Trade as a Threshold Variable for Multiple Regimes: Reply

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Abstract. In response to Huang and Chang's (2004) comment and in light of a major methodological advancement in threshold estimation, this note re-examines Papageorgiou's (2002) finding that trade can be a threshold variable. By employing the data-sorting method developed by Caner and Hansen (2004) that corrects for potential regressor endogeneity, it is shown that the hypothesis continues to find support.

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In Papageorgiou (*Economics Letters*, September 2002) I have used the endogenous splitting methodology due to Hansen (2000) to examine whether trade is a threshold variable splitting countries in multiple regimes. As pointed out by Huang and Chang's (2004) comment there was an error in one of the results reported in Papageorgiou (2002). In particular, in the third round of splitting of threshold estimation the p-values obtained from the three alternative threshold models should be 0.142 (not 0.033) for trade share, 0.16 (not 0.121) for literacy rate, and 0.537 (not 0.105) for initial income [par.3, p.87]. The error was due to a typo in one line in the GAUSS code and I am grateful to the authors for pointing this out. The corrected p-value on trade shares renders my original claim, that trade is a threshold for middle-income countries, weaker.

In response to Huang and Chang's comment and in light of a major methodological advancement in threshold estimation, in this note I re-examine my original hypothesis. In particular, I repeat the exercise presented in Papageorgiou (2000) by using the alternative methodology proposed by Caner and Hansen (2000) extends Hansen (2000) to incorporate regressor endogeneity – a problem that plaques growth regressions – in endogenous threshold estimation.

In what follows is a brief, non-technical, outline of the Caner-Hansen method.[1] The structural equation of interest can be written as

$$y_i = \theta_1' z_i 1(q_i \leq \gamma) + \theta_2' z_i 1(q_i > \gamma) + e_i, \tag{1}$$

where, for each i, y_i is the dependent variable, z_i is an m-vector of explanatory variables, q_i is the threshold variable assumed to be strictly exogenous, γ is the threshold parameter, θ_1 and θ_2 are m-vectors of slope parameters that may differ depending on the value of q_i, and e_i is a

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[1] For more details on the theoretical foundation of this methodology see Caner and Hansen (2004). The GAUSS programs used in this exercise are modifications of those publically available at Bruce Hansen's website http://www.ssc.wisc.edu/~bhansen/progs/ivtar.html.

Table 1: Four Regimes Obtained by Caner-Hansen's Threshold Regression Estimation

Regime 1:	$y_{i,1960} \leq \$879$	(19 countries)
Regime 2:	$\$1794 \leq y_{i,1960} < \$879$; $TS_{i,1985} \leq 30.99$	(8 countries)
Regime 3:	$\$1794 \leq y_{i,1960} > \$879$; $TS_{i,1985} > 30.99$	(21 countries)
Regime 4:	$y_{i,1960} > \$1794$	(48 countries)

Notes: y denotes per capita income and TS denotes trade shares.

random disturbance term. The vector of explanatory variables is partitioned into a m_1 dimensional subset, z_{1i}, of exogenous variables uncorrelated with e_i, and a m_2 dimensional subset of endogenous variables, z_{2i}, correlated with e_i. $1(q_i \leq \gamma)$ is an indicator variable that is one if $q_i \leq \gamma$ and zero otherwise. In addition, to structural equation (1) the model requires a suitable set of $k \geq m$ instrumental variables, x_i, that includes z_{1i}.

To apply the Caner-Hansen methodology to our growth exercise we need first to decide on endogenous and exogenous variables. Second, we need to identify a set of valid instruments. We assume that the subset of exogenous variables, z_{1i}, includes only initial income ($y_{i,1960}$), whereas the subset of endogenous variables, z_{2i}, includes investment in physical capital (s_{ik}), investment in human capital (s_{ih}) and population growth ($n_i + g + \delta$). We employ a set of five instruments initially used in Johnson and Papageorgiou (2005). Three of our instruments are from Bloom, Canning, and Sevilla (2003) and two are from the Center for International Earth Science Information Network's (CIESIN) National Aggregates of Geospatial Data: Population, Landscape and Climate Estimates (PLACE) dataset.[2] The country-sample (96 countries) and data (real GDP, working-age population, average share of real investment, secondary-school enrolment rates, adult literacy rates and trade shares) are as in Papageorgiou (2002).

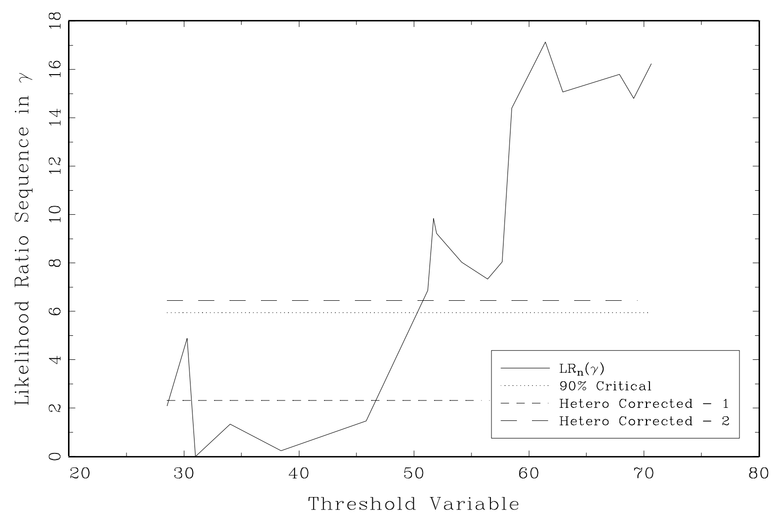
Table 1 presents the regimes obtained from this exercise. The interesting result here is that although threshold variables and threshold values may differ from Hansen (2000) in the first two rounds of splitting, in the third round trade shares continue to split the subsample of 29 middle income countries into two regimes very similar to those obtained in Papageorgiou (2000).[3] Figure 1 presents the normalized likelihood ratio sequence $LR_n^*(\gamma)$ statistic as a function of the trade shares. The least-squares estimate γ is the value that minimizes the function $LR_n^*(\gamma)$ which occurs at $\hat{\gamma} = 30.99\%$. The three horizontal lines represent three alternative asymptotic 90% critical values; dotted line = uncorrected, short-dashed line = heteroskedastic correction by quadratic, long-dashed line = heteroskedastic correction by nonparametric kernel.

A caveat of this methodology is that theory for deriving p-values for thresholds variables has not been yet developed, and our reported thresholds depend solely on whether or not the likelihood

[2] For details on these instruments see Johnson and Papageorgiou (2005).

[3] Another result that is fully explored in Johnson and Papageorgiou (2005) is that the country regimes obtained are almost identical to those in Hansen (2000) suggesting that results were not driven from the regressor exogeneity assumption.

Figure 1: Threshold Variable and Confidence Intervals



function obtains a minimum. This may not be as desirable as the p-values reported in Hansen (2000) and further work should certainly focus on filling this gap. Albeit this caveat though, results indicate that trade as a threshold variable continues to be an intriguing possibility that deserves our attention as new data and advancements in econometric theory of threshold estimation become available.

References

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