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Keywords Economic growth, natural resource curse, institutions, oil price volatility, oil income, macroeconomic policy

JEL Classification C23, E02, F43, O13, Q32

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Oil, Volatility and Institutions: Cross-Country Evidence from Major Oil Producers*

Amany El-Anshasy[a], Kamiar Mohaddes[b†], and Jeffrey B. Nugent[c]

[a] Department of Economics and Finance, United Arab Emirates University, UAE

[b] Faculty of Economics and Girton College, University of Cambridge, UK

[c] Department of Economics, University of Southern California, USA

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[†] Corresponding author. Email address: km418@cam.ac.uk.

1 Introduction

According to the resource curse paradox, abundance of oil (natural gas, minerals and other non-renewable resources) is believed to be an important determinant of economic failure. This paper investigates whether the poor performance of resource-rich countries, when compared to countries which are not endowed with oil, is due to the abundance of oil in itself or whether instead the curse is due to price volatility in global oil markets and production volatility due to political factors (for instance, wars, and sanctions). More importantly, we try to establish whether there is a role for institutions and the government (fiscal policy) in offsetting some of the negative growth effects due to the curse.

There are different explanations for why resource-rich economies might be subject to a curse. Dutch disease (see Corden and Neary 1982, Neary and van Wijnbergen 1986, and Krugman 1987) is one of the channels through which the resource curse makes itself felt: an increase in natural resource revenue leads to an appreciation of the real exchange rate, which raises the cost (in foreign currency) of exports of the products of other industries, making them less competitive with possible negative effects on economic activity. Economic growth might also be adversely affected by the resulting re-allocation of resources from the high-tech and high-skill manufacturing sector to the low-tech and low-skill natural resource sector. Another explanation for the resource curse paradox focuses on the political economy considerations and argues that large windfalls from oil and other resources create incentives for the rent-seeking activities that involve corruption (Mauro 1995 and Leite and Weidmann 1999), voracity (Lane and Tornell 1996 and Tornell and Lane 1999), and possibly civil conflicts (Collier and Hoeffler 2004). Some of these considerations have been recently formalized by Caselli and Cunningham (2009), with a recent survey provided in van der Ploeg and Venables (2009).[1] A number of recent empirical works have also focused on the role of institutions. Mehlum et al. (2006) and Béland and Tiagi (2009), using a cross-sectional approach, show that the impact of natural resources on growth and development depends primarily on institutions, while Boschini et al. (2007) illustrate that the type of natural resources possessed is also an important factor. These authors argue that, when one controls for institutional quality and includes an interaction term between institutional quality and resource abundance, a threshold effect arises. This suggests there are levels of institutional quality above which resource abundance becomes growth enhancing.

Empirical support for the resource curse was originally provided by Sachs and Warner (1995) who showed the existence of a negative relationship between real GDP growth per

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[1] See Sachs and Warner (1995) and Rosser (2006) for an extensive examination of these prominent accounts of the natural resource curse paradox.

capita and different measures of resource abundance, such as the ratio of resource exports to GDP, even when controlling for institutional quality. However, the empirical evidence on the resource curse paradox is rather mixed. Most papers in the literature tend to follow Sachs and Warner's cross-sectional specification introducing new explanatory variables for resource dependence/abundance, while others derive theoretical models that are loosely related to their empirical specification. Some of these papers confirm Sachs and Warner's results; see, for instance, Rodriguez and Sachs (1999), Gylfason, Herbertsson, and Zoega (1999), and Bulte, Damania, and Deacon (2005) among others. An important drawback of these studies with few exceptions, however, is their measure of resource abundance. Brunnschweiler and Bulte (2008) argue that the so-called resource curse does not exist when one uses the correct measure of resource abundance in regressions. They also show that while resource dependence, when instrumented in growth regressions, does not affect growth; resource abundance in fact positively affects economic growth.

There are also a number of other reasons why the econometric evidence on the negative effects of resource abundance on output growth might be questioned. Firstly, the literature relies primarily on a cross-sectional approach to test the resource curse hypothesis, and as such does not fully take account of the time dimension of the data. Secondly, a cross-sectional growth regression augmented with the resource abundance variable could suffer from endogeneity and omitted variable problems, and this is perhaps the most important reason for being skeptical about the econometric studies suggesting a positive or negative association between resource abundance and growth. For example, Alexeev and Conrad (2009) show evidence against the resource curse hypothesis by considering a few additional regressors, such as exogenous geographical factors.

In addition, even when panel data techniques are used, most studies make use of homogeneous panel data models, such as fixed and random effects estimators, the instrumental variable (IV) technique proposed by Anderson and Hsiao (1981, 1982), and the generalized methods of moments (GMM) model of Arellano and Bond (1991) and Arellano and Bover (1995), among others.[2] While homogeneous panel data models allow the intercepts to differ across countries all slope parameters are constrained to be the same. Therefore, a high degree of homogeneity is still imposed. As discussed in Pesaran and Smith (1995), the problem with these dynamic panel data techniques, when applied to testing growth effects, is that they can produce inconsistent and potentially very misleading estimates of the average values of the parameters, since growth regressions typically exhibit a substantial degree of cross-sectional heterogeneity.

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[2] For a comprehensive survey of the econometric methods employed in the growth literature, and some of their shortcomings, see Durlauf et al. (2005, 2009).

Accounting for (some of) these shortcomings and using appropriate econometric techniques, the recent empirical literature seems to provide evidence against the conventional resource curse literature and argues for the positive effect of resource abundance on development and growth, see for instance Arezki and van der Ploeg (2007), Cavalcanti et al. (2011b, 2014), and Esfahani et al. (2013, 2014). Moreover, while Cavalcanti et al. (2014) and van der Ploeg and Poelhekke (2010) show a direct positive effect of resource abundance on growth, they provide evidence for the negative relationship between resource volatility and growth. Cavalcanti et al. (2014) also demonstrate that volatility exerts a negative impact on economic growth operating mainly through lower accumulation of physical capital.[3]

Using annual (and monthly) data on a sample of 17 major oil producers over the period 1961–2013, we study the long-run effects of oil revenue and its volatility (an annual country-specific measure of revenue volatility) on economic growth under varying institutional quality. In contrast to the earlier literature on the resource curse we take into account all three key features of the panel (dynamics, heterogeneity and cross-sectional dependence), using the autoregressive distributed lag (ARDL) approach as well as its cross-sectionally augmented version (CS-ARDL) for estimation. Our results suggest that (i) there is a significant negative effect of oil revenue volatility on output growth, (ii) higher growth rate of oil revenue significantly raises economic growth, and (iii) better fiscal policy (proxied by institutional quality) can offset some of the negative effects of oil revenue volatility. We therefore argue that volatility in oil revenues combined with poor governmental responses to this volatility drives the resource curse paradox, not the abundance of oil revenues as such.

The rest of this paper is organized as follows. Section 2 describes the data used in our analysis and offers some preliminary evidence on the impacts of oil abundance and the volatility of oil revenue on economic growth. In Section 3 we estimate the long-run growth effects oil revenue and its volatility, and then investigate the role of institutions in dampening the negative effects of the oil curse. Finally, Section 4 offers some concluding remarks.

2 Preliminary evidence based on correlations

We start by providing some preliminary evidence on the oil curse, in particular looking at the relationship between oil abundance and economic growth as well as the volatility-growth

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[3] Most closely related to our paper is Cavalcanti et al. (2014), but our paper differs from theirs in many dimensions. First, we investigate the long-run effects of oil revenue volatility instead of the volatility of commodity terms of trade (CToT). Second, our annual *realized* oil volatility measure is based on monthly data, while they *estimate* the volatility of the commodity terms of trade from a GARCH(1,1) model on annual observations. Third, and more importantly, we formally investigate the role of institutions and the government (fiscal policy) in dampening the negative effects of the resource curse, which they do not consider.

relationship. But first we begin with a description of the data used in this paper. The primary source of real GDP data used for computing growth rates in real terms is annual data taken from the World Bank's *World Development Indicators* (WDI) database. However, since we want to allow for slope heterogeneity across countries, we need a sufficient number of time periods to estimate country-specific coefficients. To this end, we extended the sample for several countries by splicing the real GDP series using the *Penn World Table Version 8.0* database, from which we also obtained total factor productivity (TFP) data. Moreover, we obtain annual and monthly data on oil prices and oil production from the International Monetary Fund's *International Financial Statistics* database.

Table 1: List of the 17 Countries in the Sample

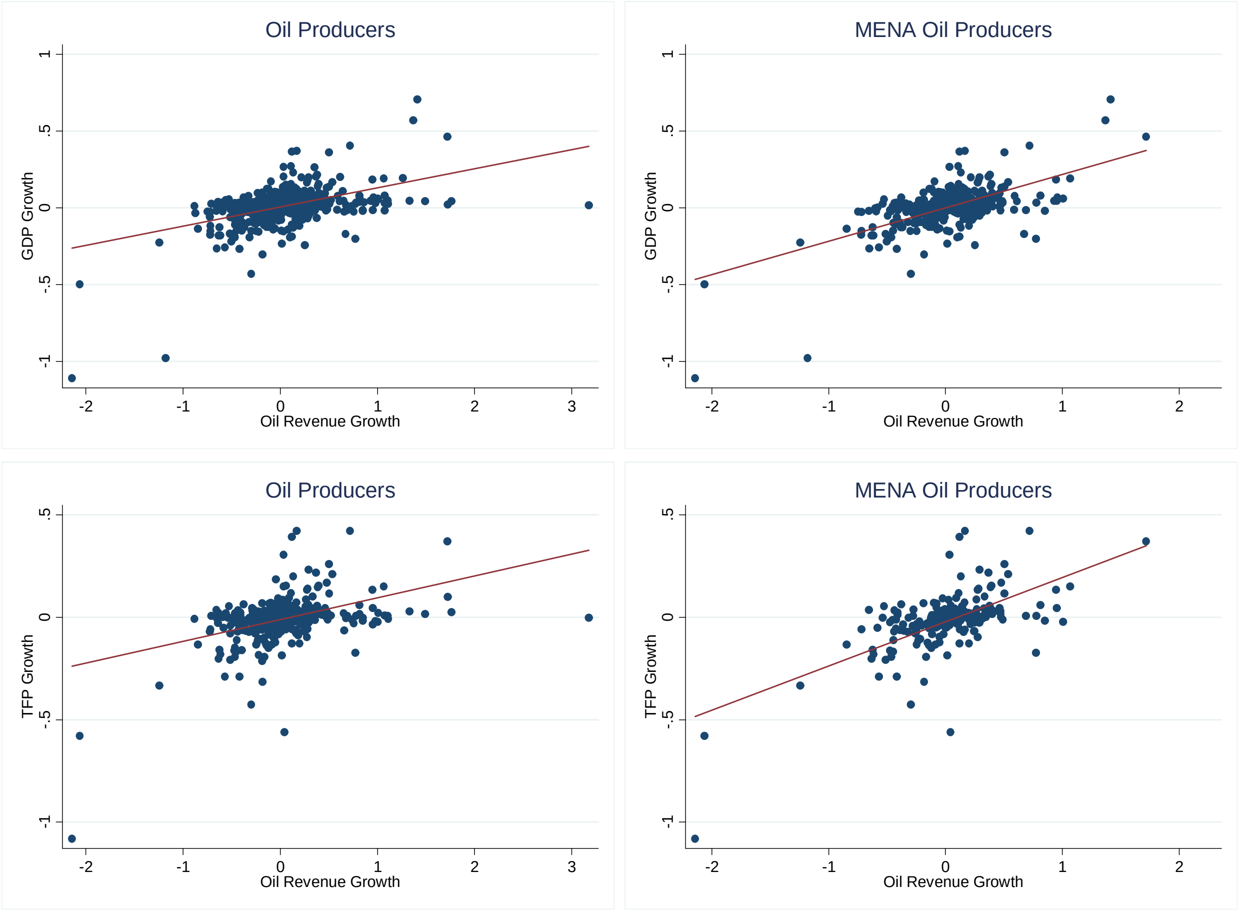
MENA Oil Producers	Other Oil Producers
Algeria*	Ecuador*
Bahrain	Indonesia
Iran*	Nigeria*
Iraq*	Mexico
Kuwait*	Norway
Libya*	United States
Oman	Venezuela*
Qatar*	
Saudi Arabia*	
United Arab Emirates*	

Notes: * indicates that the country is a current member of the Organization of the Petroleum Exporting Countries (OPEC).

We included as many oil exporting countries from the MENA region for which we have data on oil production. However, since we are interested in employing heterogeneous panel estimates (rather than pooling the data) we only include countries in our sample for which we have at least 30 consecutive annual observations ($T_i \geq 30$) on GDP growth, oil prices and oil production. Given this requirement on the time-series dimension, we end up with the following ten MENA countries: Algeria, Bahrain, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, and United Arab Emirates (UAE).

However, we are not only interested in the experience of MENA oil producers, but also those of other major oil producers in the rest of the world (for which the same data requirements are satisfied), which may add more in the way of diversity with respect to levels of per capita income and institutional quality. Specifically, therefore, we add three non-MENA members of the Organization of the Petroleum Exporting Countries (OPEC) (Ecuador, Nigeria, and Venezuela), a former member of OPEC (Indonesia) and three countries which are members of the Organization for Economic Co-operation and Development (Mexico, Norway, and United States). To capture the influence of these institutional differences we also include an aggregate institutional quality index based on data from the Political Risk Services Group (PRSG). Thus our full sample includes 17 oil producers (Table 1), from both advanced and developing parts of the world, some with a lot more diversified economies than others, and some with better (fiscal and monetary) institutions than others. The numbers of observations in the time series per country vary between 30 and 53, covering wherever possible the period 1961 to 2013.

Figure 1: Scatter Plots of Oil Revenue Growth against Real GDP and TFP Growth Rates, 1961-2013

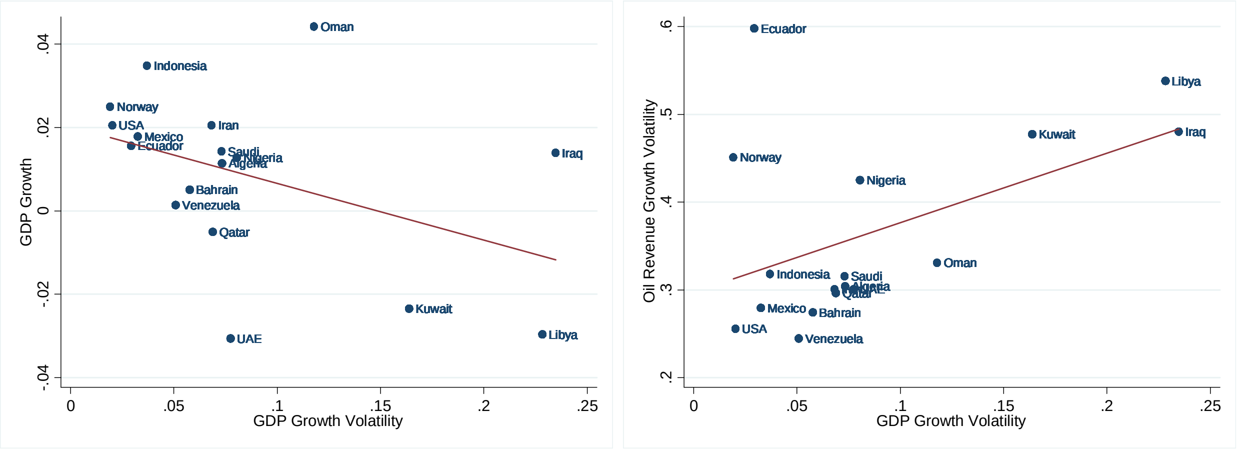


Source: Authors' calculation based on data from World Bank *World Development Indicators* (WDI), *Penn World Table Version 8.0*, and International Monetary Fund *International Financial Statistics* databases.

Figure 1 illustrates the simple bivariate relationship between oil revenue growth and the growth of real GDP per capita based on the 17 countries in our sample over the period 1961-2013. The figure reveals a mild positive correlation between the two variables. If we look at this same relationship for the ten MENA countries alone, we see that this positive relationship still exists and is potentially slightly stronger. To examine alternative channels through which management of resource revenues can potentially affect GDP growth rates, we also plot in Figure 1 the relationship between the growth rate of real total factor productivity (TFP) and that of real oil revenue. This relationship is clearly positively related and once again, the relationship seems stronger in the sample of the ten MENA oil producers.

As noted in some of the most recent literature on the topic (see Section 1), there seems to be growing support for the view that it is the volatility in commodity prices and revenues in particular, rather than oil (natural resource) abundance *per se*, that drives the resource curse paradox. See, for instance, Cavalcanti et al. (2014). In Figure 2 we plot the relationship between real GDP per capita growth and its volatility (measured by its standard deviation over the full sample). In this case, we see a rather clear negative relationship between the two variables. The observation that higher volatility in output dampens growth was in fact discussed extensively in the seminal paper of Ramey and Ramey (1995). However, we also note that for major oil producers there is a positive relationship between the volatility in oil revenue and GDP growth suggesting therefore, that there seems to be some evidence that the excess volatility in oil prices and production is associated with higher volatility in GDP growth, which in turn has a negative effect on output growth.

Figure 2: Scatter Plots of GDP Growth and Volatility of Oil Revenue Growth against Volatility of GDP Growth, 1961-2013



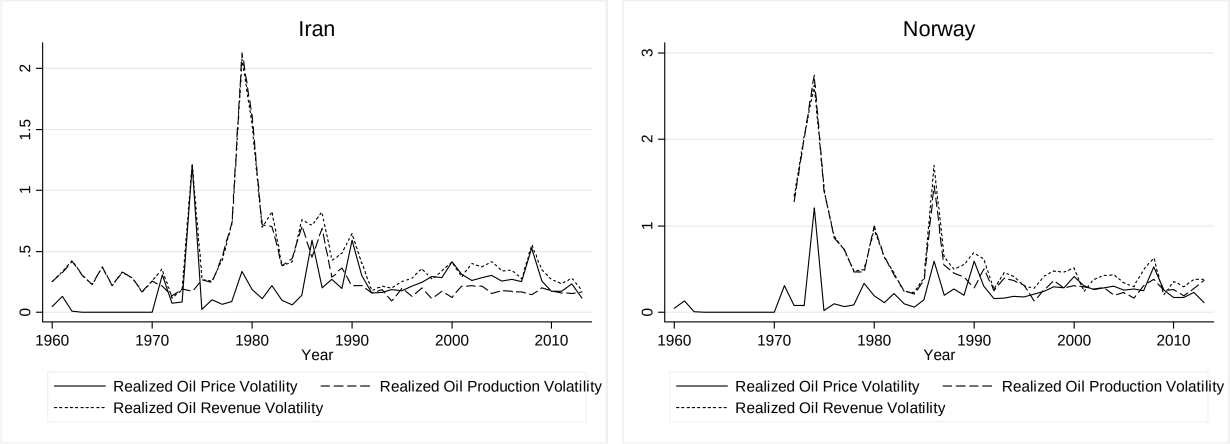
Source: These are cross-sectional averages over 1961-2013. See also notes to Figure 1.

To investigate the consequences of excess volatility of oil revenues for long-run growth, and given that we want to utilize the time-varying dimension of volatility (rather than using the standard deviation over 1961-2013), we follow the finance literature and use a measure of realized oil price volatility, see Mohaddes and Pesaran (2014) for more details. Our measure of realized oil revenue volatility for year t is then given by

$$vol_t^o = \sqrt{\sum_{\tau=1}^{12} \left(g_{t,\tau}^o - \overline{g}_t^o\right)^2} \tag{1}$$

where $g_{t,\tau}^o = \Delta \ln(R_{t,\tau}^o)$, $\overline{g}_t^o = \frac{1}{12}\sum_{\tau=1}^{12} g_{t,\tau}^o$, and $g_{t,\tau}^o$ denotes the rate of change in oil revenue $\left(R_{t,\tau}^o\right)$ during month τ in year t. The same method is also used to calculate annual volatilities of oil production and oil prices. While, as noted in the introduction, there are a few empirical papers in the literature investigating the volatility channel of impact, they focus on commodity price volatility rather than on resource revenue volatility (see, for instance, Cavalcanti et al. 2014). However, the volatility of commodity prices is not the only factor impacting resource-rich economies and in fact, the theoretical growth model for major oil exporting economies developed in Esfahani et al. (2014) shows that it is the volatility of production/export revenues that matters in terms of long-run growth.

Figure 3: Realized Volatility of Oil Prices, Production, and Revenues, 1961–2013

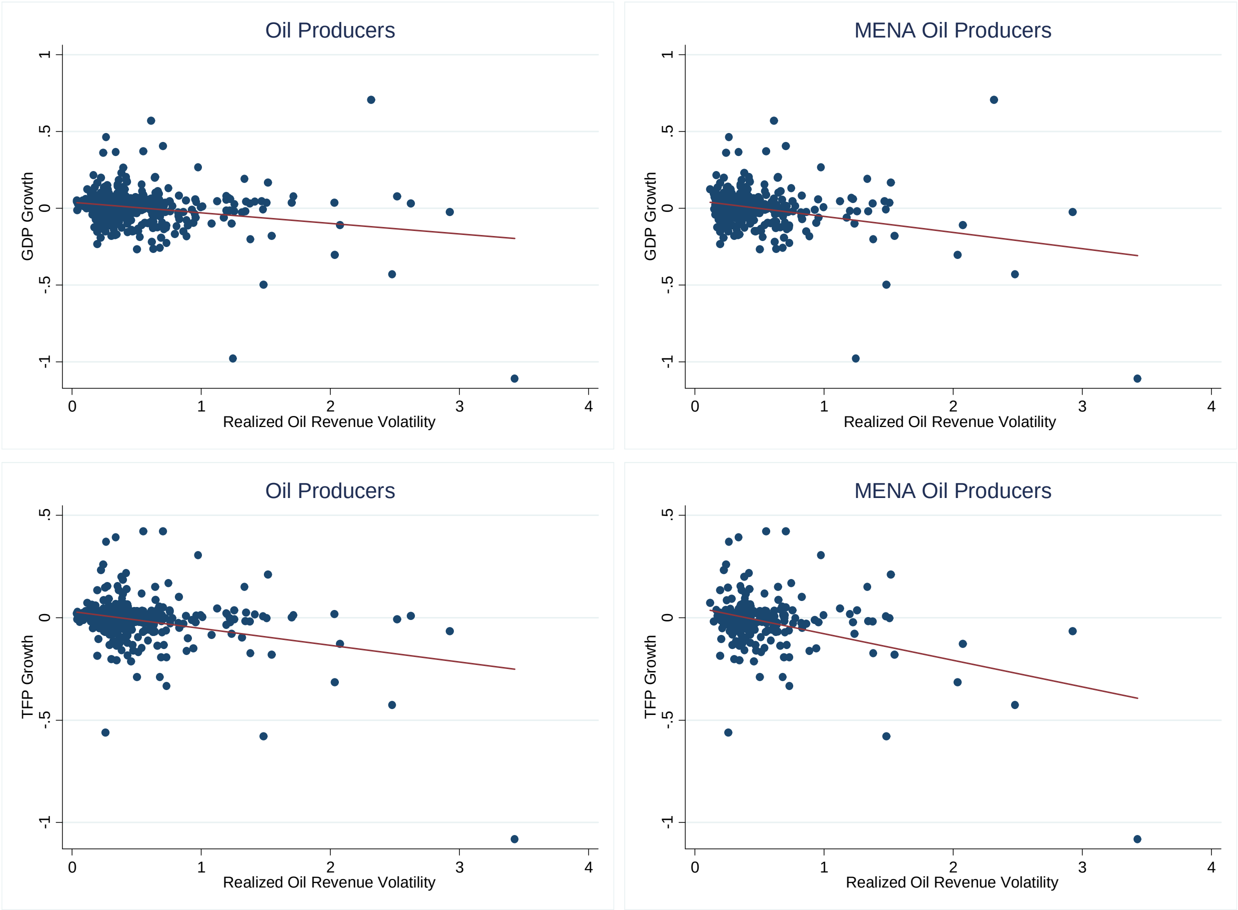


Source: See notes to Figure 1.

To give an example we plot the realized volatilities of oil prices, production and revenue for Iran and Norway in Figure 3, from which we see that oil price volatility was rather small before 1970. This is not surprising as during this period oil prices were largely regulated by the major international oil companies. Substantial volatility was first experienced due to the first (1973/74) and second oil price shocks (1978/79) after which volatility continued to remain a major feature of the oil markets. Moreover, with the OPEC pricing system collapsing in 1985, crude oil prices were instead determined by international markets alone, which resulted in further price volatility. However, this figure clearly shows that volatility of oil production was also important for these two economies, with revenue volatility being substantially larger than oil price volatility in almost all years and for both countries. Therefore it is the combined effects of price and quantity volatilities that should be considered in our analysis and so we only report the results using revenue volatility below.

We plot the realized oil revenue volatility against growth rates of real GDP and TFP for the 17 major oil producers in our sample. As expected, Figure 4 shows the negative association between the GDP growth and realized volatility (based on annual data) for both the full sample and for MENA oil producers only. This negative relationship is also evident in the case of TFP growth and realized oil revenue volatility.

Figure 4: Scatter Plots of Realized Oil Revenue Volatility against Real GDP and TFP Growth Rates, 1961-2013



Source: See notes to Figure 1.

Overall the scatter plots in Figures 1 and 4 seem to suggest that while oil revenue enhances real output per capita growth (as well as TFP growth), volatility exerts a negative impact on economic growth operating mainly through lower productivity. These preliminary findings, although in contrast to the 'traditional' resource curse literature, are supported in the recent literature, see Cavalcanti et al. (2011b, 2014), Esfahani et al. (2013, 2014), Mohaddes and Pesaran (2014), and van der Ploeg and Poelhekke (2009). Below we will use an autoregressive distributed lag (ARDL) specification as well as the cross-sectionally augmented ARDL (CS-ARDL) approach for estimation in order to investigate whether the above results continue to hold up once we deal with, for instance, possible endogeneity problems and cross-sectional dependence. We will also investigate the potential role of institutions in dampening the negative effects of resource revenue volatility on growth as was seen in Figure 4.

3 Estimates of the long-run effects

To explore the importance of heterogeneities, dynamics, and simultaneous determination of oil revenue, volatility, and growth, we begin with the following baseline panel autoregressive distributed lag (ARDL) specification

$$\Delta y_{it} = c_i + \sum_{\ell=1}^{p} \varphi_{i\ell} \Delta y_{i,t-\ell} + \sum_{\ell=0}^{p} \boldsymbol{\beta}_{i\ell}' \mathbf{x}_{i,t-\ell} + u_{it}, \tag{2}$$

where y_{it} is the log of real GDP for country i at time t, $\mathbf{x}_{it} = \left(\Delta oil_{it},\ \sigma_{it}^{oil}\right)'$, oil_{it} is the log of real oil revenue, and σ_{it}^{oil} is the realized volatility of oil revenues. Given that we are working with growth rates which are only moderately persistent, a lag order of 3 should be sufficient to fully account for the short-run dynamics. We therefore use the same lag order (p) for all variables/countries, but consider different values of p in the range of 1 to 3. Having estimated (2), we obtain the long-run Mean Group (MG) effects, $\widehat{\boldsymbol{\theta}}_i$, from the OLS estimates of the short-run coefficients, $\widehat{\boldsymbol{\beta}}_{i\ell}$ and $\widehat{\varphi}_{i\ell}$, using

$$\boldsymbol{\theta}_i = \frac{\sum_{\ell=0}^{p} \boldsymbol{\beta}_{i\ell}}{1 - \sum_{\ell=1}^{p} \varphi_{i\ell}} \tag{3}$$

Finally, to obtain the Pooled Mean Group (PMG) estimates, the individual long-run coefficients are restricted to be the same across countries, namely

$$\boldsymbol{\theta}_i = \boldsymbol{\theta}, \qquad i = 1, 2, ..., N. \tag{4}$$

First, note that ARDL specification above also allows for a significant degree of cross-country heterogeneity and accounts for the fact that the effect of oil revenue and realized volatility on growth could vary across countries, depending on country-specific factors such as institutions, geographical location, or cultural heritage. Second, in a series of papers, Pesaran and Smith (1995), Pesaran (1997), and Pesaran and Shin (1999) show that the traditional ARDL approach can be used for long-run analysis, and that the ARDL methodology is valid regardless of whether the regressors are exogenous, or endogenous, and irrespective of whether the underlying variables are stationary or non-stationary. Clearly these features of the panel ARDL approach are appealing as reverse causality could be very important in our empirical application.

Table 2: Mean Group (MG) and Pooled Mean Group (PMG) Estimates of the Long-Run Effects on Real GDP Growth, 1961-2013

(a) Based on the ARDL Approach

	ARDL (1 lag)		ARDL (2 lags)		ARDL (3 lags)	
	MG	PMG	MG	PMG	MG	PMG
$\widehat{\theta}_{\Delta oil}$	0.139***	0.101***	0.138***	0.133***	0.106***	0.085***
	(0.029)	(0.010)	(0.028)	(0.013)	(0.037)	(0.015)
$\widehat{\theta}_{\sigma}$	-0.064***	-0.057***	-0.057***	-0.069***	-0.050*	-0.041**
	(0.014)	(0.010)	(0.013)	(0.011)	(0.026)	(0.016)
$\widehat{\lambda}$	-0.861***	-0.744***	-0.892***	-0.736***	-0.894***	-0.626***
	(0.072)	(0.080)	(0.116)	(0.110)	(0.153)	(0.071)
$N \times T$	721	721	703	703	685	685

(b) Based on the Cross-Sectionally Augmented ARDL (CS-ARDL) Approach

	CS-ARDL (1 lag)		CS-ARDL (2 lags)		CS-ARDL (3 lags)	
	MG	PMG	MG	PMG	MG	PMG
$\widehat{\theta}_{\Delta oil}$	0.221***	0.235***	0.199***	0.207***	0.243***	0.326***
	(0.062)	(0.021)	(0.062)	(0.019)	(0.062)	(0.039)
$\widehat{\theta}_{\sigma}$	-0.036***	-0.057***	-0.025*	-0.065***	-0.027	-0.028*
	(0.009)	(0.010)	(0.013)	(0.009)	(0.037)	(0.016)
$\widehat{\lambda}$	-0.843***	-0.687***	-0.898***	-0.712***	-0.855***	-0.634***
	(0.059)	(0.076)	(0.085)	(0.074)	(0.101)	(0.096)
$N \times T$	715	715	700	700	685	685

Notes: The ARDL and CS-ARDL specifications are given by equations (2) and (5) respectively. The dependant variable is the growth rate of real GDP, Δy_{it}. $\widehat{\theta}_{\Delta oil}$ is the coefficient of the growth rate of real oil revenue (oil_{it}), $\widehat{\theta}_{\sigma}$ is the coefficient of the realized volatility of oil revenues (σ_{it}^{oil}), $\widehat{\lambda}$ is the coefficient of the error-correction term, $\widehat{\boldsymbol{\theta}}_i = \widehat{\lambda}_i^{-1} \sum_{\ell=0}^{p} \widehat{\boldsymbol{\beta}}_{i\ell}$, and $\widehat{\lambda}_i = 1 - \sum_{\ell=1}^{p} \widehat{\varphi}_{i\ell}$. Symbols ***, **, and * denote significance at 1%, 5%, and at 10% respectively.

The MG and PMG estimates of equation (2) are reported in Table 2a, from which we can see the positive and significant effects of oil revenue growth on real GDP growth no matter the lag order of the ARDL. These estimates seem to suggest that an increase in oil revenue by 10% can potentially increase GDP growth between 0.85 and 1.33 percentage points. However, we also observe a negative and significant effect of oil revenue volatility on economic growth. This seems to support the evidence in Figures 1 and 4 and is in line with the recent results in the literature. Note that, although the MG and PMG estimates are very similar, given that we are working with a relatively small number of countries, we shall focus on the PMG estimates in this paper. Finally, the results in Table 2 indicate that the error-correction coefficients, $\widehat{\lambda}$ (where $\lambda_i = \sum_{l=1}^{p} \phi_{il} - 1$), fall within the dynamically stable range (being statistically significant and negative); therefore, we obtain evidence for conditional convergence to country-specific steady states. Moreover, the speed of adjustment, based on the estimates from $\widehat{\lambda}$, suggests that it takes 2-3 years before equilibrium is reached, which seems reasonable given that we are working with moderately persistent growth rates.

As discussed in Section 1, we are certainly not the first ones to show the positive effects of oil abundance on output growth. This result is also documented in Cavalcanti et al. (2011a), which base their analysis on a panel of 53 countries (including a number of MENA countries: Algeria, Bahrain, Egypt, Iran, Kuwait, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, and the UAE) over the somewhat shorter period 1980-2006. To check for the robustness of their results they consider three different proxies measuring resource abundance, namely the real value of oil production, the rent component of oil income, and oil reserves (although they do not consider the role of volatility). Irrespective of the particular measure used, they conclude that oil abundance is in fact a blessing and not a curse in the long run as well as in the short run, and challenge the consensus view that oil abundance affects economic growth negatively. The positive effect of resource abundance on development and growth is also supported by Cashin et al. (2014, 2012), Cavalcanti et al. (2011b), Esfahani et al. (2013, 2014), Leong and Mohaddes (2011), and van der Ploeg and Poelhekke (2009, 2010).[4] Therefore, using appropriate econometric techniques, the recent empirical literature seems to provide evidence against the conventional resource curse literature, which argues for an unconditional negative relationship between resource income and growth.

Note, however, that the above panel ARDL methodology assumes that the errors in the oil revenue-volatility-growth relationships are cross-sectionally independent. This assumption is likely to be problematic as there are a number of factors such as exposures to common shocks (i.e. oil price shocks), that could lead to cross-sectional error dependencies, which in turn can lead to badly biased estimates if the unobserved common factors are indeed correlated with the regressors. To overcome this problem, we employ the CS-ARDL approach, based on Chudik and Pesaran (2015), which augments the ARDL regressions with cross-sectional

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[4] Note that none of these studies include a measure of resource revenue volatility in their models.

averages of the regressors, the dependent variable and a sufficient number of their lags, which in our case is set to 3 regardless of p, the lag order chosen for the underlying ARDL specification.[5] More specifically, the cross-sectionally augmented ARDL regressions are given by

$$\Delta y_{it} = c_i + \sum_{\ell=1}^{p} \varphi_{i\ell}\Delta y_{i,t-\ell} + \sum_{\ell=0}^{p} \boldsymbol{\beta}'_{i\ell}\mathbf{x}_{i,t-\ell} + \sum_{\ell=0}^{3} \boldsymbol{\psi}'_{i\ell}\bar{\mathbf{z}}_{t-\ell} + e_{it}, \tag{5}$$

where $\bar{\mathbf{z}}_t = \left(\overline{\Delta y}_t, \bar{\mathbf{x}}'_t\right)'$, $\overline{\Delta y}_t$ and $\bar{\mathbf{x}}_t$ denote the simple cross-sectional averages of Δy_{it} and $\mathbf{x}_{it}$ in year t, and all the other variables are as defined in equation (2).

Table 2b reports the estimates based on the CS-ARDL approach. As before, we have the opposing (and significant) effects of oil revenue growth and its realized volatility on output growth. However, note that, once we deal with cross-sectional dependence, we generally obtain larger coefficients for Δoil_{it} and smaller coefficient for σ_{it}. Nevertheless, the message stays the same: clearly, it is volatility, rather than oil revenue/prices, which drives the oil curse.

Table 3: PMG Estimates of the Long-Run Effects on Real TFP Growth, 1961-2013

	1 lag		2 lags		3 lags	
	ARDL	CS-ARDL	ARDL	CS-ARDL	ARDL	CS-ARDL
$\widehat{\theta}_{\Delta oil}$	0.053***	0.090***	0.054***	0.129***	0.008	0.119***
	(0.009)	(0.012)	(0.011)	(0.015)	(0.013)	(0.019)
$\widehat{\theta}_{\sigma}$	-0.028***	-0.025***	-0.037***	-0.042***	-0.029**	-0.045***
	(0.007)	(0.006)	(0.012)	(0.008)	(0.014)	(0.011)
$\widehat{\lambda}$	-0.722***	-0.747***	-0.697***	-0.711***	-0.703***	-0.656***
	(0.070)	(0.060)	(0.080)	(0.069)	(0.084)	(0.068)
$N \times T$	501	495	488	485	475	475

Notes: The ARDL and CS-ARDL specifications are given by equations (2) and (5) respectively. The dependant variable is the growth rate of real TFP, Δtfp_{it}. $\widehat{\theta}_{\Delta oil}$ is the coefficient of the growth rate of real oil revenue (oil_{it}), $\widehat{\theta}_{\sigma}$ is the coefficient of the realized volatility of oil revenues (σ^{oil}_{it}), $\widehat{\lambda}$ is the coefficient of the error-correction term, $\widehat{\boldsymbol{\theta}}_i = \widehat{\lambda}_i^{-1}\sum_{\ell=0}^{p}\widehat{\boldsymbol{\beta}}_{i\ell}$, and $\widehat{\lambda}_i = 1 - \sum_{\ell=1}^{p}\widehat{\varphi}_{i\ell}$. Symbols ***, **, and * denote significance at 1%, 5%, and at 10% respectively.

To establish whether TFP is a potential channel through which the oil curse operates, we next turn to estimating the long-run effects of volatility and the growth rate of oil revenue on TFP growth. Table 3 reports the PMG estimates based on the ARDL and CS-ARDL specifications. We observe that (as in Table 2 where real output was the dependent variable)

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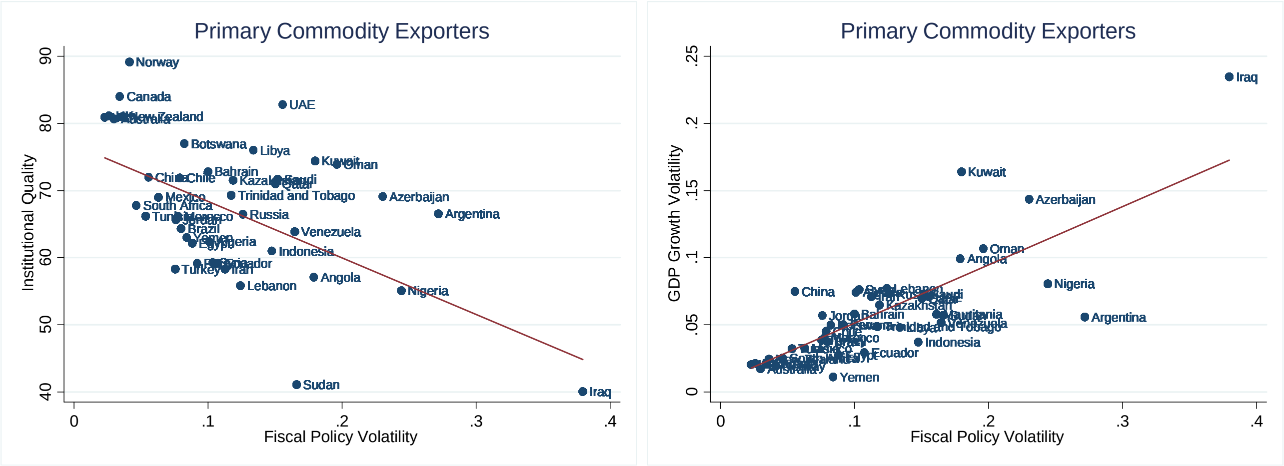
[5] See also Chudik et al. (2013, 2015) for a discussion of the estimation of long-run or level relationships in economics as well as a discussion of the relative merits of the CS-ARDL approach and other existing approaches in the literature.

oil revenue growth (volatility of oil revenue growth) has a statistically significant positive (negative) effect on productivity growth. This positive effect is also documented in Esfahani et al. (2014)—for a number of major oil producers using a VARX* methodology and oil export revenue as their variable—and Cavalcanti et al. (2014)—for 52 major commodity exports using the cross-sectionally augmented PMG approach with commodity terms of trade growth and volatility as their variables. However, this result does not fit well with the Dutch disease hypothesis, which predicts that an increase in oil revenue/prices will lead to real exchange rate appreciation and through that a fall in output in the non-resource and more dynamic traded-goods sector, and in turn leads to a reduction of TFP growth and eventually the GDP growth rate (clearly contradicting the results in Tables 2 and 3). Overall the results in Tables 2–3 seem to suggest that it is oil revenue volatility (rather than the level of oil revenue) which exerts a negative impact on economic growth operating through the TFP channel.

The question is then what is the potential role of institutions and policy makers, and in particular fiscal policy, in dampening this negative effect of oil revenue volatility? To investigate this, we follow Fatás and Mihov (2013) and for each country run a regression of the log difference of government consumption on the log difference of GDP. We then calculate the volatility of the errors from these regressions and label them as "Fiscal Policy Volatility" (FPV). This volatility is interpreted as the component of discretionary policy which is not related to smoothing the business cycle, such as changes in political preferences or the decision by the politicians to generate a short-term boom so as to keep the population happy—as was seen in the GCC following the Arab Spring. Ideally, we would like to include this measure of policy volatility in our ARDL and CS-ARDL regressions, however, given that we only have annual data on government consumption for most of the MENA countries we cannot obtain annual data on FPV, and so we are not able to run panel regressions using FPV. We therefore need to obtain a proxy for FPV, i.e. the changes in fiscal policy which are exogenous to changes in economic conditions and the business cycle.

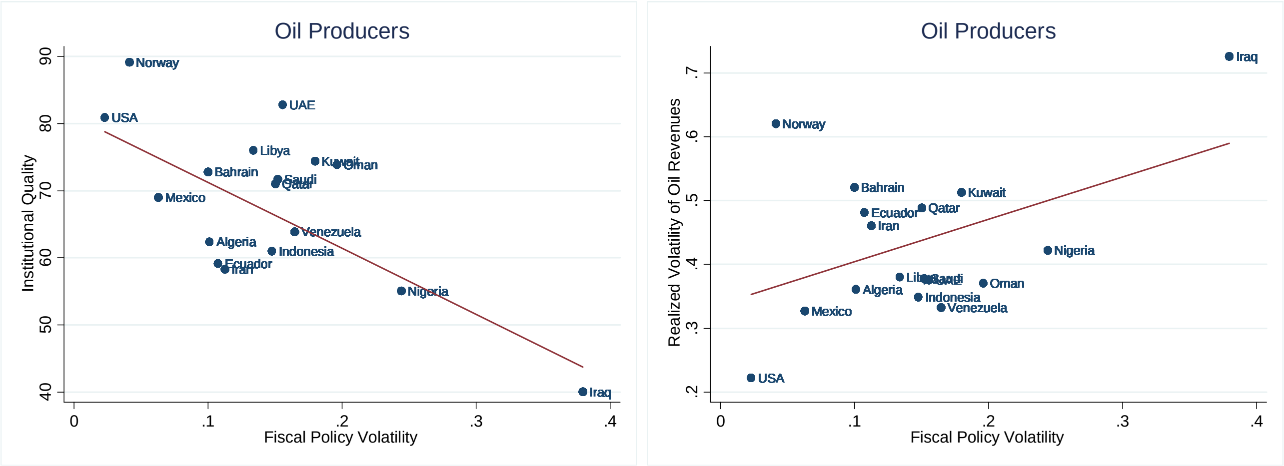
Figure 5 plots the relationship between FPV and institutional quality, based on data from the *Political Risk Services Group* databases. The sample here, in addition to the 17 major oil producers, also includes seven other major primary commodity exporters. Based on data for all primary commodity exporters (oil, gas, minerals etc.) there is clearly a negative relationship between FPV and institutional quality. In fact, Figure 5 also illustrates the strong positive relationship between FPV and GDP growth volatility. Focusing on the 17 original countries in our sample, Figure 6 also shows a strong negative association between institutional quality and policy volatility on the one hand, and a positive relationship between fiscal policy volatility and realized volatility of oil revenues on the other hand. Based on

Figure 5: Scatter Plots of Institutional Quality and GDP Growth Volatility against Fiscal Policy Volatility, 1961-2013



Source: Data on institutional quality and government consumption are from the *Political Risk Services Group* and the International Monetary Fund *World Economic Outlook* databases respectively. See also notes to Figure 1. These are cross-sectional averages over 1961-2013.

Figure 6: Scatter Plots of Institutional Quality and Realized Oil Revenue Volatility against Fiscal Policy Volatility, 1961-2013



Source: See notes to Figure 5.

the scatter plots in Figures 5 and 6, it seems that institutional quality could act as a good proxy for FPV, and given that we have time series data on institutional quality we use this variable in our regressions.

To capture the role of fiscal policy, we augment the ARDL specification in equation (2) and the CS-ARDL specification in equation (5) with an interactive term, $\left(I_{it} \times \sigma_{it}^{oil}\right)$, which is the product of institutional quality and the realized volatility of oil revenues. More specifically, the ARDL specification is now given by

$$\Delta y_{it} = c_i + \gamma_i \left[I_{it} \times \sigma_{it}^{oil}\right] + \sum_{\ell=1}^{p} \varphi_{i\ell} \Delta y_{i,t-\ell} + \sum_{\ell=0}^{p} \boldsymbol{\beta}_{i\ell}' \mathbf{x}_{i,t-\ell} + u_{it}, \tag{6}$$

where I_{it} is the institutional quality and all the other variables are as defined in equation (2). As before, the cross-sectionally augmented ARDL (CS-ARDL) regressions include the cross-sectional average of the dependent variable and the regressors together with three lags of these cross-sectional averages

$$\Delta y_{it} = c_i + \gamma_i \left[I_{it} \times \sigma_{it}^{oil}\right] + \sum_{\ell=1}^{p} \varphi_{i\ell} \Delta y_{i,t-\ell} + \sum_{\ell=0}^{p} \boldsymbol{\beta}_{i\ell}' \mathbf{x}_{i,t-\ell} + \sum_{\ell=0}^{3} \boldsymbol{\psi}_{i\ell}' \bar{\mathbf{z}}_{t-\ell} + e_{it}, \tag{7}$$

where $\bar{\mathbf{z}}_t = \left(\overline{\Delta y}_t, \bar{\mathbf{x}}_t'\right)'$, and all the other variables are as defined in equation (5).

Table 4 reports the MG and PMG estimates based on the ARDL and the CS-ARDL specifications and as before we observe a significant and negative effect of realized oil revenue volatility on output growth no matter the lag order, $p = 1, 2, 3$.[6] However, as expected, the coefficient of the institutional quality variable is positive and significant (with a similar magnitude across the different specifications). This is in line with the scatter plot in Figure 5, which showed a positive association between policy volatility and GDP growth volatility (the latter of which has a dampening effect on output growth, see, for instance Ramey and Ramey 1995). Therefore, the results in Table 4 indicate that the negative growth effects of oil revenue volatility can to some extent be offset provided that growth and welfare enhancing policies and institutions are adopted. This is very encouraging indeed and points to the central role of policy makers and politicians in turning the endowment of oil into a blessing rather than a curse.

Therefore, while abundance of oil in itself is growth enhancing, the main problem in terms of long-run growth is the adverse effects of excess oil revenue volatility (due to, for instance, large swings in government expenditure). Because revenues are highly volatile

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[6] Note that our findings contrast with other studies on the role of institutions in resource abundant economies, which maintain that the abundance itself is a curse; see, for instance, Mehlum et al. (2006), Boschini et al. (2007), and Béland and Tiagi (2009).

their management needs appropriate institutions and political arrangements so that the domestic expenditures from oil revenues become less volatile. Norway's experience suggests that it might be possible within a democratic political system with good institutions and an accountable government to avoid some of the undesirable consequences of oil revenue volatility. The Norwegian Government Pension Fund, which aims to manage petroleum revenues in the long term is an example of how a stabilization and sovereign wealth fund can help offset not only the volatility of oil revenues but also help to smooth out government expenditures.

Table 4: Mean Group (MG) and Pooled Mean Group (PMG) Estimates of the Long-Run Effects on Real GDP Growth including Institutional Quality, 1984-2012

(a) Based on the ARDL Approach

	ARDL (1 lag)		ARDL (2 lags)		ARDL (3 lags)	
	MG	PMG	MG	PMG	MG	PMG
$\widehat{\theta}_\sigma$	-0.201***	-0.227***	-0.177**	-0.122***	-0.157*	-0.201***
	(0.057)	(0.043)	(0.077)	(0.036)	(0.081)	(0.025)
$\widehat{\gamma}$	0.002**	0.002***	0.002*	0.001*	0.003*	0.002***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
$\widehat{\lambda}$	-0.882***	-0.776***	-0.982***	-0.757***	-1.078***	-0.751***
	(0.083)	(0.080)	(0.117)	(0.127)	(0.145)	(0.094)
$N \times T$	486	486	485	485	484	484

(b) Based on the Cross-Sectionally Augmented ARDL (CS-ARDL) Approach

	CS-ARDL (1 lag)		CS-ARDL (2 lags)		CS-ARDL (3 lags)	
	MG	PMG	MG	PMG	MG	PMG
$\widehat{\theta}_\sigma$	-0.307***	-0.261***	-0.223***	-0.163***	-0.215	-0.150***
	(0.088)	(0.049)	(0.074)	(0.029)	(0.337)	(0.028)
$\widehat{\gamma}$	0.004***	0.002***	0.004**	0.002***	0.005**	0.002***
	(0.001)	(0.000)	(0.002)	(0.001)	(0.002)	(0.000)
$\widehat{\lambda}$	-0.818***	-0.665***	-0.957***	-0.778***	-0.819***	-0.625***
	(0.082)	(0.057)	(0.123)	(0.115)	(0.192)	(0.073)
$N \times T$	486	486	485	485	484	484

Notes: The ARDL and CS-ARDL specifications are given by equations (6) and (7) respectively. The dependant variable is the growth rate of real GDP, Δy_{it}. $\widehat{\theta}_\sigma$ is the coefficient of the realized volatility of oil revenues (σ_{it}^{oil}), $\widehat{\gamma}$ is the coefficient of institutional quality (I_{it}), $\widehat{\lambda}$ is the coefficient of the error-correction term, $\widehat{\boldsymbol{\theta}}_i = \widehat{\lambda}_i^{-1} \sum_{\ell=0}^{p} \widehat{\boldsymbol{\beta}}_{i\ell}$, and $\widehat{\lambda}_i = 1 - \sum_{\ell=1}^{p} \widehat{\varphi}_{i\ell}$. Symbols ***, **, and * denote significance at 1%, 5%, and at 10% respectively.

4 Concluding remarks

Although the early literature showed the existence of a negative relationship between real GDP per capita growth and resource/oil abundance, the so called resource curse, more recent evidence is not so clear cut. Firstly, the early literature used cross-country analysis that fails to take account of dynamic heterogeneity and error cross-sectional dependence, and this could bias the results. Secondly, the early analysis ignores the effects of oil revenue volatility on growth, which turns out to be important. Using annual data on sample of 17 major oil producers over the period 1961–2013 and appropriate econometric techniques that take into account all three key features of the panel (dynamics, heterogeneity and cross-sectional dependence), we provided evidence for the positive long-run effect of oil revenue on growth, with oil revenue volatility affecting growth negatively. We, therefore, argue that it is the volatility in oil revenue and the government's inappropriate economic and political responses to these volatilities that are the curse and not the abundance of revenues from oil production/exports in itself. Seen from this perspective, oil revenue can be both a blessing and a curse, and the overall outcome very much depends on the way the negative effects of oil revenue volatility are countered by use of suitable policy mechanisms that smooth out the flow of government expenses over time.

Therefore, the undesirable consequences of oil revenue volatility can be avoided if resource-rich countries are able to improve the management of volatility in resource income by setting up forward-looking institutions such as Sovereign Wealth Funds (if they have substantial revenues from their exports), or adopting short-term mechanisms such as stabilization funds with the aim of saving when commodity prices are high and spending accumulated revenues when prices are low. The government can also intervene in the economy by increasing public capital expenditure when private investment is low, using proceeds from the stabilization fund. Alternatively the government can use these funds to increase the complementarities of physical and human capital, such as improving the judicial system, property rights, and human capital. This would increase the returns on investment with positive effects on capital accumulation, TFP, and growth. Improving the functioning of financial markets is also a crucial step as this allows firms and households to insure against shocks, decreasing uncertainty and therefore mitigating the negative effects of volatility on investment and economic growth.

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