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Oil prices, socio-political destabilization risks, and future energy technologies

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ABSTRACT

Our review of some modern trends in the development of energy technologies suggests that the scenario of a significant reduction of the global oil demand can be regarded as quite probable. Such a scenario implies a rather significant decline of oil prices. The aim of this article is to estimate the sociopolitical destabilization risks that such a decline could produce with respect to oil exporting economies. Our analysis of the relationship between changes in oil prices and political crises in these economies shows a large destabilizing effect for price declines in the respective countries. The effect is highly non-linear, showing a power-law type relationship: oil price changes in the range higher than $60 per barrel only exert very slight influence on sociopolitical instability, but if prices fall below this level, each further decrease by $10 leads to a greater increase in the risks of crises. These risks grow particularly sharply at a prolonged oil price collapse below $40 per barrel, and become especially high at a prolonged oil price collapse below $35 per barrel. The analysis also reveals a fairly short-term lag structure: a strong steady drop in oil prices immediately leads to a marked increase in the risks of sociopolitical destabilization in oil-exporting countries, and this risk reaches critical highs within three years. Thus, the possible substantial decline of the global oil demand as a result of the development of the energy technologies reviewed in the first section of the present article could lead to a very substantial increase in the sociopolitical destabilization risks within the oil exporting economies. This suggests that the governments, civil societies, and business communities of the respective countries should amplify their effort aimed at the diversification of their economies and the reduction of their dependence on the oil exports.

1. Energy for societies, past and future

Performance and the very existence of industrial and postindustrial economies depend on energy resources, particularly fossil fuels. From the natural science point of view, everything that happens in macroworld is caused by, or equivalent to, energy transformations. Physical chemist and Nobel Laureate Frederick Soddy wrote in *Wealth, Virtual Wealth and Debt* (Soddy, 1926, p. 56):

> If we have available energy, we may maintain life and produce every material requisite necessary. That is why the flow of energy should be the primary concern of economics.

William Stanley Jevons, who was one of the founders of neoclassical economics, arguably the dominant school of economic thought in the 20th century, forecasted that the British Empire was going to decline, when its coal mines are exhausted, as he stated in *The Coal Question; An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal-Mines* (Jevons, 1906):

> Coal in truth stands not beside but entirely above all other commodities. It is the material energy of the country – the universal aid – the factor in everything we do. With coal almost any feat is possible or easy; without it we are thrown back into the laborious poverty of early times.

Indeed, after its "peak coal" and World War I, the UK had been surpassed by the US. However, Jevons did not see oil coming. Nevertheless, the empire on which the sun never sets, drastically reduced in size and international significance. Coal-based UK dominance was replaced with the dominance of the gasoline powered US. Internal combustion engines radically changed industries and economies. However, the demand in oil may also decline substantially in the forthcoming decades due to the development of some alternative energy technologies.

Global wind power may provide > 70 TW with existing

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technologies annually (Archer and Jacobson, 2005). Moreover, the amount of sun radiation received by the planet is about 23,000 TW per year, and that is only for continents (Perez and Perez, 2015). Modern renewable energy technologies depend on rare metals and other materials, which can become bottlenecks. Although, they are usually recyclable (Viebahn et al., 2015), reserves of neodymium and yttrium may become bottlenecks due to geopolitical considerations (Been, 2014). After the era of finite fossil fuels, rational decision would be to go with renewable energy, especially given amounts of potentially available resources.

While production of wind turbines requires rare materials, their use depends on available physical space, since costs of production naturally invite economy of scale for the turbine size, resulting in large turbines. Offshore wind farms are placed where they do not affect sea traffic routes. Onshore wind farms placement is more problematic, because electricity transmission is relatively expensive and electricity consumption occurs where people live, which means restrictions in the land availability for wind turbines ("not in my backyard" problem). However, it was estimated that providing 50% of the world's electricity consumption through wind power would take only 47 km^2 (Jacobson and Delucchi, 2011).

Photovoltaic systems are more flexible than wind farms in regard to land use. Moreover, placing them on rooftops converts wasted space into the site of energy production. Photovoltaic systems' energy return on energy investment (EROI) is about 10 to 25 for modern technology, and is expected to reach up to 60 in 2020 (Görig and Breyer, 2016). This, of course, depends on geography and seasonality. Placing photovoltaic panels in deserts where supply of sun radiation is better than in other places, meets certain limitations due to decrease in efficiency at high temperatures. Cooling them, which could partially solve this problem, is hardly an option for arid areas, such as the Sahara, Atacama, or even California (Skoplaki and Palyvos, 2009).

Energy production from biomass may also find its' market in certain geographic regions. However, agriculture is heavily subsidized in developed countries today. Replacing food crops with bioethanol sources would undermine farmers' incentives, since bioethanol EROI for most sources is below 3, which is well below conventional sources (Hall et al., 2014).

Hydroelectric power can provide 3–4 TW annually (Perez and Perez, 2015). However, an important feature of hydro-power is that it can be turned on almost immediately, unlike coal and natural gas power plants, for which lag is at the scale of hours. This provides perfect opportunities for energy storage, so called pumped storage (Glasnovic and Margeta, 2015). Pumped storage does not require rivers, and can operate everywhere, at above zero temperatures. In the case of sub-zero temperature, pumped storage can work with non-water liquids, ironically, including gasoline.

Although nuclear power meets concerns regarding environmental issues and possible terrorist threat, nevertheless, slow progress on true renewables creates niche for nuclear power reactors (Darmani et al., 2014; Elliott, 2017; Khatib and Difiglio, 2016; Pahle et al., 2016). Moreover, Fast Breeders offer extension for the nuclear power resource base for > 1500 years, since they are able to utilize isotope ^{238}U, comprising 99.28% of the Earth's uranium, and not usable with presently dominating technology. Not less important, Fast Breeders will also be able to use thorium, which exceeds amounts of uranium in the Earth by a factor of two (Mahoney et al., 2015; Marchenko and Solomin, 2013; Nash, 2015; Sarangi, 2017).

Perspectives of nuclear fusion is hard to discuss here. Whether or not it will move from the realm of physics research to economic opportunities in more or less the near future, is not clear. However, progress in this field should be monitored, since it potentially offers unlimited supply of energy and all the corresponding consequences for humankind.

Oil accounts for 40% of energy consumption, with 65% of it used in transportation, whereas electricity accounts for about 18% of total energy consumption (IEA, 2016). Given that most of renewable energy end consumption should occur via electric power outlets, transition to renewables also depends on electricity transmission systems. Thus, electric vehicles become a critical point in transition to renewables, and their development could lead to a very significant decline of oil consumption (Dallinger et al., 2017; Hedegaard et al., 2012). Another option would be hydrogen cells, which are usable for individual vehicles (and other small scale applications), as well as for large electric networks (Cho et al., 2016; Schiebahn et al., 2015).

Unlike other energy technologies, natural gas besides electricity production, can be consumed regardless of electric grids, for central and residential heating, as well as for transportation. Thus, a decrease in oil supply will be (and already is) compensated with natural gas (Hedegaard et al., 2012), until economical electricity storage and smart grids change the field. The present oil consumption infrastructure is well compatible with the one for natural gas, and requires only minor modifications, including transportation. Importantly, a switch to natural gas from oil and coal significantly reduces CO_2 emissions.

Thus, our review of some modern trends in the development of energy technologies suggests that the scenario of a significant reduction of the global oil demand can be regarded as quite probable. Such a scenario implies a rather significant decline of oil prices. The aim of this article is to estimate the sociopolitical destabilization risks that such a decline could produce with respect to the oil exporting economies.

2. Oil prices and sociopolitical destabilization in oil exporting economies

The role of oil in the political stability of oil-exporting countries has long attracted the attention of researchers. The question is, of course, multifaceted. Thus, a significant number of papers show that oil-exporting states have a significantly greater risk of involvement in various types of armed conflict than other states (for a detailed review of such works see Nillesen and Bulte, 2014, also Colgan, 2010).

Regarding internal instability, two main hypotheses have been developed. One hypothesis points out that oil (and other valuable resources) provide funding for the insurgents, as well as the motivation for attempts to seize power – the so-called "greed model" (Collier and Hoeffler, 2004). Another common hypothesis states that dependence on export of natural resources leads to a weakening of the state — the so-called "Dutch disease" (Fearon, 2005; Fearon and Laitin, 2003).

A number of studies have shown an increased likelihood of violent internal conflicts in the oil-exporting countries as compared to other countries (Collier and Hoeffler, 2004; Ross, 2004a, 2004b, 2012; Fearon, 2005; Humphreys, 2005). Lujala (2010) finds that oil substantially prolongs conflict when located inside the conflict zone. Bell and Wolford (2015) show that in poor countries the discovery of new oil fields alone (even before the start of actual mining) significantly increases the likelihood of internal conflict. Moreover, the probability of civil wars in the countries producing oil, gas and diamonds is found to have increased in the period from the beginning of the 1970s until the end of the 1990s (Ross, 2006).

One should note, however, that there is still no fully unanimous agreement in this field — some works (e.g., Cotet and Tsui, 2013) point at the absence of a significant link between the discovery of new oil fields and the onset of internal conflicts, coup attempts, and civil wars; others (Soysa and Neumayer, 2007) find no relation between a country's oil resources and the onset of civil wars; finally, it is stated that in oil-rich countries corruption can lead not to increasing destabilization, but, on the contrary, to the strengthening of the regime through providing the means to bribe opposition groups (Fjelde, 2009).

Most of the works cited above use either the volume of a country's proven oil reserves or its oil exports as percent of GDP as their independent variables. However, Smith (2004) has argued that such an approach, omitting changes in the current pricing of oil, can lead to contradictory results. For example, if prices are rising, large oil reserves can stabilize a regime by providing additional resources; but if prices are falling a regime with large reserves that has become dependent on their revenue may be destabilized. Smith enriched his analysis by adding variables for the oil boom of the 1970s and the oil bust of the 1980s. The results show that, though oil resources in general tended to enhance regime stability, the oil price collapse during the 1980s was related to increased instability in the oil-exporting countries (Smith, 2004). Turchin (2006) obtained similar results for the specific case of Saudi Arabia. Filin finds a correlation between oil prices and the level of political instability in Iran (using his own intra-elite conflict index); notably, his work detects a three-year time lag: "average oil price in the current three-year period has turned out to be a very strong predictor of the level of intensity of intra-elite conflict in the following three-year period" (Filin, 2012: 330; see also: Filin, 2013a: 114, 2013b: 38).

In this paper, we test the hypothesis that oil price decreases lead to sociopolitical destabilization in countries financially dependent upon oil exports, while oil price increases enhance stability. We pay particular attention to the time lag with which oil price changes affect regime risks. We also examine threshold effects to identify the price level marking the sharpest exacerbation of risks in oil-exporting countries.

3. Data and methods

3.1. Data

We chose Brent oil prices[1] as our independent variable. Average yearly prices for Brent oil are taken according to data from the *Energy Information Administration.*[2]

To account for inflation, we use the consumer price index normalized to 2014[3]; thus all prices below are in constant 2014 U.S. dollars.

We use as our dependent variables the set of sociopolitical destabilization indicators registered in the CNTS database. We include only oil-exporting countries, which we define as those countries that each had at least 1% of the world's total oil exports in 2012 (according to the U.S. Energy Information Administration). This presents us with a list of 19 countries, namely (from highest to lowest share in the world oil exports): Saudi Arabia, Russia, the UAE, Kuwait, Nigeria, Iraq, Venezuela, Qatar, Norway, Angola, Iran, Algeria, Canada, Kazakhstan, Libya, Mexico, Azerbaijan, Oman, and Colombia. We use aggregated values of the relevant political instability indicators for all these countries — for example, the total number of major anti-government demonstrations registered in all these countries in a given year, or the mean value of the integral index of sociopolitical destabilization in a given year. It appears essential to emphasize that the unit of observation in our case is all the oil exporting countries, on the whole, which excludes from the analysis certain characteristics that are certainly significant if the unit of observation is an individual oil-producing country, such as the nature of the government in the countries considered, or their treatment of their oil wealth (such as sovereign funds).

3.2. Cross National Time Series (CNTS) and its methodology

The Cross-National Time Series (CNTS) database is a result of data compilation and systematization started by Arthur Banks (Banks and Wilson, 2015) in 1968 at the State University of New York — Binghamton. The work was based on generalizing the archive of data from The Statesman's Yearbooks, published since 1864. The database contains approximately 200 indicators for > 200 countries. The database contains yearly values of indicators starting from 1815 excluding the periods of World Wars I and II (1914–1918 and 1939–1945).

The CNTS database is structured by sections, such as territory and population, technology, economic and electoral data, internal conflicts, energy use, industry, military expenditures, international trade, urbanization, education, employment, legislative activity, etc.

In our paper we view in detail the data describing the internal conflicts (*domestic*). This section includes data starting from 1919 based on the analysis of events in 8 various subcategories, which are used for building the general *Index of Sociopolitical Destabilization* (domestic9). In this process the compilers of the CNTS database give each category a certain weight (see Table 1).

3.3. Test methodology

We use OLS regression analysis to test the effect of oil price levels on the Index of Sociopolitical Destabilization aggregated across all 19 countries. We limit ourselves to the period of 1977–2010. We begin in 1977 as it was only after the oil price boom of 1973–74, and OPEC's efforts to sharply increase oil prices, that high price levels and large swings in prices became common. As it would take several years for countries to develop dependency on high levels of oil exports, we start with a three-year lag. As regards the years after 2010, the world system arguably experienced a sort of phase transition in the level of protest activity in 2011–2012 with the wave of instability spreading across the Arab World (see Fig. 1 published in one of the previous issues of the *Technological Forecasting and Social Change*). This transition makes the data before and after 2011 somewhat incomparable.

4. Test results

Simple OLS regressions on each of the CNTS political instability variables provides the following results (see Table 2). The table features the variables' names in lines and values of Pearson correlation coefficient in columns.

For 8 out of 9 correlations the relation goes in the predicted direction (i.e. the correlation is negative, with lower Brent oil prices being correlated to higher levels of the sociopolitical destabilization indicator). Despite the small N, for 4 out of 9 indicators the correlations are statistically significant at the < 0.05 level.

In case of absence of a statistically significant impact of oil prices upon sociopolitical destabilization one would hardly expect a series of 9 tests to bring about more than one such a correlation. Thus, our test results can be viewed as preliminary evidence in support of the hypothesis on the presence of such an impact.

As regards the correlations, though almost half of them are statistically significant, they are still rather weak in terms of absolute values. Thus, the variation in oil prices explains about 19% of the variation in the aggregated indicator of the number of political strikes in oil-exporting countries (see Fig. 2), and 26% of the variation in the aggregated indicator of sociopolitical destabilization (see Fig. 3).

4.1. Adding a time lag

Let us now take into account possible time lags. As we have noted earlier, Filin's research on Iran has shown low oil prices to correlate with sociopolitical destabilization in this country with a certain time lag (Filin, 2012: 330; Filin, 2013a: 114, 2013b: 38). Indeed, in years with high oil prices, the elites in the oil-producing countries have the opportunity to accumulate huge reserves of resources from the sale of oil. Therefore, short-term drops in oil prices do not lead to destabilization, because accumulated resources make it possible to neutralize growing discontent for a certain period of time (1–2 years) until the resources are exhausted. Let us check whether the same pattern is observed at the global level.

[1] We based our research on Brent; however, similar results are obtained with WTI and Dubai Crude (cf. Akaev et al., 2012).

[2] Energy Information Administration. Europe Brent Spot Price FOB (Dollars per Barrel). URL: http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=A (accessed on: 24.01.2016).

[3] World Bank. World Development Indicators Online. Washington DC: World Bank, Electronic version. URL: http://data.worldbank.org/indicator/FP.CPI.TOTL (accessed on: 24.01.2016).

Table 1
Weights of subcategories used at compiling the Index of Sociopolitical Destabilization.

Subcategory	Variable name	Weight in the Index of Sociopolitical Destabilization (domestic9)[a]
Assassinations	domestic1	25
General strikes	domestic2	20
Guerrilla warfare	domestic3	100
Government crises	domestic4	20
Purges	domestic5	20
Riots	domestic6	25
"*Revolutions*"[b]	domestic7	150
Anti-government demonstrations	domestic8	10

For calculating the Index of Sociopolitical Destabilization (*Weighted Conflict Measure*, domestic9) the numerical values of each subcategory are multiplied by the corresponding weights, the results of the multiplications are summed up, the sum is multiplied by 100 and divided by 8 (for more detail on the use of the CNTS variables for the analysis of sociopolitical destabilization factors see, e.g., Slinko et al. 2017; Коротаев, А.В. et al., 2016; Коротаев, А.В. et al., 2017; Коротаев, А. et al., 2017; Коротаев, Слинько et al., 2016).

[a] Note that these weights have been identified by the developers of the CNTS database, and not by us.

[b] Note that the name of this variable ("Revolutions") is rather misleading, since in reality in most cases the respective columns of the CNTS database register coups and coup attempts rather than revolutions proper as they are understood in political science (see, e.g., Goldstone, 2014; Гринин et al., 2015). Thus, below we will denote this variable just as "Coups and coup attempts" rather than "Revolutions".

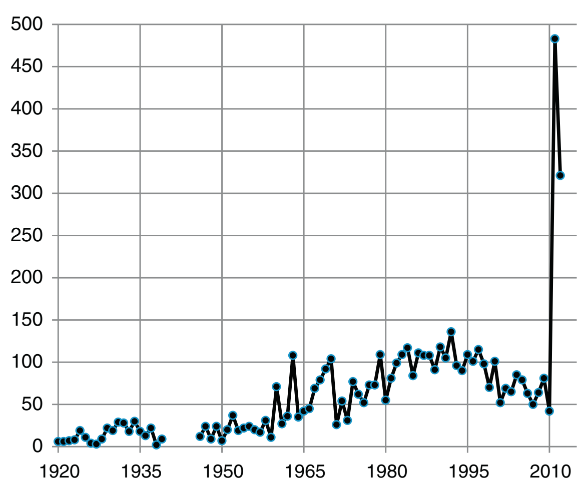

Fig. 1. Dynamics of the total number of major anti-government demonstrations registered in the world per year in CNTS database (1920–2012).
(Akaev et al., 2017, 317, Fig. 1.)

Table 2
Correlations between Brent oil prices and CNTS indicators of sociopolitical destabilization, 1977–2010.

No.	Sub-category	Pearson correlation coefficient
1.	*Assassinations*	− 0.273
2.	*General strikes*	− 0.431[a]
3.	*Guerrilla warfare*	− 0.155
4.	*Government crises*	− 0.237
5.	*Purges*	0.028
6.	*Riots*	− 0.204
7.	*Coups and coup attempts*	− 0.441[a]
8.	*Anti-government demonstrations*	− 0.342[a]
9.	*Aggregated sociopolitical destabilization index*	− 0.514[a]

$N = 34$.
[a] Correlation is significant at < 0.05.

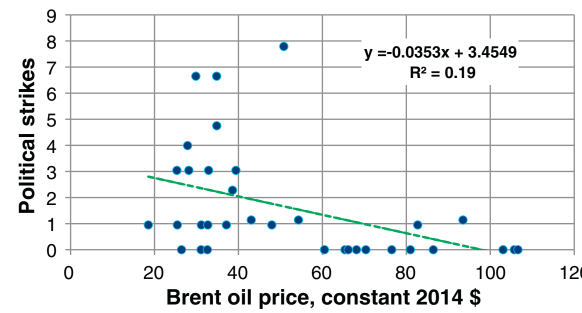

Fig. 2. Correlation between average yearly prices of Brent oil and total numbers of major political strikes in oil-exporting countries, without a time lag, 1977–2010 (scatterplot with fitted regression line).
Notes: $r = -0.431$, $p = 0.011$ (2-tailed), $R^2 = 0.19$. *F*-statistic: 7.309 on 1 and 32 DF, *p*-value: 0.01089. A high value of the probability of type I error ($p = 0.464$) indicates the absence of autocorrelation and, consequently, the independence of residues. Multicollinearity is lacking because only one factor is used as an independent variable.

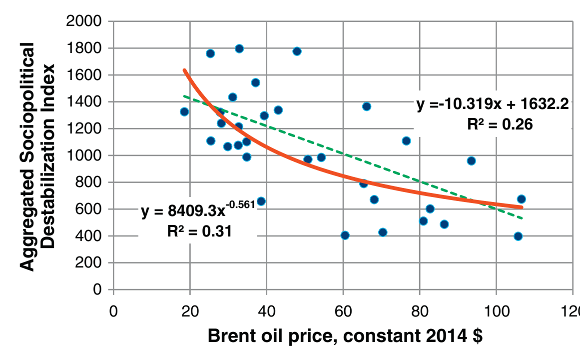

Fig. 3. Correlation between average yearly prices of Brent oil and mean values of Sociopolitical Destabilization Index in oil-exporting countries, without a time lag, 1977–2010 (scatterplot with fitted regression lines).
Note: $r = -0.514$, $p = 0.002$ (2-tailed), $R^2 = 0.26$ (for linear regression), $R^2 = 0.31$ (for power-law regression). *F*-statistics: 11.48 on 1 and 32 DF, *p*-value: 0.001884. The result of the heteroscedasticity test is insignificant ($p = 0.11$) which indicates that the homogeneity of the dispersion condition is satisfied. There are no signs of heteroscedasticity. There is no multicollinearity in the data, since only one factor is used as an independent variable.

We find that correlation between the low oil prices and high levels of sociopolitical destabilization increases markedly if the effect of time lag is taken into account. Low oil price in a given year is a better predictor of sociopolitical instability not the same year (X), but one year later (X + 1), and an even better predictor two years later (X + 2). However, the best correlation is observed for low oil price and the onset of sociopolitical instability three years later (X + 3). As the number of lag years grows up from zero, the determination coefficient grows from 0.264 to 0.439, reaching its peak for a three year time lag (see Table 3 and Fig. 4). Tests for longer time lags (4 and 5 years) show the decreasing trend of the lag effect, with determination coefficient going down from 0.439 to 0.216. Thus, very low oil prices serve as the best predictor of sociopolitical destabilization in oil exporting countries with a three year time lag (Fig. 5).

Thus, we see that taking time lags into account leads to a serious increase both in correlation strength and statistical significance. The number of significant correlations increases from 4 out of 9 to 7 out of 9. Correlation strength also goes up very remarkably. For example, correlation strength for low oil prices and political assassinations increases from − 0.273 ($R^2 = 0.07$) without a time lag to − 0.456 ($R^2 = 0.21$) with a 3-year time lag; correlation strength for low oil prices and anti-government demonstrations goes up from − 0.342 ($R^2 = 0.12$) to − 0.458 ($R^2 = 0.21$); and correlation strength for low oil prices and coups and coup attempts increases from − 0.441 ($R^2 = 0.19$) to − 0.523 ($R^2 = 0.27$). Correlation strength for low oil prices and the aggregated Sociopolitical Destabilization Index goes up

Table 3
Correlations between Brent oil prices and CNTS indicators of sociopolitical destabilization with a three-year time lag, 1977–2010.

Sub-category	Pearson correlation coefficient
Assassinations	− 0.456***
General strikes	− 0.288*
Guerrilla warfare	− 0.306*
Government crises	− 0.387**
Purges	− 0.180
Riots	− 0.212
Coups and coup attempts	− 0.523***
Anti-government demonstrations	− 0.458***
Aggregated sociopolitical destabilization index	− 0.663****

* Correlation is significant at 0.05 $< p <$ 0.1 level (2-tailed)–0.025 $< p <$ 0.05 (1-tailed).
** Correlation is significant at < 0.05 level (2-tailed).
*** Correlation is significant at < 0.01 level (2 tailed).
**** Correlation is significant at < 0.001 level 9 (2 tailed).

Table 4
Correlations between 5-year moving averages of Brent oil prices and aggregate CNTS Sociopolitical Destabilization Index for the oil exporting countries, with a three year time lag, 1977–2008.

Sub-category	*Pearson correlation coefficient*
Assassinations	− 0.737****
General strikes	− 0.418**
Guerrilla warfare	− 0.567***
Government crises	− 0.646****
Purges	− 0.193
Riots	− 0.243
Coups and coup attempts	− 0.746****
Anti-government demonstrations	− 0.741****
Aggregated sociopolitical destabilization index	− 0.884****

** Correlation is significant at < 0.05 level (2-tailed).
*** Correlation is significant at < 0.01 level.
**** Correlation is significant at < 0.001 level.

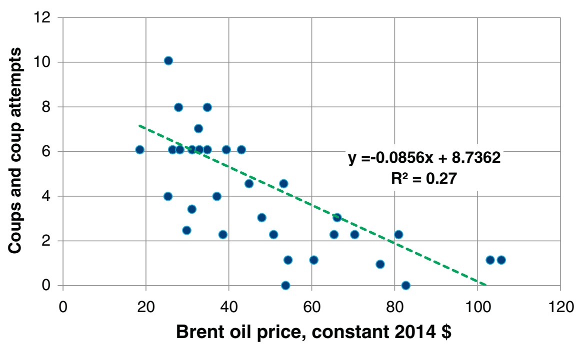

Fig. 4. Correlation between average yearly prices of Brent oil and a total number of coups and coup attempts in oil-exporting countries three years later, 1977–2010 (scatterplot with fitted regression line).
Note: $r = -0.523$, $p = 0.002$ (2-tailed), $R^2 = 0.27$ (for linear regression). F-statistic: 12.03 on 1 and 32 DF, *p*-value: 0.001518. The result of the heteroscedasticity test is insignificant ($p = 0.054$), which indicates that the homogeneity of the dispersion condition is satisfied. There are no signs of heteroscedasticity. The probability of type I error is higher than the generally accepted significance level ($p = 0.056$), which indicates the absence of autocorrelation and, consequently, the independence of residues. There is no multicollinearity in the data, since only one factor is used as an independent variable.

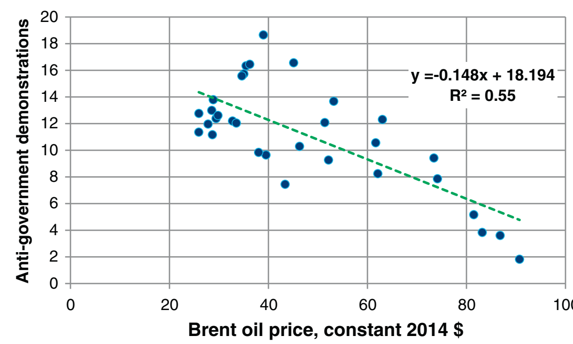

Fig. 6. Correlation between average yearly prices of Brent oil and a total number of major anti-government demonstrations in oil-exporting countries three years later (for 5 year moving averages), 1977–2010 (scatterplot with fitted power-law and linear regression lines).
Note: $r = -0.741$, $p < 0.001$ (2-tailed), $R^2 = 0.55$ (for linear regression), $R^2 = 0.51$ (for power-law regression). *F*-statistic: 36.61 on 1 and 30 DF, *p*-value: $1.21 \cdot 10^{-6}$. The result of the heteroscedasticity test is insignificant ($p = 0.62$), which indicates that the homogeneity of the dispersion condition is satisfied. There are no signs of heteroscedasticity. There is no multicollinearity in the data, since only one factor is used as an independent variable.

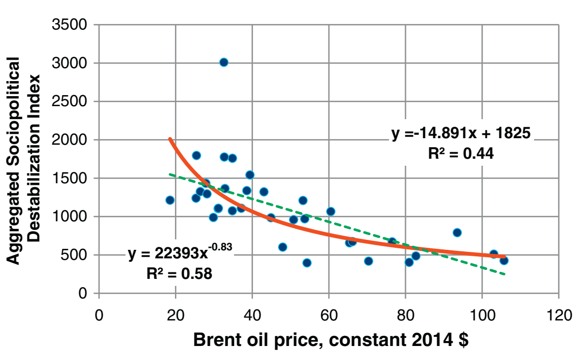

Fig. 5. Correlation between average yearly prices of Brent oil and a mean value of CNTS Sociopolitical Destabilization Index in oil-exporting countries three years later, 1977–2010 (scatterplot with fitted power-law and linear regression line).
Note: $r = -0.663$, $p < 0.001$ (2-tailed), $R^2 = 0.44$ (for linear regression), $R^2 = 0.58$ (for power-law regression). F-statistic: 25.08 on 1 and 32 DF, *p*-value: $1.94 \cdot 10^{-5}$. The result of the heteroscedasticity test is insignificant ($p = 0.077$), which indicates that the homogeneity of the dispersion condition is satisfied. There are no signs of heteroscedasticity. A high value of the probability of type I error ($p = 0.082$) indicates the absence of autocorrelation and, consequently, the independence of residues. There is no multicollinearity in the data, since only one factor is used as an independent variable.

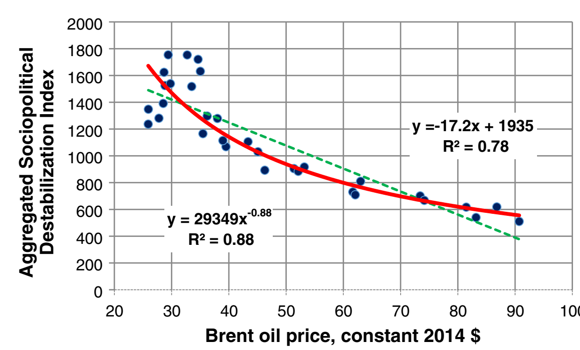

Fig. 7. Correlation between average yearly prices of Brent oil and mean values of CNTS Sociopolitical Destabilization Index in oil-exporting countries three years later (for 5 year moving averages), 1977–2010 (scatterplot with fitted power-law and linear regression lines).
Note: $r = -0.884$, $p < 0.001$ (2-tailed), $R^2 = 0.78$ (for a linear regression), $R^2 = 0.88$ (for a power-law regression). *F*-statistic: 106.9 on 1 and 30 DF, *p*-value: $2.094 \cdot 10^{-11}$. Из результатов теста Global Stat tests' results indicate that the data satisfy all the statistical assumptions underlying the OLS-regression ($p = 0.1$). There is no multicollinearity in the data, since only one factor is used as an independent variable.

from − 0.514 (R^2 = 0.26) to − 0.663 (R^2 = 0.44). Thus, taking into account the 3-year time lag makes the correlations considerably stronger. Note that this brings some light to the causation issue. Indeed, the correlation between the oil prices and sociopolitical destabilization in the oil-exporting countries can be accounted for not only by the decline of political stability with the decline of the oil revenues. It can also be accounted for by the decline of the oil production (and, hence, the increase in oil prices) with the growth of instability in the oil producing countries. However, if this direction of causation had prevailed, we would expect to find a positive correlation between the two variables, whereas in fact it is negative. In addition, the fact that the decline of the oil prices tends to lead to the sociopolitical destabilization of oil-exporting countries with a 3-year time lag supports the direction of causation from the oil prices change to the change in political stability, rather than the other way round.

Let us also note that a particularly strong correlation (R^2 = 0.58) for the aggregate CNTS Sociopolitical Destabilization Index is observed not for a linear regression, but for a power-law one. We shall return to the power-law relationship below.

First, however, we should avoid the simple point-values for oil prices and instead use 5-year moving averages in order to exclude the highly pronounced stochastic components in these variables.

The use of 5-year moving averages combined with 3-year-long lag leads to a further increase in correlation strength (see Table 4 and Figs. 6 and 7). The Pearson correlation coefficient for three correlations (oil prices with political assassinations, coups and coup attempts, and anti-government demonstrations) is remarkably higher than 0.73, meaning that this simple relationship explains more than half the variation in each of these indicators of sociopolitical instability. For the Aggregated Sociopolitical Destabilization Index, the fraction of variance explained is 78%. These strong correlations show that a collapse of oil prices can truly exacerbate intra-elite conflicts and intensify mass protest movements.

If we look at *changes* in oil prices and subsequent instability, rather than the level of prices, we still find strong correlations. Table 5 shows the correlation between the decline in oil prices in a given year and the growth of political instability (e.g. increases in the CNTS indicators) three years later, using moving averages of oil prices. The correlations between changes are all in the right direction (negative), and are statistically significant for six of the eight primary indicators. These correlations, however, are not as high as in the case of the correlation between the oil price level and the level of instability in three years, which, in our opinion, is largely due precisely to the fact that in the latter case we are dealing with a power-law relationship, rather than a linear correlation.

Table 5
Correlations between change in Brent oil prices and change in the CNTS indicator of sociopolitical destabilization three years later, 1978–2008 (for 5 year moving averages).

Sub-category	Pearson correlation coefficient
Assassinations	− 0.330*
General strikes	− 0.571**
Guerrilla warfare	− 0.276
Government crises	− 0.343*
Purges	− 0.586**
Riots	− 0.477**
Coups and coup attempts	− 0.253
Anti-government demonstrations	− 0.561**
Aggregated sociopolitical destabilization index	− 0.563**,***

* Correlation is significant at 0.05 $< p <$ 0.1 level (2-tailed) ~ 0.025 $< p <$ 0.05 (1-tailed).
** Correlation is significant at < 0.05 level (2-tailed).
*** Correlation is significant at < 0.001 level (2-tailed).

5. Discussion and conclusion

Thus, our research suggests that prolonged decline in oil prices leads to an almost inevitable growth of sociopolitical instability in oil-exporting countries, while a systematic increase of the prices serves as a powerful factor of sociopolitical stabilization. The relationship appears to be of power-law type. That is why oil price changes in the range higher than $60 per barrel only exert very slight influence on the sociopolitical instability in oil-exporting countries. However, if prices fall below this level, further decrease by each $10 leads to a more and more pronounced increase in the sociopolitical destabilization risks. These risks grow particularly sharply at a prolonged oil price collapse below $40 per barrel, and become nearly inevitable at a prolonged oil price collapse below $35 per barrel. Our analysis has also revealed three year time lags — though a strong steady drop in oil prices immediately leads to a marked increase in the risks of sociopolitical destabilization in oil-exporting countries, this risk becomes really high three years after that. It appears that during high price periods most oil exporting countries tend to accumulate substantial reserves of stability that tend to be exhausted within three years of consistently low prices (note that a steady growth of oil prices also tends to produce its stabilizing effect with a three year time lag). Of course, even if the oil prices drop below $35 for many years, the risks of sociopolitical destabilization can still be mitigated and even fully avoided with the help of adequate policy measures. Indeed, the oil price decline in the 1980s and the early 1990s greatly contributed to the collapse of the USSR and the onset of the Algerian civil war (see, e.g., Гринин et al., 2010) — but, for example, Saudi Arabia managed to avoid any substantial political destabilization, though not without significant effort (see, e.g., Turchin, 2006).

However, our analysis indicates that the possible substantial decline of the global oil demand as a result of the development of the energy technologies reviewed in the first section of the present article could lead anyway to a very substantial increase in the sociopolitical destabilization risks within the oil exporting economies. This suggests that the governments, civil societies, and business communities of the respective countries should amplify their effort aimed at the diversification of their economies and the reduction of their dependence on the oil exports.

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