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Measuring threshold effects in non-dynamic panels: the impact of terms of trade on FDI inflows under different regimes of institutional quality

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Scope of the work I

- relationship between the Foreign Direct Investment (FDI) inflows and the terms of trade (TOT);
- assumption is that the impact of terms of trade is strongly conditioned by the level of institutional quality that the countries experience;
- corruption and weak property rights tend to rise the cost to install new investment;

Scope of the work II

- as a consequence, foreign investors decide not to invest in domestic (developing) economy even though it faces an "opportunity" given by the uprising trend in the terms of trade that they experienced from the beginning of the 2000's;
- The empirical methodology estimates the thresholds (meaning those levels of the institutional quality from which the impact of terms of trade on FDI tend to change) and the coefficients of the regression equation as well

Structure

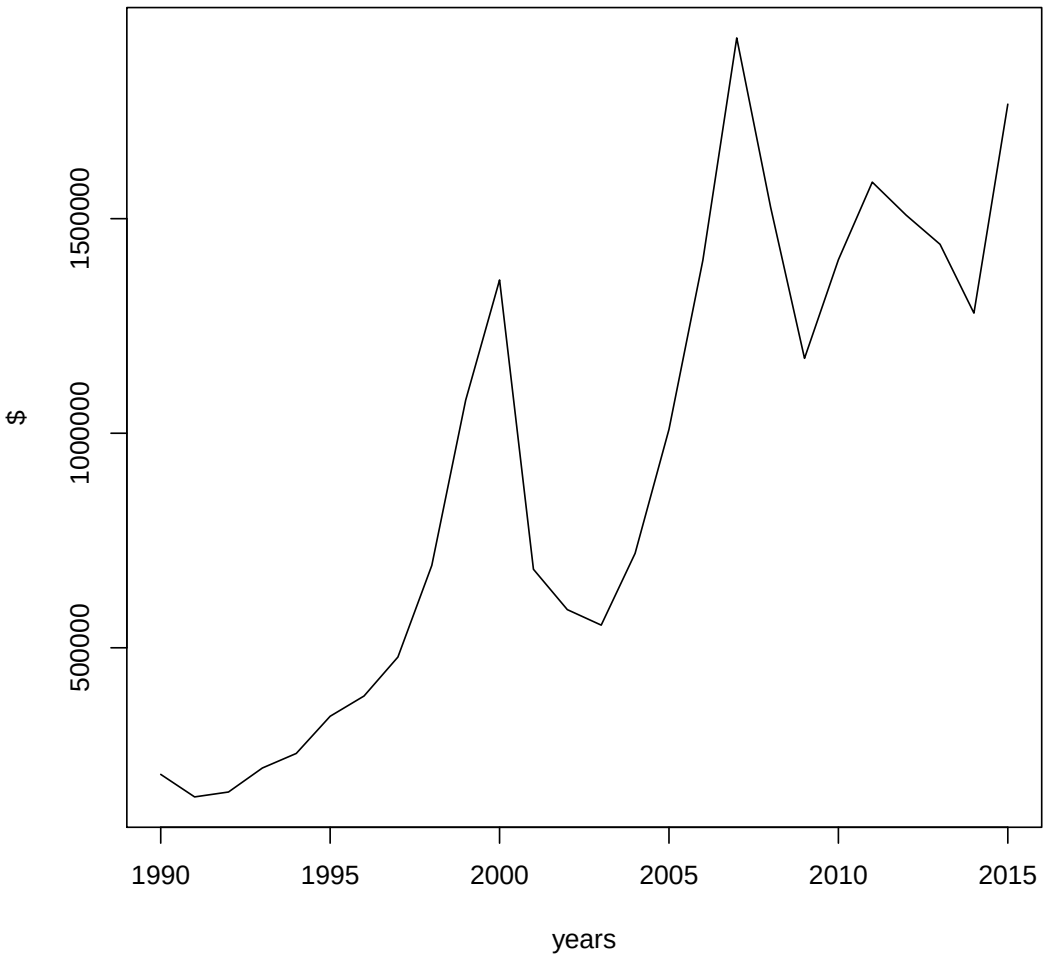
1. Stylized facts, motivation;
2. Theoretical background;
3. Statistical methodology;
4. Results;
5. Concluding remarks;

Financial Openness: developed vs. developing countries

- The financial openness that begins in the decade of the 80s has spread at a global scale in the nineties.
- However, the speed of growth has been substantially different between developed and developing countries. Nowadays, the worldwide flow of foreign direct investment (FDI) is 8 times higher than in the beginning of the decade of the 90s for the developed countries.

Global FDI inflows

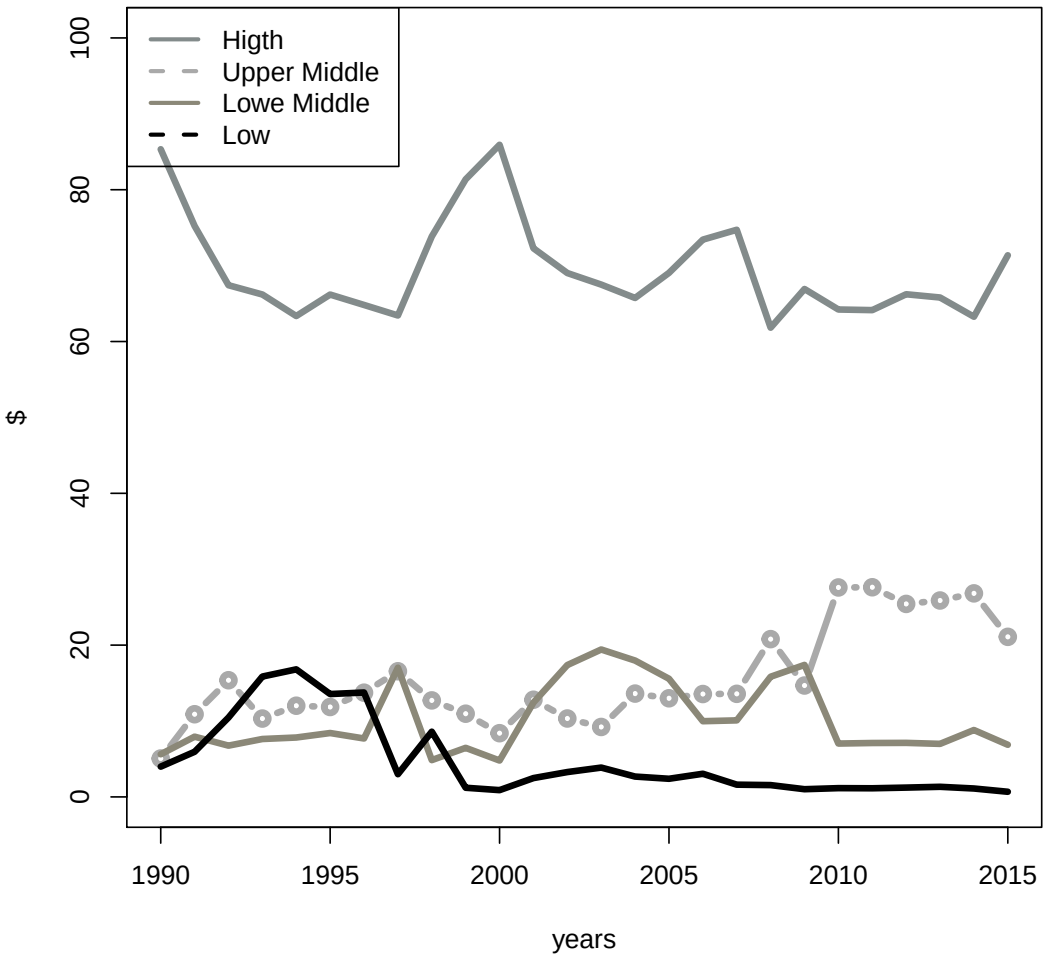
Figure 1. IED Millons of current dollars 1990−2015



Source: Own elaboration based on UNCTAD data for 181 countries.

FDI:Developed vs. Developing countries

Figure 2. Average IED by income levels

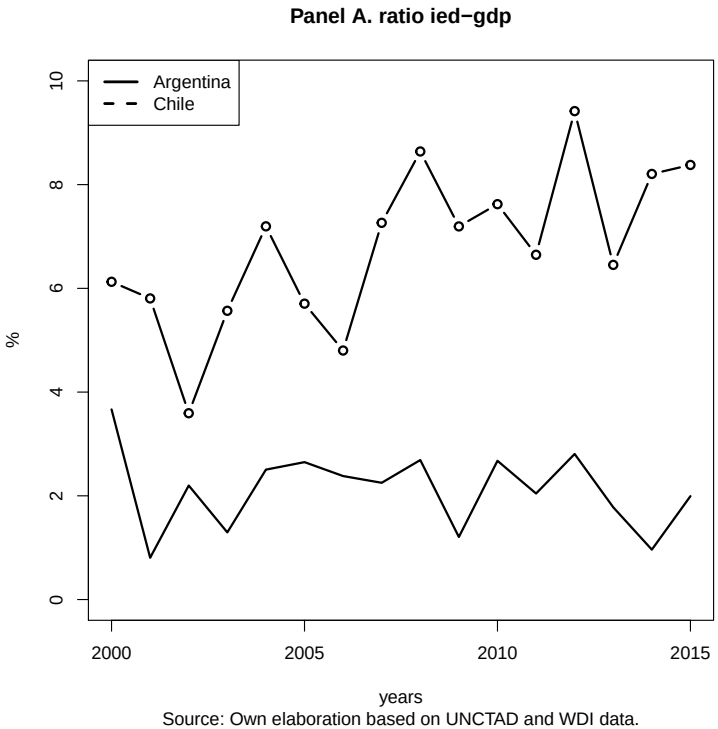


Source: Own elaboration based on UNCTAD data for 181 countries.

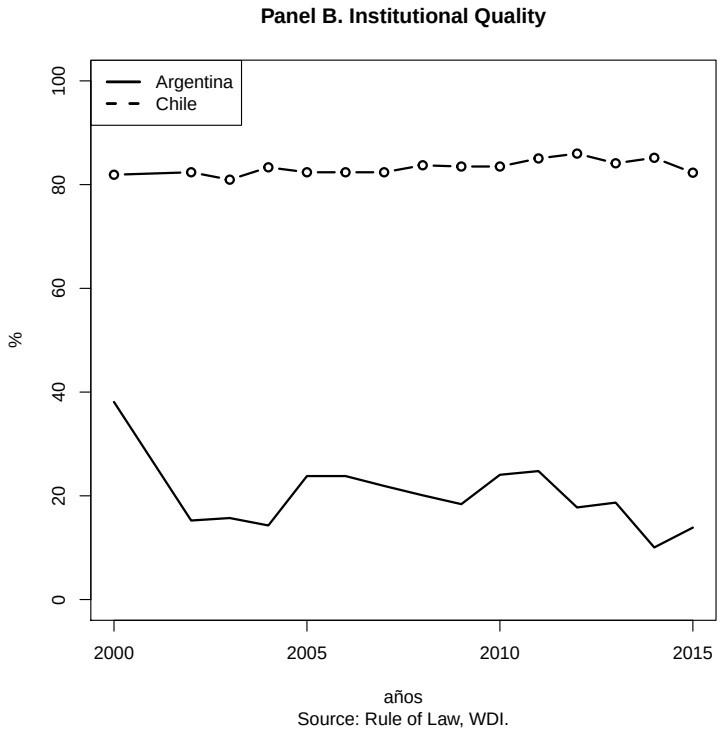
Increasing gap

- These differences in the reception of the FDI across countries with different income levels tend to reinforce the existing gap between the levels of per-capita income between developed and developing countries
- In this paper we tackle the problem of the lack of external financing of developing countries that tend to interrupt their process of convergence towards a higher level of income.

Hypothesis 1: The variable that explains the behavior of the FDI is the institutional quality. I

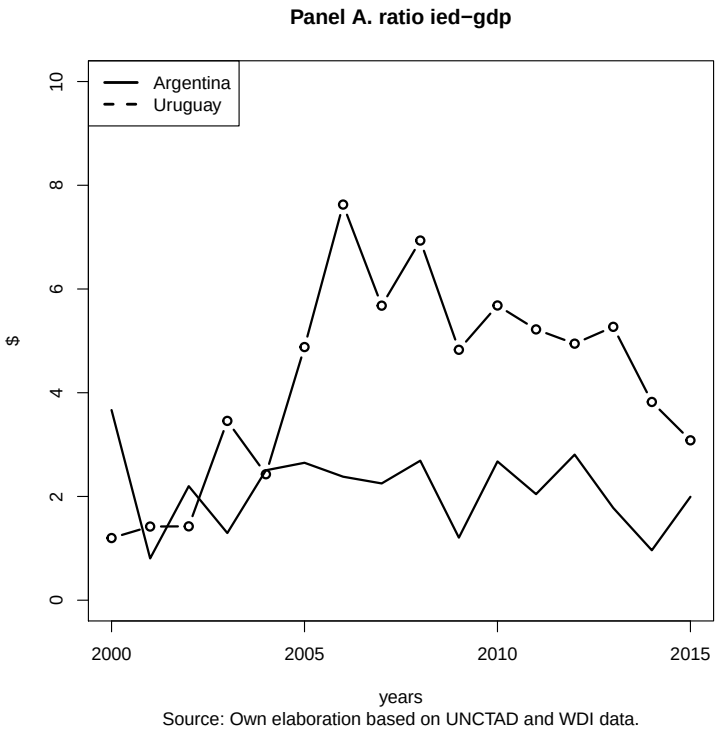


Source: Own elaboration based on UNCTAD and WDI data.

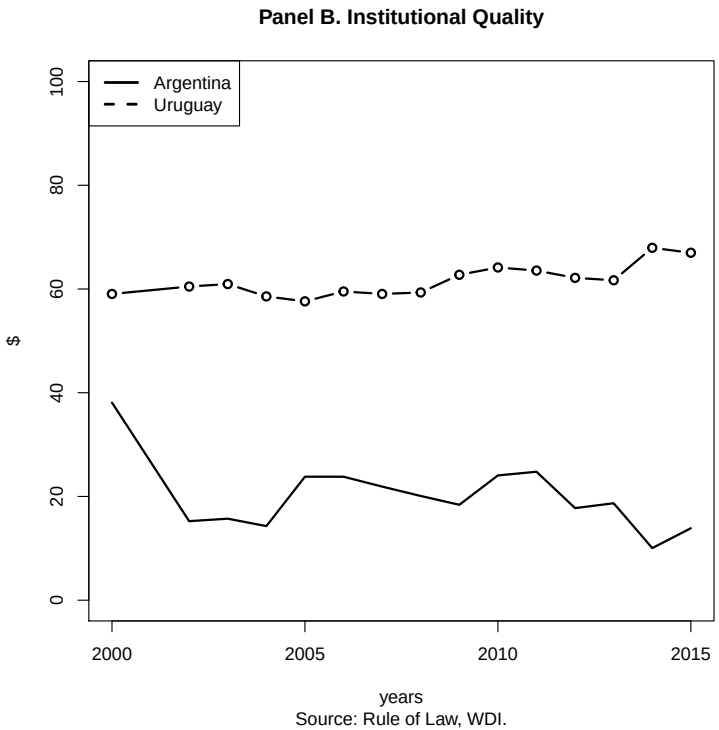


Source: Rule of Law, WDI.

Hypothesis 1: The variable that explains the behavior of the FDI is the institutional quality. II

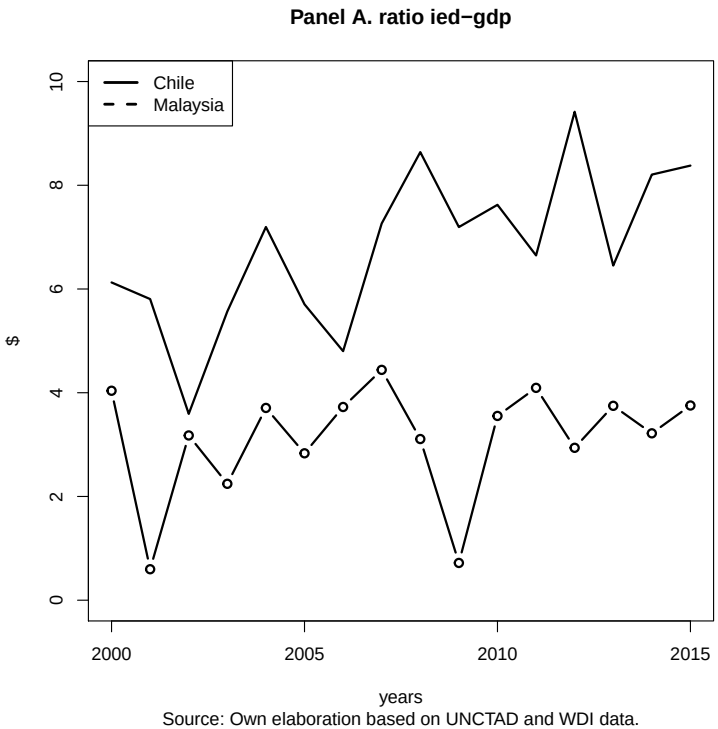


Source: Own elaboration based on UNCTAD and WDI data.

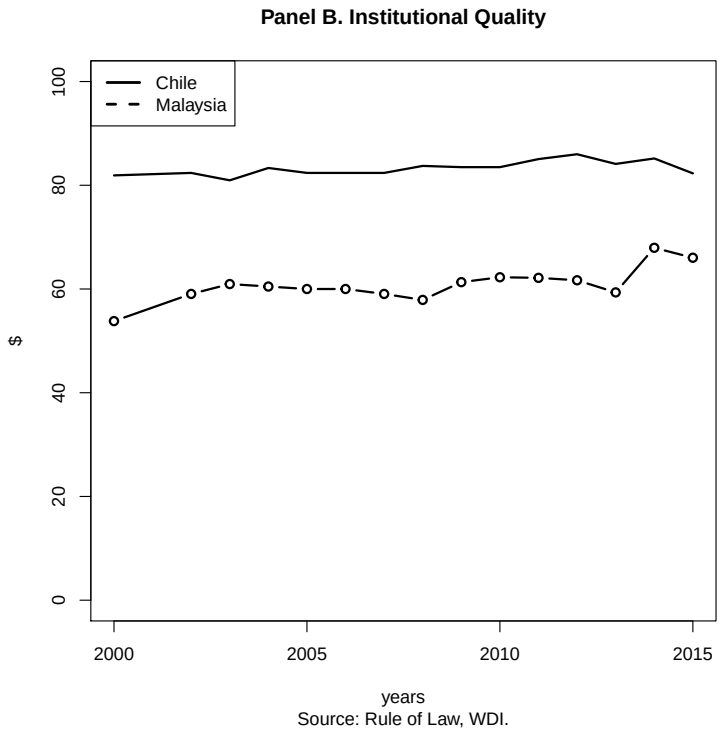


Source: Rule of Law, WDI.

Hypothesis 1: The variable that explains the behavior of the FDI is the institutional quality. III



Source: Own elaboration based on UNCTAD and WDI data.



Source: Rule of Law, WDI.

Hypothesis 2: The impact of terms-of-trade shocks depend on the level of institutional quality I

- The second hypothesis of this work is related to the behaviour of the terms of trade. The vast majority of the emerging economies experienced a boom in the price of the commodities they produce in the first decade of the 21st century;

Hypothesis 2: The impact of terms-of-trade shocks depend on the level of institutional quality II

- the data indicates that the capital tends to flow to developed countries, giving rise to the Lucas's Paradox. The theoretical explanation offered here is that only the countries that present high quality institutionally can take advantage of this "opportunities";

Lucas Paradox, Alfaro I

- Lucas (1990): The differences in the production per worker between both countries is explained by the different levels of capital per worker that each economy employs. He point out three failures: differences in human capital, externalities of human capital, political risk.
- Alfaro et al. (2005): a) Differences in fundamentals (TPF, Institutions), and b) imperfections in capital markets;

Gertler and Rogoff, Agènor and Aizenman I

- Barone and Descalzi (2011), Barone and Descalzi (2012) based on the intertemporal model, and assuming asymmetric information (as proposed by Gertler and Rogoff, 1990) study the effects of permanent disturbances to terms of trade on the endogenous risk premium.
- Agènor and Aizenman develop a model with asymmetric response of the current account to terms-of-trade shocks;

FDI, Terms of trade shocks and IQ: First attempts I

- Barone and Descalzi (2013) studies the relationship between the FDI inflows and the terms of trade by distinguishing the group of more developed countries (based on the IMF classification) from the group of less developed ones.
- In Barone et al. (2017) the long-term relationship between FDI inflows and the terms of change is addressed by considering

FDI, Terms of trade shocks and IQ: First attempts II

the level of institutional quality across different countries.

FDI, Terms of trade shocks and IQ: First attempts III

- It is found that the countries with low institutional quality suffer from a penalty; when the terms of exchange improve, they can no take advantage of all the benefits (meaning lower their risk premium and greater FDI inflows). The countries with the highest institutional quality experience a greater FDI inflows.

FDI, Terms of trade shocks and IQ: First attempts IV

- Walsh and Yu (2010): weak institutions (corruption) add cost to the investment and reduce the benefits; in addition, the political uncertainty (difficulty in exercising property rights) add uncertainty to FDI.

The model I

$$y_{i,t} = \beta' x_{i,t}(\gamma) + \mu_i + \varepsilon_{i,t} \quad (1)$$

- $y_{i,t}$ μ_i and $\varepsilon_{i,t}$ are 1X1 random varaibles;
- μ_i is a time invariant effect;
- β' is a a 1Xk vector of coefficients than tend to capture the differential impact of the independent variable $x_{i,t}$ on $y_{i,t}$;
- $x_{i,t}(\gamma)$ is a kx1 vector depending on the thresholds;

The model II

If there is only one threshold, say γ. Thus, $K = 2$ and

$$\beta = (\beta_1 \ \beta_2)' = \begin{pmatrix} \beta_1 \\ \beta_2 \end{pmatrix} \tag{2}$$

while the vector of independent variables equal to:

$$x_{i,t}(\gamma) = \begin{pmatrix} x_{i,t} I(q_{i,t} \leqslant \gamma) \\ x_{i,t} I(q_{i,t} > \gamma) \end{pmatrix} \tag{3}$$

The model III

- $q_{i,t}$ is a 1x1 scalar that represent the "threshold variable" and γ is the threshold.

In a compact form:

$$y_{i,t} = (\beta_1 \ \beta_2) \begin{pmatrix} x_{i,t} I(q_{i,t} \leqslant \gamma) \\ x_{i,t} I(q_{i,t} > \gamma) \end{pmatrix} + \mu_i + \varepsilon_{i,t} \quad (4)$$

- Explanatory variables, $x_{i,t} = tot_{i,t}$;
- Dependent variable, $y_{i,t} = fdi_{i,t}$;
- The impact *tot* on *fdi* inflows depend on q;

The model IV

The framework can be extended to consider additional regressors in the regression equation:

$$y_{i,t} = (\beta_1 \ \beta_2 \ \theta) \begin{pmatrix} x_{i,t} I(q_{i,t} \leqslant \gamma) \\ x_{i,t} I(q_{i,t} > \gamma) \\ z_{i,t} \end{pmatrix} + \mu_i + \varepsilon_{i,t}$$

Where

$$z_{i,t} = \begin{pmatrix} rd_{i,t} \\ gdp_{i,t} \\ ac_{i,t} \\ \pi_{i,t} \end{pmatrix}$$

The model V

- $rd_{i,t}$ the rate of dependency, $gdp_{i,t}$ the Gross Domestic Product, $ac_{i,t}$ the trade openness, and $\pi_{i,t}$ the rate of inflation;
- N=113 (developed and underdeveloped countries) for 2000-2015;

The model VI

In the case of two thresholds (γ_1 and γ_2) the model could be extended as follows:

$$y_{i,t} = (\beta_1\ \beta_2\ \beta_3\ \theta) \begin{pmatrix} x_{i,t} I(q_{i,t} \leqslant \gamma_1) \\ x_{i,t} I(\gamma_1 < q_{i,t} \leqslant \gamma_2) \\ x_{i,t} I(\gamma_2 < q_{i,t}) \\ z_{i,t} \end{pmatrix} + \mu_i + \varepsilon_{i,t}$$

The analysis can be extended to compute a greater number of thresholds.

Estimation procedure

i the time invariant effect is removed by applying fixed effect transformation (the average values are subtracted from the original system);

ii Ordinary least squares is applied to obtain $\hat{\beta}(\hat{\gamma})$;

iii $\hat{\gamma} = \underset{\gamma}{\mathbf{min}} S_1(\gamma)$. $S_1(\gamma)$ is the sum of squared errors that depends on γ

Inference: testing for a threshold I

i The likelihood ratio test of H_0 is based on $F_1 = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma}}$;

ii Treat the regresors and threshold variable as given, holding their values fixed in repeated bootstrap samples;

iii Take the regression residuals (obtained by adjusting the model under the alternative hypothesis $H_1 : \beta_1 \neq \beta_2$ grouping them by individuals, and treat the sample $\{e_1^*, e_2^*, ..., e_n^*\}$ as the empirical distribution to be used for bootstrapping;

iv draw (with replacement) a simple of size n from the empirical distribution and use these errors to create a bootstrap sample under $H_0 : \beta_1 = \beta_2$ given by $\hat{y}_{it}^* = \hat{\beta}_1' x_{it}^* + e_{it}^*$ (* indicates fixed-effects transformation);

v Use the bootstrap sample, estimate the model under the null and the alternative hypothesis;

Inference: testing for a threshold II

vi Compute the bootstrap value of the likelihood ratio statistic F_1;

vii Repeat this procedure a large number of times an calculate de percentage of draws for which the simulated statistics exceeds the actual. This is the bootstrap estimate of the asymptotic p-value for F_1 under H_0. The null of no threshold effect is rejected if the p-value is smaller than the desired critical value.

viii Asymptotic distribution of threshold estimate: the threshold estimator is consistent, and its asymptotic distribution is highly non-standard;

ix Asymptotic distribution of slope coefficients T:he inference on β can proceed as if the threshold estimate $\hat{\gamma}$ were the true value.

Test for threshold effects

Table 1

Likelihood Ratio (LR) Tests for threshold effects

Test for single threshold (H_0: No threshold)	
F_1	61.60
P-value	0.0067
(10%, 5%, 1% critical values)	(31.1623, 38.3010, 56.2927)
Test for double threshold (H_0: one threshold)	
F_2	39.60
P-value	0.0700
(10%, 5%, 1% critical values)	(31.4251, 45.1039, 69.0910)
Test for triple threshold (H_0: two threshold)	
F_3	13.28
P-value	0.6833
(10%, 5%, 1% critical values)	(53.9367, 65.4345, 100.7954)

Source: Own calculations.

The model is estimated by least squares, allowing for (sequentially) Zero, one, two and three thresholds. The table shows the corresponding F_1, F_2 and F_3. 300 replications were used for each of the bootstrap tests.

Estimated coefficients

Table 2

Regression estimates (β): triple threshold model

Coefficient[1]	SE	t-stat	P>|t|
$\hat{\theta}_1$= 4.12138	9.988207	0.41	0.680
$\hat{\theta}_2$=12.02998	2.729704	4.41	0.000
$\hat{\theta}_3$=4.736985	2.701167	1.75	0.080
$\hat{\theta}_4$=0.081439	0.0484867	1.68	0.093
$\hat{\beta}_1$=--4.27453	1.80051	-2.37	0.018
$\hat{\beta}_2$=17.17243	3.752802	4.58	0.000
$\hat{\beta}_3$ =40.2041	4.63922	8.67	0.000
$cons$=-104.3576	26.46088	-3.94	0.000

Source: Own calculations.

1. $\hat{\theta}_1$, $\hat{\theta}_2$, $\hat{\theta}_3$ and $\hat{\theta}_4$ are the estimated coefficients for rd, gdp, ac and π, respectively; $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$ are the estimated coefficients for the iq variable that is lower than the corresponding threshold.

Terms of trade shocks: IQ matters

- Following Hansen (1999), we apply a threshold regression on a non-dynamic panel with individual-specific fixed effects.
- The method consists of estimating an OLS regression to calculate the thresholds (i. e. the levels of institutional quality from which a change in the response of foreign direct investment to the terms of trade is expected) and the slopes of equations.
- This method, based on a fixed-effects transformation requires a non-standard asymptotic theory to compute confidence intervals and test hypothesis.
- The results indicate that two thresholds are identified and that the institutional quality is a key variable to explain the lack of growth in developing countries.