HOW DOES FINANCIAL DEVELOPMENT AFFECT ECONOMIC GROWTH VOLATILITY? EVIDENCE FROM A PENALIZED PANEL QUANTILE REGRESSION

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ABSTRACT

This paper aims to examine the effect of financial development on economic growth volatility for a sample of 63 countries during the period 1996-2016. Previous studies have reported mixed and inconclusive results regarding such an effect. I ascribe these controversial findings to the limitations of the ordinary least squares (OLS) regression and adopt the method of quantile regression with panel data as developed in Canay (2011). This methodological contribution allows us to test whether the effect of financial development varies across the full distribution, especially at the extreme quantiles of economic growth volatility. Unlike OLS regression, quantile regression captures the whole picture of the relationship between financial development and economic growth volatility by estimating the effect at each quantile of the distribution. Overall, our empirical results show that the effect of financial development on economic growth volatility is negative. However, this effect appears to not be uniform across the quantiles of the economic volatility distribution. This paper sheds more light on the association between financial development and economic growth volatility.

Contribution/Originality: This study contributes to the existing literature by empirically investigating the potentially heterogeneous patterns of financial development effects across economic growth volatility distribution by applying the quantile regression approach proposed by Koenker and Bassett Jr (1978). Moreover, I adopt fixed-effect models which provide the ability to control unobservable time-invariant country characteristics.

1. INTRODUCTION

The link between financial development and economic growth has been the subject of extensive literature. From a theoretical perspective, it is firmly established that well-developed stock markets and correctly functioning banking systems spur economic growth and are therefore consistent with the proposition of "more finance, more growth." From the standpoint of empirical research (Beck, Levine, & Loayza, 2000; Beck & Levine, 2004; Beck, Demirguc-Kunt, Laeven, & Levine, 2008; Goldsmith, 1969; King & Levine, 1993a; King & Levine, 1993b; Levine, 1997; Levine & Zervos, 1998; Levine, Loayza, & Beck, 2000; McCaig & Stengos, 2005; Rajan & Zingales, 1998; and Thumrongvit, Kim, & Pyun, 2013) studies on the finance-growth nexus report strong and robust evidence sustaining the hypothesis that economic growth is positively associated with financial development. In addition to economic growth, policymakers have also considered economic stability as a major objective of macroeconomic policies (Huang, Fang, & Miller, 2014; Mishkin, 2009; Yellen & Akerlof, 2006). Therefore, academic researchers have focused on examining the relationship between financial development and macroeconomic volatility.

The theory provides competing hypotheses regarding how financial development can affect economic growth volatility. First, it is argued that a well-developed financial system can smooth economic growth volatility by withdrawing or reducing financial constraints that cause the propagation of business cycles and thus lead to a higher fluctuation of economic growth indicators (Bernanke & Gertler, 1989; Kiyotaki & Moore, 1997). A second argument is that the positive or negative effects of financial development on growth volatility are subject to real and monetary shocks, credit supply, and the prevailing stage (early, intermediate, or late) of financial development (Aghion, Bacchetta, & Banerjee, 2004; Bacchetta & Caminal, 2000; Morgan, Rime, & Strahan, 2004).

Some existing empirical studies on the impact of financial development on economic growth volatility also provide conflicting and inconclusive findings. For example, Beck, Lundberg, and Majnoni (2006), by using a panel of 63 countries during the period 1960–1997, and the volatility of terms of trade and inflation as a proxy for real and monetary volatility, respectively, presented weak evidence that financial intermediaries alleviate economic expansion. Other empirical studies report a negative effect of financial development on macroeconomic volatility (Acharya, Imbs, & Sturgess, 2011; Da Silva, 2002; Dabla-Norris & Srivisal, 2013; Denizer, Iyigun, & Owen, 2000; Larrain, 2006; Mallick, 2014; Manganelli & Popov, 2015; and Raddatz, 2006). Conversely, further studies report the evidence of a nonlinear relationship, especially U-shaped, between financial development and output volatility (Alatrash, Leff, Minten, Soupre, & Van Schoot, 2014; Arcand, Berkes, & Panizza, 2012; Dabla-Norris & Srivisal, 2013; Easterly, Islam, & Stiglitz, 2002; and Ibrahim & Alagidede, 2017). That is, financial development dampens economic growth volatility to an optimal point, after which any increase in the level of financial development will increase economic volatility. More recently, Zouaoui, Mazioud, and Ellouz (2018) examine the relationship between financial development and economic growth volatility for a sample of 50 developing countries during the period 1960-2016 by using a semi-parametric, panel-fixed effects regression model and find that the financial development-volatility relationship is not linear and has multiple turning points.

I ascribe these conflicting findings to the regression techniques used by the referenced studies. Most of these studies employ classical regression estimation techniques such as ordinary least squares (OLS) estimation, panel regression, or instrumental variables regression. These estimation techniques only focus on the conditional mean of the dependent variable, which may result in biased results, especially where the distribution heterogeneity of the dependent variable is neglected (Binder & Coad, 2011). In contrast to previous studies, in this paper, I examine the effect of financial development on economic growth volatility by taking into account the distribution heterogeneity and using the panel quantile regression with fixed effects as introduced by Canay (2011).

The advantages of employing the panel quantile regression with fixed effects are threefold. First, the use of the panel regression methodology allows us to get greater efficiency in estimating the effect of financial development on economic growth volatility because employing a cross-country study provides more informative data, variability, and therefore more degree of freedom. Second, the panel data framework allows the consideration of unobserved individual heterogeneity in the estimation process. The omission of such heterogeneity may lead to unbiased estimators. Third, the use of the quantile regression framework helps us to get a complete picture of the relationship between financial development and economic growth volatility because this method allows us to describe the entire distribution of the economic growth volatility by estimating the effect of financial development at each quantile of the economic growth volatility distribution. In addition, the panel quantile regression with fixed effects produces more robust estimators compared with classical approaches, especially when the distribution of the dependent variable is skewed and/or the error term is not normal distributed.

In summary, I employ a fixed effect panel quantile regression to explore the effect of financial development on economic growth volatility for selected developed and developing countries during the period 1996-2016. This paper may contribute to the existing literature in several ways. First, the work gives a more detailed picture than is currently available on the association between financial development and economic growth volatility by constructing point estimates at each quantile, especially in the highest and lowest ones, by using panel quantile regression. Second,

I use the principal component analysis (PCA) framework to construct a comprehensive proxy of financial development. As such, I construct three indices: bank system development index, stock market development index, and overall financial development index. Third, I estimate based on both developed and developing countries.

The remaining paper below is structured with section 2 describing the data, variables, and descriptive statistics, section 3 presenting the estimation approach, section 4 providing empirical results and analysis, and section 5 consisting of the conclusions.

2. DATA DESCRIPTION, VARIABLES, AND DESCRIPTIVE STATISTICS

2.1. Data

The aim of this paper is to examine the effect of financial development on economic growth volatility by using data from 64 developing and developed countries over the period 1996-2016. Countries are selected so that there are enough available data on variables used in the regression analysis. The list of countries considered in our study is given in Table 1.

Table 1. List of countries.

Developed countries (30 countries)	Australia, Austria, Belgium, Canada, Chile, Cyprus, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea Rep., Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, United States.
Developing countries (34 countries)	Argentina, Bahrain, Brazil, Bulgaria, China, Colombia, Croatia, Czech Republic, Egypt, Estonia, Hungary, India, Indonesia, Jordan, Kuwait, Lithuania, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Peru, Philippines, Poland, Qatar, Romania, Russian Federation, Saudi Arabia, South Africa, Sri Lanka, Thailand, Tunisia, Turkey, United Arab Emirates.

Note: The countries are classified into developed and developing countries according to the World Bank's classification of countries.

Table 2. Principal component analysis.

Panel A: Bank development subindex (FD_BANK)				
	PC_1	**PC_2**	**PC_3**	**PC_4**
Eigen values	3.240	0.640	0.094	0.023
Percentage of variance	0.810	0.160	0.024	0.006
Cumulative percentage	0.810	0.970	0.994	1.000
Variables	Comp_1	Comp_2	Comp_3	Comp_4
DMBA	0.489	0.527	0.694	-0.026
FSD	0.507	-0.491	-0.011	-0.708
LL	0.506	-0.494	0.045	0.705
PRIVATE	0.496	0.485	-0.718	0.029
Panel B: Market development subindex (FD_MARK)				
	PC_1	PC_2	PC_3	
Eigen values	2.037	0.850	0.112	
Percentage of variance	0.679	0.283	0.038	
Cumulative percentage	0.679	0.962	1.000	
Variables	Comp_1	Comp_2	Comp_3	
SMKT	0.507	0.728	0.459	
SMTV	0.679	-0.009	-0.734	
TURNOVER	0.530	-0.684	0.499	
Panel C: Overall financial development index (FD_OVERALL)				
	PC_1	PC_2		
Eigen values	1.414	0.585		
Percentage of variance	0.707	0.293		
Cumulative percentage	0.707	1.000		
Variables	Comp_1	Comp_2		
FD_BANK	0.707	0.707		
FD_MARK	0.707	-0.707		

2.2. Variable Measures

2.2.1. Financial Development Measures: Principal Component Analysis (PCA)

The review of previous studies reveals that financial development is measured through a variety of proxies. However, there is no consensus evidence showing the appropriate proxy to measure the extent of financial development (Tang & Tan, 2014). To overcome this problem, I employ the method of principal component analysis to construct a comprehensive indicator for financial development. To do so, I follow (Ang & McKibbin, 2007; Ang, 2009; Coban & Topcu, 2013; Gries, Kraft, & Meierrieks, 2009; Huang, 2010; Saci & Holden, 2008; Shahbaz, Shahzad, Ahmad, & Alam, 2016; Tang & Tan, 2014; and Topcu & Payne, 2017) together with three sub-indices and the overall financial development index. The first financial development subindex (FD_BANK) is constructed using banking sector development proxies, including deposit money bank assets to GDP (DMBA), financial system deposit to GDP (FSD), liquid liabilities to GDP (LL), and private credit by deposit money banks to GDP (PRIVATE). The second financial development subindex (FD_MARK) is obtained based on the stock market development index, which covers the stock market capitalization to GDP (MKT), stock market turnover ratio (TURNOVER), and stock market total value traded to GDP (SMVT). The third financial development subindex is an overall index computed as the principal component of the seven typical measures of financial development as mentioned above.

Table 2 shows the result of the principal component analysis of each financial development indicator with the factor scores for each variable.

2.2.2. The Dependent Variable and Control Variables

Our main dependent variable is economic growth volatility. Following the studies of Easterly, Islam, and Stiglitz (2000); Acemoglu, Johnson, Robinson, and Thaicharoen (2003); Ahamada and Coulibaly (2011) and Ma and Song (2018) among others, the volatility of economic growth (VOLAT) is measured by the standard deviation of real gross domestic product (GDP). I use a five-year rolling window to compute the standard deviation. The real GDP per capita is drawn from the World Development Indicator (WDI) published by the World Bank.

In accordance with existing literature, I include a set of control variables that are known to influence economic growth volatility. The set of control variables includes GDP growth rate (GROWTH), inflation rate (INFL), financial openness (FO), government expenditure (EXPEND), remittances and compensation of employees as a percentage of GDP (REMITTANCE), the logarithm of real per capita gross domestic product in 1996 (Initial GDP), and the trade dependency ratio being the sum of exports and imports of goods and services measured as a share of gross domestic product (TO). The definition and data sources of our variables are reported in Table 3.

2.3. Descriptive Statistics

Table 4 reports descriptive statistics for the variable of interest used in our study, where I give the number of observations (N), the mean, the standard deviation, and the minimum and the maximum for both the full sample countries and the developing and developed countries. The economic volatility of our sample countries is, on average, equal to 2.3% and ranges between 0.6% and 6.3%. In addition, economic growth volatility is about 2.9% in developing countries and 2% in developed countries over the full period.

The mean difference of economic volatility between developed and developing countries is statistically significant at 1% level. Furthermore, I find that developed countries are characterized by higher levels of financial development compared with developing countries. Indeed, the T-test for the mean difference is statically significant for all proxies of financial development. Regarding control variables, the inflation rate average is 4.3%, constituting about 6.2% in developing countries and 2.1% in developed countries. The economic growth is equal to 3.5% on average and is significantly higher in developing countries when compared with developed countries.

Table 3. Definitions and sources of variables.

Variable	Definition	Source
VGDP	Macroeconomic volatility computed as the five-year rolling window standard deviations of real GDP growth rate.	Authors' calculation
VINFL	Aggregate price volatility computed as 5-year rolling window standard deviations of annual inflation rate.	Authors' calculation
DMBA	Deposit money bank assets to GDP (%).	WDI*
FSD	Financial system deposits to GDP (%).	WDI
LL	Liquid liabilities to GDP (%).	WDI
PRIVATE	Private credit by deposit money banks to GDP (%).	WDI
SMKT	Stock market capitalization to GDP (%).	WDI
SMTV	Stock market total value traded to GDP (%).	WDI
TURNOVER	Stock market turnover ratio (%).	WDI
GROWTH	Annual growth rate of real GDP.	WDI
FO	Financial openness index constructed by Chinn and Ito.	Chinn-Ito website**
REMITTANCE	Migrants' remittances are given by the sum of workers' remittances and compensation of employees as a percentage of GDP.	WDI
EXPENDITURE	Government consumption divided by GDP.	WDI
INFLATION	Inflation, GDP deflator (annual %).	WDI
GDP_INITIAL	Logarithm of real per capita GDP in 1996.	Authors' calculation
TRADE	The trade dependency ratio is the sum of exports and imports of goods and services measured as a share of GDP.	WDI
SCHOOL	Log of one plus the average years of secondary schooling of the adult population.	Authors' calculation
REER	Real effective exchange rate.	WDI

Note: *WDI denotes the World Bank's World Development Indicators database; ** Data are available at the Chinn-Ito index website

In addition to descriptive statistics, I conduct further analysis concerning the normality of the variables used in this study. Table 5 reports the Skewness and the Kurtosis statistics for all the variables as well as the test for normality proposed by Doornik and Hansen (2008), which is based on a test by Shenton and Bowman (1977). As can be seen clearly, the distributions of all the variables are skewed, and the Kurtosis values show that the distributions of our variables of interest exhibit tail data exceeding the tails of the normal distribution. The Doornik and Hansen (2008) normality test is statistically significant for all variables, indicating the rejection of the normality hypothesis. This result suggests that the use of the classical OLS regression may not be appropriate for our data analysis, and the quantile approach could be more suitable and more robust for non-normal errors and outliers.

3. PENALIZED PANEL QUANTILE REGRESSION WITH FIXED EFFECTS

To understand how quantile regression works, we start from the classical linear regression model. Consider the following linear model:

$$y_i = x_i' \beta + \varepsilon_i \qquad (1)$$

In Equation 1, $y_i \in \Re$ is a scalar variable denoting a dependent variable, while $x_i \in \Re^k$ and $\beta \in \Re^k$ are column vectors of size k representing the set of covariates (independent variables) and regression coefficients, respectively.

It is commonly assumed that $E(\varepsilon|x) = 0$. Thus I obtain the conditional mean model. However, if $E(Med|x) = 0$ then I get the conditional median model. The regression parameters in the conditional mean model are obtained by solving the following linear optimization problem:

$$\hat{\beta} = \underset{\beta \in \Re^k}{\operatorname{argmin}} \sum_{i=1}^{n}(y_i - x_i'\beta)^2 \qquad (2)$$

Table 4. Descriptive statistics.

Variable	All countries					Developing countries					Developed countries					T-test for mean difference
	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	
Economic volatility																
VGDP	1280	0.025	0.016	0.006	0.063	680	0.029	0.017	0.006	0.063	600	0.020	0.013	0.006	0.063	10.16***
VINFL	1274	0.030	0.034	0.004	0.131	675	0.046	0.040	0.004	0.131	599	0.013	0.011	0.004	0.059	19.22***
Financial development																
DMBA	1309	0.828	0.427	0.218	1.683	703	0.577	0.299	0.218	1.683	606	1.118	0.364	0.218	1.683	-29.53***
FSD	1287	0.659	0.397	0.176	1.804	704	0.460	0.241	0.176	1.264	583	0.898	0.416	0.176	1.804	-23.61***
LL	1293	0.757	0.431	0.237	1.903	696	0.565	0.306	0.237	1.903	597	0.981	0.448	0.292	1.903	-19.75***
PCDMB	1308	0.701	0.411	0.140	1.555	703	0.446	0.278	0.140	1.555	605	0.996	0.335	0.278	1.555	-32.43***
SMC	1261	0.617	0.465	0.105	1.815	665	0.459	0.401	0.105	1.815	596	0.794	0.469	0.105	1.815	-13.65***
SMTVT	1274	0.366	0.420	0.007	1.451	672	0.196	0.267	0.007	1.451	602	0.555	0.476	0.007	1.451	-16.80***
SMTO	1262	0.541	0.465	0.037	1.651	662	0.431	0.439	0.037	1.651	600	0.663	0.462	0.037	1.651	-9.13***
Control variables																
FO	1323	1.149	1.422	-1.202	2.360	714	0.460	1.410	-1.202	2.360	609	1.956	0.925	-1.202	2.360	-22.38***
REMITTANCE	1237	0.015	0.021	0.000	0.075	634	0.024	0.025	0.000	0.075	603	0.006	0.008	0.000	0.053	17.58***
TO	1339	0.895	0.541	0.284	2.449	709	0.809	0.413	0.284	2.204	630	0.992	0.643	0.284	2.449	-6.23***
INFL	1338	0.043	0.047	-0.013	0.172	709	0.062	0.054	-0.013	0.172	629	0.021	0.021	-0.013	0.154	18.14***
GROWTH	1344	0.035	0.029	-0.025	0.090	714	0.042	0.031	-0.025	0.090	630	0.026	0.025	-0.025	0.090	10.55***
EXPEND	1339	0.170	0.045	0.092	0.247	709	0.157	0.044	0.092	0.247	630	0.185	0.042	0.092	0.247	-11.91***
GDP_INI	1323	9.385	0.795	7.844	10.447	693	8.855	0.735	7.844	10.447	630	9.968	0.292	8.991	10.447	-35.55***
SCHOOL																
REER																

Note: This table reports descriptive statistics of the variables of interest. I report the mean (MEAN), the standard deviation (SD), the minimum (MIN), and the maximum (MAX). The statistics are computed for all countries, and both developing countries and developed countries. I also report the T statistics, in the last column, for differences between developing and developed countries. All variables are defined in Table 3.
***Statistical significance at the 1% level.

Table 5. Normality test.

Variable	Skewness	Kurtosis	D-H	P-Value
VGDP	1.011	3.014	496.96***	0.000
DMBA	0.413	2.145	59.59***	0.000
FSD	1.290	4.505	335.63***	0.000
LL	1.130	3.729	318.96***	0.000
PCDMB	0.504	2.267	60.532***	0.000
SMC	1.093	3.392	323.11***	0.000
SMTVT	1.314	3.661	382.07***	0.000
SMTO	0.983	3.020	167.34***	0.000
FO	-0.649	1.767	305.93***	0.000
REMITTANCE	1.747	5.054	2856.95***	0.000
TRADE	1.442	4.612	393.23***	0.000
INFLATION	1.408	4.386	559.47***	0.000
GROWTH	-0.042	2.633	1.16	0.559
EXPENDITURE	-0.134	2.017	48.18***	0.000
GDP_INITIAL	-0.428	1.939	147.08***	0.000
SCHOOL	-0.422	3.293	15.73***	0.000
REER	0.280	2.945	29.49***	0.000

Note: this table reports Skewness and Kurtosis for the variables of interest.
***Statistical significance at the 1% level.

In the median regression model, the same calculation is made, but here β is obtained by minimizing the sum of the absolute deviations, commonly known as the least absolute deviation (LAD) regression, as follows:

$$\hat{\beta} = \underset{\beta \in \Re^k}{\text{argmin}} \sum_{i=1}^{n} |y_i - x_i'\beta|$$

(3)

OLS and LAD regression, as given by Equation 2 and Equation 3, respectively, may suffer from some limitations, which, in turn, could alter the quality of the estimates. First, OLS or LAD produce estimators that are best unbiased linear estimators if errors are independent and identically distributed as a normal distribution. However, these assumptions may not hold, especially when the mean distribution of the dependent variable is commonly affected by extreme values. Therefore, it is more appropriate to use non-mean-based models. Second, OLS and LAD methods provide only one estimate based on the central distribution of the dependent variable. Therefore, OLS and LAS provide only a partial view of the relationship between the dependent variable and the independent variables and the covariates. In other words, neither the OLS nor the LAD methods consider the full distribution of the dependent variable, liquidity creation, especially in the tail regions. To overcome these drawbacks, other regression models have emerged, like the QR approach.

Koenker and Bassett Jr (1978) developed a new approach named the quantile regression (QR), which is a natural extension of the OLS and LAD models. However, unlike the OLS and LAD regression, the QR approach enables the estimation of a set of models for conditional quantile functions by allowing the consideration of the effect of the independent variables on the entire distribution of the response variable, not merely its conditional mean. Furthermore, the QR approach is proved to be more robust in the face of non-normal errors and extreme values and does not need strict assumptions as for classical linear regression like normality, homoscedasticity, or absence of outliers (Johnston & Dinardo, 1997).

Formally, Quantile regression consists of extending the median regression case to all other quantiles of interest. Therefore, the quantile regression estimation of β across different quantiles can be found by solving:

$$\hat{\beta}_\tau = \underset{\beta \in \Re^k}{\text{argmin}} \sum_{i=1}^{n} \rho_\tau(y_i - x_i'\beta)$$

(4)

Where $\rho_\tau(x) = x(\tau - I(x < 0))$ denotes the loss function and $I(.)$ denotes the indicator function. For each value of $\tau \in (0,1)$, the loss function assigns a weight of τ to positive residuals and a weight of $(1 - \tau)$ to negative residuals. In Equation 4, $\hat{\beta}_\tau$ is called the τth regression quantile. To minimize the objective function in Equation 4,

the Barrodale and Roberts (1974) approach can be used which is mainly based on the simplex algorithm. Koenker and Machado (1999) establish that the minimization of Equation 4 is related to likelihood-based inference using independently distributed asymmetric Laplace densities (ALD). That is, minimizing Equation 4 is equivalent to maximizing an ALD-based likelihood function. $\hat{\beta}_\tau$ is consistent and asymptotically normal under certain regularity conditions (Canay, 2011). The quantile approach has received increased attention in academic circles and has been widely employed in different research fields, especially in economic studies (Binder & Coad, 2015; Rosendo, Simões, & Andrade, 2018; Wang, Zhu, Guo, & Peng, 2018; Zhu, Duan, Guo, & Yu, 2016; Zhu, Guo, You, & Xu, 2016; Zhu, Xia, and Guo, & Peng, 2018).

However, the classical QR method does not consider the unobserved individual heterogeneity. To overcome this shortcoming, some works, including those by Koenker (2004); Lamarche (2010); Galvao Jr (2011), and Canay (2011), provide econometric theory to deal with unobserved individual heterogeneity and propose applying quantile regression to the case of panel data. Therefore, the proposed fixed effect panel quantile regression model is given as follows:

$$Q_{y_{it}}(\tau_k | \alpha_i x_{it}) = \alpha_i + x_{it}^T \beta_{\tau_k} \qquad (5)$$

As discussed in Lancaster (2000) and Neyman and Scott (1948) the incorporation of a substantial number of fixed effect (α_i) may lead to incidental parameters problems that render estimators inconsistent. Besides, in the quantile regression framework, the removal of unobserved fixed effects cannot be achieved by classical approaches that rely on the hypothesis that expectations are linear operators (Canay, 2011). To overcome this problem of eliminating individual fixed effects in the QR framework, Koenker (2004); Lamarche (2010); Galvao Jr (2011), and Canay (2011) propose the penalized quantile regression for panel data by introducing a penalty term in the minimization problem. Formally, the estimation of parameters in Equation 5 is conducted by solving the following minimization problem:

$$\left(\hat{\beta}(\tau_k, \gamma), \{\alpha_i(\gamma)\}_{i=1}^N\right) = \frac{min}{(\alpha, \beta)} \sum_{k=1}^K \sum_{t=1}^T \sum_{i=1}^N z_k \rho_{\tau_k}\left(y_{it} - \alpha_i - x_{it}^T \beta(\tau_k)\right) + \lambda \sum_{i=1}^N |\alpha_i|$$
$$(6)$$

Where i is the index of banks (N), T is the number of observations by bank, K is the index for quantiles, x_{it}^T is the matrix of covariates, ρ_{τ_k} denotes the loss function, and z_k is the relative weight given to the kth quantile. z_k is introduced to control the contribution of the Kth quantile in the estimation of fixed effects. To solve the minimization problem in Equation 6, I follow Lamarche (2010) and I employ equally weighted quantile $z_k = 1/K$. λ which is the penalty term used to reduce fixed effects to zero. Following Lv (2017), I set $\lambda = 0.65$.

In this paper, I examine the effect of competition on bank efficiency. I modify the specification of previous studies by constructing the following conditional quantile econometric model for τ:

$$VOLAT_{it} = \alpha_i + \mu_t + \beta_{1\tau}FD_{it} + \beta_{2\tau}GROWTH_{it} + \beta_{3\tau}FO_{it} + \beta_{4\tau}TRADE_{it} +$$
$$\beta_{5\tau}INFLATION_{it} + \beta_{6\tau}EXPENDITURE_{it} + \beta_{7\tau}REMITTANCE_{i,t} + \beta_{8\tau}GDP\_INITIAL_{i,t} +$$
$$\beta_{9\tau}REER_{i,t} + \beta_{10\tau}SCHOOL_{i,t} + \varepsilon_{it} \qquad (7)$$

Where the countries are indexed by *i* and time by *t*. VOLAT is the economic growth volatility. The description of other variables is provided in Table 3.

4. ESTIMATION RESULTS AND DISCUSSION

4.1. Panel Unit Root Test Results

Before running our fixed effects panel quantile regression models, it is important to test whether the variables of interest are stationary. I conduct three panel unit root tests, namely the Fisher-type unit root test based on an augmented Dickey-Fuller (Fisher-ADF) (Dickey & Fuller, 1979), the Fisher-type unit root test based on the Phillips-Perron test (Fisher-PP) Phillips and Perron (1988), and the Im, Pesaran, and Shin (2003) test (IPS). Table 6 presents

the results of the panel unit root tests. The findings suggest that the null hypothesis that all the panels contain a unit root could not be rejected for all the variables at level. However, at the first difference of all variables, the null hypothesis could almost be rejected at the 1% level. These results imply that the use of the first difference for all variables is necessary.

Table 6. Panel unit root test.

	Levels			First difference		
	Fisher-ADF	**Fisher-PP**	**IPS**	**Fisher-ADF**	**Fisher-PP**	**IPS**
VGDP	3.184	−3.872***	1.502	−4.387***	−23.487***	−8.947***
SDINFL	−1.954***	−3.453***	−2.741***	−9.579***	−19.474***	−8.021***
FD_BANK	3.515	7.019	3.211	−9.591***	−12.208***	−8.030***
FD_MARK	−5.508***	−0.838	−4.558***	−13.868***	−12.001***	−11.486***
FDBOND	5.226	3.968		−4.864***	−14.343***	
FD_OVERALL	4.560	3.510		−5.087***	−9.697***	
DMBA	6.620	7.111	4.739	−8.937***	−9.961***	−7.511***
FSD	4.952	2.815	3.477	−13.359***	−13.249***	−11.494***
LL	3.396	3.769	2.516	−13.590***	−11.973***	−11.552***
PCDMB	6.974	7.202	4.924	−7.709***	−9.484***	−6.402***
SMC	−0.267	−0.046	−2.439***	−14.591***	−10.594***	−12.254***
SMTVT	2.350	2.888	0.554	−13.929***	−6.923***	−11.492***
SMTO	1.080	−6.932***	−0.359	−17.902***	−27.922***	−15.242***
FO	−2.743***	2.288	−3.972	−4.974***	−17.355***	−4.437***
REMITTANCE	0.157	2.249		−10.727***	−17.724***	
TO	−0.299	−0.904	−1.297	−13.381***	−18.702***	−12.290***
INFL	−2.159***	−15.378***	−2.971***	−26.789***	−40.848***	−24.203***
GROWTH	0.9496	−10.956	−0.031	−25.330***	−33.105***	−22.761***
EXPEND	3.3371	3.771	2.179	−12.062***	−20.060***	−10.102***
SCHOOL	1.271	0.984		−2.340***	−13.944***	
REER	2.715	3.012	1.178	−2.302**	−18.575***	−2.978***

Note: Fisher-ADF and Fisher-PP represent the Maddala and Wu (1999) Fisher-ADF and Fisher-PP panel unit root tests, respectively. IPS represents the panel unit root tests of Im et al. (2003), respectively. The maximum number of lags is set to one. The Schwarz information criterion (SIC) is used to select the lag length. The bandwidth is selected using the Newey–West method. Bartlett is used as the spectral estimation method. The exogenous variables are the individual effects and individual linear trends. n.a. refers to not available.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.

4.2. Panel Quantile Regression Results

Before estimating the panel quantile regression model and to facilitate comparison, the model in Equation 7 is first estimated by the pooled OLS and panel data regression technique. The results are reported in Table 7, where financial development is measured using the aforementioned indices FD_BANK, FD_MARK and FD_OVERALL. For each proxy, I report the pooled OLS regression estimates and panel data estimations with both fixed and random effects. Overall, the results reported in Table 7 show that all the measures of financial development have a negative and statically significant effect on economic growth volatility. Specifically, an increase in the overall financial development level will lead to the reduction of economic volatility. In addition, the negative effect of financial development on economic volatility comes from both banking sector and financial market development. However, as discussed above, the classical regression approaches provide only a description of the average relationship between financial development and economic growth volatility and do not take into consideration the distributional heterogeneity.

Table 7. Financial development and economic growth volatility: OLS and panel regression.

| | Financial development index | | | | | | | | |
| | FD_BANK | | | FD_MARK | | | FD_OVERALL | | |
	OLS	FE	RE	OLS	FE	RE	OLS	FE	RE
Constant	0.0476***	0.0242***	0.0362**	0.0527***	0.0229***	0.0402***	0.0565***	0.0227***	0.0562***
	(7.91)	(57.42)	(2.34)	(8.83)	(57.35)	(2.86)	(6.46)	(41.34)	(3.13)
ΔFD	-0.7875***	-0.8705***	-0.8531***	-0.5418***	-0.4972***	-0.5115***	-0.9408***	-0.9111***	-0.9074***
	(-2.66)	(-4.71)	(-4.59)	(-4.85)	(-5.71)	(-5.83)	(-3.24)	(-3.97)	(-3.92)
ΔGROWTH	0.0127	-0.0011	0.0023	0.0275	0.0138	0.0192	0.0553	0.0355*	0.0408
	(0.43)	(-0.07)	(0.14)	(0.95)	(0.88)	(1.22)	(1.54)	(1.65)	(1.89)
ΔFO	-0.0031	-0.0034**	-0.0034**	-0.0032	-0.0035***	-0.0035**	-0.0016	-0.0005	-0.0007
	(-1.90)	(-2.45)	(-2.40)	(-1.91)	(-2.61)	(-2.52)	(-0.56)	(-0.28)	(-0.35)
ΔTRADE	0.0041	-0.0060	-0.0044	0.0053	-0.0029	-0.0017	-0.0092	-0.0171*	-0.0152
	(0.39)	(-0.90)	(-0.65)	(0.51)	(-0.45)	(-0.25)	(-0.61)	(-1.76)	(-1.56)
ΔINFLATION	-0.0249	-0.0262**	-0.0258*	-0.0281	-0.0285**	-0.0289**	-0.0206	-0.0432**	-0.0395*
	(-1.23)	(-1.97)	(-1.93)	(-1.41)	(-2.20)	(-2.21)	(-0.60)	(-2.03)	(-1.84)
ΔEXPENDITURE	0.1557*	0.0444	0.0710	-0.0133	-0.0549	-0.0455	0.2995**	0.1034	0.1436
	(1.73)	(0.76)	(1.22)	(-0.15)	(-0.92)	(-0.76)	(2.29)	(1.05)	(1.45)
ΔREMITTANCE	0.1420	0.1692*	0.1652*	0.1130	0.1383	0.1357	-0.1065	-0.0236	-0.0518
	(1.30)	(1.86)	(1.80)	(0.96)	(1.55)	(1.50)	(-0.38)	(-0.11)	(-0.24)
ΔGDP_INIT	-0.0025***	-	-0.0013	-0.0032***	-	-0.0018	-0.0036***	-	-0.0036*
	(-4.01)	-	(-0.78)	(-5.15)	-	(-1.21)	(-3.98)	-	(-1.90)
ΔREER	-0.0255**	-0.0304***	-0.0289***	-0.0285***	-0.0312***	-0.0304***	-0.0471***	-0.0405***	-0.0417***
	(-2.46)	(-3.90)	(-3.70)	(-2.72)	(-4.13)	(-3.99)	(-3.42)	(-4.28)	(-4.39)
ΔSCHOOL	0.0283**	0.0128	0.0147	0.0185	-0.0034	-0.0005	0.0207	0.0026	0.0062
	(2.22)	(1.01)	(1.16)	(1.26)	(-0.25)	(-0.04)	(1.27)	(0.16)	(0.37)

Notes: This table reports the result of the impact of financial development on economic growth volatility using OLS and panel regression with fixed (FE) and random (RE) effects. FD_BANK is bank system development index. FD_MARK is financial market development index. FD_OVERALL is overall financial development index. The other variables are defined in Table 3. Figures in parentheses are t-values. Δ is the first difference.
***Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

Table 8. The effect of banking sector development on economic growth volatility: A panel quantile regression.

Independent variables	Quantiles									
	10th	20th	30th	40th	50th	60th	70th	80th	90th	95th
Constant	0.019	0.0355***	0.0422***	0.0407***	0.0475***	0.0497***	0.0497***	0.0507***	0.0765**	0.1141***
	(1.56)	(5.19)	(7.72)	(7.44)	(8.15)	(7.10)	(5.34)	(3.52)	(2.37)	(2.71)
ΔFD_BANK	-0.494**	-0.6379***	-0.6882**	-0.7577**	-0.9321***	-0.9497***	-1.0905***	-1.3223***	-1.3753*	-1.0864
	(-1.97)	(-2.78)	(-2.39)	(-2.56)	(-2.96)	(-2.86)	(-3.48)	(-3.81)	(-1.78)	(-1.15)
ΔGROWTH	0.061**	0.0255	0.0033	-0.0003	0.0003	-0.0106	-0.0167	-0.0109	0.0086	0.0397
	(1.96)	(1.21)	(0.19)	(-0.02)	(0.021)	(-0.73)	(-1.22)	(-0.63)	(0.25)	(1.24)
ΔFO	-0.0038**	-0.0027*	-0.0029*	-0.0039**	-0.0042***	-0.0040***	-0.0049***	-0.0038**	-0.0051	-0.0107
	(-2.28)	(-1.83)	(-1.74)	(-2.09)	(-3.36)	(-3.23)	(-3.22)	(-2.13)	(-1.14)	(-1.34)
ΔTRADE	-0.0156	-0.0087	-0.0053	-0.0082	-0.0115	-0.0072	-0.0094	-0.0051	0.0048	0.0129
	(-1.44)	(-0.93)	(-0.75)	(-1.22)	(-1.52)	(-1.11)	(-1.23)	(-0.47)	(0.30)	(0.75)
ΔINFLATION	-0.0047	-0.0032	-0.0080	-0.0157	-0.0151	-0.0185	-0.0371**	-0.03801*	-0.0558	-0.0724
	(-0.12)	(-0.22)	(-0.68)	(-1.52)	(-1.20)	(-1.17)	(-2.08)	(-1.66)	(-1.18)	(-1.42)
ΔEXPENDITURE	0.0701	-0.021	0.0068	0.0161	-0.0423	0.0236	-0.0289	0.0445	0.1978*	0.3433***
	(0.68)	(-0.24)	(0.079)	(0.21)	(0.57)	(0.35)	(-0.39)	(0.49)	(1.80)	(2.82)
ΔREMITTANCE	0.1719	0.0952	0.1516	0.2237*	0.2306**	0.2507**	0.2855***	0.2346***	0.1430	-0.0337
	(1.45)	(0.69)	(1.14)	(1.77)	(2.23)	(2.48)	(3.74)	(2.89)	(1.02)	(-0.22)
ΔGDP_INIT	-0.001	-0.0023***	-0.0028***	-0.0024***	-0.0029***	-0.0029***	-0.0026**	-0.0023	-0.0043	-0.0076*
	(-0.84)	(-3.37)	(-5.07)	(-4.31)	(-4.80)	(-3.99)	(-2.70)	(-1.56)	(-1.30)	(-1.75)
ΔREER	-0.0193**	-0.0123	-0.0145*	-0.0189**	-0.0266**	-0.0271**	-0.0358***	-0.0462***	-0.0600***	-0.0567**
	(-2.016)	(-1.41)	(-1.73)	(-2.18)	(-2.50)	(-2.35)	(-3.34)	(-3.08)	(-2.71)	(-2.41)
ΔSCHOOL	0.0260	0.0197	0.0052	0.0149	0.0207**	0.0155	0.0216	0.0347*	0.0391**	0.0111
	(1.15)	(1.04)	(0.422)	(1.43)	(2.48)	(1.45)	(1.47)	(1.87)	(1.98)	(0.48)

Notes: This table reports the result of the panel quantile regression model with Bond development index (FD_BANK) as a measure of financial development. All variables are defined in Table 3. Figures in parentheses are t-values. Δ is the first difference
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
* Statistical significance at the 10% level.

To control for the distributional heterogeneity and to have a more complete picture of the association between financial development and economic growth volatility, I employ the panel quantile regression with fixed effects as introduced by Canay (2011). Table 8, Table 9, and Table 10 report the result of the fixed effects panel quantile regression for the three measures of financial development, namely FD_BANK, FD_MARK, and FD_OVERALL, respectively. The results are reported for the 5th, 10th, 20th, 30th, 50th, 60th, 70th, 80th, 90th, and 95th percentiles of the conditional economic volatility distribution. The higher quantiles, such as the 60th, 70th, 80th, 90th, and 95th refer to the countries with higher economic growth volatility. However, the lower quantiles, such as the 10th, 20th, 30th, 40th, and 50th refer to the countries with lower economic growth volatility. Overall, the findings indicate that the impacts of various measures of financial development on economic growth volatility are heterogeneous.

Regarding the effect of the banking sector development (FD_BANK) on economic growth volatility, as reported in Table 8, the impact is heterogeneous. At the 95th quantile, the coefficient of ΔFD_BANK is negative but is insignificant at the 10% level. For the other quantiles, the coefficient is negative and statistically significant at conventional level, implying that the effect of banking sector development on economic growth volatility is negative and that the effect is more significant in lower volatility countries. However, the coefficient of ΔFD_BANK is greater at higher quantiles compared with lower quantiles. That is, in countries with higher economic growth volatility, the impact of bank sector development is more pronounced compared with countries with lower economic growth volatility. The corresponding panel quantile regression diagram of the coefficients is provided in Figure 1. As can be seen in Figure 1, there is a monotonic increase in the impact of bank sector development over the quantiles of economic growth volatility distribution.
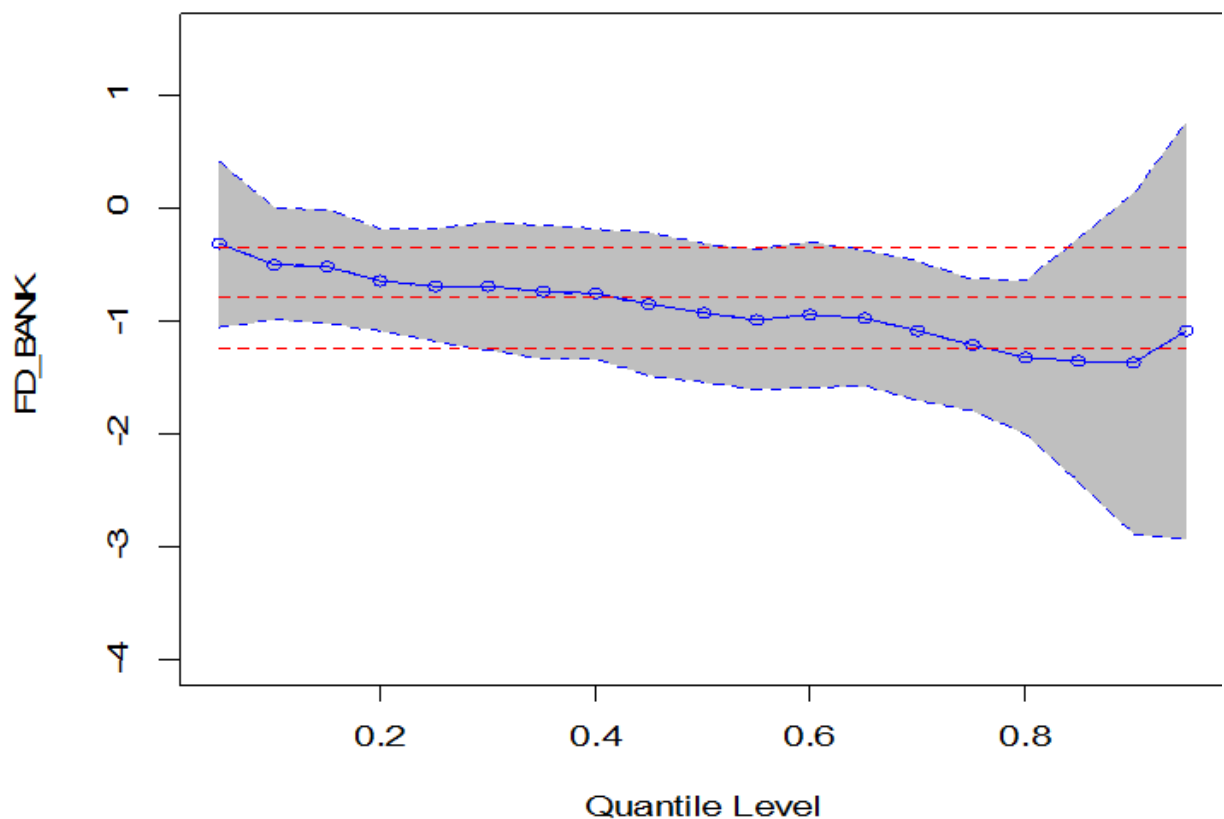

Figure 1. Quantile regression estimates with 95% confidence intervals for the impact of bank sector development (FD_BANK) on economic growth volatility. The vertical axes show the coefficient estimates of the variables over the economic growth volatility' distribution. The horizontal axes depict the quantile levels. The red horizontal dashed lines represent the corresponding OLS estimations with their 95% confidence interval.

Table 9. The effect of financial market development on economic growth volatility: A panel quantile regression.

Independent variables	Quantiles									
	10th	20th	30th	40th	50th	60th	70th	80th	90th	95th
Constant	0.0244**	0.0354***	0.0388***	0.0449***	0.0511***	0.0468***	0.0502***	0.0538***	0.0834***	0.1072***
	(2.53)	(4.83)	(6.53)	(7.55)	(8.09)	(6.30)	(5.31)	(4.15)	(3.12)	(2.64)
ΔFD_MARK	−0.2287***	−0.2317**	−0.2856**	−0.4313***	−0.5858***	−0.6857***	−0.7479***	−0.7486***	−0.8434***	−0.6064**
	(−2.73)	(−2.39)	(−2.49)	(−3.80)	(−4.32)	(−4.54)	(−4.88)	(−4.74)	(−3.75)	(−2.17)
ΔGROWTH	0.0731**	0.0270	0.0297	0.0286*	0.0251*	0.0162	0.0052	−0.0024	0.0201	0.0428
	(2.42)	(1.27)	(1.56)	(1.95)	(1.74)	(1.49)	(0.37)	(−0.11)	(0.74)	(1.31)
ΔFO	−0.0040**	−0.0026*	−0.0032**	−0.0034**	−0.0048***	−0.0039**	−0.0043***	−0.0055***	−0.0050	−0.0026
	(−2.25)	(−1.73)	(−1.85)	(−2.00)	(−3.14)	(−2.45)	(−3.03)	(−2.64)	(−1.41)	(−0.35)
ΔTRADE	−0.0213**	−0.0139*	−0.0058	−0.0006	−0.0025	−0.0008	0.0072	0.0059	0.0127	0.0123
	(−2.42)	(−1.68)	(−0.76)	(−0.08)	(−0.33)	(−0.12)	(0.83)	(0.45)	(0.94)	(0.61)
ΔINFLATION	−0.0093	−0.0098	−0.0111	−0.0148	−0.0127	−0.0171	−0.0353*	−0.0388*	−0.0749**	−0.0305
	(−0.41)	(−0.62)	(−0.92)	(−1.41)	(−0.79)	(−1.05)	(−1.82)	(−1.84)	(−2.07)	(−0.59)
ΔEXPENDITURE	−0.0394	−0.0901	−0.0569	−0.0445	−0.0607	−0.0443	−0.0471	−0.0582	−0.0179	0.1392
	(−0.40)	(−1.23)	(−0.83)	(−0.57)	(−0.93)	(−0.79)	(−0.68)	(−0.76)	(−0.17)	(0.77)
ΔREMITTANCE	0.0942	0.1891	0.1800	0.1604	0.2031	0.1237	0.1819	0.2529	0.2391*	0.0360
	(0.82)	(1.55)	(1.25)	(0.89)	(1.48)	(0.84)	(1.30)	(2.04)	(1.93)	(0.24)
ΔGDP_INIT	−0.0015	−0.0024***	−0.0025***	−0.0029***	−0.0034***	−0.0027***	−0.0028***	−0.0027**	−0.0052*	−0.0071*
	(−1.55)	(−3.16)	(−4.10)	(−4.90)	(−5.25)	(−3.46)	(−2.85)	(−2.07)	(−1.92)	(−1.71)
ΔREER	−0.0208***	−0.0098	−0.0131	−0.0171*	−0.0245**	−0.0328***	−0.0319***	−0.0461***	−0.0695***	−0.0831***
	(−2.62)	(−1.07)	(−1.35)	(−1.84)	(−2.25)	(−3.11)	(−2.75)	(−3.73)	(−3.49)	(−3.48)
ΔSCHOOL	−0.0158	−0.0112	−0.0013	0.0068	0.0081	0.0050	0.0038	−0.0088	0.0058	−0.0372
	(−0.89)	(−0.70)	(−0.12)	(0.84)	(0.74)	(0.67)	(0.46)	(−0.48)	(0.21)	(−0.75)

Notes: This table reports the result of the panel quantile regression model with Bond development index (FD_MARK) as a measure of financial development. All variables are defined in Table 3. Figures in parentheses are t-values. Δ is the first difference.
***Statistical significance at the 1% level.
** Statistical significance at the 5% level.
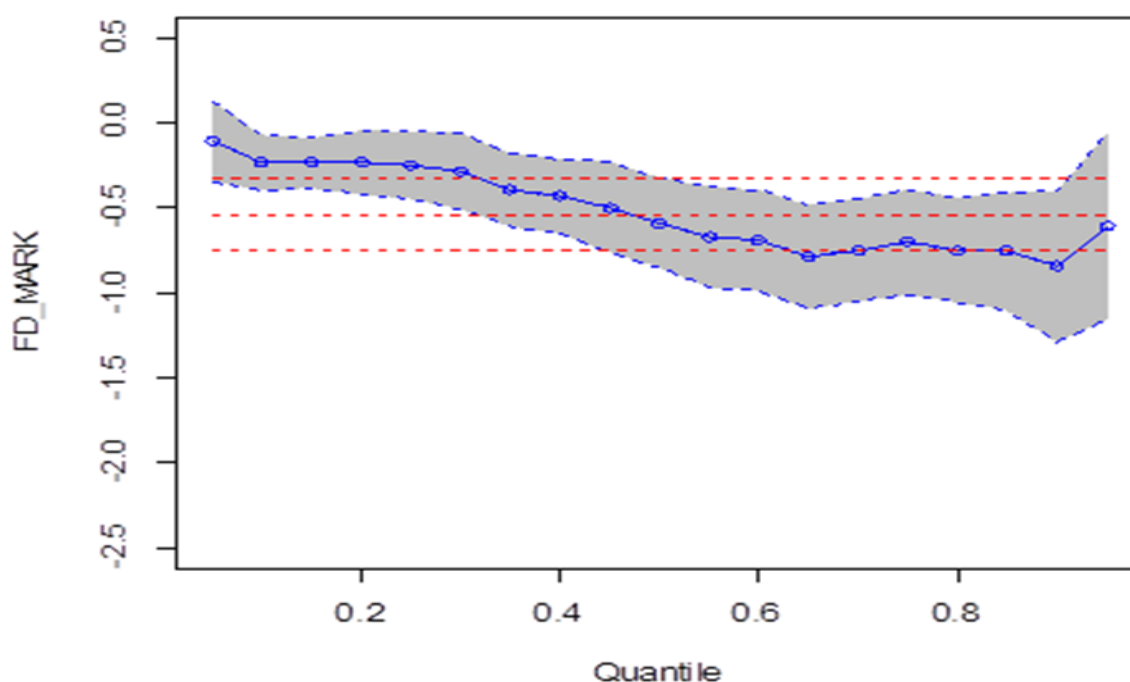* Statistical significance at the 10% level.

Figure 2. Quantile regression estimates with 95% confidence intervals for the impact of financial market development (FD_MARK) on economic growth volatility. The vertical axes show the coefficient estimates of the variables over the economic growth volatility's distribution. The horizontal axes depict the quantile levels. The red horizontal dashed lines represent the corresponding OLS estimations with their 95% confidence interval.

Regarding the financial market development (FD_MARK), the results of its impact on economic growth volatility is reported in Table 9. The corresponding panel quantile regression diagram of the coefficients is given in Figure 2. I can observe from Table 9 and Figure 2 that the effect of financial market development (FD_MARK) on economic growth volatility is negative and statistically significant for all quantiles and the effect is more pronounced at higher quantiles. These results indicate that an increase in the development level of financial markets can impede economic output volatility and therefore foster economic stability.

As regards the impact of the overall financial development level, the results are reported in Table 10. As for the other measures of financial development, I find that the coefficient of ΔFD_OVERALL is also negative and statistically significant for all quantiles except for the 95th quantile where the coefficient is negative but not significant at 10% level. The corresponding panel quantile regression diagram of the coefficients is given in Figure 3. As can be seen from Figure 3, there is a monotonic increase in the impact of overall financial development over the quantiles of economic growth volatility distribution. This implies that well-developed financial systems, including both banking sector and financial market development, can dampen output volatility by removing or reducing financial constraints and information asymmetry.

To verify the heterogeneity of the estimates, I conduct inter-quantile tests. These tests allow us to check whether the differences among the estimated coefficients of financial development indices are significant across quantiles. Following Koenker and Bassett (1982), I conduct Wald tests to check the equality of financial development coefficients across quantiles. To save space, I present only the results of the Wald test concerning whether the lower quantile (the 5th quantile) is equal to the middle quantile (the 50th quantile) and the higher quantile (the 95th quantile). The result of the Wald test of slope equality across quantiles is reported in Table 11.

Table 10. The effect of overall financial system development on economic growth volatility: A panel quantile regression.

Independent variables	Quantiles									
	10th	**20th**	**30th**	**40th**	**50th**	**60th**	**70th**	**80th**	**90th**	**95th**
Constant	0.0441***	0.0454***	0.0541***	0.0571***	0.0709***	0.0712***	0.0768***	0.0730***	0.1080**	0.1447*
	(3.75)	(4.42)	(5.22)	(6.19)	(6.68)	(7.12)	(5.86)	(3.17)	(2.31)	(1.91)
ΔFD_OVERALL	−0.5193**	−0.5429**	−0.5699**	−0.6738***	−0.6002**	−0.9897***	−1.1905***	−1.4229***	−1.4513**	−0.9480
	(−2.42)	(−2.45)	(−2.51)	(−3.07)	(−2.26)	(−2.95)	(−3.24)	(−3.34)	(−2.35)	(−1.38)
ΔGROWTH	0.0779***	0.0505**	0.0551***	0.0457***	0.0554***	0.0437**	0.0248	0.0340	−0.0049	0.0664
	(2.86)	(2.13)	(2.98)	(2.72)	(2.81)	(2.12)	(1.38)	(1.62)	(−0.16)	(1.62)
ΔFO	−0.0024	−0.0020	−0.0008	−0.0005	0.0003	−0.0008	−0.0022	0.0005	0.0051	0.0050
	(−1.08)	(−1.27)	(−0.55)	(−0.33)	(0.20)	(−0.45)	(−0.88)	(0.13)	(0.64)	(0.49)
ΔTRADE	−0.0306***	−0.0234**	−0.0181**	−0.0199**	−0.0237**	−0.0181	−0.0184	−0.0264	0.0095	0.0032
	(−2.86)	(−2.39)	(−2.04)	(−1.92)	(−2.11)	(−1.54)	(−1.35)	(−1.35)	(0.61)	(0.19)
ΔINFLATION	−0.0395*	−0.0110	−0.0049	−0.0102	−0.0020	−0.0321	−0.0212	−0.0613*	−0.1277***	−0.1723***
	(−1.85)	(−0.50)	(−0.27)	(−0.51)	(−0.08)	(−1.14)	(−0.64)	(−1.69)	(−3.27)	(−3.73)
ΔEXPENDITURE	0.0167	−0.0166	0.0925	0.0924	0.1821	0.1172	0.1132	0.1092	0.1590	0.2794
	(0.16)	(−0.14)	(0.93)	(1.01)	(1.55)	(1.03)	(1.01)	(0.80)	(1.02)	(1.44)
ΔREMITTANCE	0.0674	0.0274	−0.1373	−0.1628	−0.0443	−0.2054	−0.0551	0.0650	0.3830	1.1906
	(0.84)	(0.21)	(−0.81)	(−0.70)	(−0.15)	(−0.57)	(−0.14)	(0.13)	(0.53)	(1.39)
ΔGDP_INIT	−0.0034***	−0.0033***	−0.0040***	−0.0042***	−0.0054***	−0.0052***	−0.0055***	−0.0047**	−0.0076	−0.0106
	(−2.87)	(−3.19)	(−3.83)	(−4.59)	(−5.11)	(−5.11)	(−4.05)	(−2.02)	(−1.62)	(−1.40)
ΔREER	−0.0089	−0.0046	−0.0104	−0.0168	−0.0242*	−0.0413***	−0.0535***	−0.0633***	−0.0909***	−0.0998***
	(1.05)	(−0.64)	(−1.23)	(−1.44)	(−1.73)	(−3.30)	(−3.66)	(−3.51)	(−4.09)	(−3.98)
ΔSCHOOL	−0.0117	−0.0113	−0.0029	0.0011	0.0102	0.0088	0.0103	0.0278	0.0543	−0.0370
	(−0.73)	(−0.99)	(−0.31)	(0.13)	(1.16)	(0.86)	(0.75)	(1.19)	(1.29)	(−0.54)

Notes: This table reports the result of the panel quantile regression model with overall financial development index (FD_OVERALL) as a measure of financial development. All variables are defined in Table 3. Figures in parentheses are t-values. Δ is the first difference.
*** Statistical significance at the 1% level.
** Statistical significance at the 5% level.
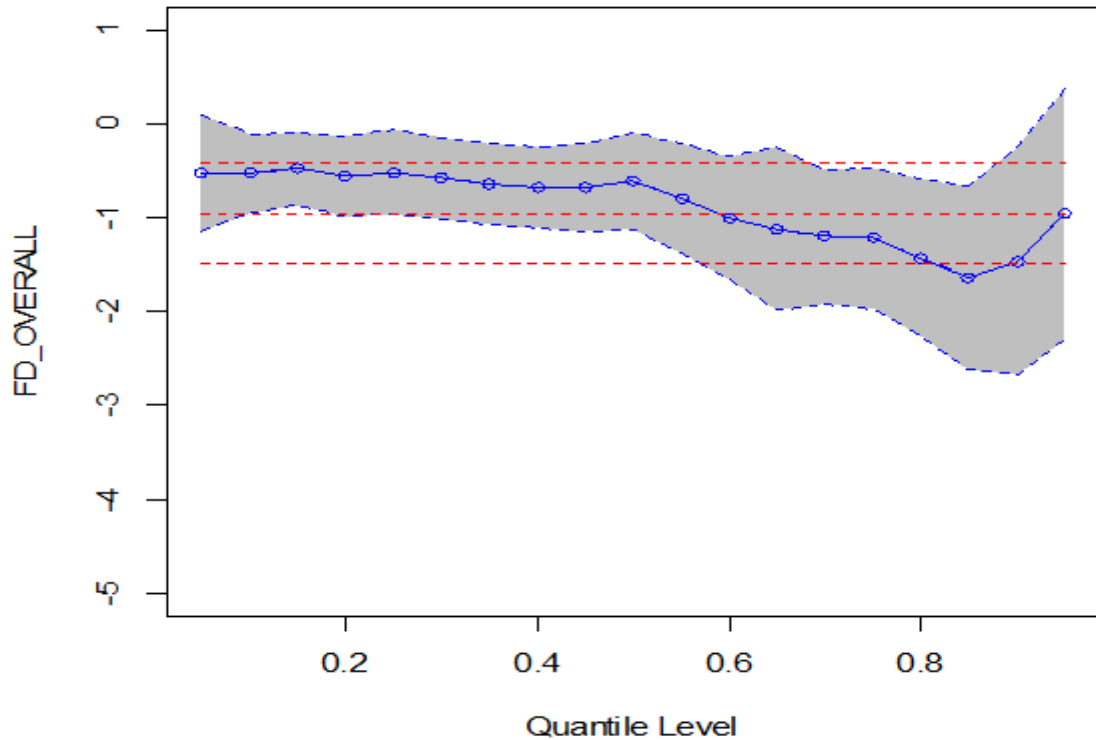* Statistical significance at the 10% level.

Figure 3. Quantile regression estimates with 95% confidence intervals for the impact of overall financial development (FD_OVERALL) on economic growth volatility. The vertical axes show the coefficient estimates of the variables over the economic growth volatility's distribution. The horizontal axes depict the quantile levels. The red horizontal dashed lines represent the corresponding OLS estimations with their 95% confidence interval.

As can be seen from Table 11, the null hypothesis of equality of slopes is rejected for all cases implying that the parameter estimates of financial development are heterogeneous across quantiles. In conclusion, our results show that it is important to consider the distributional heterogeneity when examining the effect of financial development on economic growth volatility. Besides, compared with OLS regression, the panel quantile regression with fixed effects provides a more complete picture of such associations. Next, our findings suggest that the impact of financial development, including both banking system and financial market development, on economic growth volatility is clearly heterogeneous. The results demonstrate that an increase in the level of bank system development and/or financial market development can lead to a more stable economic growth rate.

Table 11. Wald tests for the equality of slopes (5th against 50th and 95th quantiles).

	Against the 50th quantile		Against the 95th quantile	
	Test statistic	**p-value**	**Test statistic**	**p-value**
ΔFD_BANK	19.29***	0.000	2.72*	0.099
ΔFD_MARKET	16.18***	0.000	5.73**	0.016
ΔFD_OVERALL	12.45***	0.057	3.63*	0.057

*** Statistical significance at the 1% level.

**Statistical significance at the 5% level.

* Statistical significance at the 10% level.

5. CONCLUSION

The main objective of this study is to explore the impact of financial development on economic growth volatility. To do so, I employ quantile regression under the panel data framework. Unlike classical estimation methods, including OLS and panel regressions, the proposed method considers the distributional heterogeneity and unobserved individual heterogeneity. Besides, the panel quantile regression is preferred to OLS because it allows us to obtain a more complete image of the impact of financial development on economic volatility. For implementation, I use a sample of 63 developed and developing countries during the period 1996-2016. To measure the level of financial

development, I use the methodology of principal component analysis and construct three indices based on commonly used variables that describe the level of banking sector development and financial market development. The third proxy used is an overall financial development index.

For the case of OLS and panel regression, I find that banking sector development, financial market development, and overall financial development impact economic growth volatility both negatively and significantly. However, our empirical results based on the panel quantile regression show that the impact of various proxies of financial development on economic growth volatility is found to be heterogeneous across quantiles. This implies that it is important to take into consideration the distributional heterogeneity when testing the effect of financial development on economic growth volatility. All in all, looking at the full distribution of economic growth volatility instead of focusing on the average effects allows us to shed more light on the association between financial development and economic output volatility and reconcile previous empirical results.

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