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Abstract: Numerous empirical studies preset strong evidence supporting the positive relationship between Foreign Direct Investment (FDI) and the host countries' economic growth. Unlike most papers investigating this relationship using least squares-based regression, we analyze the effect of FDI on economic growth using quantile regression (QR). In this paper, we attempt to (i) reduce the omitted variable bias, (ii) solve the potential endogeneity problem of FDI, and (iii) allow heterogeneity across countries, using instrumental variable QR for panel data with fixed effect. Our empirical results reinforce the view that FDI is positively related to economic growth in under-developed countries where the rate of growth is relatively low.

Keywords: FDI, Quantile Regression, Panel Data, Endogeneity, Instrumental Variable

KRF Classification: B030104

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1. Introduction

Numerous empirical attempts have been made in the literature to determine the relationship between Foreign Direct Investment (FDI) and economic growth of host countries.[2] In an influential work, Levine and Renelt (1992) show a positive and robust correlation between the share of investment and economic growth using Leamer's extreme bounds analysis. We present some of the major findings of representative papers below.

Blomström et al. (1992) used a dataset of 78 developing and 23 developed countries for the period 1960-1985 and concluded that FDI can have a significant and positive impact on economic growth only in rather wealthier host countries, implying a certain threshold income level below which FDI has no impact on economic growth.

Borensztein et al. (1998) studied a dataset of 69 developing countries in two periods, 1970-1979 and 1980-1989. By allowing a different constant for each period but restricting identical coefficients for explanatory variables, they showed that FDI exerts a positive but insignificant influence on economic growth if the host country maintains a minimum threshold stock of human capital.

Balasubramanyam et al. (1996, 1999) used a cross-sectional annual dataset of 46 developing countries for the period 1970-1985 and identified the important role of the domestic market, competitive climate in relation to local producers, and FDI-labor interactions on economic growth. They concluded that FDI has a positive influence on the growth rate of countries pursuing the strategy of export promotion rather than import substitution.

Olofsdotter's (1998) empirical study investigates the effect of FDI in 50 developed and developing countries over the period 1980-1995, to find empirical evidence supporting the positive relationship between economic growth and FDI. However, the combination of FDI with openness and human capital shows no positive impact on economic growth. He further discovers that FDI is still beneficial for countries with a high level of institutional capability.

However, some papers such as Stocker (2000) report opposite results. Stocker (2000) investigates the relationship between FDI and economic growth using both a cross-sectional analysis of a data set of 72 countries over the period 1980-1995 and a time-series analysis of another data set of 100 countries for the period 1970-1996. These studies could confirm neither a significant relationship nor persistent Granger causality between FDI and economic growth. In

[2] In this paper, FDI is the net inflow of investment to obtain a permanent controlling interest (10% or more share) in a foreign firm, as defined by the World Bank.

addition to Stocker (2000), there are also some other empirical papers such as Carkovic and Levine (2005) showing no significant impact of FDI on economic growth. Hence, whether FDI has a positive effect on economic growth is still an empirically debatable issue.

All the papers mentioned above are based on either cross-sectional or time-series analysis. Panel data analysis is generally considered more efficient than these two methods because panel analysis can reduce the omitted-variable bias by allowing heterogeneity across countries. Therefore, panel data analysis has been applied to investigate the relationship between FDI and economic growth. For example, Nair-Reichert and Weinhold (2001) used a panel method with a sample of 24 developing countries, to address the issue of heterogeneity across countries. They found a causal relationship between FDI and economic growth. Furthermore, the impact of FDI is higher in more open economies.

Although panel analysis can provide better and richer results than both cross-sectional and time-series analyses, these three methods are based on least squares (LS)-type regression, meaning that researchers are restricted to investigating the relationship between economic growth and FDI at the mean of the conditional distribution of the dependent variable. On the other hand, quantile regression (QR), originally proposed by Koenker and Bassett (1978), can be used to study the relationship between economic growth and FDI not only at the center but also at different parts (quantiles) of the entire conditional distribution. It is noted that such heterogeneous quantile effect (i.e., the impact of FDI on economic growth can vary across quantiles) is different from the heterogeneity across countries which basically means country-specific characteristics.

Because of this flexibility, QR has been used in the FDI literature. For example, Dimelis and Louri (2002) and Girma and Görg (2003) have employed either QR or panel QR method to study the relationship between FDI and economic growth. However, these methods (i.e., QR and panel QR) can still suffer from the problem of endogeneity. While FDI can be correlated with the country-specific error term, it can be endogenous (see Carkovic and Levine, 2005; Borensztein, 1998). The problem of endogeneity remained unresolved until the work of Galvao (2011), who extended Chernozhukov and Hansen (2005, 2006) to develop the panel instrumental variable (IV) QR method. Huo (2015) employed this novel technique to investigate the impact of FDI on economic growth at various quantiles. In this paper, we extend the work of Huo (2015) by controlling for more explanatory variables to avoid the possible omitted-variable bias. Moreover, we verify the robustness of Huo's (2015) results by comparing all the possible results from (i) pooling LS, (ii) two-stage LS, (iii) panel LS with two-way effects, (iv) panel IV with two-way effects, (v), pooling QR, (vi) two-stage QR, (vii) panel QR with two-way effects, and (viii) panel IVQR with two-way effects.

The rest of this paper is organized as follows. Section 2 explains the panel IVQR method with two-way effects. Data description and empirical results are provided in section 3. Section 4 concludes the paper.

2. The Growth Model and Quantile Regression

While studying the impact of FDI, the model considers both country-specific and time effects. For example, Carkovic and Levine (2005) included a time dummy variable in each period to control for time effects. In this paper, we use a dynamic panel model to control for country-specific as well as time effects to avoid the omitted-variable bias. We consider the following growth model:

$$GY_{it} = \alpha Y_{i,t-1} + \beta FDI_{it} + X'_{it}\Gamma + \eta_i + \lambda_t + u_{it},$$
$$i = 1,2,\dots,N,$$
$$t = 1,2,\dots,T, \quad (1)$$

where GY_{it} is the growth rate of GDP per capita in country i and year t, $Y_{i,t-1}$ is the logarithm of GDP per capita in country i and year $t-1$, FDI_{it} is the FDI net inflow (percentage of GDP), and X_{it} is a set of other control variables that influence economic growth such as government consumption, gross domestic investment (GDI), inflation, money and quasi money (M2), quality of government, and political rights. The other two terms, η_i and λ_t, are country-specific and year-specific effects, respectively.

As explained in the Introduction section, FDI can be endogenous in the growth model in (1) because it is influenced by the growth rate GY_{it}. If such endogeneity is not properly considered when estimating model (1) using either the QR or panel QR method, the resulting quantile estimator will be biased or inconsistent, as demonstrated by Kim and Muller (2004). To solve the endogeneity problem in QR, Chernozhukov and Hansen (2005, 2006) proposed the IVQR method, which Galvao (2011) extended to the panel regression context, to become the panel IVQR method. When employing the panel IVQR method, we use the lagged value of the explanatory variables as instruments. Following Huo (2015), we use the first to fifth lagged values of explanatory variables (denoted as w_{it}) for instruments.

We first explain how the panel IV quantile estimator is obtained. For a certain quantile index $\theta \in (0,1)$ and value of $\beta_{\theta j}$ from a previously defined grid $\{\beta_{\theta j}, j = 1,2, \ldots J\}$, we obtain the estimators $\hat{\alpha}_\theta, \hat{\Gamma}_\theta, \hat{\eta}_{i\theta}, \hat{\lambda}_{t\theta}, \hat{\zeta}_\theta$ from the following minimization program:

$$\min_{\alpha_\theta, \Gamma_\theta, \eta_{i\theta}, \lambda_{t\theta}, \zeta_\theta} \sum_{i=1}^{N} \sum_{t=1}^{T} \rho_\theta (GY_{it} - \alpha_\theta Y_{i,t-1} - \beta_{\theta j} FDI_{it} - X'_{it} \Gamma_\theta - \eta_{i\theta} - \lambda_{t\theta} - w'_{it} \zeta_\theta),$$

where $\rho_\theta(u) = u\big(\theta - I(u < 0)\big)$. The estimators $\hat{\alpha}_\theta, \hat{\Gamma}_\theta, \hat{\eta}_{i\theta}, \hat{\lambda}_{t\theta}, \hat{\zeta}_\theta$ are functions of $\beta_{\theta j}$, which needs to be estimated. Thus we denote them as $\hat{\alpha}_\theta(\beta_{\theta j}), \hat{\Gamma}_\theta(\beta_{\theta j}), \hat{\eta}_{i\theta}(\beta_{\theta j}), \hat{\lambda}_{t\theta}(\beta_{\theta j}), \hat{\zeta}_\theta(\beta_{\theta j})$.

The true coefficient on w_{it} (ζ_θ) should be zero if w_{it} is a valid instrument, because w_{it} is independent of the error term u_{it} in (1). Hence, we can estimate β_θ by taking $\hat{\zeta}_{\theta j}(\beta_{\theta j})$ as close to zero as possible, that is, with the following second minimization program:

$$\hat{\beta}_\theta = \underset{\beta_{\theta j}}{\operatorname{argmin}} \left\| \hat{\zeta}_{\theta j}(\beta_{\theta j}) \right\|_A$$

where $\|x\|_A = \sqrt{x'Ax}$ and A is a positive definite matrix. Therefore, the final panel IV quantile estimators are $\hat{\alpha}_\theta(\hat{\beta}_\theta), \hat{\Gamma}_\theta(\hat{\beta}_\theta), \hat{\eta}_{i\theta}(\hat{\beta}_\theta), \hat{\lambda}_{t\theta}(\hat{\beta}_\theta), \hat{\zeta}_\theta(\hat{\beta}_\theta)$.

3. Empirical Analysis

3.1 Data

The data set for this study consists of 60 developed and developing countries. The appendix gives the list of all countries included in the sample. The sample period is from 1991 to 2008. The following variables are obtained from the World Development Indicators database: FDI net inflows (percentage of GDP), gross domestic investment (percentage of GDP), GDP per capita (constant 2000 US$), general government final consumption expenditure (percentage of GDP) denoted as GCE, trade (percentage of GDP) equaling the sum of exports and imports of goods and services, and M2 (percentage of GDP). Human capital is usually included as a control

variable. Following Barro and Lee (2010), we measure human capital by the average years of male secondary schooling. This variable is provided in Barro and Lee (2010).

All the control variables mentioned above have been used in Huo (2015). However, some potentially important control variables have been neglected in Huo (2015). It is well known that "quality of government" and "political rights" can be significant variables explaining economic growth. If these variables are not taken into account, the results can suffer from omitted-variable bias. The quality of government can be measured using "Quality of Government by International Country Risk Guide," which gives the mean value of the ICRG variables,[3] such as corruption, law and order and bureaucracy quality (scaled between 0 and 1, the higher values indicating higher government quality). The political rights variable is measured by the grade of people participating freely in the political process, between 1 (most free) and 7 (least free) as provided by Freedom House.[4]

3.2 Estimation Results

We first investigate the relationship between economic growth and FDI using LS-type regression methods; that is, we examine the relationship between economic growth and FDI only at the center of the whole conditional distribution. For this, we employ four different LS-type regression methods: (i) pooling LS (PLS), (ii) two-stage LS (TSLS), (iii) panel LS with two-way effects (PNTW), and (iv) panel IVLS with two-way effects (PNTWIV). The estimation results are shown in Table 1.

The first column of Table 1 shows the results from pooling LS regression. The key variable, FDI, is highly significant and has a positive effect on the growth rate. The initial GDP has a significant and negative relationship with economic growth, whereas GDI has a significant and positive impact on economic growth. The significantly negative relation between openness of trade and economic growth is somewhat unexpected; it was probably caused by either the possible endogeneity in the model or heterogeneity across countries. The other explanatory variables achieve their expected sign, but their impacts on economic growth are not statistically significant.

The second column of Table 1 shows the two-stage LS regression results. A noticeable change is that the estimated coefficient of FDI has substantially increased from 0.1027 to 0.2772;

[3] The term ICRG stands for International Country Risk Guide. Borensztein et al. (1998) used the average of (i) government repudiation of contracts, (ii) risk of expropriation, (iii) rule of law, and (iv) bureaucratic quality to measure the quality of government from ICRG.
[4] The data on quality of government and political rights can be downloaded from *http://www.qog.pol.gu.se/*

this probably is an indicator that the impact of FDI on economic growth can be greatly underestimated if the issue of endogeneity is not properly taken into account. We must emphasize that although TSLS can correct the issue of endogeneity, it still avoides the issue of heterogeneity across countries, which can induce the omitted-variable bias problem. Therefore, we can conjecture that the unexpected negative sign of the variable "openness of trade" is probably due to avoiding the country-specific effects, and not due to endogeneity in the model.

The last two columns of Table 1 give the estimation results with both country-specific and period-specific effects from panel regression methods. The key variable is FDI; it is considered exogenous in the third column, but endogenous in the fourth column. Once again, we show that endogeneity needs to be taken into account properly. FDI is not significant in the third column, but it has a significant impact on economic growth in the fourth column. The estimated coefficients of initial GDP and GDI are significant under the PNTW and PNTWIV methods, indicating robust and insensitive impacts on economic growth. While the political rights variable is not significant in all specifications, but the other political variable, quality of government, is significant when based on panel regression methods. This implies that the higher the quality of government (e.g., less corrupted government), the higher would be the GDP growth rate of the country, all other factors remaining constant. All the above LS-based regression results show the positive impact of FDI on economic growth, empirically demonstrating the vital role of FDI during the last 20 years.

Table 1. LS and Panel Regression (dependent variable: GDP growth per capita)

	PLS	**TSLS**	**PNTW**	**PNTWIV**
FDI	0.1027***	0.2772***	0.042	0.2095**
	(0.0283)	(0.0526)	(0.0302)	(0.0767)
Log(initial GDP)	-0.3548**	-0.3362*	-9.0146***	-8.7716***
	(0.131)	(0.1334)	(1.1856)	(1.2081)
GDI	0.1773***	0.1768***	0.1698***	0.1497***
	(0.0195)	(0.0199)	(0.0299)	(0.0315)
GCE	-0.0288	-0.0356	0.062	0.0663
	(0.0229)	(0.0234)	(0.0527)	(0.0535)
Inflation rate	-7.00E-04	-7.00E-04	-5.00E-04	-5.00E-04
	(6.00E-04)	(6.00E-04)	(6.00E-04)	(6.00E-04)
Openness of trade	-0.0041*	-0.0103***	0.0065	0.0048
	(0.0023)	(0.0028)	(0.0084)	(0.0085)
schooling	0.0097	-0.0706	0.7282	0.4416
	(0.1323)	(0.1362)	(0.6377)	(0.6586)
M2	0.003	0.0024	-0.0248*	-0.0276**
	(0.0033)	(0.0034)	(0.0105)	(0.0107)
Political rights	-0.0582	-0.0583	-0.108	-0.1332

	(0.0634)	(0.0645)	(0.1276)	(0.13)
Quality of Government	1.1315	1.1845	4.1719**	3.639*
	(0.8313)	(0.846)	(1.434)	(1.4731)
Adjust-R square	0.103	0.0712	0.1021	0.0839

Note: (1) Standard errors are in parentheses.
(2) Constant estimates including the fixed effect terms are not shown.
(3) Significant coefficients are marked by ***(0.1%),**(1%),*(5%).

We now discuss the estimation results using QR methods. As explained previously, QR can provide an alternative perspective to parameter heterogeneity over the whole conditional distribution of the dependent variable, thereby enabling us to study the heterogeneous impact of FDI on economic growth. We employ four different QR methods: (i) pooling QR, (ii) pooling IVQR, (iii) panel QR with two-way effects, and (iv) panel IVQR with two-way effects. The estimation results are shown in Table 2 through Table 5; all the estimated coefficients are at some pre-selected quantile index (θ = 0.1, 0.2, …, 0.9) accompanied with their 90% confidence intervals, as shown in parentheses.[5]

Table 2 shows the pooling QR estimation results; this can be comparable to the pooling LS estimation results shown in the first column of Table 1. We find that the FDI estimates are positive for all quantiles except the lowest one, θ = 0.1. Thus we can argue that FDI has significantly positive effects at not only the center of the conditional distribution of economic growth, but also over the entire conditional distribution. Moreover, its impact on economic growth tends to increase as the quantile index increases. For example, the estimated coefficient of FDI is 0.0881 when θ = 0.2, whereas it increases to 0.1409 when θ = 0.8, implying that the impact of FDI on economic growth is larger when the growth rate is higher over its own conditional distribution. The expected negative relationship between initial GDP and economic growth becomes insignificant when the quantile index θ becomes larger than 0.4. The variable GDI exerts strong and positive impacts on growth across all quantiles, and its impact tends to increase as the quantile index θ increases. Government consumption shows a significant and negative effect on economic growth for a specific range of quantile indexes (i.e., from θ = 0.2 to θ = 0.5). The schooling variable has significantly positive impacts on economic growth only for the lowest quantile indexes such as θ = 0.1 and 0.2. Similarly, the political variable, quality of government, has significant and positive effects on economic growth only for low quantile indexes such as θ = 0.3 and 0.4.

Table 3 shows the QR results obtained after correcting the FDI endogeneity problem in the model. Compared to Table 2, the FDI effect on economic growth is much higher in all

[5] Confidence intervals are constructed from the relevant percentiles of 1,000 cross-sectional bootstrap replications following Kato et al. (2010).

quantile indexes considered, indicating the presence of FDI endogeneity in QR, similar to the LS regression results in Table 1.

The panel QR estimation results with country- and period-specific effects are shown in Table 4. Note that FDI is positively related to economic growth, but significant only at relatively low quantiles such as $\theta = 0.3$, 0.4, and 0.6. GDI still exerts a significantly positive influence on growth at almost all quantiles. We also find empirical evidence that education approximated by the schooling variable has a significant and positive relationship with economic growth at the medium-to-high quantiles. The political variable, political rights, plays an important role for the middle quantiles such as $\theta = 0.5$, 0.6, and 0.7, while quality of government impacts growth only at low quantiles such as $\theta = 0.1$, 0.2, and 0.3.

We now turn to our main estimation results from the panel IVQR method, which can solve two potentially important problems simultaneously, the bias problem due to the presence of endogeneity in FDI and the omitted-variable bias problem due to neglecting the country-specific and period-specific effects. The results are shown in Table 5 in which FDI tends to have a positive effect on economic growth at all quantiles, although significant only at the low quantiles between $\theta = 0.1$ and $\theta = 0.4$. The estimated coefficient for FDI starts at 0.42, at $\theta = 0.1$, and decreases gradually to 0.21, at $\theta = 0.4$. Its statistical significance disappears when θ is greater than 0.4.

Compared to the results shown in previous tables (Tables 2-4), the estimation results for FDI are quite different in terms of (i) statistical significance, (ii) magnitude of impact, and (iii) pattern of heterogeneous impact of FDI on economic growth. For example, the impact of FDI on economic growth decreases as θ increases in Table 5, whereas the opposite pattern is true in Table 2. Such noticeable differences in estimation results strongly suggest that both endogeneity and omitted-variable bias are likely to affect the estimation results and hence it is important that both of them be corrected. When compared to the results in Huo (2015), our results show that FDI has a stronger effect on economic growth in that the quantile coefficients on FDI at the low quantiles ($\theta = 0.1$, 0.2, 0.3 and 0.4) are larger in our results. Such results can indicate that the omitted-variable bias caused by the absence of some political variables might have caused a downward bias in Huo (2015).

From the corrected estimation results, we can argue that FDI is a powerful engine for economic growth at low quantiles of the conditional distribution of the growth rate variable. One possible implication is that FDI can be more effective for countries facing a period of low economic growth relative to other countries. Usually, very under-developed countries tend to suffer from low economic growth and so FDI can be beneficial to them.

Table 5 also shows that GDI has a positive and significant impact on economic growth at all quantiles and that the degree of such impacts rises while the considered quantile index increases. Table 5 further shows that initial GDP has a negative impact on economic growth at all quantiles. We note that the political variable, quality of government, is highly significant at low quantiles such as $\theta = 0.2$ and that the magnitude of impact is potentially large. Any quantile larger than 0.2 loses its statistical significance. This result indicates that reducing the degree of corruption in government is important to boost economic growth, especially for countries facing a period of low economic growth relative to other countries.

Table 2. Pooling QR Results with 90% Confidence Intervals (Exogeneity of FDI)

θ	FDI	Log GDP	GDI	GCE	Inflation
0.1	0.0939 (-0.0954,0.1432)	-0.7371 (-1.1755,-0.4237)	0.1327 (0.0888,0.2444)	-0.0805 (-0.1159,0.0129)	-1e-04 (-1.8e+308,-1e-04)
0.2	0.0881 (0.042,0.1591)	-0.4104 (-0.6486,-0.2016)	0.1588 (0.1154,0.2087)	-0.0819 (-0.1369,-0.0288)	-4e-04 (-0.6015,-4e-04)
0.3	0.1082 (0.0528,0.1583)	-0.2902 (-0.4704,-0.0098)	0.1398 (0.0958,0.1828)	-0.1001 (-0.1521,-0.0521)	-6e-04 (-0.147,0.0014)
0.4	0.1176 (0.077,0.1907)	-0.2058 (-0.4535,-0.0662)	0.1583 (0.1143,0.2086)	-0.0737 (-0.1039,-0.037)	-8e-04 (-0.0181,0.001)
0.5	0.1311 (0.0809,0.1684)	-0.1664 (-0.3617,0.0116)	0.1812 (0.1332,0.2081)	-0.0464 (-0.0779,-0.0213)	-0.001 (-0.0042,7e-04)
0.6	0.1077 (0.062,0.1807)	-0.1844 (-0.4438,0.053)	0.1757 (0.1445,0.2031)	-0.0358 (-0.0718,0.0059)	2e-04 (-0.0012,0.0124)
0.7	0.1120 (0.0683,0.2091)	-0.2043 (-0.4425,0.0971)	0.1816 (0.1538,0.2175)	-0.0224 (-0.0671,0.009)	-1e-04 (-0.0013,0.0905)
0.8	0.1409 (0.0578,0.2164)	0.1073 (-0.3522,0.3587)	0.2186 (0.1858,0.2513)	0.0138 (-0.0322,0.0439)	-5e-04 (-0.0016,0.4743)
0.9	0.1335 (0.0915,0.2298)	0.1270 (-0.1045,0.4507)	0.2232 (0.2034,0.2771)	0.0102 (-0.0286,0.0625)	-0.001 (-0.0011,1.8e+308)
θ	**Trade**	**Schooling**	**M2**	**Political Rights**	**Quality of Government**
0.1	-0.0089 (-0.0163,-1e-04)	0.5661 (0.1784,0.9138)	0.0025 (-0.007,0.009)	-0.1849 (-0.6186,0.0587)	2.2827 (-1.0799,4.9426)
0.2	2e-04 (-0.011,0.0057)	0.2483 (0.0796,0.5409)	0.0011 (-0.0058,0.0053)	-0.1255 (-0.313,0.0435)	1.6236 (-0.731,3.894)
0.3	-0.0016 (-0.0089,0.0032)	0.1493 (-0.0429,0.3117)	0.0017 (-0.0066,0.0058)	-0.0430 (-0.1888,0.0891)	1.9200 (0.4477,3.4252)
0.4	-0.003 (-0.0086,3e-04)	-0.0021 (-0.1184,0.1524)	9e-04 (-0.0025,0.0053)	0.0290 (-0.1112,0.1324)	1.7222 (0.159,3.3622)
0.5	-0.0031 (-0.0085,0.0033)	-0.1047 (-0.2184,0.1232)	-2e-04 (-0.0046,0.0038)	0.0618 (-0.0643,0.1137)	1.132 (-0.1679,2.9213)
0.6	1e-04 (-0.0053,0.0024)	-0.1103 (-0.2936,0.0781)	-0.0012 (-0.0052,0.0044)	0.0335 (-0.0298,0.129)	1.4641 (-0.1813,2.9405)
0.7	-5e-04 (-0.0041,0.0019)	-0.1232 (-0.2991,-0.0273)	-0.0021 (-0.006,0.0056)	0.0841 (-0.0449,0.178)	1.1035 (-0.3955,2.4625)
0.8	-0.0019 (-0.0043,0.0022)	-0.3592 (-0.4521,-0.1234)	-0.0045 (-0.0116,0.0014)	0.0613 (-0.0392,0.1743)	-0.8644 (-2.4276,0.6625)
0.9	-8e-04 (-0.0048,0.0034)	-0.4134 (-0.741,-0.0896)	-0.0063 (-0.0132,4e-04)	0.0045 (-0.0721,0.152)	-1.9552 (-3.2758,-0.5545)

Note: 90 % confidence intervals are in parentheses.

Table 3. Pooling IVQR Results with 90% Confidence Intervals (Endogeneity of FDI)

θ	FDI	Log GDP	GDI	GCE	Inflation
0.1	0.25 (0.07,0.43)	-0.8511 (-1.4808,-0.0976)	0.1334 (0.036,0.2797)	-0.0796 (-0.221,0.0125)	-1e-04 (-0.1021,8e-04)
0.2	0.23 (0.06,0.48)	-0.4862 (-0.8911,0.0681)	0.1673 (0.0827,0.2516)	-0.0717 (-0.1995,-0.0234)	-4e-04 (-0.0492,0.001)
0.3	0.26 (0.06,0.5)	-0.2513 (-0.678,0.0855)	0.1575 (0.0732,0.258)	-0.1204 (-0.1786,-0.0239)	-6e-04 (-0.0234,0.0014)
0.4	0.32 (0.07,0.48)	-0.2081 (-0.5809,0.144)	0.1672 (0.0873,0.253)	-0.0611 (-0.1482,-0.0218)	-9e-04 (-0.0094,0.0011)
0.5	0.26 (0.08,0.44)	-0.1171 (-0.5145,0.175)	0.2024 (0.0944,0.2495)	-0.0531 (-0.1183,-0.0065)	-0.001 (-0.0047,9e-04)
0.6	0.27 (0.09,0.44)	-0.1269 (-0.5321,0.2364)	0.1777 (0.1019,0.2541)	-0.0522 (-0.1037,0.0094)	2e-04 (-0.0048,0.0014)
0.7	0.30 (0.1,0.43)	-0.0593 (-0.5453,0.4412)	0.2053 (0.1095,0.2609)	-0.0015 (-0.0911,0.0333)	-1e-04 (-0.0015,0.0084)

0.8	0.25 (0.05,0.4)	0.1652 (-0.5142,0.6106)	0.2220 (0.1243,0.2636)	-0.0093 (-0.0779,0.0571)	-5e-04 (-0.0017,0.01)
0.9	0.25 (0.04,0.45)	0.1855 (-0.4377,0.7212)	0.2233 (0.1313,0.2799)	0.0082 (-0.0693,0.0964)	-0.001 (-0.0021,0.0078)
θ	**Trade**	**Schooling**	**M2**	**Political Rights**	**Quality of Government**
0.1	-0.0185 (-0.0348,-0.0042)	0.6031 (-0.0205,1.2303)	0.0044 (-0.0077,0.0228)	-0.2035 (-0.6518,0.2271)	1.9174 (-1.3118,5.3769)
0.2	-0.0061 (-0.0239,0.0027)	0.2699 (-0.2789,0.7606)	0.0014 (-0.0082,0.0177)	-0.1158 (-0.3613,0.2116)	1.7172 (-1.0827,3.9967)
0.3	-0.0089 (-0.0232,0.003)	0.0903 (-0.2693,0.5104)	-0.0013 (-0.0096,0.0155)	-0.0613 (-0.2522,0.2129)	1.8835 (-0.0749,3.7555)
0.4	-0.0125 (-0.0218,0.0031)	-0.0476 (-0.3002,0.3994)	-0.0013 (-0.0104,0.0138)	0.0175 (-0.1936,0.2014)	1.0503 (-0.3155,3.5318)
0.5	-0.0088 (-0.0198,0.0032)	-0.0966 (-0.3268,0.3038)	-0.0030 (-0.0101,0.0125)	0.0505 (-0.136,0.1989)	0.9655 (-0.4767,3.2449)
0.6	-0.0070 (-0.0177,0.0035)	-0.1609 (-0.3723,0.2379)	-0.0034 (-0.0097,0.0117)	0.0540 (-0.1175,0.2113)	1.7371 (-0.4186,3.2924)
0.7	-0.0074 (-0.015,0.0043)	-0.2036 (-0.446,0.1679)	-0.0033 (-0.0121,0.0103)	0.0559 (-0.1524,0.2288)	-0.1042 (-0.9492,2.6264)
0.8	-0.0040 (-0.0113,0.0053)	-0.3813 (-0.5916,0.0948)	-0.0064 (-0.0155,0.0063)	0.0386 (-0.1605,0.2487)	-0.8677 (-2.8278,1.4094)
0.9	-0.0048 (-0.0124,0.0076)	-0.4484 (-0.8302,0.0171)	-0.0085 (-0.0198,0.006)	0.0471 (-0.2176,0.2956)	-2.0700 (-3.3545,-0.2212)

Note: 90 % confidence intervals are in parentheses.

Table 4. Panel QR Results with 90% Confidence Intervals (Exogeneity of FDI)

θ	**FDI**	**Log GDP**	**GDI**	**GCE**	**Inflation**
0.1	0.072 (-0.0033,0.1528)	-9.6121 (-15.717,-3.6915)	0.1299 (-6e-04,0.3114)	-0.2258 (-0.4155,0.1172)	-0.0019 (-1.8e+308,8e-04)
0.2	0.0756 (-0.0125,0.1409)	-7.8739 (-12.1007,-5.4678)	0.1235 (0.0417,0.184)	-0.1512 (-0.3292,-0.0045)	3e-04 (-1.1372,5e-04)
0.3	0.0895 (0.0451,0.1601)	-8.1355 (-11.0457,-5.4568)	0.1301 (0.0751,0.1894)	-0.1383 (-0.2245,-0.0656)	2e-04 (-0.1858,0.001)
0.4	0.0673 (0.0209,0.1295)	-7.7739 (-10.4958,-4.0575)	0.1601 (0.1195,0.2025)	-0.1347 (-0.2323,-0.0395)	1e-04 (-0.0331,8e-04)
0.5	0.0505 (-0.0076,0.097)	-5.9719 (-8.1869,-2.527)	0.1521 (0.118,0.192)	-0.1557 (-0.2547,-0.0276)	-2e-04 (-0.006,0.0012)
0.6	0.0653 (0.0099,0.0927)	-4.2954 (-6.596,-2.3386)	0.1562 (0.1382,0.1909)	-0.1155 (-0.2117,-0.0595)	-6e-04 (-6e-04,8e-04)
0.7	0.0303 (-0.0031,0.0771)	-4.9739 (-5.7099,-2.3889)	0.182 (0.1395,0.2197)	-0.0823 (-0.1729,0.0039)	-1e-04 (-7e-04,0.0275)
0.8	0.0106 (-0.017,0.0628)	-4.5151 (-8.6577,-3.4749)	0.1819 (0.1443,0.2327)	-0.032 (-0.1839,0.0755)	-1e-04 (-9e-04,0.7348)
0.9	0.0283 (-0.0326,0.1145)	-8.5244 (-12.1822,-2.4027)	0.1942 (0.1376,0.2757)	-0.0613 (-0.1427,0.1435)	-1e-04 (-5e-04,1.8e+308)
θ	**Trade**	**Schooling**	**M2**	**Political Rights**	**Quality of Government**
0.1	0.0148 (-0.0267,0.0267)	0.8886 (-1.723,3.3572)	-0.0398 (-0.0978,-0.0086)	0.0579 (-0.6378,0.3871)	5.8698 (0.3091,11.4366)
0.2	0.0066 (-0.0118,0.026)	-0.0472 (-1.2014,1.9003)	-0.0381 (-0.0556,-0.0156)	-0.0758 (-0.3646,0.1911)	4.2435 (1.3965,8.0535)
0.3	0.0091 (-0.0093,0.0262)	0.3453 (-0.3475,1.7483)	-0.031 (-0.0434,-0.0172)	0.042 (-0.1739,0.2875)	2.8588 (0.1448,5.6875)
0.4	0.0123 (-0.0055,0.0272)	0.6564 (-0.3495,1.6584)	-0.0245 (-0.0441,-0.0079)	0.2306 (-0.1088,0.3827)	2.8904 (-0.4395,4.9997)
0.5	0.0193 (-0.0115,0.0275)	0.682 (0.1082,1.4704)	-0.0206 (-0.0356,-0.012)	0.1492 (0.0436,0.3649)	0.8835 (-1.6639,3.8166)
0.6	0.0095 (-0.0031,0.0247)	0.9499 (0.269,1.6456)	-0.0291 (-0.0381,-0.0155)	0.251 (0.0236,0.3509)	0.0971 (-1.2019,2.4907)
0.7	0.008 (-0.0041,0.0203)	0.9253 (0.1743,1.6086)	-0.027 (-0.0402,-0.0175)	0.1871 (0.016,0.3334)	-0.1194 (-1.9678,0.8508)
0.8	0.0054 (-0.0078,0.0285)	0.9974 (0.1128,2.3732)	-0.026 (-0.0359,-0.0102)	0.1186 (-0.0498,0.3422)	-1.7689 (-4.1381,2.0106)
0.9	0.0172 (-0.0072,0.0252)	1.5751 (0.0941,2.0628)	-0.0186 (-0.0336,0.0084)	0.0804 (-0.2428,0.3121)	0.0886 (-3.5973,3.9956)

Note: 90 % confidence intervals are in parentheses.

Table 5. Panel IVQR Results with 90% Confidence Intervals (Endogeneity of FDI)

θ	**FDI**	**Log GDP**	**GDI**	**GCE**	**Inflation**
0.1	0.42(0.02,0.57)	-8.7032(-17.1506,-4.2764)	0.0746(-0.0139,0.2836)	-0.2154(-0.4243,0.0814)	-9e-04(-0.0823,0.001)
0.2	0.33(0.04,0.57)	-8.5102(-14.2248,-4.3893)	0.0708(0.014,0.2175)	-0.1783(-0.3257,0.0153)	3e-04(-0.0434,9e-04)
0.3	0.25(0.07,0.53)	-7.8666(-13.0471,-4.6574)	0.1125(0.0487,0.2079)	-0.1432(-0.2719,-0.0088)	2e-04(-0.0362,0.0012)
0.4	0.21(0,0.47)	-7.7903(-12.4685,-3.8209)	0.1407(0.0718,0.2139)	-0.1014(-0.2799,0.0064)	-1e-04(-0.0258,0.001)

0.5	0.17(-0.01,0.42)	-5.1213(-11.5943,-2.4051)	0.1411(0.0897,0.21)	-0.1032(-0.2656,0.0286)	-2e-04(-0.0167,9e-04)
0.6	0.16(0,0.35)	-4.655 (-10.4134,-1.8548)	0.1463(0.1017,0.203)	-0.1168(-0.2367,0.0418)	-6e-04(-0.0136,7e-04)
0.7	0.13(-0.03,0.33)	-4.7167(-9.9877,-1.991)	0.1736(0.1051,0.2113)	-0.0597(-0.2277,0.0754)	0(-0.0141,8e-04)
0.8	0.06(-0.08,0.33)	-4.3919(-12.0051,-2.6361)	0.1754(0.1069,0.2278)	-0.0478(-0.2363,0.1287)	-2e-04(-0.0154,6e-04)
0.9	0.17(-0.09,0.45)	-9.748 (-16.8614,-1.7367)	0.1844(0.0922,0.2504)	-0.0222(-0.2178,0.263)	1e-04(-0.0193,7e-04)
$\boldsymbol{\theta}$	**Trade**	**Schooling**	**M2**	**Political Rights**	**Quality of Government**
0.1	0.0035(-0.0284,0.0399)	-0.3292(-1.6932,2.8291)	-0.0643(-0.0897,-0.0092)	-0.3148(-0.9098,0.2898)	2.8449(-0.8631,10.1704)
0.2	-0.002(-0.016,0.028)	0.2213(-1.4204,2.1205)	-0.0383(-0.0703,-0.0081)	-0.2192(-0.4655,0.2357)	4.2667(0.2551,7.9382)
0.3	0.0029(-0.0141,0.0256)	0.2921(-0.8204,1.8645)	-0.031(-0.0569,-0.0099)	0.0531(-0.2463,0.2931)	3.5055(-0.3436,6.8667)
0.4	0.008(-0.0136,0.0268)	0.6731(-0.8472,1.7413)	-0.0231(-0.0511,-0.0045)	0.1638(-0.1403,0.3818)	2.3255(-1.3177,5.4759)
0.5	0.0073(-0.0106,0.0288)	0.3138(-0.9538,1.7748)	-0.0233(-0.0474,-0.0046)	0.2007(-0.1096,0.4042)	0.5527(-2.2394,4.4524)
0.6	0.0046(-0.0095,0.0267)	0.8524(-0.6093,1.8019)	-0.0289(-0.0448,-0.0102)	0.2088(-0.1071,0.3663)	0.5386(-2.8597,3.1699)
0.7	0.0058(-0.0106,0.0269)	1.0513(-0.4553,1.8725)	-0.0288(-0.044,-0.0097)	0.2016(-0.127,0.3377)	-0.6989(-2.5562,2.3918)
0.8	0.0047(-0.0128,0.0331)	0.8692(-0.1867,2.2082)	-0.0246(-0.0421,-0.006)	0.1185(-0.1864,0.34)	-1.7461(-3.4401,2.7653)
0.9	0.0047(-0.0203,0.0362)	1.5033(-0.2705,2.7705)	-0.0178(-0.038,0.003)	0.1187(-0.2924,0.3251)	0.229(-4.5091,4.426)

Note: 90 % confidence intervals are in parentheses.

4. Conclusion

Using a dataset of 60 developed and developing countries over the period 1991-2008 and a novel estimation method called panel IVQR, as proposed by Galvao (2011), we investigated the effect of FDI on economic growth at various quantiles. Our empirical findings are fairly consistent with those of Huo (2015), in that FDI can influence economic growth at low quantiles, indicating that FDI is important for countries facing a period of low economic growth relative to other countries. In addition, a comparison of panel IVQR and other quantile estimation results show that both endogeneity and omitted-variable bias are likely to affect the estimation results, and that it is important that these two problems be addressed. Finally, we also found that the degree of corruption in government can be important, like the degree of FDI, for countries facing a period of lower growth rate relative to other countries.

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Appendix: List of 60 Countries

Australia; Bahrain; Bangladesh; Bolivia; Botswana; Brazil; Canada; Chile; China; Congo, Rep.; Costa Rica; Cote d'Ivoire; Cyprus; Denmark; Ecuador; Egypt, Arab Rep.; El Salvador; Finland; Gabon; Ghana; Guatemala; Honduras; Iceland; India; Indonesia; Israel; Italy; Japan; Jordan; Kenya; Korea, Rep.; Malaysia; Malta; Mexico; Morocco; New Zealand; Nicaragua; Pakistan; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Saudi Arabia; Senegal; Sierra Leone; Singapore; South Africa; Sri Lanka; Sudan; Sweden; Switzerland; Syrian Arab Republic; Thailand; Tunisia; Turkey; United Kingdom; United States; Uruguay; Venezuela, RB.

해외직접투자의 영향에 대한 재고찰

Lijuan Huo, 김태환, 김윤미

논문초록:

해외직접투자를 연구하는 문헌에 따르면 해외직접투자는 투자를 유치하는 국가의 경제성장에 도움이 된다는 것이 알려져 있다. 이러한 영향을 연구하는 대부분의 기존 논문들과는 달리, 본고는 분위수회귀를 이용한다. 특히, 누락변수편의, 해외직접투자의 내생성, 국가간 이질성이라는 세가지 문제들을 동시에 해결하기 위해, 최근 개발된 패널자료를 이용한 도구변수 분위수회귀 분석방법을 사용한다. 실증분석 결과에 따르면, 해외직접투자는 경제성장률이 상대적으로 낮은 저개발국가의 경제성장에 유의미한 도움을 준다.

핵심주제어: 해외직접투자, 분위수회귀분석, 패널데이터, 내생성, 도구변수

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