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RESEARCH PAPER

Non-Linear Effects of Government Size on Inflation in OPEC Countries: A Threshold Panel Approach

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Abstract
The purpose of this paper is to consider the relationship between inflation and government size in OPEC countries during the period 2000-2015. Estimation results from different linear panel models with quadratic form of government size and non-linear panel models including static and dynamic panel threshold models suggest that there is a non-linear relationship between government size and the inflation rate in these countries. The threshold value of government size is estimated as 17.76% for all the threshold panel models with different control variables. Below this threshold value, an increase in government size has a significant negative impact on the inflation rate. When government size grows larger, an increasing government size has a significant positive impact on the inflation rate. This paper suggests that it is possible to explain the contradictory evidence of previous studies by making use of a non-linear model.
Keywords: Inflation, Government Size, Threshold Panel Models, OPEC Countries.
JEL Classification: E31, H11, C24, O53.

Introduction

Inflation is one of the most important variables for policy makers. Previous studies (e.g., Han and Muligan, 2008 and Campillo and Miron, 1997) provided contradictory evidence about the link between government size and inflation. Understanding the relationship between government size and inflation might help policy makers when trying to control inflation by regulating government expenditures. The relevance of the relationship between government size and inflation for policy makers and the contradictory evidence in prior studies motivated our empirical research. In particular, our analysis might help to fill the gap of such studies focusing on developing countries.

The main goal of this paper is assessing the relationship between government size and inflation in the OPEC countries for which oil exports have a major impact. In the OPEC countries, the financing of the budget depends on oil. This is different from the situation in developed countries. In addition, these countries have a less developed tax system. Based on Han and Muligan (2008), a country with a poor tax system may be the best case for Sargent's (1982) emphasis on inflation as a fiscal phenomenon.

According to Han and Mulligan (2008), there exists a correlation between government size and inflation. They investigated the relationship between government size and inflation from a public finance perspective. Their analysis focused on the response of inflation to changes in government size considering both cross section and time series approaches. Their cross-country results indicate that there is a small positive correlation between inflation and defense

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spending. In addition, there is a small negative correlation between inflation and non-defense spending. However, these results stand in contrast with other studies, e.g., Grilli et al. (1991) and Campillo and Miron (1997) who found a positive correlation between inflation and government size. A possible reason for these contradictory results regarding the nexus government size-inflation might be the assumption of a linear relationship between government size and inflation in the earlier studies. This assumption generates a bias if the actual relationship is nonlinear. Therefore, in our analysis, we allow for the existence of a nonlinear, more specifically a U-shaped relationship between government size and inflation in OPEC countries. In addition, in order to take into account possible non-linear effects of government expenditures, the empirical analysis is based on two alternative panel models. The first one is a linear panel model that enables non-linear impact of government size by means of adding a quadratic term, while the second one is a threshold panel model using government size as threshold variable.

This paper is organized in five sections. In the following section, we discuss the theoretical framework for explaining inflation with a specific emphasis on the role of the government sector. Section 3 is devoted to the empirical model specification and data description. Section4 shows empirical results and the final section provides concluding remarks.

Theoretical Framework

In the OPEC countries, the central bank depends on the government. At the same time, due to the lack of an effective tax system, oil revenues make up for a substantial part of state income. Consequently, the government budget is highly dependent on oil revenues. Therefore, these economies may be good examples for the weak form fiscal theory also emphasized by Sargent (1982). For this reason, the focus of our empirical analysis is based on factors of inflation derived from the fiscal theory of inflation with a specific focus on the role of government activities.

Financing the Budget and Inflation

The government budget has to be financed. In most developed countries, tax income is the major component of government revenues used for funding the budget. In oil-oriented countries like as OPEC countries, besides tax income, oil income is a highly relevant component of government revenues. This establishes a potential link between government size and inflation by the following argument. Oil revenue might be considered as a rather exogenous government income component as it depends mainly on world market prices. However, oil revenue accrues in non-domestic currency (“petrodollars”). In order to use this income for funding government expenditures, the petrodollars are exchanged for domestic currency at the central bank. If this process is not neutralized by open market policies, it results in the creation of new base money. Consequently, the money supply will increase assuming that the money-creation multiplier is not changing in the short run (Mishkin, 2007). Eventually, if output does not grow at the same pace as the money creation does (due to the oil income), inflation might increase. In this case, there are two options to control inflation making use of oil revenues. When oil revenues increase, the central bank obtains enough petrodollars to control the exchange rate. Using this instrument, by an appreciation of the local currency, it might increase imports of goods and services in order to reduce domestic excess demand. Eventually, this might reduce the inflationary pressure. Furthermore, when oil revenue increases, the government budget can be financed largely by this income reducing the probability of a budget deficit, which might have a moderating effect on the inflation.

Therefore, oil revenue has an ambiguous impact on inflation. In any case, when the oil revenue increases, government size will tend to expand, and in the end, the growing size of the government size might increase the risk of budget deficits and create inflation.

Budget Deficit and Inflation

A second possible link between government size and inflation is through the budget deficit. In most developing countries, when the government budget has a deficit, the deficit can be financed in three different ways: by borrowing from the public, by borrowing from foreign countries, or by borrowing from the banking system, including the Central Bank (Jafari-Samimi et al., 2012). Due to the limited efficiency of capital markets in most developing countries such as most OPEC countries, borrowing from the public through the capital market is relatively limited in these countries (Jafari-Samimi et al., 2012).

Also, because of the debt crisis foreign financing has decreased, but most developing countries were not able to decrease their fiscal deficit (Jafari-Samimi et al., 2012). Therefore, the governments of most developing countries shifted their financial requirements to the banking system. In these countries, the simplest way of financing the budget deficit is borrowing from the central bank. At the same time, the government debt to the central bank is a component of the monetary base and, consequently, an increase in government debt to the central bank will result in a growth of money supply triggering eventually higher inflation. Inflation reduces the real value of governmental debt and cash holding. The latter effect is also known as inflation tax as it affects the real income of people in the same way as a tax and at the same time generates real revenue for the government in form of the reduced real value of its debt.

In addition, when government size is already large, a further expansion of government is likely to increase the budget deficit. When the budget deficit is financed to a substantial part by borrowing from the central bank, an increasing inflation rate might result. On the other hand, when government size is small, expanding government size does not necessarily increase the budget deficit because in an economy with a small government size, financing government expenditures with tax revenues raised from the private sector might be feasible. According to Armey (1995), there is a positive effect of government expenditure on economic growth in an economy with a small government size. Then, due to the increasing economic activity, tax revenues will increase as well which might contribute to the funding of the expanding government expenditure. Furthermore, according to Armey (1995), in an economy with small government size, government expenditure is more efficient than in an economy with large government size. This more efficient expenditure can promote aggregate supply by providing public goods for the private sector and, as a result, might have a decreasing effect on the price level.

To sum up, from a theoretical point of view, it appears to be possible that an increase in government size might have different impacts on inflation for different levels of government size.

Expanding Government Size, Economic Growth and Price Level

In the traditional Keynesian model, the expansion of government size might be used to stop a recession (Chen and Lee, 2005), but Landau (1983), Engen and Skinner (1992), Fölster and Henrekson (2001), and Dar and AmirKhalkhali (2002) found a negative relationship between government size and economic growth because there are decreasing returns of government expenditure and a crowding out effect of private investment. Also, government expenditures are often considered to be inefficient expenditures which will distort the allocation of resources (Chen and Lee, 2005). In contrast, other theoretical approaches, e.g. by Ram (1986) and Kormendi and Meguire (1986), argue in favor of expanding government size as it might enhance economic growth because the increasing government size provides an insurance function to private property. Likewise, public expenditure can enhance the private investment environment by the provision of public goods (Chen and Lee, 2005).

Armey (1995) indicates that there is a non-linear relationship between government size and economic growth. Abounoori and Nademi (2010) point out that there is a non-linear relationship between government size and economic growth for the OPEC member country Iran. Their results confirm the existence of Armey's (1995) curve in Iran. Abounoori and Nademi (2010) find that the threshold level of government size – measured as share of GDP – is about 35%. This means that for a government size smaller than 35%, economic growth is promoted by expanding government size, while extending government size once the threshold of 35% is passed has a negative impact on economic growth.

Economic growth increases aggregate supply of the economy and might have a negative impact on the price level. However, expanding government size beyond the threshold level of government size decreases economic growth and, consequently, might have a positive impact on the price level. Therefore, when government size is large, expanding government size cannot promote aggregate supply, but rather results in creating inflation. However, when government size is small, expanding government size can promote aggregate supply without generating inflationary tendencies.

Figure 1 provides a stylized illustration of the functional relationship between government size and inflation in oil-oriented countries. When government size is small, an increasing government size might have a negative impact on inflation. The argument for this effect is that because of low or no budget deficit, an increase in government size has mainly a positive effect on aggregate supply according to the Armey Curve. In contrast, when government size is relatively large, a further increase of government size will have a positive impact on inflation. This is the result of the corresponding budget deficit and its financing by borrowing from the central bank as well as of a decreasing aggregate supply effect.

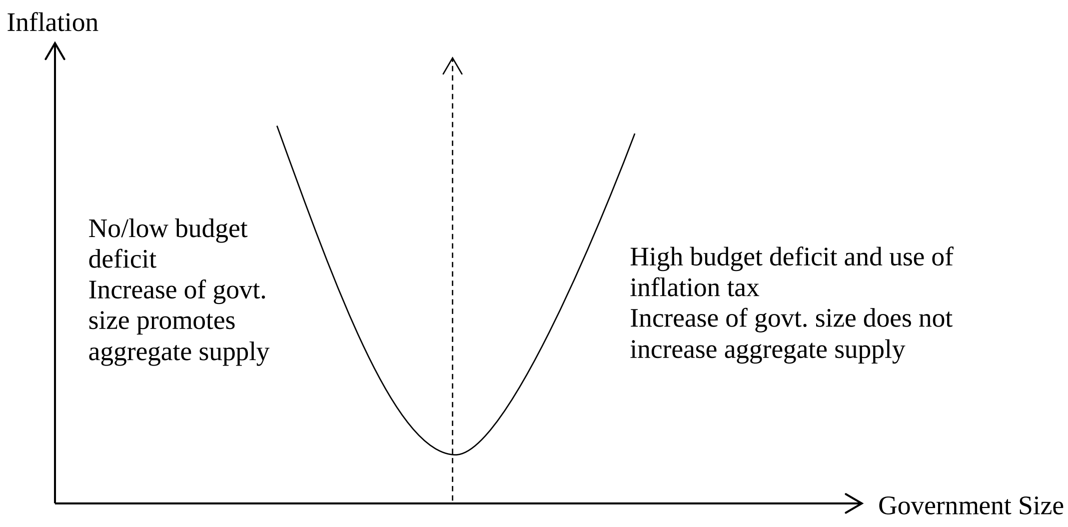

Figure 1. Possible link between Government Size and Inflation
Source: Theoretical framework of the research.

Model Specification and Data Description

In this section, we first describe the empirical models for inflation based on the discussion of relevant factors in the previous section. Furthermore, the data used for the estimation of the models are described.

In order to reflect the potentially non-linear relationship between government size and inflation, we consider two alternative models. The first one presented in equation (1) is a linear panel model allowing for a quadratic impact of government size (gs):

$$inf_{it} = \alpha_0 + \alpha_1 gs_{it} + \alpha_2 gs_{it}^2 + \beta X_{it} + \varepsilon_{it} \quad (1)$$

The second model (2) allows for two regimes as a function of government size, which are linked to different effects of government size on inflation:

$$inf_{it} = \beta X_{it} + I[\mathrm{gs}_{it} \le \gamma] * (\alpha_0 + \alpha_1 gs_{it}) + I[\mathrm{gs}_{it} > \gamma] * (\alpha_2 + \alpha_3 gs_{it}) + \varepsilon_{it}, \quad (2)$$

$$\text{with } I[\mathrm{gs}_{it} > \gamma] = \begin{cases} 1 & if \quad \mathrm{gs}_{it} > \gamma \\ 0 & if \quad \mathrm{gs}_{it} \le \gamma \end{cases},$$

where i and t are indices of country and time, respectively. inf_{it} is the inflation rate which is obtained from the consumer price index CPI_{it} for each country as

$$inf_{it} = \frac{CPI_{it} - CPI_{i,t-1}}{CPI_{i,t-1}} \quad (3)$$

gs_{it} is the measure of government size which is defined as the ratio of general government final consumption expenditure divided by GDP.

X_{it} is a vector of control variables affecting inflation including $gm2_{it}$, oil_{it} and un_{it}. Thereby, $gm2_{it}$ is the growth of broad money which includes cash, coins and balances held in checking and savings accounts; oil_{it} is the share of oil rent in GDP, where the oil rent is given by the difference between the value of crude oil production at world prices and total costs of production; and un_{it} denotes the unemployment rate that is calculated as the ratio of the number of unemployed workers divided by the active population. Unemployed workers are defined as those workers who have the ability and willingness to work and seek work, but do not have any job.[1]

In addition, the first lag of inflation is included as explanatory variable in the dynamic linear and threshold models. Thus, both the linear and the threshold models are estimated in a static and a dynamic variant.

In the threshold model with government size as threshold variable, inflation is modelled as having two regimes corresponding to high and low government size. Thereby, γ denotes the threshold value of government size that determines a regime change. This threshold value is estimated by minimization of the residual sum of squares. To this end, equation (2) is estimated by Ordinary Least Squares (OLS) for each observed value of government size, which might serve as a potential threshold (we follow the usual approach of considering only values falling between the 15%- and 85%-percentile of the observed values to avoid a regime with too few observations). Then, following Chan (1993) and Hansen (1999), the threshold value that minimizes the sum of squares of the residuals is selected as value of γ for the further analysis. In order to test for the existence of two regimes in the government size, we have used the bootstrap procedure proposed by Hansen (1997; 1999; 2000). The hypothesis for this test is the following:

1. Based on the International Labor Organization (ILO) definition.

$$\begin{cases} H_0: \alpha_0 = \alpha_2, \alpha_1 = \alpha_3 \\ H_1: Otherwise \end{cases} \tag{4}$$

The null hypothesis (H_0) indicates that the model is linear, i.e. it cannot be differentiated between two distinct regimes of government size. The alternative hypothesis (H_1) indicates that the model is nonlinear, and the threshold value is relevant. Under the null hypothesis, the threshold value is unidentified. Therefore, the critical value cannot be obtained by simulation. To solve this problem, Hansen (1996) has introduced a statistic to calculate the asymptotic *p*-value for a large enough sample making use of a bootstrap method.[1] The F_1-statistic for the linearity test is given by

$$F_1 = \frac{RSS_0 - RSS_1(\hat{\gamma})}{\hat{\sigma}^2}, \tag{5}$$

where RSS_0 and $RSS_1(\hat{\gamma})$ are the residual sum of squares under the null hypothesis and the alternative, respectively, and $\hat{\sigma}^2$ is the variance of the error terms in equation (2).

In addition, for testing one threshold against two threshold values, we considered the following model:

$$inf_{it} = \beta X_{it} + I[\,gs_{it} \le \gamma_1] * (\alpha_0 + \alpha_1 gs_{it}) + I[\,\gamma_1 < gs_{it} \le \gamma_2] * (\alpha_2 + \alpha_3 gs_{it}) + I[\,gs_{it} > \gamma_2] * (\alpha_4 + \alpha_5 gs_{it}) + \varepsilon_{it}\,, \tag{6}$$

with $I[gs_{it} \le \gamma_1] = \begin{cases} 1 & if \quad gs_{it} \le \gamma_1 \\ 0 & if \quad gs_{it} > \gamma_1 \end{cases}$, $I[\,\gamma < gs_{it} \le \gamma'] = \begin{cases} 1 & if \quad \gamma_1 < gs_{it} \le \gamma_2 \\ 0 & if \quad \text{otherwise} \end{cases}$ and $I\,I[\,gs_{it} > \gamma'] = \begin{cases} 1 & if \quad gs_{it} > \gamma_2 \\ 0 & if \quad gs_{it} \le \gamma_2 \end{cases}$

According to Hansen (1999), we have estimated the model (6)[2]. Then, we have tested one threshold against two thresholds by F_2 statistic as following:

$$F_2 = \frac{RSS(\hat{\gamma}) - RSS(\hat{\gamma}')}{\hat{\sigma}^{2\prime}},$$

Where $RSS(\hat{\gamma})$ is residual sum of square in model (2) which has only one threshold and $RSS(\hat{\gamma}')$ is residual sum of square in model (6) which has two threshold values. $\hat{\sigma}^{2\prime}$ is the variance of the error terms in equation (6). If F_2[3] is large, the null hypothesis of existence one threshold value has to be rejected and, at least, there are two distinct threshold values.

Finally, again following Hansen (1999), we constructed confidence intervals for the threshold value at 5% significance level as follows:

$$LR(\gamma) = \frac{RSS(\gamma) - RSS(\hat{\gamma})}{\hat{\sigma}^2} \tag{7}$$

where $RSS(\gamma)$ is the residual sum of square for each possible threshold value γ and $RSS(\hat{\gamma})$ is the residual sum of square for the estimated threshold value ($\hat{\gamma}$). Then, by plotting $LR(\gamma)$ against each threshold value (γ) and drawing a flat line at $C(\alpha)$, we obtain the confidence interval defined by $LR(\gamma) \le C(\alpha)$ at α significance level. Critical values are obtained by direct inversion of the distribution function of $C(\alpha)$[4] (Hansen, 1999).

1. For more detail, see Hansen (1996, 2000).
2. For more detail, please see Hansen (1999).
3. The critical values are obtained by a bootstrap method.
4. Critical value is 7.35 at 5% significance level (Hansen, 1999).

$$C(\alpha) = -2\log(1 - \sqrt{1-\alpha}) \quad (8)$$

For dealing with possible problems of endogeneity, we use GMM estimators for both the linear and the threshold models. Following Seo and Shin (2016) the threshold panel GMM method has been used for estimating the dynamic threshold model. Thereby, following Arellano and Bond (1991), the lagged endogenous variables have been used as instrument variables. In this case, 2–4 lags of the endogenous variables were used as the instrument and the dynamic models have been estimated by the first difference GMM estimator.

We obtained the data from the World Development Indicator (WDI) database[1] for the period of 2000-2015. The OPEC countries including Algeria, Angola, Ecuador, Equatorial Guinea, Gabon, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Kingdom Saudi Arabia (KSA), United Arab Emirates (UAE) and Venezuela are considered.

Table 1. Descriptive Statistic of Inflation and Government Size in OPEC Countries

Variable	Descriptive Statistics			
	Mean(%)	**Max(%)**	**Min(%)**	**St. dev**
Inflation	13.3	324.99	-10.06	32.49
Government Size	14.54	42.50	2.73	5.50
Oil Rent in GDP	29.74	83.50	3.03	15.81
The Growth of Broad Money	22.85	303.73	-14.07	28.19
Unemployment	9.98	29.77	0.80	6.09

Source: Own calculations based on WDI Data.

Table 1 provides descriptive statistics for the variables in the OPEC countries during the period of 2000-2015. Among these countries, Angola exhibits the highest mean of the yearly inflation rate with 53%, while Libya has the lowest value with only 1.7%. The maximum yearly inflation rate of 325% occurred in Angola in 2000 and the lowest inflation rate was observed 2007 in Iraq with -10%.

Among the selected countries, Saudi Arabia (KSA) exhibits the highest mean of government size with 23%, while Nigeria with a mean share of only 8% has the lowest value. The maximum government size reported amounts to 42.5% in Angola for the year 2000, while the minimum occurred 2005 in Equatorial Guinea with 2.7%.

The maximum share of oil rent in GDP is belonging to Equatorial Guinea with 83.50% and the minimum share of oil rent in GDP is belong to Nigeria with 3.03%.

Among these countries, Angola exhibits the highest of the yearly growth of broad money with 303.73%, while Equatorial Guinea has the lowest value with 14.07%.

Finally, the maximum rate of unemployment is belonging to Algeria with 29.77% and the minimum rate of unemployment is belonging to Kuwait with 0.8%.

Empirical Results

Before fitting the different models introduced above, the variables are tested with regard to their stationarity. To this end, the ADF Fisher chi-square test introduced by Maddala and Wu (1999), the Levin, Lin & Chu (2002) test and the PP-Fisher Chi-Square test introduced by Choi (2001) are used.

The results[2] of all tests indicate that the null hypothesis of non-stationarity is rejected at the 5% significance level for all variables in the model. Consequently, we can apply standard econometric methods for the estimation of the models.

1. https://data.worldbank.org/products/wdi
2. The results of the unit-root tests are reported in the Appendix.

For checking the robustness of the results obtained for the nonlinear relationship between inflation and government size, we consider eight models with different sets of explanatory variables.

Table 2 and 3 summarize the estimation results of the linear static and dynamic panel models allowing for a nonlinear effect of government size by adding a quadratic term. The results demonstrate that there is a pronounced U-shaped relationship between government size and inflation in all models considered. Adding or replacing control variables does not change this nonlinear relationship in a qualitative way. Also, the implicit threshold values of government size which is calculated by $\frac{\partial Inf}{\partial GS}=0$ for each model are reported in Tables 2 and 3. For the linear panel OLS models, this implicit threshold value of government size falls between 13.44% and 14.85%. For the linear panel GMM model, it is between 15.44% and 17.21%.

In addition, the share of the oil rent in GDP has a significant positive impact on inflation in most of the linear model specifications including this variable, in particular in the dynamic models.

The growth of broad money has also a significant positive impact on inflation in all of the linear model specifications, which is consistent with the monetary theory of inflation.

No significant impact is found for the unemployment rate, which is at odds with the traditional (short-term) Philips curve, but conforms to the new classical theory of the Philips curve as well as with the long run Philips curve.

Table2. Linear Panel Model with OLS Method

	Model 1	**Model 2**	**Model3**	**Model4**	**Model5**	**Model6**	**Model7**	**Model 8**
Intercept	29.62^{***} (7.28)	65.23^{***} (12.23)	32.47^{***} (11.02)	25.17^{***} (9.31)	68.25^{***} (11.64)	25.87^{***} (8.65)	71.95^{***} (10.14)	76.57^{***} (9.22)
GS	-4.74^{***} (0.77)	-10.07^{***} (0.99)	-5.39^{***} (0.98)	-4.84^{***} (0.91)	-10.09^{***} (0.98)	-4.84^{***} (0.90)	-10.05^{***} (0.91)	-10.10^{***} (0.90)
GS^2	0.16^{***} (0.02)	0.34^{***} (0.02)	0.19^{***} (0.02)	0.18^{***} (0.02)	0.34^{***} (0.02)	0.18^{***} (0.02)	0.34^{***} (0.02)	0.34^{***} (0.02)
Oil	-0.14^{**} (0.06)	0.25^{**} (0.11)	-0.02 (0.12)	-	0.25^{**} (0.11)	-	-	-
Gm2	0.59^{***} (0.04)	-	0.51^{***} (0.05)	0.49^{***} (0.04)	-	0.50^{***} (0.04)	-	-
UN	0.14 (0.18)	0.28 (0.36)	-	0.07 (0.37)	-	-	0.42 (0.36)	-
Adjusted R^2	0.78	0.64	0.81	0.81	0.64	0.81	0.60	0.60
Redundant Fixed Effect	2.45 (0.00)	10.52 (0.00)	2.55 (0.00)	3.83 (0.00)	10.85 (0.00)	3.93 (0.00)	10.51 (0.00)	10.85 (0.00)
Hausman Test	10.9 (0.053)	5.08 (0.27)	12.65 (0.01)	15.01 (0.00)	5.04 (0.16)	16.72 (0.00)	0.32 (0.95)	0.58 (0.78)
Threshold GS ($\boldsymbol{when \frac{\partial Inf}{\partial GS}=0}$)	14.81%	14.81%	14.18%	13.44%	14.83%	13.44%	14.78%	14.85%

Note: ***, **and * represent the significance levels at 1%, 5% and 10%, respectively. Standard errors and P-values are in parentheses for the coefficients and the Redundant Fixed Effect and Hausman tests, respectively.
Source: Research finding.

In the dynamic linear models, the first lag of inflation is significant. This indicates that the dynamic models should be preferred to the static ones. Furthermore, according to the theory of adaptive expectations of inflation, the first lag of inflation also allows the interpretation as a proxy for inflation expectations, for which the estimation results indicate a positive impact on actual inflation. The results of first and second order Arellano and Bond (1991) test Arellano and Bond (1991)'s test indicates that the null hypothesis of no first-order autocorrelation was rejected while the second-order autocorrelation was not confirmed. Finally, the J-statistic of the Sargan test for the validity of instrument variables indicates that the null hypothesis of exogeneity of instrumental variables does not have to be rejected.

Table3. Linear Dynamic Panel Model with GMM Method

	Model 1	Model 2	Model3	Model4	Model5	Model6	Model7	Model 8
Inf(-1)	0.38*** (0.01)	0.41*** (0.004)	0.377*** (0.005)	0.41*** (0.002)	0.375*** (0.001)	0.370*** (0.003)	0.425*** (0.001)	0.42*** (0.001)
GS	-4.82** (2.22)	-5.07*** (0.79)	-5.436*** (0.928)	-4.649*** (0.412)	-5.532*** (0.519)	-6.224*** (1.57)	-5.176*** (0.16)	-5.14*** (0.11)
GS^2	0.14** (0.06)	0.16*** (0.02)	0.176*** (0.028)	0.149*** (0.011)	0.171*** (0.015)	0.188*** (0.04)	0.156*** (0.004)	0.15*** (0.003)
Oil	0.23* (0.12)	0.20*** (0.01)	0.128*** (0.044)	0.146*** (0.009)	-	-	-	-
Gm2	0.06*** (0.01)	-	0.066*** (0.004)	-	0.093*** (0.006)	0.088*** (0.01)	-	-
UN	0.79 (0.61)	-0.38 (0.31)	-	-	-	0.954* (0.52)	0.024 (0.14)	-
Arellano–Bond AR(1)	-4.87 (0.00)	-4.68 (0.00)	-4.87 (0.00)	-4.61 (0.00)	-4.98 (0.00)	-4.98 (0.00)	-4.69 (0.00)	-4.72 (0.00)
Arellano–Bond AR(2)	0.52 (0.60)	-0.62 (0.53)	0.50 (0.61)	-0.92 (0.35)	0.42 (0.67)	0.47 (0.63)	-0.92 (0.35)	-0.93 (0.35)
J-statistic	8.47 (0.38)	10.44 (0.40)	9.802 (0.36)	10.537 (0.39)	12.599 (0.32)	12.05 (0.21)	12.784 (0.23)	12.86 (0.30)
Threshold GS $(when \frac{\partial Inf}{\partial GS} = 0)$	17.21%	15.84%	15.44%	15.60%	16.17%	16.55%	16.58%	17.13%

Note: ***, ** and * represent the significance levels at 1%, 5% and 10%, respectively. Standard errors and P-values are in parentheses for the coefficients and the Arellano–Bond and J-statistic tests, respectively.
Source: Research finding.

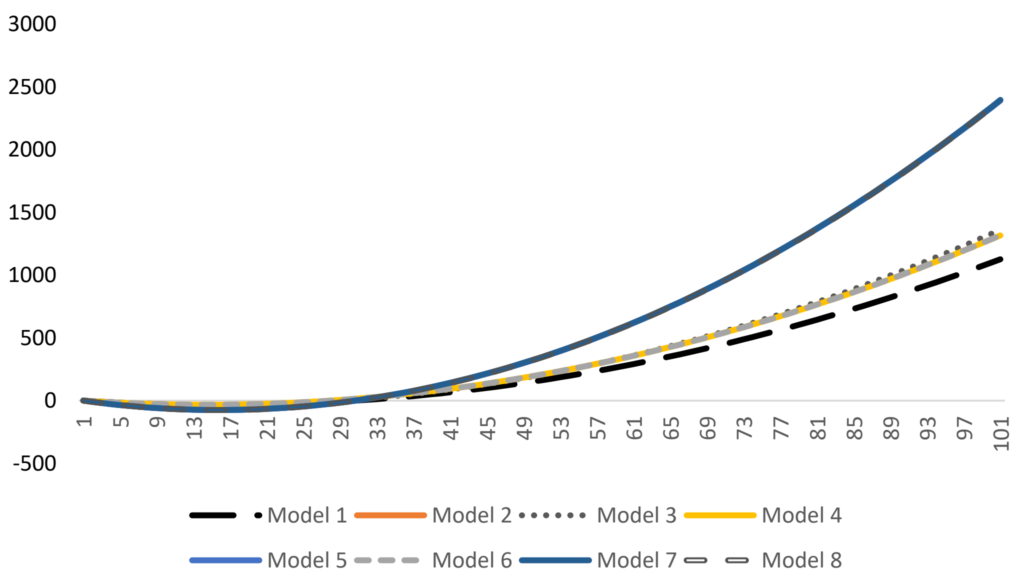

Figure 2. Impact Curve of Government Size for Panel Models with OLS Method
Source: Research finding.

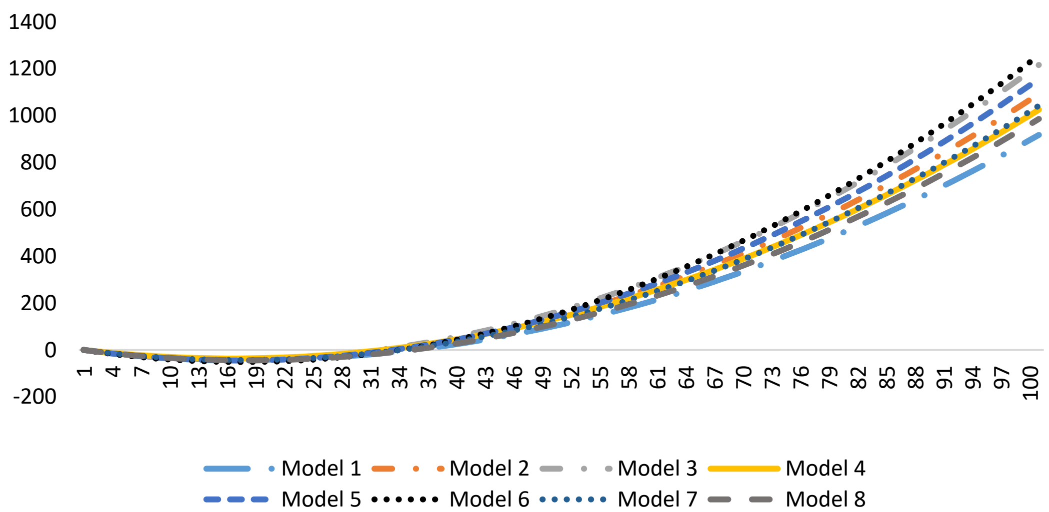

Figure 3. Impact Curve of Government Size for Panel Models with GMM Method
Source: Research finding.

Figures 2 and 3 exhibit the partial effect of government size on inflation taking into account the quadratic term. The form of these impact curves is quite similar with a minimum for a government share between 15 and 20%.

Now, we turn to presenting the results of the threshold panel models including fixed effect threshold panel and random effect threshold panel as static models and dynamic threshold panel GMM models. As in the case of the panel models, for checking the robustness of the nonlinear relationship between inflation and government size, we provide results for eight models with different sets of explanatory variables.

Table 4. Threshold Panel Model with Government Size as a Threshold Variable (Fixed Effects)

	Model1	**Model2**	**Model3**	**Model4**	**Model5**	**Model 6**	**Model 7**	**Model 8**
Intercept (When GS<= 17.76)	3.54 (8.49)	0.82 (8.3)	8.03 (4.87)	2.87 (8.58)	0.72 (0.92)	15.03*** (3.35)	8.99* (5.29)	13.85*** (3.06)
Intercept (When GS>17.76)	-101.3*** (26.31)	-105.47*** (26.41)	-130.55*** (47.58)	-103.92*** (26.88)	-103.01*** (25.86)	-114.96*** (46.83)	-131.06*** (47.88)	-115.61*** (46.87)
GS (When GS<= 17.76)	-0.054 (0.47)	-0.06 (0.49)	-0.31 (0.31)	-0.012 (0.46)	-0.09 (0.49)	-0.37** (0.15)	-0.31 (0.31)	-0.37** (0.15)
GS (When GS>17.76)	5.06*** (0.20)	5.30*** (1.42)	6.33*** (2.40)	5.23*** (1.44)	5.16*** (1.33)	6.15** (2.40)	6.33*** (2.41)	6.14** (2.40)
Oil	-0.002 (0.06)	-	0.13*** (0.03)	-	0.01 (0.06)	-	0.13*** (0.03)	-
Gm2	0.37*** (0.08)	0.34*** (0.07)	-	0.35*** (0.07)	0.36*** (0.08)	-	-	-
UN	-0.31* (0.18)	-	-	-0.29 (0.18)	-	-0.12 (0.09)	-0.07 (0.09)	-
Threshold Value	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)
Adjusted R^2	0.69	0.69	0.57	0.69	0.69	0.57	0.57	0.57

Note: ***, ** and * represent the significance levels at 1%, 5% and 10%, respectively. Standard errors and P-values are in parentheses for the coefficients and the threshold value, respectively.
Source: Research finding.

Table 5. Threshold Panel Model with Government Size as a Threshold Variable (Random Effects)

	Model1	Model2	Model3	Model4	Model5	Model 6	Model 7	Model 8
Intercept (When GS<= 17.76)	-1.83 (6.47)	-6.55 (3.97)	1.59 (7.76)	-6.77 (4.46)	-1.58 (3.75)	18.39*** (5.03)	0.83 (9.42)	19.72*** (4.62)
Intercept (When GS>17.76)	-88.61*** (23.96)	-89.87*** (21.11)	-190.0*** (44.37)	-91.55*** (21.80)	-86.41*** (19.87)	-187.57*** (46.83)	-198.38*** (43.97)	-186.56*** (36.87)
GS (When GS<= 17.76)	-0.09 (0.38)	0.11 (0.24)	-0.54 (0.43)	-0.09 (0.23)	-0.06 (0.22)	-0.90** (0.37)	-0.51 (0.43)	-90.61** (36.87)
GS (When GS>17.76)	4.31*** (0.20)	4.49*** (0.99)	9.38*** (2.15)	4.57*** (1.02)	4.21*** (0.96)	9.37 (2.41)	9.38*** (2.13)	9.38*** (2.40)
Oil	-0.10 (0.18)	-	0.41*** (0.08)	-	-0.10 (0.07)	-	0.42*** (0.07)	-
Gm2	0.64*** (0.08)	0.61*** (0.09)	-	0.61*** (0.09)	0.65*** (0.10)	-	-	-
UN	0.07 (0.18)	-	-	0.06 (0.15)	-	0.13 (0.32)	-0.01 (0.40)	-
Threshold Value (P-Value)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)
Adjusted R^2	0.77	0.76	0.57	0.75	0.77	0.53	0.57	0.53

Note: ***, **and * represent the significance levels at 1%, 5% and 10%, respectively. Standard errors and P-values are in parentheses for the coefficients and the threshold value, respectively.
Source: Research finding.

Table 6. Dynamic Threshold Panel Model with Government Size as a Threshold Variable (GMM Method)

	Model 1	Model2	Model3	Model4	Model5	Model 6	Model7	Model 8
Inf(-1)	0.39*** (0.01)	0.38*** (0.001)	0.40*** (0.001)	0.37*** (0.001)	0.38*** (0.003)	0.41*** (0.001)	0.40*** (0.001)	0.41*** (0.0006)
GS (When GS<=**17.76**)	-0.96** (0.46)	-1.09*** (0.18)	-1.07*** (0.28)	-1.13*** (0.28)	-1.09*** (0.29)	-1.08*** (0.08)	-0.87*** (0.32)	-1.01*** (0.06)
GS (When GS>**17.76**)	3.99*** (0.10)	3.56*** (0.02)	3.49*** (0.03)	3.53*** (0.01)	3.99*** (0.03)	3.31*** (0.009)	4.06*** (0.04)	3.21*** (0.01)
Oil	0.23** (0.09)	-	0.13*** (0.01)	-	0.16*** (0.03)	-	0.22*** (0.01)	-
Gm2	0.01 (0.01)	0.06*** (0.002)	-	0.06*** (0.001)	0.02*** (0.004)	-	-	-
UN	0.03 (0.61)	-	-	0.28 (0.19)	-	-0.18*** (0.06)	-1.25*** (0.32)	-
Arellano–Bond AR(1)	-4.30 (0.00)	-4.67 (0.00)	-3.83 (0.00)	-4. 49 (0.00)	-4.33 (0.00)	-3. 95 (0.00)	-3.57 (0.00)	-3.98 (0.00)
Arellano–Bond AR(2)	0.53 (0.59)	0.54 (0.58)	-1.54 (0.12)	0.48 (0.62)	0.46 (0.64)	-1.44 (0.14)	-1.01 (0.31)	-1.66 (0.09)
J-statistic	7.08 (0.42)	9.22 (0.41)	8.12 (0.52)	8.80 (0.35)	7.62 (0.47)	10.70 (0.29)	8.46 (0.38)	11.69 (0.30)
Threshold Value (P-Value for F_1-Test)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)	17.76 (0.00)
P-Value for F_2-Test	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Interval Confidence for Threshold Value (at 5% Significance Level)	[17.74, 18.45]	[17.74, 18.45]	[17.71, 18.45]	[17.71, 18.45]	[17.71, 18.45]	[17.71, 18.45]	[17.71, 18.45]	[17.71, 18.45]

Note: ***, **and * represent the significance levels at 1%, 5% and 10%, respectively. Standard errors and P-values are in parentheses for the coefficients and the Arellano–Bond and J-statistic tests, respectively.
Source: Research finding.

Tables 4, 5, and 6 show the estimation results of both the static and dynamic threshold panel models. Tables 4 and 5 provide the results of the threshold panel model according to equation (2), which includes the estimated threshold level of government size. According to the results of the linearity tests shown in Tables 4, 5, and 6, the threshold effect in the model is significant. In addition, the results of F_2 test for dynamic models indicate that we cannot reject the null hypothesis of one threshold vale at 5% significance level. Consequently, there is only one threshold value. Furthermore, the confidence intervals for the threshold value are rather tight for all dynamic threshold panel models.

According to the estimation results in both threshold models, government size has a non-linear impact on inflation. The threshold value of government size is estimated as 17.76% for all the threshold panel models with different control variables. Below this level of government size, in most fixed and random effect models, government size and inflation rate exhibit a negative relationship (insignificant or significant), i.e., with increasing government size inflation decreases. However, above this critical level of government size, in all static threshold models, there is a positive relationship between government size and inflation, i.e., an increase in government size will increase inflation. Also in all dynamic threshold panel models, there exists a significant U-shaped relationship between government size and inflation in OPEC countries.

These results confirm our hypothesis that government size has a non-linear impact on inflation in OPEC countries[1]. This finding is in line with the theoretical framework regarding supply side effects as discussed by Armey (1995).

Table 7. Government Size of OPEC Countries Comparing with Threshold Level of 17.76%

	Algeria	Angola	Ecuador	Equatorial Guinea	Gabon	Iran	Iraq	Kuwait	Libya	Nigeria	Qatar	KSA	UAE	Venezuela
2000	-	+	-	-	-	-	-	+	+	-	+	+	-	-
2001	-	+	-	-	-	-	-	+	+	-	+	+	-	-
2002	-	+	-	-	-	-	+	+	-	-	-	+	-	-
2003	-	+	-	-	-	-	-	+	-	-	-	+	-	-
2004	-	+	-	-	-	-	+	+	-	-	-	+	-	-
2005	-	+	-	-	-	-	+	-	-	-	-	+	-	-
2006	-	+	-	-	-	-	-	-	-	-	-	+	-	-
2007	-	-	-	-	-	-	+	-	-	-	-	+	-	-
2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2009	-	-	-	-	-	-	+	+		-	-	+	-	-
2010	-	-	-	-	-	-	+	-		-	-	+	-	-
2011	+	+	-	-	-	-	-	-		-	-	+	-	-
2012	+	+	-	-	-	-	-	-		-	-	+	-	-
2013	+	+	-	-	-	-	+	-		-	-	+	-	-
2014	+	+	-	-	-	-	+	-		-	-	+	-	-
2015	+	-	-	+	-	-	+	+		-	+	+	-	-

Note: Symbol (+/-) indicating whether the corresponding observation is in the upper or lower regime of government size (Symbol + for GS>17.76%. and symbol – for GS<17.76%)
Source: Research finding.

1. As a robustness check, we re-estimated both the dynamic threshold and linear panel models leaving out the observations for Venezuela and Angola, which show the highest inflation rates among all OPEC countries. The results indicate that the qualitative findings regarding the nonlinear impact of government size on inflation do not change.

Table 7 indicates which countries have been above/below the threshold level of government size during the period of 2000-2015. Table 7 shows that the countries Ecuador, Gabon, Iran, Nigeria, UAE and Venezuela were below the threshold level of government size in the considered period. The government size of KSA was above the threshold level for the whole period except in 2008. Also in Angola and Iraq in most of the years from 2000 to 2105, the government size was above the threshold value.

The growth of broad money has a significant positive impact on inflation in most of the threshold panel models – except Model 1 in Table 6, where the coefficient is not significant) –that is consistent with the monetary theory of inflation. However, the size of the estimated coefficient is very small. These small estimates together with the large estimated coefficients of government size confirms that the OPEC economies may be good examples for the weak form of the fiscal theory of inflation also emphasized by Sargent (1982).

As in the linear models, the unemployment rate has no significant impact on inflation in most of the estimated threshold panel models, which is at odds with the existence of a relationship as described by the Keynesian Philips Curve for the OPEC countries. This finding may be rather consistent with the new classical theory of the Philips curve as well as with the monetarist long run theory of the Philips curve. This finding suggests that the policy makers in these countries cannot use demand side policies like monetary and fiscal expanding policies for decreasing unemployment because there is not a robust tradeoff between inflation and unemployment. Instead, it might be better to pursue supply side policies like reforming the institutional framework and investing on research and development in order to decrease unemployment.

The oil rent (as percentage share of GDP) exhibits a significant positive impact on inflation in most of the threshold panel models, especially in the dynamic versions. Thus, it seems that the oil rent is a relevant source of inflation in OPEC countries. As already described, oil revenue accrues in non-domestic currency ("petrodollars"). In order to use this income for funding of government expenditures, the petrodollars have to be exchanged for domestic currency at the central bank. If this process is not neutralized by open market policies, it results in the creation of new base money. Eventually, if output does not grow at the same pace as the money creation does (due to the oil income), inflation might increase.

In dynamic threshold model, the first lag of inflation is significant in all models that indicate the inflation expectation has a significant positive impact on inflation that is consistent with monetary theory of inflation. Furthermore, it shows that the dynamic models may have more efficient estimation than static threshold models. Arellano and Bond (1991)'s test indicates that the null hypothesis of no first-order autocorrelation was rejected while the second-order autocorrelation was not confirmed. Also, the results of J-statistic indicate that the null hypothesis of erogeneity of instrument variables has not been rejected in all dynamic threshold models.

Finally, comparing the results of the linear quadratic models with the threshold models also confirms our hypothesis that there is a threshold impact of government size on inflation in OPEC countries.

Conclusion

The paper presents empirical evidence on the relationship between government size and the inflation rate in OPEC countries. Taking into account potential non-linearities, both with regard to the level of the inflation rate and the impact of government size, different static and dynamic linear and threshold models are estimated for the inflation rate. The estimation results confirm that the impact of government size on inflation is non-linear. For a government size below the threshold defined implicitly by the estimated threshold models and the linear models allowing for a quadratic form of the impact of government size, an increase in government size has a significant negative impact on inflation, while the sign of the effect changes for higher values of government size.

For the unemployment rate, no significant effect on inflation is found in most of the linear and nonlinear panel models, which is considered as support for the new classical theory of the Philips curve as well as for the concept of a long run Philips curve in monetary theory. This finding suggests that policy makers in these countries may rather focus on supply side policies to decrease unemployment in their countries as no significant link between unemployment rate and inflation rate is found.

Furthermore, in most of the linear and nonlinear models, the broad money growth and oil rent have a significant positive impact on inflation. The small size of the coefficient of the growth of broad money alongside the large size of the coefficient of government size may be taken as confirmation of the weak form of the fiscal theory also emphasized by Sargent (1982).

Summing up, our findings differ from previous studies such as Grilli et al. (1991), Campillo and Miron (1997) and Han and Muligan (2008) who found a linear relationship between government size and inflation. Han and Muligan (2008) indicate that there is a slightly positive correlation between inflation and defense spending. Additionally, there seems to be a slightly negative correlation between inflation and non-defense spending. The result of Han and Muligan (2008) is contrary to other studies such as Grilli et al. (1991) and Campillo and Miron (1997) who found a positive correlation between inflation and government size. Our results suggest that it is possible to explain the contradictory evidence of these previous studies by making use of a non-linear model for the relationship between inflation and government size at least for the case of OPEC countries. Furthermore, our findings imply that policy makers in OPEC countries may make use of the link between government expenditures and inflation in order to control the latter. Given that according to the results of the linear and nonlinear dynamic models the oil rent has a significant positive impact on inflation, policy makers in OPEC countries may also influence inflation by regulating the oil price or their quota in the supply of oil. In principle, they could save their excess oil income when the price is high to deal with a budget deficit that might come up when facing negative oil price shocks.

Future research might focus on the specific institutional setting and economic structure of OPEC countries to understand better what triggers the identified non-linear relationships. A deeper understanding of these mechanisms together with the empirical findings provided might help to improve economic policy targeting the high and volatile inflation rate in some OPEC countries like as Angola, Venezuela and Iran.

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Appendix:

Table I. Unit Root Tests

Variables	ADF - Fisher Chi-square	P-Value	Levin, Lin & Chu t	P-Value	PP- Fisher Chi-Square	P-Value
inf_{it}	388.56	0.00	-23.54	0.00	595.83	0.00
inf_{it-1}	87.24	0.00	-25.66	0.00	101.70	0.00
gs_{it}	55.28	0.00	-2.83	0.00	55.67	0.00
gs_{it}^2	56.09	0.00	-2.71	0.00	59.17	0.00
$gm2_{it}$	66.91	0.00	-6.84	0.00	75.95	0.00
un_{it}	73.92	0.00	-6.83	0.00	42.41	0.03
oil_{it}	44.60	0.02	-3.99	0.00	47.77	0.01

Note: Probabilities for the PP-Fisher test are computed using an asymptotic Chi-square distribution. The other tests assume asymptotic normality.
Source: Research finding.