CORRUPTION IN ARAB COUNTRIES: A GREASE OR SAND IN THE WHEEL OF ECONOMIC GROWTH? A PANEL SMOOTH TRANSITION REGRESSION APPROACH

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SUMMARY

The relationship between corruption and economic growth has long been dealt with in the literature. Yet, no consensus has been drawn about the way how corruption might affect economic growth. This paper aims at revisiting the relationship between corruption and growth in the context of Arab countries using a panel threshold model with smooth transition (PSTR). The study covers 14 Arab countries over a period from 2007 to 2017.

Our results show that the institutional quality variable divide the sample into two regimes. In the first regime (low institutional quality), reducing corruption risk hinders economic growth. The second regime (high institutional quality) stipulates that a lower risk of corruption will have a positive effect on economic growth. The results on a country basis reveal two heterogenous groups and one homogenous group in terms of hydrocarbons endowment: (1) Algeria, Egypt, Jordan, Lebanon Sudan, Syria and UEA are in favor of "grease in the wheels" hypothesis, (2) Bahrain, Kuwait, Morocco and Tunisia demonstrate "the sand in the wheel" hypothesis and (3) Oman, Saudi Arabia and

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Qatar showed a strong support toward "the sand in the wheel" hypothesis.

KEY WORDS: Institutions, Corruption, Natural Resources, Economic Growth, PSTR.

JEL CLASSIFICATION: O43, D73, Q35, C24.

الفساد في الدول العربية: معوق أم محرك لعجلة النمو الاقتصادي؟ مقاربة نموذج العتبة ذات الانتقال السلس في السلاسل المقطعية

ملخص

طالما تم تناول العلاقة بين الفساد والنمو الاقتصادي في الأدبيات. ومع ذلك، لم يتم التوصل إلى إجماع حول الطريقة التي يمكن أن يؤثر بها الفساد على النمو الاقتصادي. تهدف هذه الورقة إلى إعادة النظر في العلاقة بين الفساد والنمو في سياق الدول العربية باستخدام نموذج العتبة ذات انتقال سلس .في السلاسل المقطعية. تغطي الدراسة 14 دولة عربية خلال الفترة من 2007 إلى 2017. أظهرت النتائج أن متغير النوعية المؤسساتية يقسم النمو الاقتصادي في دول العينة إلى نظامين. في النظام الأول (جودة مؤسسية متدنية)، أين يؤدي الحد من الفساد إلى إعاقة النمو الاقتصادي .أما في النظام الثاني (جودة مؤسسية عالية) فإن الحد من الفساد يؤثر بشكل إيجابي على النمو الاقتصادي .

كما بينت النتائج حسب الدول، وجود مجموعتين غير متجانستين ومجموعة واحدة متجانسة من حيث وفرة الموارد الطاقوية. حيث تضم المجموعة الأولى (الجزائر، ومصر، والأردن، ولبنان، والسودان، وسوريا، والامارات العربية المتحدة) التي تؤيد فرضية "الفساد محرك لعجلة النمو". أما المجموعة الثانية (البحرين، والكويت، والمغرب، وتونس) فتضم دولا تؤيد "فرضية الفساد معوق لعجلة النمو".

في حين تضم المجموعة الثالثة (عمان، والمملكة العربية السعودية، وقطر) والتي تدعم بقوة فرضية "الفساد معوق لعجلة النمو".

كلمات المفتاحية: المؤسسات، الفساد، النمو الاقتصادي، الموارد الطبيعية، نماذج العتبة ذات الانتقال السلس في السلاسل المقطعية.

LA CORRUPTION DANS LES PAYS ARABES : OBSTACLE OU MOTEUR DE LA CROISSANCE ÉCONOMIQUE ?" UNE APPROCHE DE RÉGRESSION EN PANEL A EFFET DE SEUIL AVEC UNE TRANSITION LISSE (PSTR)

RÉSUMÉ

La relation entre la corruption et la croissance économique a longtemps été traitée dans la littérature. Cependant, aucun consensus n'a été établi sur la manière dont la corruption pourrait affecter la croissance économique. Cet article vise à revisiter la relation entre la corruption et la croissance dans le contexte des pays arabes en utilisant une régression en panel à effet de seuils à transition lisse (PSTR). L'étude couvre 14 pays arabes sur une période allant de 2007 à 2017.

Nos résultats montrent que la variable « qualité des institutions » divise l'échantillon en deux régimes. Dans le premier régime (faible qualité institutionnelle), la réduction du risque de corruption freine la croissance économique. Le second régime (haute qualité institutionnelle) stipule qu'un risque moindre de corruption aura un effet positif sur la croissance économique. Les résultats par pays révèlent deux groupes hétérogènes et un groupe homogène en termes de dotation en hydrocarbures : (1) l'Algérie l'Égypte, la Jordanie, le Liban le Sudan, la Syrie et les EAU sont favorables à l'hypothèse « graissage dans le rouage », (2), Le Bahrain, la Tunisie, le Maroc et le Koweït démontrent « l'hypothèse du " sable dans les rouages" et (3) l'Arabie Saoudite, Oman et le Qatar ont montré un fort soutien à l'hypothèse "du sable dans les rouages ".

KEY WORDS : Institutions, corruption, ressources naturelles, croissance économique, PSTR.

INTRODUCTION

Several contributions addressed the relationship between corruption and economic growth. However, there seems to be no consensus on how corruption is expected to affect growth. The literature has highlighted different channels, such as human capital, investment incentives, the structure of public spending and political instability.

The reflection in the literature was divided between two orientations. The first, considers that corruption could accelerate economic growth (Beck & Maher, 1986; Campos et al., 1999; Leff, 1964; Lui, 1985) and the second focuses instead on highlighting the negative effects of this phenomenon and generally found that corruption hinders economic growth (ABDELLA, 2017; Barreto, 1996; Mauro, 1995; Murphy et al., 1993; Rock & Bonnett, 2004; Tanzi, 1998).The empirical literature in this area has consistently reported a negative correlation between economic growth and the level of corruption, and there has been little evidence of positive effects at best. The most recent studies have checked the robustness of the negative effect of corruption on growth by introducing interaction effects (P. G. Méon & Weill, 2008) and nonlinearities into the corruption-growth relationship (T. Aidt et al., 2008; Méndez & Sepúlveda, 2006). However, there is evidence that suggests positive impacts such as (Ahmed & Asmaa, 2016; Marakbi & Turcu, 2016; P.-G. Méon & Sekkat, 2005) enabling us to conclude that we are far from a consensus on this relationship.

Many empirical studies have been carried out in the context of Arab countries on the impact of corruption on economic growth, primarily based on linear panel data (Ahmed & Asmaa, 2016; Metarref et al., 2021; Saidi & Marif, 2021), non-linear dynamic panel data (Boudjana & Bergougui, 2018) and country case studies such as (Kaddachi & Ben Zina, 2022). However, no previous research has examined the impact

of corruption on economic growth using the threshold regression approach.

In this study, we analyse the interconnections between corruption, institutional quality, and economic growth the aim of this article is to empirically model the relationship between corruption and growth, using a panel threshold model with smooth transition in the context of Arab countries. Furthermore, in this article we intend to compare the impact of corruption on economic growth between hydrocarbon-rich Arab countries and poor hydrocarbon-poor Arab countries.

By introducing a threshold effect based upon institutional quality, we estimate a panel smooth threshold model for 14 Arab countries during the period (2007 to 2017).

The article is organized as follows: In Section 1, we review the existing empirical literature on the impact of corruption on growth. Section 2 describes the data sources and the methodology used in this analysis. Section 3 presents the empirical findings and Section 4 the robustness.

1- LITERATURE REVIEW

The literature on the effect of corruption on economic growth is characterized by three mainstream conflicting views. The first one sees corruption as sand in the wheel of economic growth, the second one, sees it as a grease and the last one as a combination of both.

The first mainstream is represented by scholars like Mauro, whose paper in 1950 was the first to address corruption as a negative phenomenon that affects the economy. He pointed out that there is a significant negative correlation between corruption and private investment and concluded that corruption contributes to the reduction of economic growth. This finding was supported by several studies such as (ABDELLA, 2017; Rock & Bonnett, 2004).

According to (Tanzi & Davoodi, 1998), corruption hinders economic growth by increasing public investment in low-productivity infrastructure for rent-seeking purposes, this leads to a reduction in public spending on health and education and a drop in the productivity of public investment. Likewise, other scholars such as (Cieślik &

Goczek, 2018; Gründler & Potrafke, 2019; Mo, 2001; Pellegrini & Gerlagh, 2004) explore other channels through which corruption affect economic growth, such as political instability, trade openness, stock of international investment and inflation respectively. The findings confirm that corruption has a negative effect on growth across these channels.

In this regard, several studies such as (Chang & Hao, 2017; d'Agostino et al., 2016; Erum & Hussain, 2019) using panel data models confirmed the results of latest studies examining "the sands in the wheel" hypothesis.

The second mainstream in which we find (Acemoglu & Verdier, 2000; T. S. Aidt, 2003; Cooray & Schneider, 2018; Dreher & Gassebner, 2013; Egger & Winner, 2005; Heckelman & Powell, 2010; Leff, 1964; Lui, 1985; P.-G. Méon & Weill, 2010; Nye, 1967; Wedeman, 1997) consider corruption as a grease in the wheel of economic growth, This assumption argues that corrupt practices, such as, bribery and nepotism foster economic growth because they function as a lubricant, that speeds up bureaucratic procedures and reduces waiting time. However, this hypothesis can only hold true in the context of weak institutional quality.

The third and the last mainstream in the literature considers a combination of the precedents. Based on a non-linear approach, (Méndez & Sepúlveda, 2006) were the first to test the non-linearity hypothesis by introducing a squared term of corruption as a regressor of GDP per capita. The results showed that the relationship between GDP per capita and corruption was an inverted U shaped in countries characterized by a high level of freedom, these findings were supported by the study of (Swaleheen, 2011).

(P.-G. Méon & Sekkat, 2005) introduced an interaction term between governance indicators and corruption index for 54 developing countries. The results suggest that corruption can have positive effects on economic growth in countries where institutions are ineffective. On the other hand, corruption can hamper economic growth in countries where institutions are effective.

(T. Aidt et al., 2008) illustrated in their seminal study that the relationship between corruption and economic growth is a regime-specific relationship. By using a panel threshold regression of (Caner & Hansen, 2004) and introducing the political institutions as a threshold, the results showed that in countries with high quality political institutions, corruption will negatively impact economic growth. In countries with low quality political institutions, corruption has no effect on economic growth.

(Ahmed & Asmaa, 2016) examined both hypotheses of "greasing the wheels" and "sanding the wheels" on a sample of 15 Arab countries. By introducing an interaction term between a composite governance indicator and the corruption perception index in a panel regression model, the empirical analysis of the study has shown that the link between corruption and economic growth is not linear. It has been shown that reducing corruption will not necessarily increase economic growth in Arab countries and that the positive impact of anti-corruption efforts on economic growth depends on institutional quality.

(Marakbi & Turcu, 2016) explored at the relationship between growth and corruption using the Panel smooth threshold regression. Their results show a negative impact of corruption on economic growth in countries with high levels of institutional quality; Contrary to countries with low levels of institutional quality, where corruption does not affect growth and could contribute to the acceleration of economic activity.

(Boudjana & Bergougui, 2018) explored the impact of corruption through investment and public spending channels in 19 Arab countries, by using Panel ARDL model with interaction terms. The results indicated that in the short term, reducing corruption has a negative impact on economic growth, but has a positive impact in the long term. Additionally, the study revealed that reducing corruption enhances the efficacy of public spending in promoting economic growth but diminishes the efficacy of investment in the same regard.

(Alfada, 2019) investigates the impact of corruption on economic growth in Indonesia using a threshold model. The results indicate that

corruption negatively affects economic growth in Indonesia's provinces. In addition, the threshold model has led to the identification of a critical level of corruption beyond which it has a detrimental effect on economic growth. On the other hand, below the estimated threshold, the rise of corruption level will hinder economic growth, and the destructive effect will be stronger when the corruption level is above the estimated threshold.

(Nur-tegin & Jakee, 2020) revisited the dispute hypothesis using firm level and individual level micro-data from the World Bank Enterprise Survey (WBES). The results suggest that some types of corruption can contribute to "greasing" business transactions, the evidence supporting the "sand" hypothesis is stronger.

(Belloumi & Alshehry, 2021) investigated the relationship between corruption, investments, and economic growth in the GCC countries from 2003 to 2016. The study used panel data analysis techniques and found a long-run unidirectional causality running from corruption to economic growth. The results suggested that corruption has a negative impact on economic growth in the long run but a positive influence on domestic investment.

2- METHODOLOGY AND DATA

2.1- Empirical model methodology

The literature reckons that one of the major advantages of using the Panel Data analysis is their ability to capture the heterogeneity associated with the nature of the data via individual effects (random or fixed) and time effects between individuals. Thus, the estimated coefficients of the observed predictors will be identical across all the observations (individuals and time). However, in many applications, the hypothesis of slops poolability may be infringed. The latter warrants the adoption of techniques that might support better the heterogeneous nature of the sample.

Therefore, a threshold regression model is suggested to detect the potential non-linear relationship between economic growth and corruption, by considering the institutional quality as transition variable.

As a function of the selected variables, the regression pattern is defined as follows. GDP is the logarithm of real GDP; LL is the logarithm of total population ; LK is the logarithm of real Gross fixed capital formation; INF is the semi-logarithm of the inflation rate; OPENNESS is the logarithm of trade openness as percentage of GDP; SCHO is the logarithm of years of schooling; RENT is the logarithm of total natural resources share in GDP; EXPENDITURE is the logarithm of the real general government finale consumption; CORRUPTION is the logarithm of corruption risk index and INS is the law-and-order index.

Using the PSTR model-setting method, a nonlinear model of the optimal capital structure is constructed:

$$\begin{aligned} GDP_{it} = u_i &+ \beta_{11}LL_{it} + \beta_{12}LK_{it} + \beta_{13}INF_{it} + \beta_{14}OPENNES_{it} \\ &+ \beta_{15}SCHO_{it} + \beta_{16}RENT_{it} + \beta_{17}CORRUPTION_{it} \\ &+ \beta_{18}EXPENDITURE \\ &+ F(s_{it};\alpha,\gamma)[\beta_{21}LL_{it} + \beta_{22}LK_{it} + \beta_{23}INF_{it} \\ &+ \beta_{24}OPENNES_{it} + \beta_{25}SCHO_{it} + \beta_{26}RENT_{it} \\ &+ \beta_{27}CORRUPTION_{it} + \beta_{28}EXPENDITURE\big) + \varepsilon_{it} \end{aligned}$$

2.1.1. Panel Smooth Transition Regression Model (PSTR)

In this paper, we adopt the Panel Smooth Threshold Regression developed by (Gonzalez et al., 2005)**.** This type of threshold model allows a smooth transition between regimes.

To illustrate, we consider a PSTR with a single transition function:

$$\boldsymbol{y_{it} = (u_i + \sum_{j=1}^{p} \beta_{1j} x_{it} + \sum_{j=1}^{p} \beta_{2j} x_{it}\,[F(s_{it};\alpha,\gamma)] + \varepsilon_t \ldots\ldots (1)}$$

Where $i = (1 \ldots N)$ and $t = (1 \ldots T)$; N and T denote the cross-section and time dimensions of the panel, respectively; $\boldsymbol{y_{it}}$: The dependent variable; $\boldsymbol{x_{ik}}$: k-dimensional vector of time-varying independent variables; $\boldsymbol{F(s_{it};\alpha,\gamma)}$**:** the transition function is a continuous and integrable function on 0 at 1. It depends on the threshold variable (s_{it}), the threshold (α) and the transition coefficient of (γ) which measure the transition speed; $\boldsymbol{u_i}$ represents the fixed individual effect; $\boldsymbol{\varepsilon_{it}}$: the error terms.

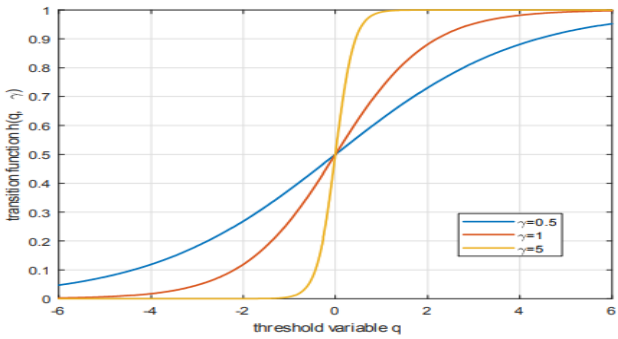
With regard to the form of the transition function, (Gonzalez et al., 2005) proposed to retain a logistic transition function of order m following the form:

$$\boldsymbol{F(s_t;\alpha,\gamma) = (1 + exp\{-\gamma \prod_{j=1}^{m}(s_{it} - \alpha_j)\})^{-1},\ \gamma > 0\ and\ \ \alpha_1 \leq \alpha_2 \leq \cdots \leq \alpha_m \ldots (2)}$$

Where $\boldsymbol{m}$ representing the number of thresholds; for $\boldsymbol{m = n}$, the model has $\boldsymbol{n + 1}$ regimes. From an empirical point of view, (Gonzalez et al., 2005) point out that it is usually sufficient to consider m = 1 or m = 2.

Figure 1 shows the logistic function with m = 1. On the x-axis are the values of the transition variable s_{it} arbitrarily taken between –6 and 6 and on the y-axis the value of the function $F(qit;\ \gamma, c)$. Also shown in the same figure are the graphs of the transition function for four values of the smoothing parameter γ: γ = 0.5, γ = 1 and γ = 5.

Figure 1. Logistics transition function with c = 0



Source: (Fouquau et al., 2008)

As γ approaches infinity, the transition function tends to an indicator function; the PSTR model then has the same transition mechanism as a two-regime PTR model. On the other hand, the transition function becomes constant when as γ approaches 0; amounts to a linear panel model with homogeneous coefficients and individual fixed effects.

The system is gradually moving from one regime to another. The PSTR model is open to interpretation in two ways:

- A model with an infinity of regimes that is limited by two extreme regimes. This is similar to a linear and heterogeneous panel data

model, where coefficients can vary between individuals and over time.

- A nonlinear model, where the system gradually transitions between two extreme linear and homogeneous regimes.

2.1.2. Model specification tests

Specifying and estimating a PSTR model is done in the following four steps (see appendix 1):

- **Step1 (linearity test):** Testing the linear model against a threshold effect model (H_0: β_{1j}=β_{2j} versus H_1: $\beta_{1j} \neq \beta_{2j}$). This null hypothesis can be conveniently tested through restriction tests such as Wald test, Fisher test and Likelihood ratio test. the Wald LM test can be written as:

$$\boldsymbol{LM = \frac{NT(SSR_0 - SSR_1)}{SSR_0}}$$

Where SSR_0 , represents the panel sum of squared residuals for the linear fixed effect model; SSR_1, represents the panel sum of squared residuals for PSTR model with two regimes.

A likelihood ratio test can be written like:

$$\boldsymbol{LR = -2[Log(SSR_1) - Log(SSR_0)]}$$

If the linear model is rejected, we proceed to the second step.

- **Step2 (Determination of the number of transition functions**): this step consists of iteratively testing the different cases, the procedure stops when the alternative hypothesis is accepted (H_0 : r=a versus H_1 : r=a+1).

The test is based on restriction tests, where we denote SSR_0 as the panel sum of squared residuals of a PSTR model with (a) transition function and SSR_1 as the the panel sum of squared residuals of a PSTR model with (a+1) transition function

- **Step3 (determination of threshold and transition parameter):** After determining the number of transition function, we proceed with the estimation of parameters(α, γ). There is no general test for the estimation of the parameters. In our work, we followed the

procedure proposed by (Gonzalez et al., 2005), which consists of estimating a PSTR for each potential specification (α, γ) and retaining the model that minimizes the sum of the squares of residues (RSS).

The selection of starting values for α such that $\boldsymbol{\alpha_{it,min} > min(s_{it}), \alpha_{it,max} < max(s_{it})}$.

For the transition coefficient, (Fouquau et al., 2008) proposed a MATLAB code with a vector of initial values.

- **Step4 (model estimation):** Estimation of PSTR model parameters by nonlinear least squares (NLS).

2.2- Variables and data

Having as a goal to revisit the relationship between economic growth and corruption based on the Panel Smooth Threshold Regression (PSTR) methodology, we rely on a balanced panel with data covering 14 Arab countries (Table 1) for the period spanning from 2007 to 2017. 10 out of 14 countries in our sample are hydrocarbon-rich ones by referring to the definition of the IMF (Lundgren et al., 2013). Behind our choice of these countries, we intend to obtain in-depth information regarding the impact of hydrocarbon resources abundance on the growth-corruption nexus.

The choice of the study period was limited by data availability. It should be noted that Mauritania, Yemen, Libya and Iraq did not include our sample due to a lack of data.

Table 1. Sample composition

	Countries
Hydrocarbons rich	**Algeria, Bahrain, Egypt, Kuwait, Oman, Qatar, Saudi Arabia, Sudan, Syria, UEA**
Hydrocarbon poor	**Jordan, Lebanon, Morocco, Tunisia**

Source: established by the authors

In our analysis, we include a set of variables divided into dependent variable represented by real GDP; core variables which is corruption; transition variable through the institutional quality; and Control variables: Labour, capital, public expenditures inflation, openness, natural resources rents and average years of schooling.

To capture the extent of corruption, we used corruption risk index extracted from the International Country Risk Guide Index. Known as a threat to economic and financial development. This index gives a rating of 0 for a high risk of corruption (extreme corruption), and a rating of 6 for a low risk of corruption (no corruption).

In addition to the core variable, we have included a set of control variables already mentioned, which follows an empirical literature such as, (Barro, 1991; Bassanini et al., 2001; Hussain & Haque, 2016).

The transition variable represented by institutional quality was proxied by the *rule of law* index. *Law and Order* index. The latest one is from the ICRG database. Through this index, we assess the strength of the legal system and the popular observance of the law. The score takes 0 for the low rating (low institutional quality) and 6 for the highest rating (high institutional quality).

All variables are expressed in natural logarithms, except the threshold variable and the inflation rate on which a semilogarithmic transformation has been applied. Table.2 below summarizes all the variables we use in this article and their sources; descriptive statistics are also provided in this table.

Table 2. Data summary and sources

	Variables	Description and source	Obs	Mean	Std. error	Min	Max
Dependent variable	GDP	Log of the real GDP (constant 2015 US$). from WDI database 2022	154	25,24	0,94	23,45	27,22
Core variable	Corruption	Log of corruption risk index From ICRG dataset 2017 (0, indicating a high level of corruption, to -6, representing a low level of corruption).	154	0,77	0,43	-0,69	1,39
Transition variable	Institutional quality	Rule of Law index from ICRG dataset 2017. (0, indicating a low level of law rule, to -6, representing a high level of law rule)	154	4,25	0,82	2,50	5,00
Control variables	Labour	Log of total population, from WDI database 2022	154	16,19	1,24	13,86	18,44
	Capital	Log of gross fixed capital formation in us$ for the year 2015, from WDI database 2022.	154	23,94	1,27	20,74	27,34
	Inflation	Semi-log of inflation rate, from WDI 2022	154	6,90	9,09	-4,86	36,91
	Public expenditure	Log of general government finale consumption (constant 2015 US$), From WDI 2022	154	23,42	1,06	21,50	26,02
	Openness	Log of the trade openness rate, from WDI 2022.	154	4,33	0,77	0,32	5,26
	School	Log of the Average Years of Schooling, from Barro-Lee (2018) dataset	154	7,57	1,99	3,00	10,80
	Natural resources rent	Log of Natural resources rent as percentage of GDP, from WDI 2022	154	1,89	2,50	-6,59	4,08

Source: Authors' calculations

3- RESULTS AND DISCUSSION

3.1- Specification tests

(Gonzalez et al., 2005) Suggest a procedure to specify the PSTR model in 3 steps: i) testing the non-linearity hypothesis, ii) parameters estimation, iii) the determination of the transition's function's number.

3.1.1. Linearity test

In this step, we test the hypothesis of linearity of the relationship between economic growth and corruption. This test is performed by calculating the Wald, Fisher or LRT statistics for the null hypothesis: $H_0: \gamma = 0$ or $H_0 : \beta_0 = \beta_1$. Table 3 shows the results of different linearity tests.

Table 3. LM, LMF and LR tests of linearity

Test	H1: PSTR model with at least one Threshold Variable (r=1)
	Statistics
Wald Tests (LM)	31.37***
Fisher Tests (LMF)	4.22***
LRT Tests (LRT)	35.08***

*** p<0.01, ** p<0.05, * p<0.1

H0: Linear model; H1: PSTR model with m = 1 or m = 2.

Source: Author construction, based on results from Matlab2018.

The P-values of the different statistics (LM, LMF, LRT) displayed in Table 3, point out the possibility of rejecting the null hypothesis of linearity at the 1% significance level. Therefore, we accept the alternative hypothesis of the PSTR model with at least one threshold.

3.1.2. No remaining non-linearity test (number of regimes)

Rejecting the linear hypothesis requires determining the number of transition functions, thus, we performed no remaining non-linearity test to identify the optimal number of transition functions which is always less than or equal to two following (Fouquau et al., 2008).

Table 4. No remaining non-linearity test

Test	H1: PSTR with at least r = 2
	Statistics
Wald Tests (LM)	18.776***
Fisher Tests (LMF)	2.013*
LRT Tests (LRT)	20.02***

*** p<0.01, ** p<0.05, * p<0.1

Source: Author construction, based on results from Matlab2018.

The results of the different statistics (LM, LMF, LRT) (Table 4) show that the estimated PSTR model has at least two regimes at (1%;5%) significance level respectively. Based on our prior assumption, we define r=2 to be the maximum number of thresholds, which means that our PSTR model will be estimated with two extreme regimes.

3.1.3. Institutional quality threshold and transition parameter

The transition function parameters that include the threshold value are shown in Table 5, the optimal threshold value and the transition parameter were obtained by running several OLS regressions for a set of combination ($\boldsymbol{\gamma}$, $\boldsymbol{\alpha}$) by considering Eq.1 as linear when the values $\boldsymbol{\gamma}$ and $\boldsymbol{c}$ are fixed, the combinations are determined by conducting a grid search within the values of γ and $\boldsymbol{\alpha}$ such that γ >0, and $\boldsymbol{\alpha_{j,min}} > \boldsymbol{min_{it}}\{\boldsymbol{s_{it}}\}$ and $\boldsymbol{\alpha_{j,max}} < \mathbf{max}\{\boldsymbol{s_{it}}\}$, $\boldsymbol{j} = \mathbf{1}, \ldots, \boldsymbol{m}$. the combination which minimizes the SSR and the information criterions values is regarded as optimal (see Gonzalez et al (2017)).

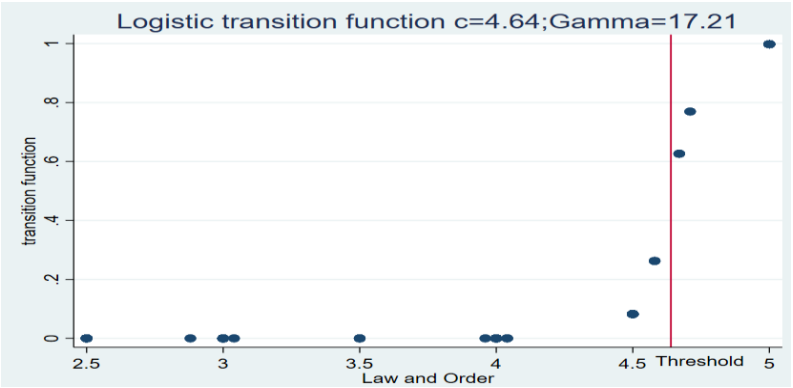
Table 5. Transition function parameters

Threshold value	Transition parameter	SSR	AIC	BIC
4.6395	17.21	1.244	-4.454	-4.099

Source: Author construction, based on results from Matlab2018.

After obtaining the values of the threshold and the transition parameter, we can estimate the transition function in Eq.2. Figure.2 illustrates the transition function with respect to the transition variable ($inst_{it}$) , threshold value $c = 4.6395$ and transition parameter $\gamma = 17.21$.

Figure 2. Estimated transition function of the PSTR model



Source: Author construction, based on results from Matlab2018.

The chart above shows that the transition from lower to higher regimes is relatively gradual. When the threshold variable takes values under the threshold value ($inst \leq 4.64$), the model is in the lower regime where 56.46% (87 obs) of total observations are located. When the threshold variable takes values above the threshold value ($inst > 4.64$), the model is in the upper regime where 45.54% (67 obs) of total observations are located.

Following the transition function, it may be said that most observations are localized in the lower regimes implying that grease in wheel hypothesis could be stronger than the sand in the wheel hypothesis in our sample.

3.2- Results of the PSTR model estimate

Regarding the results of the non-remaining linearity test, we performed PSTR estimation on 14 Arab countries over the period of 2007 to 2017, by applying the Nonlinear least Square (NLS) method using Fouquau et al's (2008) MATLAB code. Assuming $m = 1$ (2 regimes), and the ***Law and Order*** index as a transition variable, the results are displayed in table.6.

Table 6. PSTR estimation results

	Panel Smooth Threshold Regression **Dependent variable: GDP** **Transition variable:** Institutional quality (*Law and order*)		
	Regimes	$inst \leq 4.64$	$inst > 4.64$
	Variables	**Coef**	**Coef**
Core variable	Corruption	-0,16*	0,73***
Control variables	Capital	0,26***	0,13***
	Labor	0,08***	-0,18***
	Openness	-0,13***	0,05
	Inflation	-0,06***	-0,03
	Schooling	1,60***	-1,43***
	Rent	0,03	-0,08***
	Public expenditures	0,14***	0,06*

*** p<0.01, ** p<0.05, * p<0.1

Source: Author construction, based on results from Matlab2018.

By controlling for other variables that may explain the economic growth, column (1) in Table 6 represents the estimation results for the lower regime (Weak institutional quality), and column (2) in table 6 represents the estimation results for the upper regime (high institutional quality).

Overall, the results of the estimates show that all the control variables are statistically significant under both regimes, with the exception of the variable *Openness* and *Inflation* in the second regime and variable *Rent* in the first regime.

Furthermore, the regression results show that control variables, such as openness and inflation have a negative impact on economic growth in a weak institutional environment, and that the negative effect is reversed when institutional quality is relatively higher except for "inflation" where the impact remains negative. However, the significance of this relationship becomes less prominent when considering the magnitude of the coefficient itself. This finding aligns with the seminal research conducted by (Barro, 1995; Bruno & Easterly, 1998; Romer, 1993)

Regarding trade openness, the available evidence indicates a nuanced and diverse relationship between trade openness and economic growth, which is contingent upon specific countries and contexts. While in the short term, trade openness may exhibit a positive

influence on economic growth, in the long term, particularly within low-income countries or in the presence of poor institutional quality, it may have a detrimental effect (Fatima et al., 2020; Keho, 2017; Silajdzic & Mehic, 2018).

In contrast to the previous, variables, such as labor, capital, schooling and public expenditures, have a positive effect on economic growth when institutional quality is lower, aligning with previous literature findings (Barro, 1991, 2003; Barro & Lee, 1994).

The effect is reversed only for the variables, "labor" and "schooling" when the institutional quality is relatively higher. The other variables we mentioned earlier kept the same positive sign in the second regime.

These results align with the existent literature. Except for the variable of schooling that demonstrates a contradictory nature as it lacks empirical support within the current body of literature. The presence of bias due to the endogeneity problem, the later possesses the capacity to modify the signs of coefficients, could potentially elucidate the reasons behind these results.

For the corruption risk variable, the estimation results for the lower regime and the upper regime reveal that corruption risk is significantly correlated with economic growth. In the lower (upper) regime, reducing corruption risk will negatively (positively) impact the economic growth. This result corroborates the findings of (Marakbi & Turcu, 2016) and the same result was found by (T. Aidt et al., 2008) when focusing on political institutions.

In summary, these findings indicate that the relationship between corruption and GDP growth is not linear with respect to institutional quality as found by (Méndez & Sepúlveda, 2006) and (Ahmed & Asmaa, 2016). However, the results of the estimation cannot be directly interpreted as the elasticity of growth with respect to the risk of corruption and should be calculated as follows:

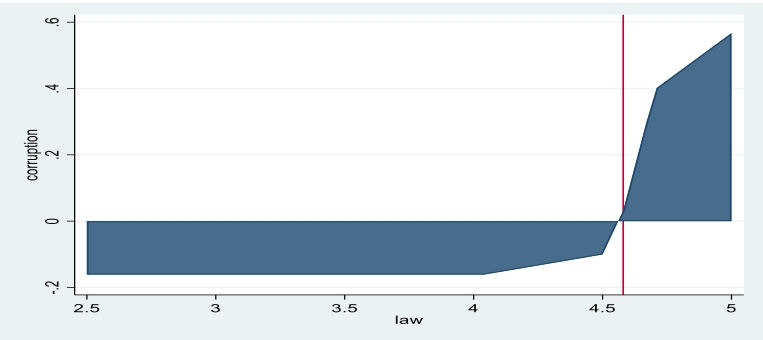
$$\frac{\delta y_{it}}{\delta x_{it}} = \boldsymbol{\beta_{1j}} + \boldsymbol{\beta_{2j}} \boldsymbol{F}(\boldsymbol{s_{it}}; \boldsymbol{\alpha}; \boldsymbol{\gamma}) \ldots\ldots\ldots\ldots \textbf{(3).}$$

3.3- Marginal effects

According to Eq.3, the total marginal effects of corruption risk on economic growth are measured and plotted, as shown in Fig.3

The marginal effect scatter plot of the corruption control takes an S-curve form. The threshold value divides the scatter plot into two partial scatters. On the left (lower regime), the marginal effect of corruption risk on growth takes values below zero. On the right (upper regime), the marginal effect of corruption on growth is above zero.

Figure 3. Total marginal effect of corruption control on economic growth scatter plot



Source: Author construction, based on results from Matlab2018.

Furthermore, when the institutional quality is weak (lower regime), reducing corruption risk will hinder economic growth. The adverse effects continue to decline while institutional quality improves until the threshold value is reached. This finding is in line with the grease in the wheel hypothesis and corroborate with the conclusions of the empirical literature on the relationship between corruption and growth. This outcome may also be explained in a general context in the conclusions of (Addison & Baliamoune-Lutz, 2003) who see that institutional improvement may be a very slow and uncertain process that may lead to negative responses on economic activity in a weak institutional environment.

In contrast, when institutional quality is relatively high, the results suggest that a lower risk of corruption will have a positive effect on economic growth. This finding confirms the sanding wheel hypothesis.

On a country basis, the findings point to some relevant contrasts: (1) in Algeria, Egypt, Jordan, Lebanon, Sudan, Syria and UEA there is a strong support for the "grease in the wheels" hypothesis.

In contrast to, Oman, Saudi Arabia, Tunisia, and Qatar where the institutional quality is relatively better, support is entirely in the "sand in the wheel" hypothesis.

Furthermore, in countries like Bahrain, Kuwait and Morocco, the sand-in-the-wheel hypothesis prevails.

These results allowed us to form three subgroups based on their agreement with the sand-in-the-wheel hypothesis as follows:

Table 7. Sample classification with regard to the estimation results

Countries	Hydrocarbons endowment	Institutional quality	Agreement with sand in the wheel hypothesis	Group
Algeria	Rich	Relatively Low	Strong Disagreement	1
Bahrain	Rich	Relatively high	Agreement	2
Egypt	Rich	Relatively Low	Strong Disagreement	1
Jordan	Poor	Relatively high	Strong Disagreement	1
Kuwait	Rich	Relatively high	Agreement	2
Lebanon	Poor	Relatively Low	Strong Disagreement	1
Morocco	Poor	Relatively high	Agreement	2
Oman	Rich	Relatively high	Strong Agreement	3
Saudi Arabia	Rich	Relatively high	Strong Agreement	3
Sudan	Rich	Relatively low	Strong Disagreement	1
Syria	Rich	Relatively low	Strong Disagreement	1
Tunisia	Poor	Relatively high	Strong Agreement	3
Qatar	Rich	Relatively high	Strong Agreement	3
UEA	Rich	Relatively high	Strong Disagreement	1

Source: Author construction, based on results from Matlab2018.

The analysis of the marginal effects by country shows that the endowment of natural resources has no impact on the corruption-growth link, insofar as, institutional quality affects the relationship. These results are consistent with the resource curse literature (Belarbi et al., 2016; Brunnschweiler & Bulte, 2008; Mehlum et al., 2006), in which institutional quality plays an important role in determining whether natural resource abundance is a curse or a blessing.

Overall, the results of PSTR estimation supports both hypotheses, and consolidate the finding of (Ahmed & Asmaa, 2016; T. Aidt et al.,

2008; Marakbi & Turcu, 2016; P.-G. Méon & Sekkat, 2005; Nur-tegin & Jakee, 2020) with a dominance for the sand in the wheel hypothesis.

4- ROBUSTESSNES CHECKS

This section provides a robustness check to assess the sensitivity of our findings to changes in the model specification.

We achieve this by re-estimating our model using different measures of corruption and institutional quality with an extended sample period from 2007 to 2021 (210obs). We used the political corruption index extracted from *V-Dem* dataset. The index is calculated by determining the mean of the following components: (a) the index of corruption in the public sector, (b) the index of corruption in the executive branch, (c) the indicator measuring corruption in the legislative branch, and (d) the indicator reflecting corruption in the judicial branch. To clarify, each of these distinct governmental domains carries equal weight in the final index computation.

This index yields a score of 1 for extreme corruption, and a score of 0 in the absence of corruption. In our article, we look at the impact that controlling corruption has on economic growth. Therefore, we have inverted the index of political corruption, so that the indicator takes a value of 0 for the low control of corruption and 1 for high control of corruption.

The transition variable represented by institutional quality was proxied by the *rule of law* index. The latest one is from the V-Dem database. Through this index, we assess the strength of the legal system and the popular observance of the law. The score takes 0 for the low rating (low institutional quality) and 1 for the highest rating (high institutional quality).

The results of our robustness check (table.8 and table.9 in Appendix.2) remain broadly similar to those of the original study. The signs of the estimated coefficients remain the same, but the values of the coefficients for the core variable are slightly higher. In addition, the coefficients for the openness and inflation variables become significant in the second regime.

We also attempt to replicate the results of the original study using the Panel Threshold Regression model for the same samples with the ICRG index and V-dem Index. However, we made a change to the specification of the model by taking only the core variables as regime dependent.

The results of our robustness check (table.9) corroborate the original results, with the exception of the *ICRG_corruption* coefficient below the threshold, which is not statistically significant.

CONCLUSION

If the harmful effects of corruption, already established by the literature, on economic growth is not to be demonstrated, the results to which our investigation led make it possible to explore another dimension of the relation between corruption and economic growth.

In this paper, we examined the relationship between corruption and economic growth, by considering "Institutional quality" as the threshold variable. We selected a panel of 14 Arab countries based on the availability of data, covering the period from 2007 to 2017. It turns out that starting from a threshold, that our model determined, the negative effect of corruption on economic growth starts fading. This result can be attributed to the consequences of the efforts that targeted achieving a stable legal framework, to the improvement the judicial system has known and to the law enforcement policy and the political system as a whole.

Through the application of a panel threshold model with smooth transition (PSTR), we were able to determine the threshold represented by the variable "Institutional quality". With no surprise, our control variables turn out to be significant except for the variable "rent" in the first regime and the variables "openness" and "inflation" in the second regime. Our results confirmed the literature regarding the sign. As expected, corruption, inflation, exert a negative effect on economic growth in a context of weak institutions. In contrast, labor, schooling and rent registered in the case of weak institutions a positive impact on economic growth and the inverse in the case of high-quality institutions.

Our findings on a country basis showed that natural resources endowment does have any impact on the corruption-growth link,

insofar as, institutional quality affects the relationship which corroborate with the literature on resource curse. The previous was translated by the formation of heterogenous groups: group (1) Algeria, Egypt, Jordan, Lebanon Sudan, Syria and UEA that supported the hypothesis of "grease in the wheels" and group (2) Bahrain, Kuwait, Morocco and Tunisia where the hypothesis "the sand in the wheel" is the dominant one. The exception in our results was the third group, a homogenous one, composed of, Oman, Saudi Arabia and Qatar characterized by a relatively better institutional quality, demonstrated a strong support for "sand in the wheel" hypothesis.

Unlike Algeria, Egypt, Jordan, Sudan, Syria and UEA that are a rentier economies, and this rent is the reason for the existence of rent seeking groups which justifies the "grease in the wheels" hypothesis, Lebanon and Jordan on the other hand, which are a poor countries in terms of natural resources endowment, also demonstrated the same hypothesis as later ones. The reason for the case of Lebanon can come from the strong political instability the country has been witnessing high levels of corruption[2] centered around the international aid.

The second group, despite their differences in terms of natural resources endowment, but they share a relatively a better institutional quality compared to the first group and that is the reason for being in the "sand in the wheel" hypothesis.

Based on the robustness check, our analysis remains unaffected by variations in the estimation method and alternative measures of corruption and institutional quality. However, it is crucial to recognize the susceptibility of our estimation technique to endogeneity issues and the presence of notable imperfections in our data. The potential endogeneity between institutional quality and economic growth introduces a source of bias that may affect the accuracy of our estimates regarding the impact of institutions on economic outcomes. These inherent weaknesses pose substantial challenges to our research, potentially influencing the interpretation of our results. Future research

[2] In 2020, the corruption perception index (CPI) score and rank were 25/100 and 149/180 respectively.

on threshold effects models should prioritize addressing the endogeneity problem.

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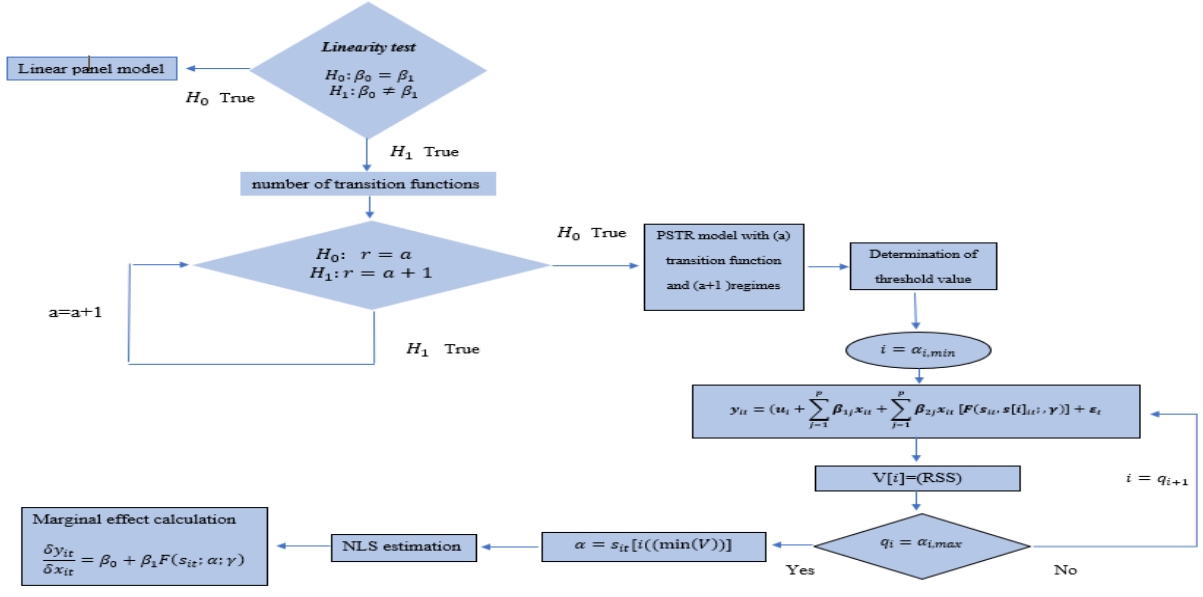
Appendix 1. Flowchart of PSTR modelling



Source: authors' construction

Appendix2. Breakdown of countries by regime.

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Algeria	1*	1	1	1	1	1	1	1	1	1	1
Bahrain	2*	2	2	2	2	2	1	1	1	1	1
Egypt, Arab Rep.	1	1	1	1	1	1	1	1	1	1	1
Jordan	1	1	1	1	1	1	1	1	1	1	1
Kuwait	2	2	2	2	2	2	2	2	1	1	1
Lebanon	1	1	1	1	1	1	1	1	1	1	1
Morocco	2	2	2	2	2	2	1	1	1	1	1
Oman	2	2	2	2	2	2	2	2	2	2	2
Qatar	2	2	2	2	2	2	2	2	2	2	2
Saudi Arabia	2	2	2	2	2	2	2	2	2	2	2
Sudan	1	1	1	1	1	1	1	1	1	1	1
Syrian Arab Republic	2	2	2	2	2	1	1	1	1	1	1
Tunisia	2	2	2	2	2	2	2	2	2	2	2
United Arab Emirates	1	1	1	1	1	1	1	1	1	1	1

*1: Regime1; *2: Regime2

Source: Author construction, based on results from Matlab2018.

Appendix3. Robustness check results**.**

Table 8. PSTR estimation results using V-Dem indexes.

	Panel Smooth Threshold Regression		
	Dependent variable: GDP		
	Transition variable: Institutional quality (*Rule Of Law*)		
	Regimes	$inst \leq 0.574$	$inst > 0.574$
	Number of Obs	145(69%)	65(31%)
	Variables	**Coef**	**Coef**
Core variable	Corruption	-1,30***	2,61***
Control variables	Capital	0,15***	0,29***
	Labor	0,58***	-0,54***
	Openness	-0,04*	0,76***
	Inflation	-0,05***	-0,04
	Schooling	1,27***	-2,19***
	Rent	0,00	-0,17***
	Public expenditures	0,01	0,34

*** p<0.01, ** p<0.05, * p<0.1

Source: Author construction, based on results from Matlab2018.

Table9. PTR estimation results using ICRG indexes and V-Dem indexes

Panel Threshold Regression				
VARIABLES			**GDP**	**GDP**
Threshold			**Law and Order(ICRG)**	**Rule of Law(V-Dem)**
Threshold Value			**4.00****	**0.039****
Regime independent variables		**Capital**	**0.0955*****	**0.0836*****
		Labor	**0.266*****	**0.243*****
		Openness	**-0.0492***	**-0.0419**
		inflation	**-0.00831*****	**-0.00848***
		Schooling	**0.110*****	**0.107*****
		Rent	0.0197	-0.0218
		expenditure	**0.152*****	**0.168*****
Regime dependent variables	**Below the threshold**	**ICRG_corruption**	-0.0140	
	Above the threshold	**ICRG_corruption**	**0.0369***	
	Below the threshold	**V-Dem_Corruption**		**-0.348****
	Above the threshold	**V-Dem_Corruption**		**2.366****
Constant			**14.44*****	**10.75*****
Observations			154	210
R-squared			0.789	0.780
Number of id			14	14

*** p<0.01, ** p<0.05, * p<0.1

Source: Author construction, based on results from Stata 17.