**Conditioned Export-Led Growth Hypothesis:**

**A Panel Threshold Regressions Approach**

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**Abstract**

This paper deals with a reassessment of the export-led growth hypothesis in a panel threshold regressions context, which allows testing for the existence of other variables conditioning the effects on the export-growth nexus. The resulting estimation covers a broad sample of 72 countries for the period 1974-2003. Overall, the empirical results give support to the export-led growth hypothesis, where the estimated thresholds indicate that growth was conditioned by countries’ initial output and human capital levels. The effects of exports on growth, although exhibiting diminishing returns, were found to have great relevance in accelerating the income convergence process across countries.

**Keywords:** Export-led growth; Panel threshold regression;

**Resumo**

O presente artigo discute uma reavaliação da hipótese de crescimento econômico orientado para exportação. Estima-se um modelo de regressões em painel com valores limites (threshold), o qual permite que se testem outras variáveis condicionantes da relação entre exportação e crescimento. A estimação é procedida com base em uma ampla amostra, com 72 países no period 1974-2003. De modo geral, os resultados empíricos confirmam a hipótese de crescimento econômico orientado para exportação, sendo que os valores limites (thresholds) estimados indicam que o crescimento foi condicionado pelo produto inicial e pelo nível de capital humano inicial dos países da amostra, Os efeitos das exportações sobre crescimento, embora indiquem a ocorrência de retornos decrescentes, foram estimados como tendo um impacto de grande relevância na aceleração do processo de convergência de renda entre países.

**Palavras-chave:** Crescimento orientado para exportação; regressões em painel com threshold;

Classificação JEL: O40; C23

Área da ANPEC: Crescimento, desenvolvimento econômico e instituições

**I. Introduction**

The export-led growth (ELG) hypothesis stands that those countries following an outward-orientation strategy tend to obtain superior growth performances. Edwards (1991) argues that the main channel linking trade and growth can be traced back to an original contribution by Lewis (1955), which basically relates an increase in trade with a higher capacity for a developing nation to absorb technological innovations.

The empirical literature has given emphasis to the high correlation between economic growth and trade liberalization, especially in cross-country studies (for a survey on empirical works, see Giles and Williams, 2000). In a more recent work, Foster (2006) proposes the use of threshold regression techniques to examine whether any relationship between exports and growth may depend upon a third conditioning variable. Focusing on a comprehensive sample of African countries, the presence of thresholds is found to be determined by the initial level of GDP per capita, the share of exports in GDP, and export growth. . The threshold approach also allows for the conclusion that the effect of exports on GDP growth is larger in those countries with relatively lower initial levels of income, lower levels of exports to GDP, and higher export growth rates.

Therefore, the objective of this paper is thus to extend the Foster (2006) model to account for a larger sample and for different threshold alternatives. Specifically, the aim of this study is to assess the conditioned export-led growth hypothesis, using panel threshold regression techniques and assuming three different threshold variables: the initial level of GDP per worker, the human capital per capita level, and the export share in GDP. The sample comprises 72 countries and data ranges from 1974 to 2003. Additionally, special attention is given to the construction of human capital measures using an alternative specification that accounts for educational quality differentials between countries.

The paper is organized as follows: Section II briefly discusses the econometric methodology, results are in Section III, and we present some concluding remarks in Section IV.

**II. Panel Data Approach to Economic Growth**

Islam (1995), in one of the first attempts to use panel data econometrics to assess economic growth, argues that – given differences in the production function across countries – rates of economic growth vary over countries as a result of differences in capital intensity, technology and institutional infrastructure. However, a panel data approach also has some drawbacks; particularly, the assumption of parameter homogeneity over cross-section units. The threshold regressions approach, as shown below, is an alternative which alleviates such a pitfall.

*Panel Threshold Regressions Model*

Threshold regression models allow individual observations to be divided into regimes based on the value of an observed variable. First introduced into a univariate time series context (Tong, 1983), the appropriate econometric techniques for threshold regressions with panel data were presented/ first given/ originated/ initially outlined/ initially used/ first proposed/ discovered, etc by Hansen (1999). Allowing for fixed individual effects, the panel threshold regressions (PTR) model divides observations into two or more regimes, depending on whether a threshold variable is smaller or larger than a threshold value. These regimes are then distinguished by producing different regression slopes.

The PTR approach can be summarized into three steps. First, the threshold value estimate is obtained by a grid search selection over its possible values, choosing that which minimizes the sum of squared errors (SSE) from least squares (LS) estimates of the model structural equation. Second, inference about the statistical significance of the threshold effect is made by using a bootstrapping procedure to simulate the asymptotic distribution of a likelihood ratio test for the null hypothesis that the parameters estimated for the different regimes are equal. Finally, to check for the consistency of the estimated threshold value, confidence intervals are constructed using a likelihood ratio statistic. The extension for the multiple thresholds case follows the same general approach applied in a sequential estimation procedure. Further details can be found in Hansen (1999).

*Empirical Specification*

The general empirical specification to be estimated can be expressed as in equation (1). In the form of a PTR specification, the regime-dependent coefficient is the one related to the ELG hypothesis. Notice that this general specification reduces to the linear case when the threshold is always smaller or larger than the threshold value.

 (1)

where  is the growth rate of output per worker,  is a measure of the initial level of output per worker,  is a measure of physical capital input constraints,  is a measure of labor input constraints,  is a measure of human capital per capita,  is a measure of exports,  is the indicator function,  is one of the possible threshold variables,  is the threshold value,  and  are country and time specific effects,  is the error term assumed to be independent and identically distributed (iid) with mean zero and finite variance , and the subscripts *i* and *t* refer to country and period, respectively.

**III. Empirical Results**

The gross data comes mainly from the Penn World Tables v.6.2 (HESTON et. al., 2006) and refers to the constant prices entries in the period 1974-2003 for 72 countries[[2]](#footnote-2). Following Wössmann (2003), we have constructed two distinct measures of human capital stock, both based on the Mincerian human capital theory with decreasing returns to education. These two measures were constructed using the number of average schooling years by educational level, adjusted by education quality, and obtained from the Barro and Lee (2000) Dataset and the General Index of Qualitative Indicators of Human Capital (QIHC-G) recently built by Altinok and Murseli (2007).

In order to choose the best proxy measures for each of the theoretical explanatory variables of equation (1), we carried out a proxy-variable search procedure (see Galimberti, 2009), which produced the following results (with expected signs in brackets): the log of the real GDP per worker in the previous year (-); the log of investment share in output (+); the labor force growth (-); the stock of human capital per capita in the previous period[[3]](#footnote-3) (+); and the product between exports to GDP ratio and exports growth (+).

*Panel Linear Specification Results*

As a benchmark for the panel threshold regressions (PTR) results, we first estimate the panel linear case. The results in Table 1 are divided into two samples, where the second sample includes only those countries where the QIHC-G variable is available.

Notice that all coefficient estimates are statistically significant and in accordance with their expected signs. The results based on a simple analysis of variance (ANOVA) for the estimated equation show that the exports variable has the highest share in terms of explanatory power. Beyond this, the quality-adjusted human capital measure presented a higher covariance with growth than the non-adjusted measure. Finally, when the educational quality differentials are taken into account, the physical capital estimated effects on growth are lower and the effects of the labor force constraint become more pronounced.

**Table 1. Panel Linear Specification Results.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables and Tests | First Sample | ANOVA(1) | Second Sample | ANOVA(1) |
| Initial Output per worker - ln(yi,t-1) | -0.0452  (-5.96)\*\*\* | 2.82% | -0.0484  (-4.82)\*\*\* | 2.98% |
| Investment rate - ln(Ii,t) | 0.0246  (3.80)\*\*\* | 16.31% | 0.0176  (3.67)\*\*\* | 10.59% |
| Labor force growth - ni,t | -0.5357  (-1.97)\*\* | 4.38% | -0.7474  (-2.82)\*\*\* | 7.18% |
| Mincerian Human Capital - | 0.0047  (1.94)\*\* | 2.19% | --- | --- |
| Quality-adjusted Human Capital - | --- | --- | 0.0100  (2.96)\*\*\* | 5.63% |
| Exports - | 0.5985  (6.89)\*\*\* | 20.78% | 0.4942  (6.15)\*\*\* | 19.47% |
| Cross-section Effects Test(2) | Fixed | 6.46% | Fixed | 6.57% |
| Period Effects Test(2) | None | --- | None | --- |
| Observations (N x T) | 72 x 6 | --- | 57 x 6 | --- |
| R-squared | 0.5294 | --- | 0.5242 | --- |
| F-statistic | 5.25\*\*\* | --- | 5.06\*\*\* | --- |
| Akaike information criterion | -4.8307 | --- | -5.0112 | --- |

Notes: - t-statistics are reported in brackets. All estimates use White Heteroscedasticity consistent standard errors and covariance.

- \*, \*\*, and \*\*\* indicate unilateral statistical significance at 10, 5, and 1 percent levels, respectively.

(1) Shares relative to the sum of squared deviations of the dependent variable.

(2) The cross-section and period effects specification were tested using a Likelihood Ratio test to detect redundant fixed effects.

*Panel Threshold Specification Results*

The PTR specification (1) to the ELG hypothesis is estimated considering three possible thresholds: the initial level of output per worker, the human capital measures, and the ratio of exports to GDP. Since the econometric procedure searches for one to three multiple thresholds, a maximum of four regimes can be reached. The first step of the estimation procedure is to test for the existence of threshold effects. This test follows Hansen (1999) and the F statistic is obtained through bootstrapping techniques. The results are presented in Table 2, where significant threshold effects are found only for the initial output per worker and the Mincerian human capital. The estimated threshold values and the respective coefficients for the exports variable over the different regimes[[4]](#footnote-4) are presented in Table 3.

**Table 2. Tests for threshold effects.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Threshold Variable | Sample | Single Threshold | | Double Threshold | | Triple Threshold | |
| F1 | p-value(1) | F2 | p-value(1) | F3 | p-value(1) |
| Initial Output per worker - ln(yi,t-1) | **1st** | **18.54** | **0.0250** | **13.99** | **0.0520** | 12.69 | 0.1830 |
| 2nd | 5.79 | 0.5390 | 10.96 | 0.0950 | 2.63 | 0.9060 |
| Mincerian Human Capital - | **1st** | **28.36** | **0.0040** | 2.18 | 0.9910 | 1.68 | 0.9950 |
| Quality-adjusted Human Capital - | 2nd | 8.12 | 0.3830 | 7.32 | 0.3500 | 5.09 | 0.5210 |
| Exports share on GDP - X/Y | 1st | 9.13 | 0.2180 | 6.79 | 0.3390 | 3.53 | 0.7690 |
| 2nd | 5.51 | 0.5750 | 3.70 | 0.7580 | 6.83 | 0.2630 |

Notes: The specifications where threshold effects are found to be significant are in bold.

(1) p-values obtained by 1000 bootstrap replications.

The first significant threshold variable, initial output per worker, divided the sample into three regimes, where the border values (and their related percentiles over the sample) are: US$ 3,320 (15th) and US$ 5,086 (20th). Notice that the first threshold value is very close to the World Bank (2008) classification for the upper limit of lower middle income countries (US$ 3,855). Such evidence gives support to the fact that the relationship between exports and growth is stable for the countries in the category of low income and lower-middle income countries. However, it also implies that the impact of exports on growth changes for countries in the middle and high income classifications. In fact, the estimated coefficient for exports in this transitional regime[[5]](#footnote-5) indicates a stronger effect of exports on growth of about 4 times the effect for the other regimes.

In the case of the second significant threshold variable – the human capital measure – the sample was divided into two regimes, where the switching regime value is 1.72 (20th percentile). The estimated coefficient for exports indicates that countries with low human capital levels[[6]](#footnote-6) have stronger effects of exports on growth (about 3 times greater than countries with high human capital levels). This result may seem contradictory to the idea that ELG would benefit from human capital through gains in technological absorption efficiency. However, the results show that the ratios of exports to GDP are significantly lower for the first regime: 21% versus 31% for the second regime. Therefore, although no statistically significant threshold was found for the exports share measure, the result for the human capital threshold can be related to diminishing returns to exporting.

Finally, an interesting picture derived from these results is presented in Appendix A. If we denote ELG regimes as those where exports have a stronger effect on growth, we are able to see that the occurrence of ELG evidence not only decreases over time but also does not relate to mean growth rate by period.

**Table 3. Threshold and Exports slope coefficient estimates over the regimes.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Threshold  Variable | Thresholds | | | | Regimes | Exports Coefficient  Estimates | t-stat (1) | Obs. | ANOVA(2) |
| No | Estimate | Percentile | 95% Conf. Interval |
| Initial Output  per worker | 1 | 8.1075 | 15th | [7.9345, 8.2437] | *xi,t* *I*{ln(*yi,t-1*)} ≤ 8.1075 | 0.5738 | 2.7373 | 67 | 2.22% |
| *xi,t I*{8.1075 < ln(*yi,t-1*) ≤ 8.5343} | 2.2203 | 4.3666 | 23 | 9.30% |
| 2 | 8.5343 | 20th | [8.5343, 8.7814] |
| *xi,t I*{8.5343 < ln(*yi,t-1*)} | 0.5186 | 6.9796 | 342 | 13.83% |
| Mincerian  Human Capital | 1 | 1.7265 | 20th | [1.4993, 1.7355] | *xi,t I*{*Hi,t-1* ≤ 1.7265} | 1.4972 | 4.8914 | 88 | 7.52% |
| *xi,t I*{1.7265 < *Hi,t-1*} | 0.4932 | 6.3536 | 344 | 14.64% |

Notes: (1) t-statistics are calculated using White Heteroscedasticity consistent standard errors and covariance. All the coefficient estimates are statistically significant at the 1 percent level.

(2) See Footnote 2 of Table 1. The explanatory power for the other explanatory variables remained approximately the same as in the linear specification estimates.

**IV. Conclusions**

This paper provides new evidence on the export-led growth hypothesis based on recently built panel threshold estimation techniques. Based on a comprehensive sample of 72 countries in the period 1974-2003, we found that the relationship between exports and growth is conditioned by countries’ initial levels of output and human capital. Stronger positive effects of exports on growth were found for countries in a transitional regime between the low and high income countries. Such results indicate the relevance of outward-directed production to accelerate income convergence among countries. This conclusion was also corroborated by the result that the export effect on growth decreases over time

A strong ELG regime was also found for countries with lower human capital levels. That result can be reasoned based on the high correlation between human capital and share of exports to GDP and therefore, linked to the hypothesis of diminishing returns to exporting. Finally, it is worth noticing that in respect to the role of educational quality differentials, we found evidence in favor of the superiority of the quality-adjusted measure of human capital stock against the measure adjusted for returns on education.

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**Appendix A - Distribution of estimated ELG regimes throughout the periods.**



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2. A detailed description of the data construction and sample can be found at an extended version of this paper available at: http://ideas.repec.org/p/pra/mprapa/13417.html. [↑](#footnote-ref-2)
3. Notice that this result relates to the endogenous growth model specification of the human capital and the best adjustment obtained based on its delayed measure indicates the presence of endogeneity. [↑](#footnote-ref-3)
4. The other variable coefficients were omitted in these results as they do not change significantly from the linear specification. [↑](#footnote-ref-4)
5. This transitional regime includes the following countries (period): Cameroon (1974-83), China (1994-98), Republic of Congo (1974-83; 1994-98), India (1984-98), Indonesia (1974-78), Pakistan (1974-88), Senegal (1984-93), Sierra Leone (1974-78; 1984-93), Sri Lanka (1974-83), Syria (1974-78), and Thailand (1974-83). [↑](#footnote-ref-5)
6. This regime with a stronger effect of exports on growth included the following countries (period): Benin (1974-03), Brazil (1979-83), Cameroon (1974-93), China (1974-78), Republic of Congo (1974-88), Egypt (1974-88), El Salvador (1974-83), Guatemala (1974-93), Honduras (1974-88), India (1974-83), Kenya (1974-83), Malawi (1974-88; 1994-04), Mali (1974-04), Nepal (1974-04), Nicaragua (1974-78), Pakistan (1974-93), Portugal (1974-83), Rwanda (1974-04), Senegal (1974-04), Sierra Leone (1974-04), Syria (1974-83), Tanzania (1979-88; 1994-04), Tunisia (1974-88), Turkey (1974-83) and Zimbabwe (1974-93). [↑](#footnote-ref-6)