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Oil Price Shocks, Protest and the Shadow Economy: Is there a Mitigation Effect?

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February 2020

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Abstract

In this paper, we study the impact of exogenous variations of international oil prices on the incidence of protest, while exploring the role of the shadow economy as a mitigating factor. We find that oil price shocks are negatively associated with protests, but the effect is less severe the higher the initial size of the shadow economy. To explain these results, we show that the size of the shadow economy responds counter-cyclically to oil-price-driven income shocks. In particular, we find that the decline in the GDP per capita growth following a negative oil price shock leads to an increase in the size of the shadow economy. This suggest that the shadow economy's capacity to absorb persistent oil price fluctuations without provoking political unrest, should regard it as a mitigation tool rather than an economic burden.

Keywords: Oil Price Shocks; Protest; Shadow Economy; Income

JEL: D74, O13, O17, Q34

I. Introduction

The effect of natural resource wealth and income fluctuations on political stability has been widely explored in the literature (see Bazzi and Blattman, 2014 for a survey). Resource-rich countries are frequently subject to severe price swings that affect largely their macroeconomic fundamentals, including political unrest. In this paper, we focus on the question of whether international oil price fluctuations induce political instability, and whether the shadow economy can play a mitigation role. We argue that oil price fluctuations have lower impact on social unrest in countries incubating big shadow economies.

Our argument is built on two important strands of economic literature. First, the early work by rentier state theorists arguing that oil rents may create a cursory stability by building social bases whose support hinges upon the continuous availability of funds and the distribution networks (Beblawi and Luciani, 1987; Karl, 1997; Ross, 2001). It follows that the fall in oil-fueled-revenues will make it quite difficult for the state to continue engaging in widespread distribution, which inversely affects household incomes.

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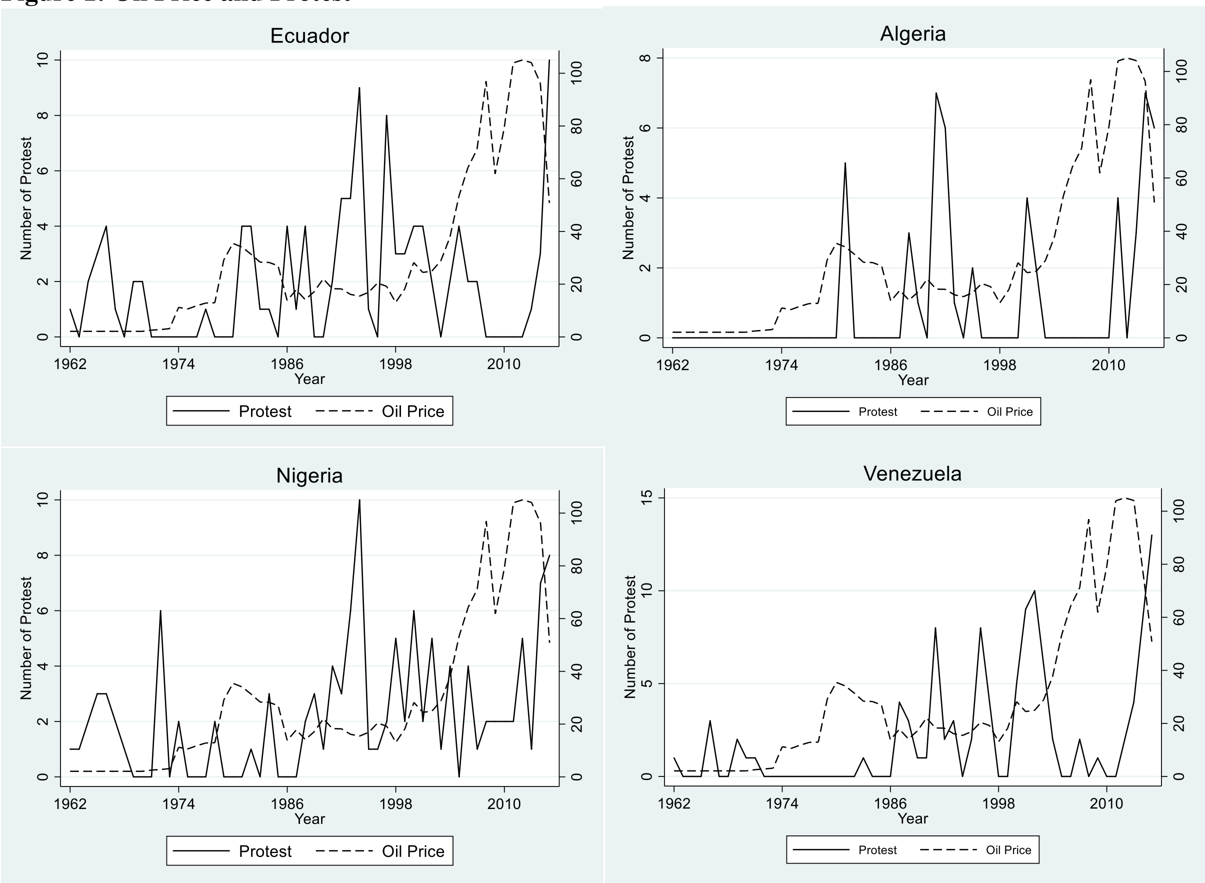
Social unrest is then more likely to break out with economic hardships lowering the opportunity cost for engaging in anti-state protest. This was evident in the social upheavals that broke out in Venezuela in 2016 following the government's decision to cut the social subsidies amid the decline in oil prices.[2] Figure 1 presents a preliminary evidence of the relationship between international oil price movements and protest in a number of countries. It can be seen that in periods of low (high) oil prices, we witness an uptick (decline) in the number of protests.

Figure 1: Oil Price and Protest



Second, shadow economy might act as a countercyclical device to buffer against social unrest by providing an alternative source of income for the disgruntled citizens during economic downturns (e.g. Eilat and Zinnes, 2002; Boeri and Garibaldi, 2002; Dell'Anno and Solomon, 2007; Bajada and Schneider, 2009). As such, it acts as an insurance policy against economic volatility through creating jobs and providing profit opportunities for business. In such setting, the existence of the shadow economy may increase the opportunity cost for protesting during periods of sluggish growth. More generally, the existence of the shadow will reduce the effect of oil price fluctuations on political stability. However, the mitigation role of the shadow economy is contingent upon its countercyclical response to oil price shocks and official economy growth. In other words, the size of shadow economy should decrease during booms and increase during economic slowdowns (Elgin, 2012; Loayza and Rigolini, 2011).

[2] See "https://edition.cnn.com/2017/04/21/americas/venezuela-crisis-explained/index.html"

To the best of our knowledge, the mitigation role of the shadow economy in the nexus between oil windfalls and political stability is overlooked in the literature. In the context of oil producing countries, investigating evolution of the shadow economy in reaction to oil price fluctuations and its implications for political stability is particularly appealing. Not only because of the vulnerability of those economies to export shocks, but also because of the considerable share of informal economies in their official GDP. According to the latest data from Medina and Schneider (2018), the average percentage share of the shadow economy to GDP in oil producing countries ranges from 11 percent to 62 percent, with an average size of around 31 percent, which points to a significant role of the shadow economy in those economies.

Based on this, we hypothesize that oil price fluctuations negatively affect political instability in countries with low shadow economies, but not in countries with considerable share of shadow economies in their GDP. We test this hypothesis using panel data covering the period 1991-2015 and 144 countries. Our empirical strategy starts by investigating how social unrest evolves following fluctuations in international oil prices. We look at less severe incidences of political instabilities, namely protest, which remains less studied compared to more violent events of civil wars and regime breakdowns. Our exogenous measure for oil revenues is measured by variation in international oil prices weighted by time-invariant country's oil exports share to GDP. This circumvents the problems associated with conventional measures of resource abundance measured in terms of the values of oil production or as the share of resource rents in GDP. We, then, investigate whether a higher size of shadow economy can mitigate the impact of oil price shocks on social unrest. To explain our findings, we move on studying the reaction of the shadow economy to exogenous oil-induced income shocks. We apply an instrumental variables approach, using oil price shocks as an instrument, to overcome endogeneity problems associated with modelling the impact of growth shocks on shadow economy activities. Several robustness checks and modifications should help to support the validity of the underlying exogeneity assumptions.

Our findings point out that oil price shocks negatively affect the number of protests and that the effect is more severe the lower the initial level of the shadow economy. This works through the countercyclical behavior of the shadow economy to oil-driven growth shocks. Our results indicate that a 1 percentage point decline in the GDP per capita increases the shadow economy by 1.1 percent. From a policy perspective, the results suggest that for highly resource dependent countries, the shadow economy sector might serve as an important risk management device owing to its capacity to absorb persistent oil price fluctuations without provoking political unrest in the society. This should regard the shadow economy as a mitigation tool rather than an economic burden. Hence, policymakers should take this into account in their planning and conceptualization of reforms.

This paper contributes to the literature in three dimensions. First, our study is related to the literature on the association between economic shocks and civil conflict driven by deep economic grievances or weak state capacity to buy off political opposition (e.g. Collier and Hoeffler, 1998; Fearon and Latini, 2003; Miguel, Sctyanath and Sergenti, 2004; Ross, 2004; Brückner and Ciccone, 2010; Besley and Persson, 2011; Hendrix and Salehyan, 2012; Dube and Vargas, 2013; Lei and Michaels, 2014). Closely related is the relative deprivation hypothesis (Gurr, 1968) where feelings of deprivation are likely to arise not only from intergroup comparisons, but also from intrapersonal comparisons of past welfare. More broadly, an important strand of literature emphasizes the role played by natural resources, particularly oil and mineral rents, in enhancing civil conflicts either through funding rebel organizations (i.e. greed-driven) or fueling discontent over the unequal distribution of income (i.e. grievance-driven) as well as state strategies to combat social unrest (Ross, 2004; Bannon & Collier, 1999; de Soysa, 2002; Lujala, 2009; Wantchekon, 2002; Collier and Hoeffler, 2004; Ishak, 2019). In contrast to these studies, we estimate the effect of economic shocks on less violent incidences of social unrest (i.e. protests) which remains largely unexplored coupled with the recent findings of Bazzi and Blattman (2014) showing oil price shocks to be not associated with war outbreaks, but with shorter less intense civil conflicts. To best of our knowledge, there is only the study of Smith (2004) that examines the impact of oil price shocks on anti-state protest and finds that oil wealth is associated with fewer protest. One concern with this study is that it is based on a cross-country empirical specification, which makes it difficult to make causal inferences. Another concern regarding its measure of the time-varying value of oil exports to GDP, being partly based on oil production, makes it endogenous to social unrest.[3]

Second, there is a very little evidence for the mitigation role of the shadow economy on social unrest amid economic shocks.[4] We find a beneficial role of the a countercyclical shadow economy in soothing protests breakout, providing a counter argument for existing literature showing countercylicality to exhibit negative impacts through reducing tax bases and deepening economic stagnation (Elgin, 2012). Third, our work contributes to the empirical studies on the reaction of the shadow economy to growth cycles, in which there have been little consensus on whether shadow economy behaves pro- or countercyclically. Some country specific studies refer to the negative association between the size of shadow economy and the official economy, and find unemployment to be the main driver of shadow economy (e.g. Dobre and Alexandra, 2009; Dell'Anno et al., 2007; Elgin, 2012; Schneider and Humetner, 2014; Bitzenis, Valchos and Schneider, 2016). Others offer a competing view of the procyclical relationship between the official economy's growth and the expansion of the shadow economy (e.g. Giles, 1997a; 1997b; Giles and Tedds, 2002; Bajada, 2003). Other studies emphasize the conditional response of underground economy. For instance, according to Loayza and Rigolini (2011),

[3] Other authors have looked at the effects of rising food prices on social unrest and mostly pointed to a strong positive relationship (Berazneva and Lee, 2013; Smith, 2014; Weinberg and Bakker 2014). Such relationship was also found to be rather conditional on the degree of the development of the country (i.e. low income vs. high-income countries) (Arezki and Brückner, 2011) or on the type of the political system (democracy vs. autocracy) (Hendrix and Haggard, 2015). In a more comprehensive study, Bazzi and Blattman (2014) find no evidence of an impact of high commodity price shocks on the onset of new civil wars.

[4] The literature on the shadow economy is so far either focusing on estimating its size and discerning its causes (e.g. Schneider and Enste, 2000; Medina and Schneider, 2018) or studying its impact on official economy and vice-versa on either limited subset of countries or using cross-country variation (e.g. Dell'Anno et al., 2007; Tedds and Schneider, 2002). Other cross-country studies examined its relationship with other macroeconomic variables such inequality, inflation and corruption (e.g. Dreher and Schneider, 2010). See Goel and Nelson (2016) for recent review of literature.

the informal unemployment appears to be countercyclical in the short run, but the degree of countercyclicality is rather decreasing with its size. However, none of these studies identifies the source of growth shocks and none succeeds in addressing endogeneity problems associated with examining the response of the shadow economy to economic growth cycles. In contrast, we focus on a particular type of economic shocks (international oil price shocks) to establish a source of exogenous variation and use that as instrument for business cycles.

The remainder of the paper is structured as follows. Sections 2 and 3 describe our data and empirical methodology. Section 4 presents our main findings and robustness checks; and section 5 concludes with a broader discussion of the results and providing policy implications.

II. Data

Our panel dataset combines information on oil price shocks, shadow economy and protest over the period 1991 to 2015. The country-specific measure of annual oil price shocks for country i at time t is constructed by multiplying the time-invariant whole-period average of country i's share of oil exports to GDP δ_i with the annual ln-change in international oil prices $\Delta \ln OilPrice_t$ and takes the following form:

$$OilPriceShock_{it} = \delta_i \, \Delta \ln OilPrice_t$$

This specification captures that oil price shocks should have a greater impact on countries with greater dependence on oil.[5] The oil exports data are from the United Nations' Comtrade data set reported according to the SITC1 system. The calculated country's share of oil to GDP δ_i was revised so that extreme values are replaced by the second highest value to avoid some of the problems associated with the reported export values that may be inaccurate for specific countries (Feenstra et al., 2005).[6] Data on international oil prices is taken from United Nations Conference on Trade and Development Commodity Statistics (UNCTAD, 2016).

To measure the shadow economy, we rely on the data taken from Medina and Schneider (2018), who define the shadow economy as "all the economic activities hidden from official authorities to avoid paying taxes and all social security contributions, to avoid governmental bureaucracy or the burden of regulatory framework, and for institutional reasons including corruption law, the quality of political institutions and weak rule of law". Their dataset covers the shadow economic activities in 158 countries during the period from 1991 to 2015. The estimates on the size of the shadow economy, measured as a percentage of GDP, are based on the Multiple Indicators Multiple Causes (MIMIC) model. This empirical approach first treats the shadow economy as an unobserved (latent) variable, identifying multiple causes and indicators for estimating its size. Second, it uses structural equations model to estimate the causal relationships between the unobserved variable and the observed indicators. A key

[5] See Bazzi and Blattman (2014), and Brückner, Ciccone and Tesei (2012) for a similar methodology.

[6] Only 15 observation were modified for The Bahamas (1975-1983), Congo Republic (2015), Oman (1970-1971), Equatorial Guinea (2000-2004) and Qatar (1971-1972).

advantage of this dataset is that it uses a light intensity approach instead of GDP as an indicator variable, and hence, capturing a wider range of economic activities that may be not reported in official GDP figures. A second advantage of this dataset is having a longer time span and a wider country coverage. Our measure of GDP growth is calculated using data on real GDP per capita from World Development Indicators (World Bank, 2018).

We rely on the data from Cross-National Time-Series Data Archive (CNTS) (Banks, 2018) to construct our indicators for protest. The CNTS dataset measures different types of political instabilities ranging from less intense incidences of protests to major events of civil wars and coups. Given the purpose of this paper, we only select 3 indicators for less violent events of instabilities, namely anti-government demonstrations, general strikes and riots. Our measure for protest is a count variable (expressed in logs) calculated by summing the numbers of all demonstrations, strikes and riots that took place in a given country at a given year; hence, it captures the magnitude or the intensity of instability. Table 1 provides the summary statistics for our variables of interest.

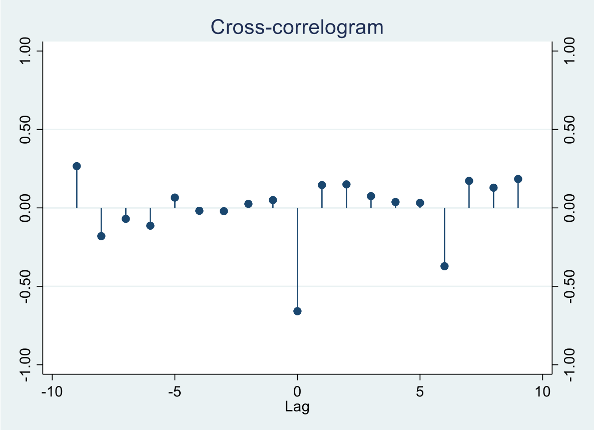
Table 1: Summary Statistics

Variable	N	Mean	SD	Min	Max
Oil price shock	3114	0.004	0.02	-0.16	0.18
Protest (log)	3114	0.46	0.78	0	4.98
Shadow Economy (% of GDP) (log)	3114	3.33	0.49	1.82	4.28
GDP per capital (log)	3114	8.46	1.57	4.75	11.63

To get a first snap shot of the relationship between oil price shocks, and the size of the shadow economy as a percentage of GDP. Figure 2(a) depicts the growth of shadow economy and the annual change in oil price and shows a negative correlation between them. To gauge more on the strength and the timing of such correlation, in Figure 2(b), we plot the cross-correlogram between the growth in the shadow economy and oil price changes. The strongest cross-correlation happens at lag zero with a negative sign indicating that an above average increase of oil prices is associated with an immediate below average growth of the shadow economy and the opposite is true. A below average increase in oil prices is more likely to be associated with an above average growth of the shadow economy on impact, suggesting a countercyclical response of shadow economy to oil price shocks.[7]

[7] We are fully aware that part of the reaction is „technical“ in the sense, that a recession/ crisis might hit the official economy harder than the shadow economy and therefore the size of the shadow measured as a fraction of officially reported GDP jumps up. Nevertheless, we will use respective data transformations in the empirical framework to make sure that the results are not driven by this effect.

Figure 2: Shadow economy (% of GDP) and oil price



Note: Figure 2(a) displays the growth in the (log) size of shadow economy (% of GDP) (solid line) averaged across the sampled countries along with the ln-change in oil price (dashed line). Figure 2(b) displays the cross-correlogram between the growth in the shadow economy and ln-change in oil price.

III. Empirical specification

Our empirical strategy assesses whether changes in international oil prices affect incidence of protest disproportionately in countries that depend more on oil and how this effect depend on the initial size of the shadow economy. Specifically, we estimate the following reduced-form equation:

$$\Delta\, lnProtest_{it} = \alpha_i + \theta_t + \gamma_i t + \beta_1 OilPriceShock_{it} + \beta_2 lnSE_{it-3} + \beta_3 OilPriceShock_{it} \times lnSE_{it-3} + \varepsilon_{it} \qquad (1)$$

The dependent variable $Protest_{it}$ is the measure of protest events in a given country i and year t, α_i is country fixed effects, θ_t is year fixed effects and ε_{it} is the error term. [8] $OilPriceShock_{it}$ is the explanatory variable of interest measured as the weighed-change in (log) oil prices averaged over the previous three years. [9] This allows us to take into account the time-dependence of shocks, besides reducing the role of transitory shocks and measurement error in the explanatory variable. To investigate the mitigation role of the shadow economy for the adverse effects of oil price shocks on protest, we add the (log) size of the shadow economy (% of GDP) $lnSE_{it-3}$, both by itself and interacted with oil price shocks. This allows us to examine the impact of oil price shocks (β_1) on protest conditional upon the initial size of the shadow economy. If the shadow economy mitigates adverse shocks, we shall expect negative oil price shocks to have a smaller effect on protest proliferation in countries with a relatively higher size of the shadow economy (i.e. positive β_3). To be consistent with the starting date of the price shock and to address reverse causality, the initial size of the shadow economy is measured at year $t-3$. Hence, if the change in oil prices is measured as the average over the years t, $t-1$, $t-2$ and $t-3$ the

[8] Since our econometric specification employ the log of protest, we add "one" to the number of each protest indicator to avoid sample selection bias that would arise from dropping country-year observations with no reported protest event in at least one year.

[9] This is same approach followed by Brückner and Ciccone (2010), Brückner, Ciccone and Tesei (2012) and Caselli and Tesei (2016).

size of shadow economy enters at year $t-3$.[10] The $\gamma_i t$ is a country-specific linear time trend to account for potential omitted variables and pre-existing trends.

Second, we examine whether changes in international oil prices affect the size of the shadow economy. The within-country specification takes the following form:

$$lnSE_{it} = \alpha_i + +\theta_t + \gamma_i t + \beta_1 OilPriceShock_{it} + \varepsilon_{it} \tag{2}$$

where α_i is country fixed effects, θ_t is year fixed effects and ε_{it} is the error term. $\gamma_i t$ is a country-specific linear time trend to mitigate potential omitted variable bias.[11] Third, we examine whether the shadow economy responds in pro- or countercyclical fashion to official economy growth shocks, we estimate a two-stage least squares (2SLS) model:

$$lnSE_{it} = \alpha_i + +\theta_t + \gamma_i t + \beta_1 \Delta lnGDP_{it} + \varepsilon_{it} \tag{3}$$

where α_i is country fixed effects, θ_t is year fixed effects, $\gamma_i t$ is country-specific time trend and ε_{it} is the error term. $\Delta logGDP_{it}$ is either the change in (log) real per capita GDP and it is instrumented by oil price shocks. Hence, an advantage of applying this approach is that it helps to circumvent endogeneity problems associated with modelling the impact of growth on the expansion of underground activities.[12] For the instrumental variable approach to be valid, oil price shocks must satisfy two conditions: (i) the independence condition requiring the instrument not to be determined by the outcome variable and (ii) the exclusion restriction. In our case, the occurrence of oil price shocks is less likely to be a function of the shadow economy's size. The corresponding exclusion restriction in equation (3) requires that oil price shocks affect the size of the size economy only through income. The next section provide evidence of the dominance effect of the income channel over other mechanisms.

In all specifications, the time variation stems from movements in international oil prices, while allowing the effect to change based on the degree of oil dependency. This helps to circumvent problems associated with using conventional measures of resource wealth such as export or production levels (typically normalized by GDP or population) which could be spuriously correlated with our outcome of interest. The included country- and year-fixed effects control for all time-invariant country characteristics and global trends. We cluster the standard errors at the country level.

The usage of (non-) differenced specifications is motivated by the time series properties of international oil prices, protest, shadow economy and GDP. In the appendix, we provide formal unit root tests for these variables. The tests cannot reject the null hypothesis of the presence of a unit root in the time series of oil price, protest and GDP in levels, but they reject it for their first differences. For the

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[10] We also considered going beyond the third lag, when choosing the initial level of the shadow economy. However, deeper lags severely reduces our sample size. Furthermore, as previously shown the shadow economy is left unaffected by lagged oil price shocks (beyond year t) which suggested that a lagged level of the shadow economy can be treated as a predertmined variable, whose lagged values are uncorrelated with the current error term.

[11] Using the three-year average oil price shocks helps to reduce the contemporaneous denominator effect of GDP in the shadow economy ratio.

[12] Instrumenting GDP by oil-price shocks is previously done by Brückner, Ciconne anf Tesei (2012), Brückner et al. (2014) and others. In these studies, they show that the variable is a strong instrument for income changes extracting a very persistent component of national income.

shadow economy, formal tests reject the null hypothesis of the presence of unit roots in levels and first difference.

IV. Empirical Results

I. Oil price shocks and protest

Table 2 presents our main results for estimating equation (1). In column 1, we look at the average effect of 3-year average oil price shocks on protest without controlling for the initial size of the shadow economy. The negative coefficient imply that oil price shocks, on average, have a negative impact on protests, but it is not statistically significant. In columns 2 and 3, we divide our sample into high shadow economy (SE) and low shadow economy (SE) countries based on whether the 3-year lagged shadow economy is above or below the median. We see that oil price shocks have no statistical significant effect on protest in high SE sample, but have a negative and statistically significant effect on protest in low SE countries. In addition, the reported chow test rejects the hypothesis that the estimated coefficient in high SE countries is the same as the coefficient in low SE countries. Hence, it is not surprising to see that the average effect of oil price shocks in the full sample to be nil, since the opposing effects in low SE and high SE samples cancel out each other (with both samples having an equal number of observations).

Table 2: Oil price shocks, protest and shadow economy

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Δ Log Protest	**Δ Log Protest**	**Δ Log Protest**	**Δ Log Protest**	**Δ Log Riots**	**Δ Log Strikes**	**Δ Log Anti-Gov Demos**
		High SE	**Low SE**				
	OLS	**OLS**	**OLS**	**OLS**	**OLS**	**OLS**	**OLS**
Oil price shock, *t*	-0.589	0.472	-1.584**	-12.406***	-9.202**	-1.883	-6.415*
	(0.437)	(0.742)	(0.696)	(3.973)	(3.763)	(1.341)	(3.739)
Shadow economy (log), *t-3*				0.122	0.103	-0.008	0.005
				(0.158)	(0.109)	(0.057)	(0.135)
Oil price shock*Shadow economy				3.391***	2.394**	0.579	1.799*
(log)				(1.097)	(1.034)	(0.363)	(1.073)
Chow test *p*-value		0.01	0.01				
Number of observations	3,114	1,557	1,557	3,114	3,114	3,114	3,114
Number of countries	144	94	102	144	144	144	144
R-squared	0.055	0.053	0.120	0.056	0.066	0.037	0.053
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country specific-time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Oil price shock is the average three year ln-change in the oil price multiplied by whole period average oil exports share to GDP (1991-2015). The dependent variable in columns 1-4 is the ln-change of sum of protest events that took place in a given country at a given year; in column 5 is ln-change in the number of riots; in column 6 is ln-change in the number of strikes; and in column 7 is the ln-change in the number of anti government protests. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the country level. Country fixed effects, year fixed effects and country-specific time trend are not reported. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Column 4 adds the 3-year lagged level of (log) shadow economy (% of GDP), both by itself and interacted with the oil price shock, as additional control variables. We see that the coefficient of oil price shock is still negative and statistically significant, while the interaction term between oil price shocks and the lagged shadow economy is positive and significant at 1 percent significance level. This suggests that negative oil price shocks significantly increases protests in low shadow economy countries, but the effect dissipates with the increase in the initial size of the shadow economy. At very high levels of shadow economies, the effect becomes very small and statistically insignificant.[13]

[13] We checked whether the effect of negative oil price shocks differ from positive price shocks by including in column 4 a dummy that takes the value of 1, if the 3-year average oil price shock is strictly negative. Our coefficients of interest remain unchanged in sign and significance, but the interaction effect was statistically insignificant. Hence, the estimated effect of

To put coefficients into perspective, based on column 4, in a low-shadow economy country (shadow economy around 7% of GDP), the effect of 1 percentage point decline in weighed-international oil price implies an increase in protests by 6 percentage points. In a mid-shadow economy country (shadow economy around 32% of GDP), the effect of 1 percentage point decline in wighed-international oil price implies an increase in protests by 0.64 percentage points. Negative oil price shocks cease to have any significant impact on protests in high-shadow economy countries, with shadow economy representing more than 35% of GDP. Put it differently, let us consider Iran, Equatorial Guinea and Nigeria as examples oil dependent countries, with shadow representing on average 17.6%, 31% and 56.4% of GDP, respectively. The coefficient estimates imply that in response to 1 percentage point decline in weighed-international oil prices, protest will increase in Iran by 2.7 percentage point, but will only increase by 0.8 in Equatorial Guinea. However, the same decline will leave no significant impact on protest in Nigeria. Finally, in columns 5-7, we disaggregate our protest measure into its three indicators: riots, strikes and anti-government demonstrations. We find that the number of both riots and anti-government demonstrations increases significantly following negative oil price shocks, but the effect becomes less severe the higher the initial size of the shadow economy. In contrast, negative oil price shocks have no statistical significant impact on strikes. The estimated coefficients also suggest that oil price shocks have a stronger impact on riots, both quantitatively and qualitatively, relative to anti-government demonstrations and strikes.

Table 3 presents various important robustness checks to our main results (in column 4). One concern is that the international price of oil could be endogenous to major oil producers and exporters introducing bias to the estimates. Specifically, reverse causality may arise, if an intensification of protest disturbs oil production and hence world supply, causing the international prices to increase. To account for that, in column 1, we drop the quintile of countries with highest whole-period average oil exports as a share of GDP, while in column 2 we exclude the top quintile of countries whose share of world oil production exceeds 3% averaged over the sample period.[14] Additionally, we drop members of Organization of the Petroleum Exporting Countries (OPEC) in column 3. In all instances, the coefficient of interests keep signs and statistical significance. Next, in columns 4 and 5, we split the sample into democratic and autocratic regimes to investigate the heterogeneity of the effects on protest. We base our classification for political regimes on the Polity IV regime database (Marshall and Jaggers, 2016) and follow the convention of classifying countries as democracies (autocracies), if their polity2 score is strictly positive (negative) (e.g. Persson and Tabellini, 2009; Caselli and Tesei, 2016).[15] Our coefficients of interest remain robust in both samples. Moreover, the chow test fail to reject the null hypothesis that impact of

negative shocks is not statistically significantly different from positive shocks. It then follows that our interpretation are also applicable in case of positive oil price shocks.

[14] The latter group was identified using Ross and Mahadavi (2015) dataset on oil production covering the period 1932-2014, and refer to the top 10 percent oil producers or countries producing (over the whole-period average) more than 3 percent of world oil production.

[15] Following Brückner and Ciccone (2011), we adjust Polity2 so that periods of interregnum, coded as 0, and transitionary periods are treated as missing. Such adjustment ensure that instability are not affected by the particular political situation in a given year. The results also remain robust to including those periods.

oil price shocks on protest in autocracies is equal to that of the full sample. Thus, there is no statistical significant difference between autocracies and democracies on the effect of protest following oil price shocks.

In column 6, we omit the quintile of country-year observations with highest share of shadow economy to GDP (more than 55% of GDP) to check whether the results are influenced by extreme observations. Similarly, in column 7, we drop the quintile of countries with the highest share of shadow economy to GDP averaged over the whole-period sample. In both cases, our main results remain robust in sign and significance. Finally, in column 8, we check whether our estimates are sensitive to the specific measure of the shadow economy. We employ an alternative measure for shadow economy taken from Alm and Embaye (2013) with estimates based on the currency demand method for the period 1984-2006. In our sample, the correlation between Medina and Schneider's (2017) estimates of the shadow economy with Alm and Embaye (2013) is around 0.78. The coefficients of interest remain qualitatively similar, despite the drop in sample size.

Table 3: Oil price shocks, protest and shadow economy – Robustness checks

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δ Log Protest	**Δ Log Protest**	**Δ Log Protest**	**Δ Log Protest**	**Δ Log Protest**	**Δ Log Protest**	**Δ Log Protest**	**Δ Log Protest**
	OLS	**OLS**	**OLS**	**OLS**	**OLS**	**OLS**	**OLS**	**OLS**
	Drop major oil exporters	**Drop major oil producers**	**Drop OPEC**	**Democratic countries**	**Autocratic countries**	**drop extreme SE values**	**Drop high SE countries**	**Alternative SE measure (1984-2006)**
Oil price shock, *t*	-12.142**	-11.299**	-24.447***	-27.419**	-12.240**	-13.732***	-13.426***	-23.151**
	(5.627)	(4.654)	(6.831)	(12.492)	(5.018)	(5.173)	(4.295)	(10.611)
Shadow economy (log), *t-3*	0.129	0.069	0.073	0.241	0.092	0.028	0.093	0.104
	(0.162)	(0.169)	(0.167)	(0.188)	(0.433)	(0.163)	(0.159)	(0.094)
Oil price shock*Shadow economy	3.500**	3.078**	7.059***	7.328**	3.441**	3.772**	3.694***	6.898**
	(1.618)	(1.289)	(1.916)	(3.062)	(1.428)	(1.477)	(1.203)	(3.163)
Chow test *p*-value				0.53	0.53			
Number of observations	2,979	2,874	2,871	2,090	830	2,828	2,982	2,116
Number of countries	137	133	132	111	56	138	138	108
R-squared	0.054	0.055	0.053	0.074	0.158	0.066	0.056	0.041
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country specific-time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Oil price shock is the average three year ln-change in the oil price multiplied by whole period average oil exports share to GDP (1991-2015). The dependent variable is the ln-change of sum of protest events that took place in a given country at a given year. In column 1, we exclude the quintile of countries with highest whole-period average oil exports as a share of GDP; in column 2, we exclude quintile of countries whose share of world oil production exceeds 3% averaged over the sample period; in column 6, we exclude the quintile of country-year observations with highest share of shadow economy to GDP; and in column 7, we drop the quintile of countries with the highest share of shadow economy to GDP averaged over the whole period sample. Democratic (autocratic) countries are defined as those whose Polity2 score strictly > (<) zero. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the country level. Country fixed effects, year fixed effects and country-specific time trend are not reported. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

In the appendix, we conduct additional robustness checks in Table A2. In column A21, we use a different weight for oil price shocks by employing the mid-period value of oil exports share to GDP. In columns A22, we restrict our sample to high oil-dependent countries (i.e. oil exporters whose whole-period average exports share to GDP is above the median). In columns A23 and A34, we differentiate between developed and developing countries. In column A25, we account for additional effects of other natural resources, namely coal, natural gas and mineral, to alleviate the concern that theses natural resources rents may be correlated with oil prices and driving the results. These natural resources are measured by their corresponding rents as a share of GDP (WDI, 2018). In all specifications, the signs and statistical significant of our variables of interest remain robust, with no statistical significant difference in effects between developed and developing countries. The rents from other natural resources and their interactions with shadow economy enter statistically insignificant and very small in magnitude. In column A16, we restrict our sample to the post 2003 period, which constitutes half of the sample period and captures the oil boom period. The estimated coefficients maintain similar significance as for the entire sample. The chow test fail to reject the null hypothesis that the estimated coefficients in this sub-sample is the same as for the full sample. Finally, in column A17, we conduct a placebo test to make sure that our results are not mechanical or driven by pre-existing trends. We find that the coefficients of interest have switched signs and lost their significance.

II. Oil price shocks, the shadow economy and GDP

In the previous section, we showed that the negative effect of oil price shocks on the incidence of protest becomes smaller the higher the initial size of the shadow economy. To explain these results, Table 4 presents our main results of the effect of 3-year average oil price shocks on the shadow economy. Column 1 shows that oil price shocks at t have a negative and statistically significant effect on the shadow economy at 1 percent significance level. In particular, the point estimate in column 2 implies that a 1 percentage point drop in weighed-international oil prices increases the shadow economy by 0.34 percent. In column 2, we look at the impact of oil price shocks at $t-1$ on the shadow economy and find a negative, but statistically insignificant effect. Hence, in line with our finding in section 2, the strongest significant impact of oil price shocks on shadow economy occurs contemporaneously.[16]

Table 4: Oil price shocks, the shadow economy and GDP per capita

Model	(1)	(2)	(3)	(4)	(5)	(6)
	logSE	logSE	Δ log GDP	logSE	logSE	logSE
	OLS	OLS	OLS	OLS	2SLS	OLS
Oil price shock, *t*	-0.344**		0.313***	-0.268		
	(0.172)		(0.103)	(0.164)		
Oil price shock, *t-1*		-0.309				
		(0.187)				
Δ logGDP per capita, *t*				-0.240***	-1.098**	-0.248***
				(0.063)	(0.483)	(0.062)
A-R Wald, F *(P value)*					[0.047]**	
A-R Wald, χ^2 *(P value)*					[0.039]**	
Stock-Wright, LM *(P value)*					[0.049]**	
			First stage for Δ GDP per capita, *t*			
Oil price shock, *t*					0.313***	
					(0.103)	
First stage F-statistic					9.18	
Number of observations	3,114	3,103	3,114	3,114	3,114	3,114
Number of countries	144	144	144	144	144	144
R-squared	0.757	0.757	0.237	0.766	0.765	0.980
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country specific-time trend	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns 1, 2, 4-6 is the (log) shadow economy as a percentage of GDP; in column 3 is the ln-change in GDP per capita. In top panel, we report estimates of the average impact of oil price shocks. The method of estimation in columns 1-4 & 6 is ordinary least squares; in column 5 is two-stage least squares with Huber-robust standard errors (reported in parentheses) clustered at the country level. The instrumental variable is the 3-year average oil price shock defined as the average three year ln-change in the oil price multiplied by whole period average oil exports share to GDP (1991-2015). The p-values [in square brackets] are for three significance tests that are robust to weak instruments and the versions we implement are robust to heteroskedasticity and arbitrary within-country correlation of the residuals. In the bottom panel, we report the corresponding first stage regressions with Huber robust standard errors (in parentheses) that are clustered at the country level. Country fixed effects, year fixed effects and country-specific time trend are not reported. Significantly different from zero at *90% confidence, **95% confidence, ***99% confidence.

[16] In unreported results, we also find that the lagged 3-year average shock in periods $t-2$ and $t-3$ have insignificant effect on the current shadow economy (results available upon request).

To test whether the impact of oil price shocks on shadow economy is driven by the official economy growth, oil price shocks should have a significant effect on GDP as pre-condition. Column 3 shows that the effect of oil price shock on (log) real GDP per capita growth is positive and statistically significant at 1 percent significance level. The results indicate that a 1 percentage point increase (decrease) in weighed-international oil prices increases (decreases) GDP per capita by 0.31 percentage points. The results come in line with Brückner, Ciconne and Tesei (2012), who find positive oil price shocks to have a positive and persistent effect on GDP per capita growth. Hence, combined with our findings in column 1, oil price shocks have a contemporaneous effect GDP per capita, which immediately affects shadow economy at period t. Furthermore, one of the main conditions for the validation of our empirical strategy is that oil price shocks do not affect shadow economy through other channels other than the official GDP. A straightforward strategy involves regressing the shadow economy on oil price shocks and GDP growth. If oil prices affect the shadow economy only through GDP fluctuations, then we would expect oil price shock to have no statistical significant impact on shadow economy when confronted with GDP growth.[17] The results reported in column 4 show indeed that the coefficient of oil price shocks shrinks in magnitude and loses its statistical significance, when the GDP growth is included. In addition, the coefficient of GDP is significant at 1 percent significance level and is of almost the same magnitude as that of oil price shocks.

Based on that, we report in column 5 the two-state least squares (2SLS) estimates for the effect of oil price shocks on the shadow economy assuming that the effect occurs through GDP (i.e. the income effect). Given that the first stage F-statistic is below 10, the recommended threshold by Staiger and Stock (1997), we therefore use weak-instrument robust inference p values (reported in square brackets) to assess significance. The estimated 2SLS coefficients imply that the negative income shocks have a positive and statistically significant effect on the size of the shadow economy, when instrumented by the 3-year average oil price shock at period t. Specifically, a 1 percentage point decline in GDP per capita increases the shadow economy by 1.1 percent at 5 percent significance level. It then follows that a 1 percentage point drop in weighed-oil prices leads to an increase in the size of the shadow economy by $1.1 \times 0.31 = 0.34$ percentage point, which equally corresponds to the magnitude of the direct effect of oil price shocks on shadow economy. For comparison, we report in column 6 the OLS estimates and still find oil-induced-GDP growth has a negative impact on shadow economy, but the magnitude is very small relative to the 2SLS estimate. This downward bias can be due to three reasons: (1) GDP fluctuations can be caused by transitory and persistent shocks, whose interplay can drive down the estimated effect; (2) the reverse causality between GDP and the shadow economy, with the shadow economy casting its reverse impact on GDP; (3) classical measurement error in GDP figures. But, using the instrumental strategy corrects for the 3 factors all together. In short, our results indicate that the shadow economy responds negatively to oil-driven-income shocks, or on other words behaves in a countercyclical fashion.

[17] This is the same approach followed by Dix-Carneiro, Soares and Ulyssea (2018).

Table 5 presents our 2SLS estimates after making a set of exclusions for a specific groups of countries. Because international oil prices can be endogenous, in the sense that major oil producing and exporting countries may affect world oil supply to increase or decrease market prices. Columns 1-3 examines the effects on shadow economy after excluding major oil exporters, major oil producers and OPEC countries. We find oil-induced GDP per capita growth continue to exhibit a negative statistically significant impact on shadow economy. In columns 4 and 5, we omit the quintile of highest share values of shadow economy to GDP and the quintile of countries with the highest share of shadow economy to GDP averaged over the whole-period sample, respectively, to check the sensitivity our estimates to potential influential observations. In both cases, our main results remain robust in sign and significance. However, the magnitude of the effect of GDP growth has increased in column 4 and so is the first stage F-statistic (i.e. exceeded the threshold of 10) making our estimates more strongly identified.

Table 5: Oil price shocks, shadow economy and GDP –Robustness checks

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	logSE	logSE	logSE	logSE	logSE	logSE	logSE
	Drop major oil exporters	Drop major oil producers	Drop OPEC	drop extreme SE values	Drop high SE countries	Dynamic model	Dynamic model
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	GMM
Δ logGDP per capita, *t*	-1.918**	-0.950**	-1.226**	-1.351**	-1.065**	-0.450*	-0.237***
	(0.953)	(0.450)	(0.486)	(0.523)	(0.505)	(0.229)	(0.070)
log SE, t-1						0.741***	0.807***
						(0.032)	(0.041)
A-R Wald, F *(P value)*	[0.014]**		[0.002]***		[0.069]*	[0.086]*	
A-R Wald, χ^2 *(P value)*	[0.011]**		[0.001]***		[0.058]*	[0.075]*	
Stock-Wright, LM *(P value)*	[0.018]**		[0.041]**		[0.069]*	[0.077]*	
	First stage for Δ GDP per capita, *t*						
Oil price shock, *t*	0.320***	0..352***	0..389***	0.341***	0.311***	0.342***	
	(0.172)	(0.112)	(0.144)	(0.099)	(0.109)	(0.112)	
First stage F-statistic	3.47	10	7.26	11.92	8.23	9.26	
AR(1)							0.00
AR(2)							0.11
AR(3)							0.17
Number of observations	2,979	2,874	2,871	2,873	2,982	3,114	3,114
Number of countries	137	133	132	141	138	144	144
R-squared	0.967	0.981	0.979	0.974	0.979	0.994	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country specific-time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the size of (log) shadow economy as a percentage of GDP. In top panel, we report estimates of the average impact of oil price shocks. In column 1, we exclude the quintile of countries with highest whole-period average oil exports as a share of GDP; in column 2, we exclude quintile of countries whose share of world oil production exceeds 3% averaged over the sample period; in column 4, we exclude the quintile of country-year observations with highest share of shadow economy to GDP; and in column 5, we drop the quintile of countries with the highest share of shadow economy to GDP averaged over the whole period sample; in columns 6 & 7, we estimate dynamic panel model by adding the lagged level of (log) shadow economy. The method of estimation in columns 1-6 is two-stage least squares with Huber-robust standard errors (reported in parentheses) clustered at the country level; in column 7 is system-GMM. The instrumental variable is the 3-year average oil price shock defined as the average three year ln-change in the oil price multiplied by whole period average oil exports share to GDP (1991-2015). The p-values [in square brackets] are for three significance tests that are robust to weak instruments and the versions we implement are robust to heteroskedasticity and arbitrary within-country correlation of the residuals. In the bottom panel, we report the corresponding first stage regressions with Huber robust standard errors (in parentheses) that are clustered at the country level. Country fixed effects, year fixed effects and country-specific time trend are not reported. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Columns 6 and 7 adjust our baseline estimations in tables 4 by including the lagged dependent variable as an additional explanatory variable. This shall create a correlation between the lagged dependent variables and error introducing what is known as the Nickel bias (Nickel, 1981). Hence, besides reporting OLS and 2SLS estimates, we also report the system-generalized method of moment (GMM) (Blundell and Bond, 1998).[18] The estimates from GMM are close to their least squares counterpart. The

[18] The Time dimension of our sample of T=25 generally reduces concerns with Nickel bias (see Nickel, 1981) in OLS specification. According to Beck and Katz (2011), Nickel Bias becomes smaller when T is 20 years or more. It is therefore not surprising to see that the results from system-GMM estimation are very close to the original least squares results. We also use the collapse option to reduce the instruments count.

results indicate that the shadow economy adjusts very slowly to shocks and that the long run effect is 3 times larger than the immediate effect. In column 6, the long-run effect of oil-price-driven GDP growth on shadow economy implies that a 1 percentage point decline in GDP increase the shadow economy by 1.7 percent.

Table 6: Oil price shocks, shadow economy and GDP –Robustness checks

Model	(1)	(2)	(3)	(4)
	logSE	logSE	logSE	logSE
	Developed vs. developing	Adding additional instruments	Adding additional covariates	Alm and Embage SE (1984-2006)
	2SLS	2SLS	2SLS	2SLS
Δ logGDP per capita, *t*	-0.893**	-1.069***	-2.637	-1.249
	(0.406)	(0.339)	(2.033)	(0.800)
Δ logGDP per capita*developed	-0.717***			
	(0.222)			
Tax revenues (% of GDP) (log)			0.071	
			(0.047)	
Corruption (log)			-0.018	
			(0.035)	
Unemployment (log)			0.074**	
			(0.031)	
A-R Wald, F *(P value)*			[0.018]**	[0.062]*
A-R Wald, χ^2 *(P value)*			[0.012]**	[0.050]*
Stock-Wright, LM *(P value)*			[0.011]**	[0.122]
	First stage for Δ GDP per capita, *t*			
Oil price shock, *t*	0.323***	0.277***	0.261**	0.434***
	(0.103)	(0.102)	(0.116)	(0.149)
First stage F-statistic	10	10.96	5.04	8.38
Hansen J-statistic		0.93		
Number of observations	3,114	3,104	1,961	2,076
Number of countries	144	144	111	108
R-squared	0.983	0.981	0.977	0.935
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country specific-time trend	Yes	Yes	Yes	Yes

The dependent variable is (log) shadow economy as a percentage of GDP. In top panel, we report estimates of the average impact of oil price shocks. The method of estimation is two-stage least squares with Huber-robust standard errors (reported in parentheses) clustered at the country level. The instrumental variable is the 3-year average oil price shock defined as the average three year ln-change in the oil price multiplied by whole period average oil exports share to GDP (1991-2015); in column 3, the additional instrumental variable is the lagged GDP growth. The p-values [in square brackets] are for three significance tests that are robust to weak instruments, and the versions we implement are robust to heteroskedasticity and arbitrary within-country correlation of the residuals. In the bottom panel, we report the corresponding first stage regressions with Huber robust standard errors (in parentheses) that are clustered at the country level. Country fixed effects, year fixed effects and country-specific time trend are not reported. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Shadow economy causes and drivers can differ between developed and developing countries. In table 6, we check whether the effects differ between developed and developing countries by adding a dummy for developed countries, both by itself and interacted with the instrumented GDP growth. According to World Bank's income classification, the developing countries is comprised of middle income (both upper middle-income and lower middle-income) and low-income countries, whereas the developed countries refer to the high-income category.[19] Columns 1 shows that the coefficient of GDP growth is negative and statistically significant, whereas the conditioning variable is also negative and significant, indicating a significant difference in the estimated effect between developed and developing countries. The corresponding significant marginal estimates of the effect are (-1.61) for developed countries and (-0.86) for the developing countries. This suggests that GDP fluctuations caused by oil price changes

[19] The developed countries are Andorra, Antigua and Barbuda, Argentina, Aruba, Australia, Austria, Bahamas, Bahrain, Barbados, Belgium, Brunei, Canada, Chile, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea Rep., Kuwait, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, New Caledonia, New Zealand, Norway, Oman, Panama, Poland, Portugal, Qatar, Saudi Arabia, Seychelles, Singapore, Slovakia, Slovenia, Spain, St. Kitts and Nevis, Sweden, Switzerland, Switzerland, Taiwan, Trinidad and Tobago, United Arab Emirates, United Kingdom, United States, Uruguay.

matter more for shadow economies in developed countries relative to developing countries. Although investigating the observed divergence goes beyond our main objective, we may refer to the difference in the shares of shadow economy to GDP between developed and developing countries as a possible explanation. In our sample, the average size of shadow economy in developed countries is 18.9% with a maximum size of 48.7% compared to an average of 37% and maximum of 71.9% of GDP in developing countries.[20] In Table A2 in the appendix, we checked whether the initial size of the shadow economy affects the estimated response of shadow economy to GDP fluctuations. We find that the negative effect of GDP growth on shadow economy marginally declines the higher the initial size of shadow economy and these marginal (declining) estimates are statistically significant. The same holds, if we condition these marginal effects on developed countries. Hence, it may be the case that high shadow developing economies respond less to GDP fluctuation than low shadow developed economies.

Next, we explore whether the main 2SLS estimates is robust to the inclusion of additional instruments and additional controls. In column 3, we add the lagged GDP per capital growth as an additional instrumental variable. The coefficient of interest remain quantitatively and qualitatively the same and Hansen test of overidentifying restrictions' J-statistic fails to reject the hypothesis that instruments are valid instruments. In column 4, we control for additional drivers of shadow economy activities, namely tax burden, corruption and unemployment (Dreher and Schneider, 2010; Bajada and Schneider, 2009). Tax burden is measured by (log) tax revenue as a percentage of GDP from World Development indicators (WDI, 2018), (log) corruption data is taken from ICRG (PRS, 2017) with higher values referring to lower corruption and (log) unemployment is calculated according to International Labor Organization (ILO) estimates and retrieved from World Development Indicators (WDI, 2018). The results remain the same despite the significant drop in the same size. Overall, the preserved negative statistical significant effect of oil-driven-GDP growth lends credence that income shocks are the dominant mechanism through which oil price shocks affect the size of the shadow economy. Finally, in column 5, we employ an alternative measure for shadow economy taken from Alm and Embaye (2013) with estimates based on the currency demand method for the period 1984-2006. The shadow economy continues to respond significantly and negatively to oil price shocks and oil-price-driven GDP growth.

In the appendix, we conduct additional robustness checks in table A3. In column A31, we use a different weight for oil price shocks by employing the mid-period value of oil exports share to GDP. In columns A32, we differentiate between high oil- and low oil-dependent countries. In all specifications, the signs and statistical significant of our variables of interest remain robust with no significant difference between high and low oil-dependent countries. In column A33, we check whether the counter-cyclicality of the shadow economy to growth shocks depends on its initial size. For this, we include an interaction term between GDP and the 3-year lagged level of the shadow economy. The interaction term enters statistically insignificant and the GDP growth continues to exhibit a significant negative impact on the shadow economy. The estimated marginal estimates show a declining slope, but they are not

[20] A test of equality between the two samples' mean reject the null hypothesis that the two means are equal (p-value=0.00)

statistically significantly different from the average effect. In column A34, we account for additional effects of other natural resources rents (% of GDP), namely coal, natural gas and mineral. The rents from other natural resources and their interactions with GDP growth enter statistically insignificant and are very small in magnitude. In column A35, we restrict our sample to the post 2003 period and see that our estimates maintain their significance. The Chow test fails to reject the null hypothesis that the estimated coefficients in this sub-sample is the same as for the full sample. Finally, in column A36, we perform a falsification test by randomly reshuffling shadow economy values among countries. We find that the estimates have switched signs and lost their significance.

IV. Conclusion

In this paper, we study the impact of oil price shocks on the incidence of protest over the period 1991-2015. Our results indicate that negative oil price shocks significantly increases protests in low shadow economy countries, but the effect dissipates with the increase in the initial size of the shadow economy and eventually vanishes at very high levels of shadow economy. In explaining this result, this paper contributes to the existing debate in the shadow economy literature of whether the shadow economy behaves pro-cyclically or counter-cyclically to growth shocks. We provide new evidence that the shadow economy is negatively associated with oil-price-driven income shocks. Our estimates indicate that a 1 percentage point decline in GDP per capita due to negative oil price shock increases the shadow economy by 1.1 percent. Therefore, unlike previous studies regarding the shadow economy as a burden, our results suggest that counter-cyclicality of the shadow economy may act as a shock absorber, providing a safety net for business and workers against economic volatility. A higher size of the shadow economy can thus contribute to the political stability by providing a complementary source of income in highly resource dependent countries with economies relatively vulnerable to external economic shocks.

This finding has several implications. First, such mitigating role should allow for reconsiderations of permanent calls to eliminate the unofficial economy, by depicting it as a source of all evil, a stance that simply conflates causes with symptoms. Governments have to recognize that the existence of a shadow economy serves implicitly or explicitly as an integral part of societies' social risk management strategies (Holzmann and Jørgensen, 2001). Second, even if the elimination of inefficiencies in the allocation of goods and factors in the economy is an aim, which is justified in its own, deregulation and structural adjustment strategies have to be designed carefully. Specifically, strategies have to be implemented in such a way that a reduction or abolishment of shadow economy will be complemented by the increase or establishment of other risk management pillars (social security payments, unemployment insurance …etc.). Third, diversification of production will reduce the state dependency on oil revenues and therefore, economic vulnerability to shocks. Thus, industrial diversification strategies can serve as an important complement to strategies aiming at reducing the role of the shadow economy. In the end, the existence of the shadow economy is always also a response to unsound economic policies and inefficient economic structures that fail to shield the economy against shocks, aspects that should be addressed in advance.

Future research should investigate drivers of the shadow economy activities in oil dependent countries. Shadow economy may exist to correct market inefficiencies by providing business opportunities for small-scale firms, low skilled, and poorly educated workers. These sectors are systemically excluded from official economies due to heavy market regulations, inability to access credit, and poor educational and training services in oil producing countries (Dreher and Schneider, 2010; Van der Ploag, 2011; and Gylfason, 2001). Furthermore, the interaction between income distribution, shadow economy size and oil price shocks should in future be investigated in a structural model of the economy. This in turn would allow to model other channels which determine the probability and timing of political protest.

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Appendix

In Table A1, we conduct formal unit root tests for log oil prices, protest, shadow economy and GDP per capita. The tests cannot reject the null hypothesis of the presence of a unit root in the time series of oil price, protest and GDP in levels, but they reject it for their first differences. Although the tests for protest contradict in levels, they both reject the hypothesis of the presence of unit roots in 1st differences. For the shadow economy, formal tests reject the null hypothesis of the presence of unit roots in levels and first difference.

Table A1: Unit root tests

Variable	Log Oil Prices (Time-Series Tests)		Log Protest (Panel Data Tests)		Log Shadow economy (Panel Data Tests)		Log GDP per capita (Panel Data Tests)	
	Level	Diff.	Level	Diff.	Level	Diff.	Level	Diff.
Dickey-Fuller	n.s.	**	n.s.	***	***	***	n.s.	***
Dickey-Fuller-GLS	n.s.	**	-	-	-	-	-	-
Philipps-Perron	n.s.	***	***	***	***	***	n.s.	***

Note: All unit root tests contain trend. For panel data, we apply the fisher type tests. Abbreviation: n.s., not significant at the 10% level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table A2, conduct further robustness check for the protest model. In column A21, we use a different weight for oil price shocks by employing the mid-period value of oil exports share to GDP. We take the average of the closest 5 years to the year 2003. In columns A22, we restrict our sample to high oil-dependent countries defined as oil exporters whose whole-period average exports share to GDP is above the median. In columns A23 and A34, we differentiate between developed and developing countries based on World's Bank income classification. In column A26, we account for additional effects of other natural resources, namely coal, natural gas and mineral, to alleviate the concern that theses natural resources rents may be correlated with oil prices and driving the results. These natural resources are measured by their corresponding rents as a share of GDP (WDI, 2018). In all specifications, the signs and statistical significant of our variables of interest remain robust, with no statistical significant difference in effects between developed and developing countries. However, we find a relatively higher effect in high oil dependent countries compared to low-oil dependent countries and the difference is statistically significant (chow test p-value 0.08). The rents from other natural resources and their interactions with shadow economy enter statistically insignificant and very small in magnitude (not reported). In column A17, we restrict our sample to the post 2003 period, which constitutes half of the sample period and captures the oil boom period. The estimated coefficients maintain similar significance as for the entire sample. The chow test fail to reject the null hypothesis that the estimated coefficients in this sub-sample is the same as for the full sample. Finally, in column A18, we conduct a placebo test to make sure that our results are not mechanical or driven by pre-existing trends. We do that by regressing past protest data (1966-1990) on current period oil price shocks. We find that the coefficients of interest have switched signs and lost their significance.

Table A2: Oil price shocks, protest and shadow economy – Robustness checks

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Δ Log Protest	Δ Log Protest	Δ Log Protest	Δ Log Protest	Δ Log Protest	Δ Log Protest	Δ Log Protest
	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	Weight average mid-period	**High oil exporters only**	**Developed countries**	**Developing countries**	**Adding additional natural resources**	**Post-2003 period**	**Falsification test**
Oil price shock, *t*	-11.814***	-12.494***	-13.207	-27.984***	-12.611***	-19.541***	1.597
	(3.827)	(4.031)	(10.685)	(9.353)	(4.365)	(6.744)	(4.587)
Shadow economy (log), *t-3*	0.118	0.173	0.180	0.089	0.094	0.003	0.048
	(0.158)	(0.235)	(0.197)	(0.242)	(0.163)	(0.349)	(0.114)
Oil price shock*Shadow economy	3.266***	3.373***	4.102	7.476***	3.423***	5.118***	-0.360
	(1.073)	(1.095)	(3.445)	(2.494)	(1.208)	(1.830)	(1.382)
Additional natural resources (with interactions)					Yes		
Chow test *p*-value		0.08	0.13	0.13		0.19	
Number of observations	3,114	1,538	0.083	0.056	3,064	1,850	3,114
Number of countries	144	72	1,055	2,059	143	144	144
R-squared	0.056	0.066	49	95	0.059	0.095	0.042
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country specific-time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Oil price shock is the average three year ln-change in the oil price multiplied by whole period average oil exports share to GDP (1991-2015). The dependent variable is the ln-change of sum of protest events that took place in a given country at a given year. The additional natural resources are mineral rents, natural gas rents and coal rents, all as a percentage of GDP. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the country level. Country fixed effects, year fixed effects and country-specific time trend are not reported. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table A3 presents additional robustness checks for 2SLS estimates. In column A31, we use a different weight for oil price shocks by employing the mid-period value of oil exports share to GDP. In columns A32, we differentiate between high oil dependent countries -defined as oil exporters whose whole-period average exports share to GDP is above the median- and low oil-dependent countries. In all specifications, the signs and statistical significant of our variables of interest remain robust. In any case, the effect is not statistically significantly different between high and low-oil exporters with the conditioning variable entering statistically insignificant. In column A33, we check whether the counter-cyclicality of the shadow economy to growth shocks depends on its initial size. For this, we include an interaction term between GDP and the 3-year lagged level of the shadow economy. The interaction term enters statistically insignificant and the GDP growth continues to exhibit a significant negative impact on the shadow economy. However, the corresponding marginal estimates at different levels of the shadow economy show a declining slope and are statistically significant (not reported). In unreported results, we also checked whether the conditional effect of the initial size of the shadow economy differs between developed and developing countries. For that, we included a dummy for developed countries, both by itself and interacted by all the variables. We still find GDP growth to preserve its negative significant sign, while all conditioning variables remain statistically insignificant. The corresponding marginal estimates exhibit the same statistical significant significant downward slope. The chow test fail to reject the null hypothesis that conditioning effects in developed countries differ from developing countries (p-value 0.24). In column A34, we account for additional effects of other natural resources rents (% of GDP), namely coal, natural gas and mineral. The rents from other natural resources and their interactions with GDP growth enter statistically insignificant and are very small in magnitude. In column A34, we restrict our sample to the post 2003 period and see that our estimates maintain their significance. The chow test fail to reject the null hypothesis that the estimated coefficients in this sub-sample is the same as for the full sample. Finally, in column A36, we perform a falsification test by randomly reshuffling shadow economy values among countries. We find that the estimates have switched signs and lost their significance.

Table A3: Oil price shocks, shadow economy and GDP – Robustness checks

Model	(1)	(2)	(3)	(4)	(5)	(6)
	logSE	logSE	logSE	logSE	logSE	logSE
	Weight average mid-period	High-oil exporters vs. low exporters	Initial level of SE	Additional natural resources	Post-2003	Falsification test
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Δ logGDP per capita, *t*	-1.032***	-1.107**	-1.114**	-1.214**	-1.228	0.108
	(0.389)	(0.505)	(0.455)	(0.596)	(1.014)	(0.485)
Δ logGDP per capita*low exporter dummy		-0.032				
		(0.256)				
log SE, t-3			0.372***			
			(0.067)			
Δ logGDP per capita*log SE			0.017			
			(0.012)			
Additional natural resources (ith interactions)				Yes		
A-R Wald, F *(P value)*		[0.061]*	[0.035]**	[0.070]*	[0.085]*	
A-R Wald, χ^2 *(P value)*		[0.051]*	[0.028]**	[0.059]*	[0.069]*	
Stock-Wright, LM *(P value)*		[0.059]*	[0.036]**	[0.042]**	[0.076]*	
	First stage for Δ GDP per capita, *t*					
Oil price shock, *t*	0.295***	0.295***	0.311***	0.264***	0.167	0.276
	(0.077)	(0.104)	(0.110)	(0.092)	(0.111)	(0.086)
First stage F-statistic	14.63	8.13	8.01	8.14	2.24	10.24
Chow test *p*-value					0.28	
Number of observations	3,114	3114	3,114	3,064	1,850	2,980
Number of countries	144	144	144	143	144	144
R-squared	0.981	0.98	0.982	0.980	0.988	0.945
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country specific-time trend	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is (log) shadow economy as a percentage of GDP. In top panel, we report estimates of the average impact of oil price shocks. The method of estimation is two-stage least squares with Huber-robust standard errors (reported in parentheses) clustered at the country level. The instrumental variable is the 3-year average oil price shock defined as the average three year In-change in the oil price multiplied by whole period average oil exports share to GDP (1991-2015). The p-values [in square brackets] are for three significance tests that are robust to weak instruments, and the versions we implement are robust to heteroskedasticity and arbitrary within-country correlation of the residuals. In the bottom panel, we report the corresponding first stage regressions with Huber robust standard errors (in parentheses) that are clustered at the country level. Country fixed effects, year fixed effects and country-specific time trend are not reported. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.