

Income Inequality and the Economic Development : Threshold Regressions

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1. Introduction

The Kuznets hypothesis that assert that there is an inverted U shape relationship between income distribution and the level of economic growth measured by per capita income has been tested in many ways. In most of the cases, a function, which can take either U -shape or inverted U -shape depending on the value of parameters, was estimated to find out which relationship prevails. For example, equations (1) and (2) are popularly used.

$$INEQ = a_0 + a_1Y + a_2(1/Y) + e \quad (1)$$

$$INEQ = b_0 + b_1\ln Y + b_2(\ln Y)^2 + e \quad (2)$$

where $INEQ$ is the income inequality and Y is the per capita income. These equations are estimated using either cross-section data, or time-series data or panel data. This procedure is unnecessarily restrictive in that the functional form is assumed. For the Kuznets hypothesis, all we need to test is if there is a positive relationship between the income inequality and per capita income at early stage of economic development or when per cap-

ita income is low and the relationship reverse to positive as economy develops or not. For this purpose we employ threshold regression to find out if there is a threshold where the relationship is reversed or not. Savvides and Stengos (2000) applied a threshold regression (TR) model and identified a threshold in the sample. Then they applied the TR model but they tested equation (1) and (2). As a result what they found is that there were different relationships between income inequality and per capita income in two groups of countries separated by the threshold income level. However, more straight interpretation of the Kuznets hypothesis is to see if there exists a threshold where the relationship between the income inequality and level of economic development turns from positive to negative. Hence we apply TR model and test a linear relationship between the income inequality and per capita income.

2. The Threshold Regression (TR) Model and Data

Following Hansen (1996, 2000), we specify the TR model as follows,

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$$\begin{aligned} y_i &= \theta' x_i + e_i & q_i &\leq \gamma \\ y_i &= \theta' x_i + e_i & q_i &> \gamma \end{aligned} \quad (3)$$

where q_i is a threshold variable.

Different from previous work, we selected a simple linear model as specification of the TR model.

$$GINI_{it} = c_0 + c_1 INC_{it} + e_{it} \quad (4)$$

Where $GINI_{it}$ is the Gini ratio of country i at time period t , and INC_{it} is the per capita income. The threshold variable is the per capita income, INC_{it} .

First of all, we tested the null hypothesis, $H_0 : \theta_1 = \theta_2$ using F test statistics and their bootstrapped P-values. The results from this test are summarized in Table1.

We use the Gini ratio from Deininger and Squire (1996) data for inequality of income distribution and GDP per capita in PPP\$ from PWT5.6 with 1985 as the benchmark year¹⁾ for the level of economic development. The samples are pooled data of cross section and time series of 562 observations.

3. Empirical Findings

Since our objective is to find out if there exist a point where the relationship between the per capita income level and degree of income inequality change, simple linear model given by equation (4) is more appropriate than models (1) and (2).

Firstly, we tested the null hypothesis of $H_0 : \theta_1 = \theta_2$. The value of Lagrange Multiplier test for no threshold is 44.54. Based on 1000 bootstrap replications, the null hypothesis is rejected with P value 0 clearly indicating the existence of threshold effect. The point estimate of the threshold is PPP\$2899 of the per capita income and the 95% confidence interval is from PPP\$2800 to PPP\$4396. This is much different from the threshold of about PPP\$2100 Savvides and Stengos (2000) found and from the turning point of about PPP\$2300 when equations (1) and (2) are directly applied. (See columns (1) and (2)). The relationship between the per capita income

level and degree of income inequality does change from positive to negative at the turning point supporting the Kuznets hypothesis. Economies of the income level near the threshold of PPP\$2899 include such countries as Brazil in 1972, Colombia in 1980, Hungary in 1972, Korea in 1978, Taiwan in 1973, etc.

We then took the samples with the per capita income above PPP\$2899 and examined if another threshold existed. We found another threshold at PPP\$7335 with P value 0. The 95% confidence interval is from PPP\$4319 to PPP\$13474. At the second turning point, the relationship becomes weakly positive. It is negative for the income level between PPP\$2899 and PPP\$7335 and then turns positive above PPP\$7335.

The result indicates that at the early stage of economic development, the income inequality increases as the per capita income rises. As per capita income rises above PPP\$2899, the inequality level declines. So, Up to this point, the result supports the Kuznets hypothesis. However, inequality start to increase again as income rises above PPP\$7335. This last part of relationship that is positive is beyond original Kuznets hypothesis. Since this positive relationship is obtained for relatively developed economies, we applied the TR model for the samples of the group of industrial countries of Deininger and Squire (1996). The results are given in Table 2. Columns (1) and (2) gives the result of equations (1) and (2) for reference. All three results show that there is a U-shaped relationship, not an inverted U-shape. All the results indicate that the income inequality increases as the per capita income rises above certain level for the industrialized countries.

This last section of positive relationship has been discussed in recent literature such as Atkinson (1997) and Aghion et. al. (1999).

Savvides and Stengos (2000) did test linear relationship below and above the threshold and reported, contrary to our results, that no relationship conforming to the inverted-U pattern was found. Eusufzai (1997) applied the Quandt log-likelihood test to the Anand and

Table 1. Estimation Results with all Sample

<i>GINI</i>	(1)	(2)	(3)	(4)	(5)	(6)
			<i>INC</i> < 2899	2899 < <i>INC</i>	<i>INC</i> < 7335	7335 < <i>INC</i>
constant (<i>t</i> -value)	-148.614 (-5.274)	45.303 -39.006	30.963 -21.569	42.028 -40.284	46.028 -18.2	30.112 12.596
$\ln INC$ (<i>t</i> -value)	48.89 -7					
$(\ln INC)^2$ (<i>t</i> -value)	-3.147 (-7.361)					
<i>INC</i> (<i>t</i> -value)		-0.00097 (-8.844)	0.00629 -7.009	-0.000735 (-6.838)	-0.0013 (-2.523)	0.00023 -1.133
1/ <i>INC</i> (<i>t</i> -value)		5413.919 (-4.233)				
sample	562	562	189	373	144	229
R ²	0.149	0.1345	0.203	0.114	0.022	0.0148
Bootstrap P-value			0		0	
Confidence interval (95%)			2800~4396		4319~13474	
Critical value	2360	2364	2899		7335	

Table 2. Results for Industrial Countries

<i>GINI</i>	(1)	(2)	(3)	(4)
			<i>INC</i> < 8645	8645 < <i>INC</i>
Constant (<i>t</i> -value)	997.056 (8.556)	11.357 (3.964)	59.825 (2.978)	27.756 (15.832)
$\ln INC$ (<i>t</i> -value)	-210.573 (-8.160)			
$(\ln INC)^2$ (<i>t</i> -value)	11.478 (8.039)			
<i>INC</i> (<i>t</i> -value)		0.00105 (6.224)	-0.00395 (-9.104)	0.000378 (2.664)
1/ <i>INC</i> (<i>t</i> -value)		95251 (8.577)		
sample	221	221	40	181
R ²	0.261	0.256	0.548	0.046
Bootstrap P-value			0	
Confidence interval			6457~8648	
Critical value	9634	9529	8645	

Kanbur (1993) cross section data set and found a break-point between \$696 and \$773 of per capita GNP in 1973 US dollars. Then he found that the relationship changed from positive to negative as the Kuznets hypothesis asserted. Our results reinforce his findings.

4. Conclusion

In this paper, we applied TR model to the relationship between the per capita income and the Gini ratio using pooling data of cross section and time series. We found a threshold at PPP\$2899 where the relationship between the per capita income level and degree of income inequality changed from positive to negative supporting the Kuznets hypothesis. We also found another threshold at PPP\$7335 where the relationship changed from negative to positive.

NOTES

- 1) We also tried with the GDP per capita from PWT6.1 that used 1996 as the benchmark year. The results were very similar to those reported in the text except that the threshold values were slightly higher.

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付記

この論文は、筆者が小口登良先生と進めていた共同研究の成果の一部である。Journal of Political Economyをはじめ内外の一流ジャーナルに多くの業績を持ち、日本における第一級の経済学研究者として活躍してこられた小口先生との共同研究は筆者にとって大きな誇りであったが、中間発表としてこの論文を海外のジャーナルに投稿し一層完成度の高い研究に仕上げたいこうと相談している矢先に小口先生は病に伏せられた。筆者は、小口先生の回復を確信し、共同研究の再開を心待ちにしていたが、薬石効なく不帰の客となられた。小口先生から受けた多大なる学恩に深く感謝するとともに、心からの哀悼の意を込めて、本論文を寄稿するものである。

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