of economic freedom are used individually in the analysis, aspects of freedom relating to the security of property rights and freedom to trade internationally appear to be most important in explaining growth and rendering business cycle volatility insignificant in cross-country growth regressions. These areas of freedom also largely eliminate the suggested pattern whereby volatility affects growth primarily in countries with low levels of freedom. Volatility remains significantly negative when areas of freedom relating to regulation of credit, labor, and business and size of government are used, again with the largest impact of volatility occurring in countries at low levels of freedom. The pattern in which volatility's effect dominates in countries at low freedom levels is preserved when aspects of freedom relating to sound money are used as well, although the significance of volatility disappears when volatility is assumed to have a uniform effect on growth across countries at different levels of freedom.

Taken together, these results suggest that it is important to account for differences in economic freedom when considering the impact of volatility on growth. Failing to control for differences in freedom—or at least the appropriate underlying components of freedom—may falsely attribute to volatility the influences that are actually due to freedom in the growth process. A key implication of this conclusion is that business cycle volatility ultimately may not be a legitimate determinant of growth across a large, diverse sample of countries. In other words, the existing evidence in support of volatility as a determinant of growth may ultimately be an artifact of the well-known relationship between economic freedom and growth. In addition, if volatility and growth are related, it appears to be so primarily in countries at low levels of freedom. All of these findings are consistent with various results reported previously in the empirical growth literature, but it was not obvious that economic freedom was the missing link in explaining the different results with respect to the volatility-growth relationship.

References

Baldinger, H., 2010, "Output Volatility and Economic Growth," *Economics Letters* 106, 15-18.

Bernanke, Ben S., 1983, "Irreversibility, Uncertainty, and Cyclical Investment," *Quarterly Journal of Economics* 98, 85-106.

Black, Fisher, 1987, *Business Cycles and Equilibrium* (Cambridge, MA: Blackwell).

Davidson, Russell and James G. MacKinnon, 1989, "Testing for Consistency using Artificial Regressions," *Econometric Theory* 5, 363-384.

Davidson, Russell and James G. MacKinnon, 1993, *Estimation and Inference in Econometrics* (Oxford: Oxford University Press).

Dawson, John W., 1998, "Institutions, Investment, and Growth: New Cross-Country and Panel Data Evidence," *Economic Inquiry* 36, 603-19.

Dawson, John W., 2010, "Macroeconomic Volatility and Economic Freedom: A Preliminary Analysis," in Gwartney, James D., Robert A. Lawson, and Joshua C. Hall, *Economic Freedom of the World: 2010 Annual Report* (Vancouver: The Fraser Institute).

Dawson, John W., and E. Frank Stephenson, 1997, "The Link between Volatility and Growth: Evidence from the State," *Economics Letters* 55, 365-69.

Dawson, John W., Joseph P. DeJuan, John J. Seater, and E. Frank Stephenson, 2001, "Economic Information versus Quality Variation in Cross-Country Data," *Canadian Journal of Economics* 34, 988-1009.

De Haan, J., Suzanna Lundstrom, and Jan-Egbert Sturm, 2006, "Market-Oriented Institutions and Policies and Economic Growth: A Critical Survey," *Journal of Economic Surveys* 20, 157-91.

Fatas, Antonio and Iliam Mihov, 2003, "The Case for Restricting Fiscal Policy Descretion," *Quarterly Journal of Economics* 118, 1419-47.

Furceri, D., 2010, "Long-Run Growth and Volatility: Which Source Really Matters?" *Applied Economics* 42, 1865-74.

Grier, Kevin B. and Gordon Tullock, 1989, "An Empirical Analysis of Cross-National Economic Growth, 1951-80," *Journal of Monetary Economics* 24, 259-76.

Gwartney, James D., Robert A. Lawson, and Joshua C. Hall, 2011, *Economic Freedom of the World: 2011 Annual Report* (Vancouver: The Fraser Institute).

Gwartney, James D., Robert A. Lawson, and Randall. G. Holcombe, 1999, "Economic Freedom and the Environment for Economic Growth," *Journal of Institutional and Theoretical Economics* 155, 643-663.

Johnson, Simon, William Larson, Chris Papageorgiou, and Arvind Subramanian, 2013, "Is Newer Better? Penn World Table Revisions and their Impact on Growth Estimates," *Journal of Monetary Economics* 60, 255-274.

Kormendi, Roger and Philip Meguire, 1985, "Macroeconomic Determinants of Growth: Cross-Country Evidence," *Journal of Monetary Economics* 16, 141-63.

Lee, J., 2010, "The Link Between Output Growth and Volatility: Evidence from a GARCH Model with Panel Data," *Economics Letters* 106, 143-45.

Levine, Ross and David Renelt, 1992, "A Sensitivity Analysis of Cross-Country Growth Regressions," *American Economic Review* 82, 942-63.

Lipford, Jody W., 2007, "Short Run Macroeconomic Performance and Economic Freedom: Can Economic Growth Rates be Higher and More Stable?" *Journal of Private Enterprise* XXIII (1), 3-29.

Martin, P. and C. Rogers, 2000, "Long-Term Growth and Short-Term Economic Stability," *European Economic Review* 44, 359-81.

Mirman, Leonard J., 1971, "Uncertainty and Optimal Consumption Decisions," *Econometrica* 39, 179-185.

Mobarak, A.M., 2005, "Democracy, Volatility, and Economic Development," *Review of Economics and Statistics* 87, 348-61.

Pitlik, Hans, 2002, "The Path of Liberalization and Economic Growth," *Kyklos* 55, 57-80.

Ramey, Garey and Valerie A. Ramey, 1995, "Cross-Country Evidence on the Link Between Volatility and Growth," *American Economic Review* 85, 1138-51.

Sandmo, Agnar A., 1970, "The Effect of Uncertainty on Saving," *Review of Economic Studies* 37, 353-360.

Stastny, M. and M. Zagler, 2007, "Empirical Evidence on Growth and Volatility," EUI Working Paper RSCAS 2007/22, European University Institute.

Table 1: Areas and Components of the EFW Index

Area 1. **Size of Government: Expenditures, Taxes, and Enterprises**
- A. General government consumption spending as a percentage of total consumption
- B. Transfers and subsidies as a percentage of GDP
- C. Government enterprises and investment
- D. Top marginal tax rate
  - i. Top marginal income tax rate
  - ii. Top marginal income and payroll tax rates

Area 2. **Legal Structure and Security of Property Rights**
- A. Judicial independence
- B. Impartial courts
- C. Protection of property rights
- D. Military interference in rule of law and the political process
- E. Integrity of the legal system
- F. Legal enforcement of contracts
- G. Regulatory restriction on the sale of real property

Area 3. **Access to Sound Money**
- A. Average growth
- B. Standard deviation of inflation
- C. Inflation: Most recent year
- D. Freedom to own foreign currency bank accounts

Area 4. **Freedom to Trade Internationally**
- A. Taxes on international trade
  - i. Revenue from trade taxes (% of trade sector)
  - ii. Mean tariff rate
  - iii. Standard deviation of tariff rates
- B. Regulatory trade barriers
  - i. Non-tariff trade barriers
  - ii. Compliance cost of importing and exporting
- C. Size of trade sector relative to expected
- D. Black-market exchange rates
- E. International capital market controls
  - i. Foreign ownership/investment restrictions
  - ii. Capital controls

Area 5. **Regulation of Credit, Labor, and Business**
- A. Credit market regulations
  - i. Ownership of banks
  - ii. Foreign bank competition
  - iii. Private sector credit
  - iv. Interest rate controls / negative real interest rates
- B. Labor market regulations
  - i. Hiring regulations and minimum wage
  - ii. Hiring and firing regulations
  - iii. Centralized collective bargaining
  - iv. Hours regulations
  - v. Mandated cost of worker dismissal
  - v. Conscription
- C. Business regulations
  - i. Price controls
  - ii. Administrative requirements
  - iii. Bureaucracy costs
  - iv. Starting a business
  - v. Extra payments / bribes / favoritism
  - vi. Licensing restrictions
  - vii. Cost of tax compliance

Source: Gwartney, Lawson, and Hall (2011), p. 5.

Table 2: Countries Included in the 99-Country Sample

Algeria
Argentina
Australia
Austria
Burundi
Belgium
Benin
Bangladesh
Bahamas
Bahrain
Barbados
Belize
Bolivia
Brazil
Botswana
Cameroon
Canada
Chile
China
Colombia
Congo, Democratic Republic of
Congo, Republic of
Costa Rica
Cote d'Ivoire
Cyprus
Denmark
Dominican Republic
Ecuador
Egypt
El Salvador
Fiji
Finland
France
Gabon
Germany
Ghana
Greece
Guatemala
Haiti
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kenya
Luxembourg
Madagascar
Malawi
Malaysia
Mali
Malta
Mauritius
Mexico
Morocco
Nicaragua
Niger
Nigeria
Nepal
Netherlands
New Zealand
Norway
Pakistan
Panama
Paraguay
Peru
Philippines
Portugal
Senegal
Sierra Leone
Singapore
South Africa
South Korea
Spain
Sri Lanka
Sweden
Switzerland
Syria
Taiwan
Tanzania
Thailand
Togo
Trinidad and Tobago
Tunisia
Turkey
U.K.
U.S.
Uganda
Uruguay
Venezuela
Zambia
Zimbabwe

Table 3: Volatility-Growth Regressions, 1980-2009

	Estimation Method				
	OLS	OLS	IV	OLS	IV
Variable	(1)	(2)	(3)	(4)	(5)
Constant	0.027***	0.055***	0.066***	−0.007	0.029
	(0.0032)	(0.0181)	(0.0220)	(0.0241)	(0.0349)
Volatility	−0.251***	−0.182**	−0.336*	−0.091	−0.278
	(0.0711)	(0.0881)	(0.1943)	(0.0679)	(0.1892)
Initial Income	—	−0.005**	−0.005**	−0.007***	−0.007***
		(0.0019)	(0.0020)	(0.0020)	(0.0018)
Investment Share	—	0.001***	0.001***	0.0008***	0.0009***
		(0.0003)	(0.0003)	(0.0003)	(0.0003)
Population Growth	—	−0.771***	−0.646**	−0.726***	−0.605**
		(0.2253)	(0.2428)	(0.2072)	(0.2302)
Initial Freedom	—	—	—	0.034***	0.025
				(0.0118)	(0.0162)
Change in Freedom	—	—	—	0.009***	0.007**
				(0.0026)	(0.0031)
Volatility of Freedom	—	—	—	−0.017	−0.012
				(0.0112)	(0.0120)
Adjusted R^2	0.11	0.37	0.33	0.45	0.41
First Stage *F*-value	–	–	9.864***	–	8.584***
Hausman *p*-value	–	–	0.3110	–	0.2127
Observations	99	99	99	99	99

Notes: The dependent variable is the average annual growth rate of real GDP per capita over the 1980-2009 period. Initial income and initial freedom are entered as natural logarithms. Investment share and population growth are averages over the sample period. Estimation is by ordinary least squares (OLS) and instrumental variables (IV), as indicated at the top of each column. Instruments for the IV estimation include the exogenous explanatory variables from the analogous OLS regression (i.e., all regressors except volatility) along with distance from the equator and dummies for diversified exporters and land-locked countries. First stage *F*-value is the *F*-statistic from the regression of volatility on the instruments. Hausman *p*-value is the level of significance of the *t*-statistic for the null hypothesis that the OLS coefficients are consistent based on the version of the Hausman test proposed by Davidson and MacKinnon (1989, 1993). Heteroskedasticity-consistent (White) standard errors are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. *Source*: Author's calculations.

Table 4: Descriptive Statistics for Macroeconomic Volatility by EFW Quartile

EFW Quartiles	Mean	Median	Max.	Min.	S.D.	No. Obs.
Most Free	0.032	0.027	0.068	0.015	0.015	29
Second Quartile	0.047	0.044	0.116	0.020	0.026	22
Third Quartile	0.042	0.042	0.072	0.027	0.012	23
Least Free	0.059	0.058	0.164	0.019	0.030	25
Full Sample	0.044	0.042	0.164	0.015	0.024	99

Notes: The volatility measure for a given country is the standard deviation of the annual growth rate of real GDP per capita over the 1980-2009 period. Quartiles based on EFW scores for all countries included in *Economic Freedom of the World: 2011 Annual Report*. *Source*: Author's calculations.

Table 5: Volatility-Growth Regressions, EFW Quartile Dummies Included, 1980-2009

	Estimation Method				
	OLS	OLS	IV	OLS	IV
Variable	(1)	(2)	(3)	(4)	(5)
Constant	0.022***	0.0809***	0.092***	0.079*	0.075
	(0.0032)	(0.0179)	(0.0211)	(0.0433)	(0.1010)
Q1 × Volatility	−0.005	0.075	−0.200	0.070	−0.167
	(0.1321)	(0.1034)	(0.2307)	(0.1165)	(0.1780)
Q2 × Volatility	−0.053	−0.068	−0.320	−0.039	−0.258
	(0.0896)	(0.0701)	(0.1946)	(0.0695)	(0.1617)
Q3 × Volatility	−0.147	−0.222**	−0.452*	−0.205*	−0.368
	(0.1054)	(0.1076)	(0.2391)	(0.1128)	(0.2540)
Q4 × Volatility	−0.296***	−0.283***	−0.482***	−0.234**	−0.367
	(0.0509)	(0.0776)	(0.1823)	(0.0920)	(0.3053)
Initial Income	—	−0.008***	−0.008***	−0.007***	−0.007***
		(0.0019)	(0.0020)	(0.0019)	(0.0021)
Investment Share	—	0.0008***	0.0009***	0.0007***	0.0008***
		(0.0003)	(0.0003)	(0.0003)	(0.0003)
Population Growth	—	−0.766***	−0.587**	−0.744***	−0.618**
		(0.2271)	(0.2511)	(0.2186)	(0.2354)
Initial Freedom	—	—	—	0.003	0.006
				(0.0193)	(0.0442)
Change in Freedom	—	—	—	0.003	0.004
				(0.0039)	(0.0082)
Volatility of Freedom	—	—	—	−0.022*	−0.015
				(0.0116)	(0.0117)
Adjusted R^2	0.20	0.45	0.37	0.47	0.41
F-value for Joint	15.179***	6.363***	4.573***	1.844	0.658
Test of Volatility	{0.0000}	{0.0001}	{0.0021}	{0.1276}	{0.6226}
First Stage *F*-value	–	–	7.392***	–	7.937***
Hausman *p*-value	–	–	0.0352	–	0.0160
Observations	99	99	99	99	99

Notes: Q1, Q2, Q3, and Q4 are dummy variables for the first, second, third, and fourth EFW quartiles, respectively. The joint test of significance of volatility is an *F*-test of joint significance of the four volatility variables in the regression; *p*-values for this test are reported in curly brackets {•}. The dependent variable is the average annual growth rate of real GDP per capita over the 1980-2009 period. Initial income and initial freedom are entered as natural logarithms. Investment share and population growth are averages over the sample period. Estimation is by ordinary least squares (OLS) and instrumental variables (IV), as indicated at the top of each column. Instruments for the IV estimation include the exogenous explanatory variables from the analogous OLS regression (i.e., all regressors except volatility) along with distance from the equator and dummies for diversified exporters and land-locked countries. First stage *F*-value is the *F*-statistic from the regression of volatility on the instruments. Hausman *p*-value is the level of significance of the *t*-statistic for the null hypothesis that the OLS coefficients are consistent based on the version of the Hausman test proposed by Davidson and MacKinnon (1989, 1993). Heteroskedasticity-consistent (White) standard errors are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. *Source*: Author's calculations.

Table 6: Volatility-Growth Regressions, Individual Areas of Freedom, OLS Estimation, 1980-2009

	Area of Freedom Included in Regression				
Variable	Area (1)	Area (2)	Area (3)	Area (4)	Area (5)
Constant	0.057**	0.038*	0.050**	0.032*	0.029
	(0.0235)	(0.0206)	(0.0223)	(0.0174)	(0.0245)
Volatility	−0.138*	−0.134	−0.146	−0.129	−0.179**
	(0.0825)	(0.0902)	(0.0884)	(0.0945)	(0.0818)
Initial Income	−0.0048**	−0.005**	−0.006***	−0.006***	−0.006***
	(0.0020)	(0.0022)	(0.0018)	(0.0021)	(0.0020)
Investment Share	0.0010***	0.0005*	0.0009***	0.0008***	0.0009***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Population Growth	−0.813***	−0.559*	−0.690***	−0.654***	−0.707***
	(0.2085)	(0.2897)	(0.2143)	(0.2359)	(0.2328)
Initial Freedom	−0.0004	0.017***	0.008	0.020***	0.018*
(Individual Area)	(0.0052)	(0.0059)	(0.0065)	(0.0066)	(0.0097)
Change in Freedom	0.002	0.003**	0.003*	0.005***	0.003
(Individual Area)	(0.0014)	(0.0014)	(0.0014)	(0.0017)	(0.0021)
Volatility of	−0.016*	−0.007	−0.015	−0.019*	0.005
Freedom (EFW)	(0.0093)	(0.0098)	(0.0100)	(0.0111)	(0.0097)
Adjusted R^2	0.41	0.33	0.40	0.40	0.37
Observations	98	84	99	92	92

Notes: Initial freedom is the 1980 value of each area of freedom as indicated at the top of each column; change in freedom is the 1980-2009 change in each area of freedom. See Table 1 for additional information on the five areas of freedom. Volatility of freedom is the standard deviation of changes in the EFW "chain" index over the 1980-2009 period, as defined in the text. Estimation is by ordinary least squares (OLS). The dependent variable is the average annual growth rate of real GDP per capita over the 1980-2009 period. Initial income and initial freedom are entered as natural logarithms. Investment share and population growth are averages over the sample period. Heteroskedasticity-consistent (White) standard errors are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. *Source*: Author's calculations.

Table 7: Volatility-Growth Regressions, Individual Areas of Freedom, EFW Quartile Dummies Included, IV Estimation, 1980-2009

	Area of Freedom Included in Regression				
Variable	Area (1)	Area (2)	Area (3)	Area (4)	Area (5)
Constant	0.010***	0.080**	0.113***	0.077**	0.083***
	(0.0301)	(0.0305)	(0.0352)	(0.0346)	(0.0311)
Q1 × Volatility	−0.097	−0.306	−0.144	−0.189	−0.124
	(0.2266)	(0.3060)	(0.2193)	(0.2392)	(0.2062)
Q2 × Volatility	−0.240	−0.379	−0.274	−0.257	−0.256
	(0.1881)	(0.2788)	(0.1934)	(0.2134)	(0.1750)
Q3 × Volatility	−0.325	−0.495	−0.440*	−0.371	−0.355*
	(0.2382)	(0.3638)	(0.2644)	(0.2920)	(0.2116)
Q4 × Volatility	−0.387**	−0.492*	−0.474**	−0.401	−0.430**
	(0.1908)	(0.2655)	(0.2062)	(0.2584)	(0.1674)
Initial Income	−0.008***	−0.008***	−0.008***	−0.008***	−0.008***
	(0.0023)	(0.0024)	(0.0020)	(0.0026)	(0.0018)
Investment Share	0.0009***	0.0005*	0.0009***	0.0007**	0.0008***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Population Growth	−0.647***	−0.322	−0.615**	−0.534*	−0.587**
	(0.2457)	(0.3227)	(0.2491)	(0.2786)	(0.2475)
Initial Freedom	−0.006	0.009	−0.008	0.0098	0.0006
(Individual Area)	(0.0060)	(0.0081)	(0.0093)	(0.0089)	(0.0119)
Change in Freedom	0.0002	0.0004	−0.0006	0.002	0.001
(Individual Area)	(0.0016)	(0.0023)	(0.0020)	(0.0025)	(0.0021)
Volatility of	−0.012	−0.003	−0.015	−0.014	0.003
Freedom (EFW)	(0.0114)	(0.0145)	(0.0107)	(0.0135)	(0.0114)
Adjusted R^2	0.43	0.21	0.40	0.37	0.40
F-value for Joint	2.374*	1.326	2.482**	0.848	3.328**
Test of Volatility	{0.0583}	{0.2685}	{0.0494}	{0.4987}	{0.0142}
First Stage *F*-value	6.443***	5.494***	7.293***	4.849***	7.128***
Hausman *p*-value	0.0732	0.0975	0.0258	0.0560	0.0922
Observations	98	84	99	92	92

Notes: Initial freedom is the 1980 value of each area of freedom as indicated at the top of each column; change in freedom is the 1980-2009 change in each area of freedom. See Table 1 for additional information on the five areas of freedom. Volatility of freedom is the standard deviation of changes in the EFW "chain" index over the 1980-2009 period, as defined in the text. Estimation is by instrumental variables. Q1, Q2, Q3, and Q4 are dummy variables for the first, second, third, and fourth EFW quartiles, respectively. The joint test of significance of volatility is an *F*-test of joint significance of the four volatility variables in the regression; *p*-values for this test are reported in curly brackets {•}. The dependent variable is the average annual growth rate of real GDP per capita over the 1980-2009 period. Initial income and initial freedom are entered as natural logarithms. Investment share and population growth are averages over the sample period. Instruments include the exogenous explanatory variables in the regression (i.e., all regressors except volatility) along with distance from the equator and dummies for diversified exporters and land-locked countries. First stage *F*-value is the *F*-statistic from the regression of volatility on the instruments. Hausman *p*-value is the level of significance of the *t*-statistic for the null hypothesis that the OLS coefficients are consistent based on the version of the Hausman test proposed by Davidson and MacKinnon (1989, 1993). Heteroskedasticity-consistent (White) standard errors are shown in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. *Source*: Author's calculations.

Figure 1: Median Volatility by EFW Index Quartile

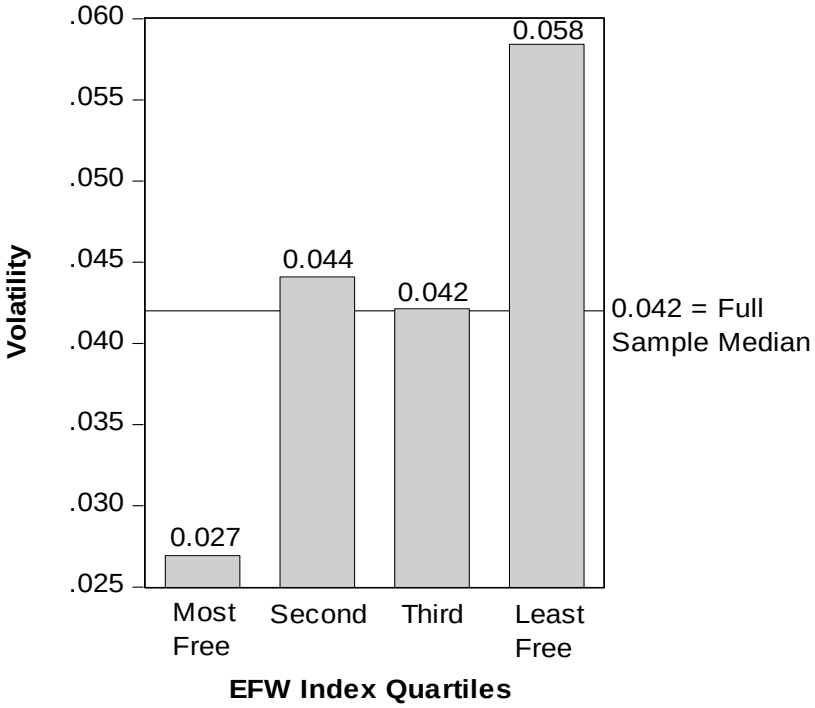

Figure 2: Volatility and Growth by EFW Index Quartile