International Journal of Marketing and Technology
(ISSN: 2249-1058)

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Title

THRESHOLD EFFECTS IN THE RELATIONSHIP BETWEEN OIL REVENUES AND GROWTH IN OIL EXPORTING COUNTRIES

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Abstract:

While there is much evidence to support the resource curse hypothesis for resource abundant countries, some studies have found that oil booms raise the economic growth of oil exporting countries. This paper examines the issue of the existence of the threshold effects in the relationship between oil revenues and output growth in oil-exporting countries, applying panel regressions. The empirical results strongly suggest the existence of a threshold beyond which oil revenues growth exerts a negative effect on output. The results indicate that the threshold of growth rate of oil revenues above which oil revenues significantly slows growth is around 18-19 percent for oil exporting countries. In contrast, linear estimation without any allowance for threshold effects would misleadingly have us believe that an increase in the oil revenues increase the growth rate. Failure to account for nonlinearities conceal the resource curse in these countries particularly during extreme oil booms as suggested in previous studies.

Field of research: oil exporting countries; oil revenues; threshold level

1. Introduction:

A large literature suggests that there is a 'resource curse': natural resource abundant countries tend to grow slower than resource scarce countries(Gelb, 1988; Sachs and Warner, 1995, 1997, 2001; Karl, 1997; Gylfason et al., 1999; Auty, 2001; Sala-i-Martin and Subramanian, 2003). The literature offers six candidate explanations for the resource curse effect: Dutch disease, governance, conflict, excessive borrowing, inequality and volatility. However, while there is much evidence to support the curse hypothesis, the findings for oil-rich countries suggest that oil booms raise the growth of oil exporters. Spatafora and Warner(1995) investigate the impact on economic growth and development of long-run movements in the external terms of trade, with special reference to the experience of 18 oil-exporting countries. The results imply that Dutch disease effects are strikingly absent. Agriculture and manufacturing do not contract in reaction to an oil price increase. Similarly, Yang and Lam (2007) examines the relationship between oil prices and economic activities for 17 oil-rich developing countries based on cointegration analysis. Their results indicate that in the majority of cases, oil booms are followed by increases in both GDP per capita and investment. The economic development of the majority of sample countries, regardless of institutional quality, does not appear to be negatively affected by an oil boom, leaving the relation of oil revenues (or prices) with the other macroeconomic variables such as the economic growth debatable. Berument and Ceylan(2007) examine the effects of oil price shocks on a number of selected MENA economies using a structural vector autoregressive model. Their results also indicate that the effects of oil price on GDP of most oil producing countries are positive. So, the issues that whether oil resources are a curse or a blessing for economic growth in oil exporting countries warrant more attention both theoretically and empirically.

We explain this inconsistency by applying a (nonlinear) threshold model in which negative effects of oil revenues on growth may well only begin to kick in after some threshold has been breached. In this regard, recently macroeconomists have adopted an econometric technique simply by looking at the inflexion point or threshold in a nonlinear relationship so that the impact of oil revenues growth on economic growth could be positive up to a certain threshold level and beyond this level the effect turns to be negative. In other words, at this structural breakpoint the sign of the relationship between the two variables would switch. If so, harmful effects of oil revenues are not universal, but appear only over the "threshold" level of oil revenues. This approach can reconcile the conflict results in the literature, supporting both the view of the resource curse and blessing, that is, low revenues growth is helpful(a blessing) for economic growth but undue oil revenues, for example during a generous oil boom, is detrimental for the sustainability of such growth.

Intuitively, in an oil-dependent economy, the exogenous increase in export revenue will release foreign exchange constraints, stimulating economic activities from both supply and demand sides. But, what is often less well understood is that this goes hand-in-hand with the real appreciation and a contraction in tradable sectors including non-oil exports, so that the natural resource blessing could become a curse. This is often taken as the main symptom of the Dutch disease (Devlin and Lewin, 2004). The revenue streams from ''black gold'' can finance productive physical and social investment so that the effect of oil revenues could be positive until a certain level. But after this level the effect turns to be negative, fueling unsustainable consumption booms and eventual fiscal crises. During the oil busts, with the low (or negative) growth rate of oil revenues, the oil-dependent economies suffer from under-capacity with their access to capital and intermediate imports restricted, particularly in the presence of capital market imperfections (Hausmann and Rigobon, 2003). So, more oil revenues can be a blessing during the busts or moderate booms. But when oil revenues are excessively high, the real exchange rate becomes highly overvalued. So, too much oil revenues exert a negative effect on growth, turning to be a curse. Moreover, rapid growth in public spending, which often follows extreme oil price increases, reduces spending quality and introduces entitlements, including recurrent cost commitments, which are often not sustainable in the long run. Efficiency often suffers from a high proportion of unfinished projects as well as from capital investments that cannot be effectively used because of shortages of recurrent resources. So, it seems that superfluous oil booms may have strong deterrent effects on output, while slight or moderate booms contribute to economic growth.

The main objective of this study is to empirically explore the relationship between oil revenues and economic growth and estimate the threshold level of oil revenues growth for oil exporting developing countries by means of applying a panel framework allowing us to capture both inter-country and inter-temporal variation. In other words, this paper explores an interesting policy issue of how far the oil revenues are non-detrimental for the economic growth of oil exporting countries.

The remainder of this paper is organized as follows: Section 2 discusses the methodology and data used to obtain the empirical findings reported in this paper. Section 3 provides empirical results. Finally, section 4 presents a summary of the main conclusions.

2. Methodology and Data:

In this section we investigate the nonlinear effects of oil revenue changes on economic activities for 13 oil-exporting countries (Algeria, Colombia, Ecuador, Indonesia, Iran, Kuwait, Libya, Mexico, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela) using five-year-averaged data over the period 1965–2005. Following the work of Levine and Renelt (1992), which searched for a set of robust variables to model growth and the theoretical contributions to the new growth theory literature following Romer (1990), a degree of convergence on the most appropriate empirical specification for modeling growth, has occurred[1]. Most models include as explanatory variables: investment, population growth, and initial per capita GDP. We include these, together with oil revenues.

To model the non-linearity of the oil revenues-growth relationship and the estimation of threshold of oil revenues this paper uses a spline technique, allowing the relationship to have a kink turning point. The equation to estimate the threshold of oil revenues growth has been considered in the following form[2]:

$$\Delta \ln y_{it} = \alpha_i + \alpha_t + \beta_1 \Delta \ln oilrev_{it} + \beta_2 D_{it}(\Delta \ln oilrev_{it} - k) + \delta X_{it} + \Delta \varepsilon_{it}$$

$$D_{it} = \begin{cases} 1 \;\; if \quad \Delta oilrev_{it} > k \\ 0 \;\; if \quad \Delta oilrev_{it} \le k \end{cases}$$

where y_{it} is the non oil real GDP (based on constant local currency), α_i is a fixed effect, α_t is a time effect, $oilrev_{it}$ is oil revenues in real terms (taking the ratio of nominal oil revenues in US dollars to the US Producer Price Index), k is the threshold level of the growth rate of oil revenues, D_{it} is a dummy variable that takes a value of one for oil revenues growth rates greater than k percent and zero otherwise, X_{it} is a vector of control variables which includes investment as a share of GDP (igdp), population growth ($\Delta \ln pop$), the log of initial income level measured as the five-year average of real non oil GDP per capita $(\ln GDPC_0)$. The index "i" is the cross-sectional index while "t" is the time-series index. The data are obtained from World Development Indicators (WDI) and OPEC Bulletins.

The coefficient of the dummy variable (β_2) measures the incremental effect of oil revenues growth on the economic growth when it is greater than the assumed structural break level (i.e. oil revenues growth is high) and the opposite for the coefficient of β_1. In other words, the coefficient of β_2 indicates the difference in the oil revenues effect on growth between the two sides of the structural break. In the above threshold model, the sum of the two coefficients (

1. For a review of evidence, see Temple (1999).
2. Obviously, oil revenues-growth regressions must include other plausible determinants of growth. The variables are chosen based on empirical literature, theories of economic growth, and diagnostic tests.

$\beta_1 + \beta_2$) represents the economic growth rate when the growth rate of oil revenues are higher than k percent (the structural break point).

In order to smooth out business cycle fluctuations and focus on medium- and long-term relationship between oil revenues and growth, equation (1) has been estimated on the five-year average of the panel of 13 countries and 40 annual observations each. The initial income variable GDPC is computed as the five-year average of real income per capita for the previous five-year period, allowing the identification of the coefficient associated with $(\ln GDPC_{i0})$ under fixed effects.

By estimating regressions for different values of k which is chosen in an ascending order (i.e., 0.01, 0.02 and so on), the optimal value k is obtained by finding the value that maximizes the R^2 from the respective regressions. This also implies that the optimal threshold level is that which minimizes the residual sum of squares (RSS). Moreover, it is important to determine whether the threshold effect is statistically significant. In equation (1), to test for no threshold effects amount simply to testing the null hypothesis $H_0 : \beta_2 = 0$. Under the null hypothesis, the threshold k is not identified, so classical tests, such as the t-test, have nonstandard distributions. Hansen (1996, 1999) suggests a bootstrap method to simulate the asymptotic distribution of the following likelihood ratio test of H_o:

$$LR_0 = (RSS_0 - RSS_1)/\hat{\sigma}^2$$

where RSS_0, and RSS_1 are the residual sum of squares under $H_0 : \beta_2 = 0$, and $H_1 : \beta_2 \neq 0$, respectively; and $\hat{\sigma}^2$ is the residual variance under H_1. In other words, RSS_0 and RSS_1 are the residual sum of squares for equation (1) without and with threshold effects, respectively. The asymptotic distribution of LR_0 is nonstandard and strictly dominates the χ^2 distribution. The distribution of LR_0 depends in general on the moments of the sample; thus critical values cannot be tabulated. Hansen (1999) shows how to bootstrap the distribution of LR_0 in the context of a panel.

3. **Empirical Results:**

Table 1 provides the estimation results of equation (1), for the linear specification (without threshold effect) and the nonlinear one (with threshold effect). To take the significant heteroskedasticity in the panel into account, equation (1) has been estimated using Generalized Least Squares (GLS). Fixed effects and time dummies have been included (but not reported) to control for cross-country heterogeneity and time effects.

The first step to explore the relation between the growth rate of oil revenues and economic growth is to test for the existence of a threshold effect in the relationship between real GDP growth and oil revenues using the likelihood ratio, LR_0, discussed above. This implies estimating equation (1) and computing the residual sum of squares (RSS) or R^2 for different threshold levels of oil revenues growth (k). The optimal threshold level is the one that makes RSS minimum or makes R^2 maximum. Figure 1 gives an idea about the goodness-of-fit for different structural breaks. It shows the value of R^2 is maximized when the oil revenues growth structural point is 18%.The row LR_0 in Table 1 gives the observed value of the likelihood ratio. The significance levels have been computed using the bootstrap distributions of LR_0[3]. The null hypothesis of no threshold effects can be rejected at least at the 1 percent significance, strongly supporting the existence of threshold effects.

The column 1 in Table 1 provides the estimation results of equation (1), conditional on the threshold estimate. Recall that the existence of a threshold effect cannot be inferred simply from the significance level of the coefficient on the interactive term $D(\Delta \ln oilrev - k)$ as the distribution of the t-statistic for this variable is highly nonstandard under the null hypothesis of no threshold effect. This is why the null hypothesis has been tested using the bootstrap distribution of the likelihood ratio LR_0. However, the distribution of the t-values of all explanatory variables retains their usual distribution under the alternative hypothesis of a threshold effect. While oil revenues growth below its threshold level has a small positive effect on growth, oil revenues growth above the threshold level has a significant negative effect on growth. When the oil revenues growth is below the 18% threshold level, 10% percent increase in the growth rate of oil

1. For a more detailed discussion on the computation of the bootstrap distribution of *LRo,* see Hansen (1999).

revenues leads to an increase by 1.3% in the non-oil GDP growth. On the other hand, the effect of oil revenues growth when it is greater than %18 is negative and significant: 10% percent increase in the oil revenues growth leads to a decrease by -2.1% in the non-oil GDP growth. The sum of the two coefficients (-0.08) means the annual growth rate of real GDP declines by -0. 8% when the growth rate of oil revenues jumps over the structural breakpoint.

When the equation is re-estimated without the threshold effects(the column 2 in Table 1), panel results for the linear model (misleadingly) indicate that the coefficient of oil revenues growth is positive and statistically significant at 10 percent, contrary to the resource curse effect. Indeed a 10% increase in oil revenues growth would increase economic growth by 1.5%, a relatively strong positive impact when compared to the spline function results for a growth rate of oil revenues above the threshold 18%. This suggests that not taking structural breaks into account will conceal the detrimental effects of oil revenues during extreme oil booms.

All of the (control) independent variables have the predicted sign. As expected, investment ratio has a positive and significant impact on economic growth. On average, an increase in the investment-GDP ratio of 10 percentage points will boost real GDP growth by 1.3 percentage points for non-linear specification and 1.6 percentage points for linear specification. In the empirical growth literature, the log of the initial GDP per capita has been generally included in growth regressions to test conditional convergence. Conditional convergence holds if the coefficient on $\ln GDPC_0$ is negative. The results for both specifications indicate that the negative convergence effect is confirmed at various levels of significance so that a low initial GDP is associated with faster growth in output. Faster population growth is associated with faster output growth (and possibly with slower output per capita).

Figure1: Goodness of Fit for Different Structural Breaks

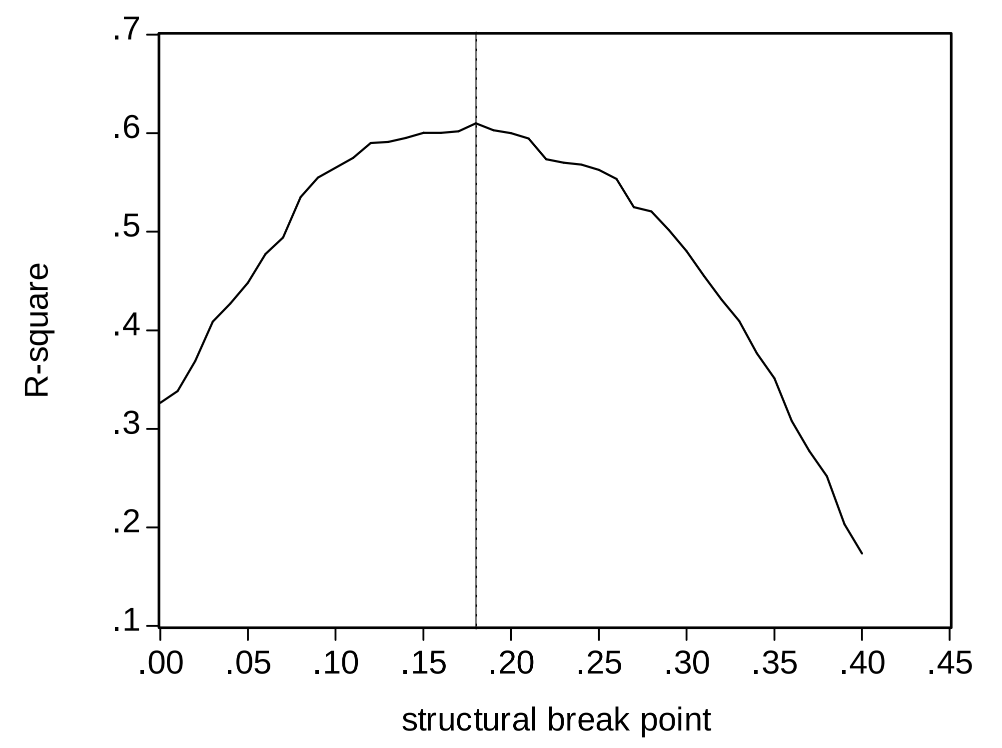

Table1: Estimation of Model (sample1965-2005)

(Dependent Variable: non-oil GDP growth)

Independent Variables	(1)	(2)
$\Delta \ln oilrev$	0.13 (1.93)[b]	0.15 (3.79)[a]
$D(\Delta \ln oil - k)$	-0.21 (-5.78)[a]	-
igdp	0.13 (7.91)[a]	0.16 (2.12)[b]
$\ln GDPC_0$	-0.04 (-7.31)[a]	-0.06 (-6.78)[a]
$\Delta \ln pop$	0.13 (2.13)[b]	0.11 (1.69)[c]

Optimal threshold(k)	18%	-
LR_0	11.26[a]	-
Critical value (1%)	6.28	-
R^2	0.61	0.31
F-statistics	8.45[a]	7.68[a]

Notes: The t-statistics, given between parentheses, are computed from White heteroskedasticity-consistent standard errors. The letters "a", "b", "c", indicate statistical significance at 1, 5, and 10 percent, respectively. The growth rate of a variable x is approximated by the first difference of the log of x, dlog(x). The estimated time dummies and country-specific effects are not reported.

Robustness:

The question of robustness is of particular interest in the empirical analysis of growth, since economic theory provides little guidance on the "true" specification. Here we examine the results sensitivity to Data frequency and additional explanatory variables. The estimation and inference in the previous section were based on five-year averages of the data. This procedure has become common practice in empirical growth literature and aims at filtering out business cycle fluctuations and allowing the focus to be on the medium- and long-term trend in the data. Threshold estimation and estimation of equation (1) have also been carried out with annual data in order to examine two issues[4]. First, it is interesting to analyze how data frequency changes the location and the magnitude of the threshold effect and the estimation results of equation (1). Second, while noisier, annual data provide more degrees of freedom, especially at the tails of the distribution for oil revenues growth. The threshold estimates with yearly data are somewhat different but very close (19 percent for annual data versus 18 percent for five year averages of data). The high-oil revenues effect (that is, $\beta_1 + \beta_2$) is more powerful for yearly data (-0.11 percent for annual data versus -.08 percent for five year averages of data). The low-oil revenues effect (coefficient β_1 in equation 1), are slightly greater for yearly data.

Our base model includes only variables that were found to be robust in the empirical growth literature. The use of fixed effects also helps capture cross-country differences in GDP growth.

1. The results are available on request (not reported here).

Since endogenous growth theory has emphasized the role of human capital in the growth process of a country, equation (1) has been augmented by including a proxy for human capital. Following the empirical growth literature, human capital is proxied by enrollment rates in the primary, secondary, and tertiary schools. All three variables came out statistically insignificant. Furthermore, their inclusion does not significantly change the results. In fact, the threshold values remain the same. The reason may be that the three proxies (primary, secondary, and tertiary enrollment) are highly correlated with the initial income variable *(lnGDPCo)*. A regression of the former on the latter yields an R^2 of 0.88, 0.83, and 0.87, respectively. In other words, the initial income variable appears to be picking up most of the cross-country variation in school enrollment.

Financial development is another important variable that was emphasized by King and Levine (1993). Following the latter, we used three different proxies for financial depth. The first measures the size of the formal financial intermediary sector relative to economic activity (the ratio of liquid liabilities of the financial system, measured by M2 to GDP); the second measures the proportion of credit allocated to the private sector (the ratio of claims on the nonfinancial private sector to total domestic credit); and the third is simply the second normalized by GDP instead of total domestic credit. Adding these variables does not change the estimated threshold values.

4. Conclusions:

This paper examines the issue of the existence of threshold effects in the relationship between oil revenues and economic growth. The data cover 13 oil-exporting countries for the period 1965-2005. To eliminate short-term fluctuations, the data have been averaged over periods of five years. The results for the linear specification, consistent with the evidence found by Spatafora and Warner (1995), Yang and Lam (2007) and Berument and Ceylan (2007) suggest a positive relationship between growth and oil revenues. But, using the structural breakpoint methodology proved that this relation tend to be positive just below a threshold for the growth rate of oil revenues equal to %18. And after this point the effect tends to be negative. Indeed, the threshold level is taken to be the point at which oil exporting countries should begin to worry about oil revenues growth. So, although a modest boom can be a blessing, but an excessive boom (where oil revenues increase above the threshold level) turns to be a curse to the oil exporting countries. It seems that failure to allow to a nonlinear association between oil revenues and growth is responsible for such odd results in oil exporting countries.

The negative and significant relationship between oil revenues and growth is robust with respect to data frequency and alternative specifications. Interestingly, using yearly data yields threshold levels that are close to the estimates from the five-year-averaged data (19% and 18% respectively) and a stronger negative relationship between oil revenues and growth.

The rich-resource countries suffering from a weak and undiversified economic base without stabilizing mechanisms in order to cushion shocks would be so vulnerable to boom–bust cycles, incurring costly instability. There is therefore a strong case for savings schemes, sound fiscal management and strong commitment to fiscal discipline to cushion the domestic economy from the sharp and unpredictable variations in oil prices and revenue. Policymakers must deploy institutional mechanisms to manage oil booms and busts through expenditure restraint, self-insurance, and diversification of the real sector. To achieve sustainable growth in the future, these countries must take policy measures that substantially enlarge and diversify their economic base. Moreover, to insulate the economy from oil revenue volatility requires de-linking fiscal expenditures from current revenue to undo the resource curse during extreme oil booms. So, an ‘‘oil revenue fund’’ (or, more generally, a ‘‘natural resource fund’’) is one such institutional mechanism for managing the oil revenues. By setting aside funds in a separate account, stabilization funds can provide a check against a natural tendency of governments to spend all of the resources at their disposal; and they can help ensure that the funds are spent on investments, so that the depletion of natural resources is offset by an increase in human and physical capital. Stabilization funds can also be used to reduce rent seeking particularly during extreme booms. By providing an open and transparent process for determining how the funds are used, stabilization funds can help prevent and diminish the often violent conflicts that have so marked resource-rich countries.

Moreover, if a country is unable to use the funds well, it may not make sense to extract natural resources as fast as possible. It may be preferable to leave the resources in the ground, increasing in value as resources become scarcer and prices increase. Another way that policy makers could decrease the vulnerability to oil shocks would be to lower borrowing constraints so that agents could better smooth consumption. Perhaps developing deeper capital markets is one solution.

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