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RESEARCH ARTICLE / ARAŞTIRMA MAKALESİ

Principal component and regression analysis of the natural resource curse doctrine in the Azerbaijani economy

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Abstract

The Azerbaijani economy has long been discussed in academic literature with reference to the theories of the natural resource curse (NRC) and Dutch disease. This is due to Azerbaijan's heavy dependence on the oil and gas industry for its economic growth and development since 1995. While revenues from mineral resources helped overcome extreme poverty and increased GDP and GDP per capita, macroeconomic stability was shaken by the sharp decline in commodity prices in 2014 and 2015. This reality prompted scholars to look into the significance of NRC and Dutch disease in Azerbaijan. This paper therefore aims to contribute to the literature by analyzing NRC using principal component and regression techniques (dynamic and ordinary least squares) in a way that has not been studied before. The results of this study show that the oil industry had a negative impact on institutional quality in Azerbaijan between 1996 and 2019, which may translate into further negative impacts. For this reason, the human capital channel of NRC was tested for possible negative impacts of NRC and several negative associations were found. These results indicate that policymakers need to take the NRC doctrine more seriously. Although the first oil boom (2005–2014) is over, the Azerbaijani economy is facing a second oil boom starting in 2020, and the lowered quality of institutions could significantly reduce the benefits of mineral revenues if left unmanaged.

Keywords: Azerbaijan economy, Dutch disease, natural resource curse, principal component analysis, regression

JEL codes: E02, C38, O13, O15, O17

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1. INTRODUCTION

According to the World Bank (2020), Azerbaijan is more dependent on its natural resources than any other post-Soviet state. Czech (2018) claimed that Azerbaijan enters into the group of 15 most oil-dependent countries in the world based on the ratio of oil revenues to GDP. Azerbaijan's oil revenues, which started at 22.5% of GDP in 2001, rose steeply, reaching a record 39.6% in 2006. Although the country has many natural resources, the non-oil sector has been de-industrialized (Sadik-Zada et al., 2021), and most of the government's money comes from crude oil and petroleum exports.

The mining industry contributed significantly to national economic growth, while manufacturing and agriculture gradually contracted. Government spending, fueled by commodity gains, encouraged growth in the tertiary sector. As a result, most major infrastructure and transportation projects were geared toward the needs of the extractive sector, particularly the development of new oil and gas deposits. This structural shift in favor of the oil and gas industry is believed to have led to problems such as the Dutch disease, in which a country is unable to foster growth in other areas of the economy and repeatedly suffers from political and institutional deficiencies as well as deficiencies in governance and thus human capital.

Amineh (2006) claimed that resource-rich post-Soviet countries, such as Azerbaijan, Turkmenistan, and Kazakhstan, would not be able to successfully industrialize due to issues arising from the NRC. Similarly, Esanov et al. (2005) argued that political reforms in resource-rich transition countries do not favor a deterministic model of policy formation. In fact, according to Kronenberg (2004), substantial differences exist between resource-rich and resource-poor transitional countries. He argued that, while resource-poor Central and Eastern European (CEE) countries performed well in catching up with developed economies, resource-rich countries seemed to lag. This was mainly due to corruption inherited from the Soviet era, which entailed a high level of state capture. Franke et al. (2009) argued in favor of the existence of the NRC in Azerbaijan because of the lack of an alternative political elite as well as a substandard democracy; moreover, they argued that a lopsided economic structure was established after high mineral revenue flowed into the country.

NRC and its economic explanation, Dutch disease, are a major economic challenge to a country if not addressed because they deprive the country of the long-term benefits of available natural resources (Krugman, 1987; Matsuyama, 1992; Lucas, 1988; Hausmann et al., 2007). This is due to the lack of preparation of the political system, governance traditions, and institutional responsiveness. Therefore, the main objective of this paper is to analyze the presence of NRC in the Azerbaijani economy using empirical models that are country-specific and theoretically grounded. To this end, the research design was based on a general descriptive assessment of the main institutional and oil-related variables, PCA, dynamic least squares (DOLS) and ordinary least squares (OLS) regressions. The study adopted a deductive approach based on the following research question: what was the impact of the oil industry on institutional quality and human capital (as measured by the variables of health care, education, and human rights) between 1995 and 2019? The paper fills the persistent research and conceptual gaps in the NRC field by analyzing the Azerbaijani economy. The use of PCA and regression techniques such as OLS and DOLS also overcomes the methodological gaps that usually exist among scholars to properly conceptualize the NRC doctrine.

The results of this study demonstrate the presence of NRC in the Azerbaijani economy due to the negative impact of the oil industry on institutional quality. Moreover, numerous negative and statistically significant coefficients identified in the regression equations for health care, education, and human rights point to the specific channel of NRC, namely the change in human capital, which is quite actual for Azerbaijan. It is an absolute necessity to transform revenues from mineral resources into long-term and sustainable economic development. While these findings are worrisome, they also challenge policymakers to think twice in times of high oil prices.

The structure of this article is as follows: The next section contains a two-level literature review, NRC at a Glance, which informs the reader of the theoretical basis of the doctrine. Azerbaijan-specific NRC literature examples are then briefly discussed. Section 3 provides all the information about the data and methodology of the study, while Section 4 presents the results of the descriptive and empirical research. The final section concludes.

2. LITERATURE REVIEW

This section is a literature review that includes a brief discussion of the theoretical underpinnings of the NRC doctrine and its relevance to the Azerbaijani economy since the collapse of the Soviet Union.

2.1. NRC at a Glance

The term NRC is used to describe the disparity in economic growth rates between resource-rich and resource-poor nations. (Auty and Warhurst, 1993). Numerous studies have provided a solid foundation for resource curse-related studies, enabling an enhanced understanding of the economic reasons of the disparity in economic growth rates between resource-rich and resource-poor nations.

NRC theory has been discussed since 1970; pioneering papers were by Sachs and Warner (1997; 1999; 2001), who discovered a negative correlation between natural resource availability and resource dependency and GDP performance in cross-national research. They also highlighted the fact that mineral-rich countries tend to be expensive countries, which hinders export-led industrialization in the long term. Furthermore, According to Auty (2001), between 1960 and 1990, resource-poor nations saw greater increases in their per capita income than did resource-rich ones. In fact, among the largest mineral exporters, the annual GDP per capita growth rate decreased from 1980 to 1993 following the boom period of 1970 to 1980 (Mikesell, 1997). Mikesell (1997) also noted that the average annual GDP growth rates of mineral exporters declined after commodity prices collapsed from 1980 to 1993. In a more recent study, Using data from a panel of 111 countries from 1996–2015, Sharma and Pal (2020) found support for the resource curse phenomenon in both the short and long term. They observed a negative impact of resource dependence on economic growth.

If a downward trend occurs in main commodity prices in the long term, then the NRC may pose a serious threat to mineral-rich countries (Arezki et al., 2014). This could lead to trade deterioration or simply the contraction of mineral revenue. A growing body of literature related to the NRC and Dutch disease has cited other risks too. For instance, through the effects of Dutch disease, REER appreciation significantly reduces the productive capacity of non-resource tradeable sectors (Krugman, 1987), encourages corruption, and decreases bureaucratic quality (Busse and Gröning, 2013). The resource curse also hinders knowledge accumulation and capital formation (Welsch, 2008), which harms education levels as the need to invest in education to provide specialized human capital to crowded-out manufacturing sectors is reduced (Wadho, 2014). Moreover, a study found that "knowledge accumulation and capital formation are inversely related to the natural-resource intensity" (Welch, 2008: 62).

Based on the example of successful countries such as Norway, Botswana, Indonesia (Gurbanov and Merkel, 2009), Chile (Havro and Santiso, 2017), and Iceland (Gylfason and Zoega, 2006), natural resources can be said to increase wealth if the negative impacts of resource abundance are minimized through institutional regulations. Thus, general claims of the existence of the NRC in a country or region should be handled very carefully. If institutions function well and the state distributes income equally and efficiently, it is possible that the abundance of natural resources may prove to be a boon instead of a bane, contributing to accelerated economic development (Acemoglu et al., 2005). However, if a country becomes dependent solely on the sale of one primary product during its developmental stages and has weak institutions, macroeconomic destabilization may be inevitable due to volatile commodity prices and political challenges (Venables, 2016).

2.2. NRC in the Azerbaijani Economy

The literature examples dealing with the NRC doctrine in the case of Azerbaijan are sparse. In general, authors claim that Azerbaijan has a high propensity for NRC and its economic explanation (Dutch disease) due to political problems, corruption, institutional mismanagement, and rent-seeking behavior (Laurila and Singh, 2001; Mahnovski, 2003; Kaser, 2003). There is a lack of solid empirical models to capture the NRC phenomenon, specifically in the Azerbaijani economy. Nevertheless, some studies that have analyzed NRC to some extent are worth mentioning.

Tsalik (2003) suggested that Azerbaijan's new agreements with multinational companies in the extractive industries in the mid-1990s could ease the burden on government officials to further reform the economy. Tsalik (2003) emphasized that Azerbaijan's domestic absorption capacity was too small to benefit from such a large influx of FDI within a short time frame. Similarly, Esanov (2001) and Hoffman (1999) argued that the domestic tax collection apparatus, financial administration, and domestic energy sector presented challenges to transparent and efficient management of oil revenues. In early articles on NRC in Azerbaijan, government decisions and new spending habits raised serious concerns. Some authors claimed that oil revenues were spent in a non-transparent manner that did not promote development outside the oil sector that could ensure long-term sustainable development; in addition, the distribution of profits at the national level was problematic (Gulbrandsen and Moe, 2007). All of this created initial evidence for NRC in Azerbaijan.

Khanna's (2011) descriptions of Azerbaijan's oil boom period highlighted the government's low willingness to redistribute oil revenue, market-distorting interventions by the state, and the influential position of oligarchs. Achieving independence from the Soviet Union did not appear to inspire Azerbaijan to manage its oil revenue in a desirable way. Consequently, if the management of oil revenue fails, the reasons behind the fiasco point to the relevance of the NRC.

Observations and analyses of political and institutional variables in Azerbaijan have supported the relevance of NRC syndrome. Bhatty (2002) considered corruption, weak state capacity, and impediments to trade the main signals of the political and institutional channel for the NRC. Bayulgen (2005) argued that oil rents encouraged an authoritarian regime, resulting in the accumulation of power in the hands of the president. Later, O'Lear (2007) provided evidence of the NRC based on survey data from Azerbaijani citizens. According to his findings, an oil-dominated economy, high accumulation of fortune by the nation's elite, political legitimacy problems, and centralized political control were clear signs of the NRC. Other indications of the NRC's political and institutional channel include internal and external patronage networks, clientelism (Bayulgen, 2005; Guliyev, 2009), autocracy (Schubert, 2006; Pomfret, 2011; Kendall and Taylor, 2012; Radnitz, 2012), problems with political freedom and democracy (Altstadt, 2017), transparency and accountability issues in revenue spending (Wakeman-Linn et al., 2003; Franke et al., 2009), and intense pushback to private sector expansion (Kalyuzhnova and Kaser, 2005). A further indication is neopatrimonialism, which refers to informal personalized rule combined with pyramidal power structures (Franke and Gawrich, 2010; Heinrich, 2010).

More recent studies continue to emphasize NRC's possiblity in Azerbaijan. For example, Biresselioglu et al. (2019) classified Azerbaijan as a country highly vulnerable to the NRC, ranking it among the top 10 countries labeled "high," as measured by the Resource Curse Vulnerability Index (RCVI). This indicated a lack of economic diversification, economic planning, and industrial development policies.

The literature reviewed in this section shows that since the mid/late 1990s, a growing number of studies have sounded the alarm about the presence of NRC in the Azerbaijani economy. The changes in the Azerbaijani economy call for further study of NRC and Dutch disease theories, because to date there are no clear conclusions about the above economic phenomena.

3. DATA AND METHODOLOGY

This section contains detailed information on quantitative data and analytical methods in separate subsections.

3.1. Data

The political and institutional channel of the resource curse in Azerbaijan was traced through the following variables: political stability and absence of violence/terrorism (POL_ST; hereinafter "the political stability index" or "political stability"), the rule of law (RULE_O_ LAW), the voice and accountability index (VO_ AND_ACC), and latent human rights protection scores (H_RIGHTS; hereinafter "human rights scores"). The first four variables were obtained from the Worldwide Governance Indicators (WGI) provided by the World Bank, while the last variable was taken from the data set of Schnakenberg and Fariss (2014), referred to by Fariss (2019) as "Latent Human Rights Protection Scores."

Furthermore, POL_ST has quantified people's expectations about the frequency of political violence and terrorism. The extent to which public authority is exercised for private gain, whether through petty or grand corruption, and the "capture" of the state by elites and corporate interests was quantified by controlling for corruption. RULE_O_LAW reflected agents' views on the reliability of social institutions, including the police and courts, the protection of private property and the quality of contract enforcement, and the incidence of violence and crime. A measure of freedom of speech, association, and the press, as well as the extent of public participation in the election of government, was captured by VO_AND_ACC. Lastly, H_RIGHTS looked at the human rights situation in a country as a whole.

All of the variables related to the political and institutional channel, excluding human rights scores, ranged between −2.5 and +2.5 (the higher the better). Human rights scores ranged from −3.8 (minimum) to 5.4 (maximum). The examined period was from 1996 to 2019.

In the DOLS analysis, both dependent and independent variables come from the previously estiamted principal components.

Of the independent variables, only the extractives dependency index (EDI) was calculated according to Hailu and Kipgen's (2017) methodology. The calculation formula is presented below:

$$EDI_t = \sqrt{[EIX_t \times (1 - HTM_t)] \times [Rev_t \times (1 - NIPC_t)] \times \times [EVA_t \times (1 - MVA_t)]} \quad (1)$$

where **EDI** is the extractives dependence index for a country at time *t*; **EIX** is the revenue from the extractive industry, expressed as a share of total export revenue; **HTM** is the export revenue from high-skill and technology-intensive manufacturing as a share of global HTM exported in year *t*; **Rev** is the share of revenue from the extractive industry in total fiscal revenue; **NIPC** is non-resource income, including tax revenue, profits, and capital gains as a percentage of GDP; **EVA** is the share of the extractives industries' value-added in GDP; and **MVA** is the countrywide non-resource manufacturing potential, as measured by per capita manufacturing value-added.

Other factors may also play a role in explaining this phenomenon. The ratio of oil exports to GDP (OIL_ EXP /GDP) indicates the importance of exports to the Azerbaijani economy as a whole, while oil rents (OIL RENTS) variable reflects the difference between the value of crude oil production at international prices and total production costs. FDI in the oil industry (OIL_ FDI) was another potential channel for booming sectors to influence the variables of interest. SOFAZ's share of the state budget (SOFAZ's_ SH) measured the state budget's performance in relation to the oil revenue transfers from SOFAZ. Last but not least, both the global financial crisis of 2008–2009 and the dramatic commodity price declines of 2014–2015 are reflected in the dummy variable ECON_SHOCK, which measures economic shocks.

The source for OIL_RENTS is the World Bank. The ratio of oil exports to GDP was calculated using official statistics from SSCRA. OIL_FDI is from SSRA, SOFAZ's_SH from SOFAZ annual reports. All the data are secondary and come from reliable sources. Descriptive statistics, normality tests, outliers, and missing values for

variables of interest can be found in tables A1 and A2 in the Appendix. Missing values were filled by the linear interpolation method, and outlier values were cleaned by the Winsorization technique.

3.2. Methodology for PCA

Considering the wide range of the collected data set, the main empirical stage started with PCA. PCA is beneficial when the data set is large and several variables need to be examined (Bro & Smilde, 2014). Jolliffe's (1990) early study on PCA stressed that if the correlation between variables is strong, it may be decreased to discover "a true dimension" of the data set that would deliver the same information with the least information loss. This reduction yields "components," which help one to identify patterns across various data series (Ringnér, 2008). Ringnér (2008) also emphasized the independence of components rather than them being uncorrelated. If the original variable quantity *a* can be reduced to *b* using newly constructed index variables or components, a large amount of information can be analyzed using a relatively simple technique. PCA is often used as a pre-analysis of variables of interest and also as an analytical bridge for further investigation.

Here, PCA provided the main components for analyzing institutional quality and its relation to the oil sector. Varimax rotation was used in the PCA to maximize the variance of the factor loadings (Dien 2010). The main components were then saved as individual time series and regressed against each other using the dynamic ordinary least squares (DOLS) method.

3.3. Methodology for Regression Analysis

The regression analysis began with the inclusion of the principal components obtained from the PCA, which grouped the variation in the data into the factors related to oil and institution. In the literature, change in institutional quality is usually evident only over time. For this reason, DOLS was the most appropriate method to account for the dynamic nature of the newly created principal components-based time series. Thus, the model specification is as follows:

$$Institutional\_quality_t = \beta_0 + \beta_1 Oil\_factor_t + \\ + \sum_{i=-m}^{i=m} \Delta\beta_1 Oil\_factor_t + \in_t \qquad (2)$$

where institutional_quality is the first component of PCA at time t; Oil_factor is the second component of PCA at time t; and $\in$ is the error terms. Furthermore, Oil_factor was added along with lags, allowing to find the best way to build the model and to test how stable the results were.

This study also used the ordinary least squares (OLS) technique to test the effect of individual oil-related variables on the selected human capital variables. Three models related to this are presented as follows:

$$OP\_Expenses_t = \beta_0 + \beta_1 Oil\ Rents_t + \beta_2 EDI_t + \beta_3 Oil\ Exports_t \\ + \beta_4 Economic\ Shocks_t + \in_t \qquad (3)$$

$$TGEE_t = \beta_0 + \beta_1 Oil\ Rents_t + \beta_2 EDI_t + \beta_3 Oil\ Exports_t + \\ \beta_4 Economic\ Shocks_t + \in_t \qquad (4)$$

$$Human\ Rights_t = \beta_0 + \beta_1 EDI_t + + \beta_2 Mining \\ industry_t + \beta_3 SOFAZ'share_t + \in_t \qquad (5)$$

In the above-listed models, *OP_Expenses* denotes the out-of-pocket expenses on health care; *TGEE* is the total government expenditure on education; *Human Rights* is the human rights scores at time t; and β_0 is the intercept in all models. Then, *Oil rents*, *EDI*, *Oil Exports*, *Economic Shocks*, *Mining Industry*, and *SOFAZ's share* are the explanatory variables at time t. Lastly, $\in_t$ is the error terms at time t.

All variables used in the regression analysis were transformed to their first difference due to the unit root in the time series (see Table A3 and A4 in the Appendix section). PCA was used in SPSS version 23, and regression and related analyses were carried out in Eviews version 11.

4. RESULTS

4.1. Figure Analysis

Figure 1 indicates that indices such as control of corruption, government effectiveness, and rule of law experienced either a downward trend or a slowdown as soon as the oil boom started in 2005. However, political stability dramatically improved starting from 2006 but fell between 2011 and 2013. Interestingly, political stability

values during the post-boom period were lower than in the first half of the oil boom period. Next, regulatory quality started to decline in 2009 but recovered after 2012. Among the selected institutional variables, voice and accountability display a strong negative trend starting in 2000. Lastly, it seems that there were positive developments in the rule of law index in 2006 and a recovery after 2012. These data showed that the negative consequences of the oil boom on Azerbaijan's economy were real. This led this study to systematically investigate oil-related variables in connection with institutional quality.

The year-over-year growth rates illustrated in Figure 2 indicate that of the six institutional variables, four were associated with lower development during the oil boom period. Specifically, the rule of law, control of corruption, regulatory quality, and the voice and accountability indices displayed a lower average growth rate compared with the catch-up period of Azerbaijan's economy. During the post-boom period, only one indicator—the political stability index—had a severe deterioration.

4.2. PCA Results

Through the use of PCA, researchers are able to compress massive data sets to a smaller collection of factors that explain most of the variance. Before the PCA, the relevance of the data set for PCA had to be analyzed, for which the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were applied. To produce optimal principal components, the data set was analyzed in its original form, and then irrelevant variables were dropped (see Jaba et al., 2009 for similar PCA adjustments). If KMO values are higher than 0.300, then PCA is recommended (Kaiser, 1974). As presented in Table 1, the KMO value was 0.772 in the first analysis phase; moreover, Bartlett's test of sphericity revealed high significance, suggesting that at least one correlation was significant among the variables. In the second phase of the analysis, the KMO value dropped to 0.624, but it was still higher than the expected threshold values and still highly significant according to Bartlett's test of sphericity.

Table 1. Kaiser–Meyer–Olkin (KMO) values and Bartlett's test results.

1st phase		
KMO measure of sampling adequacy		0.772
Bartlett's test of sphericity	Approx. chi-square	303.784
	df	55
	Sig.	0.000
2nd phase		
KMO measure of sampling adequacy		0.624
Bartlett's test of sphericity	Approx. chi-square	142.479
	df	21
	Sig.	0.000

Table 2. Communalities of the variables related to institutional quality and the oil sector in Azerbaijan's economy.

Communalities		
	Initial	**Extraction**
COC	1	0.920
ROL	1	0.944
GOVEFF	1	0.927
GOVINT	1	0.634
OIL_RENTS	1	0.764
EDI	1	0.660
OIL_BOOM	1	0.766

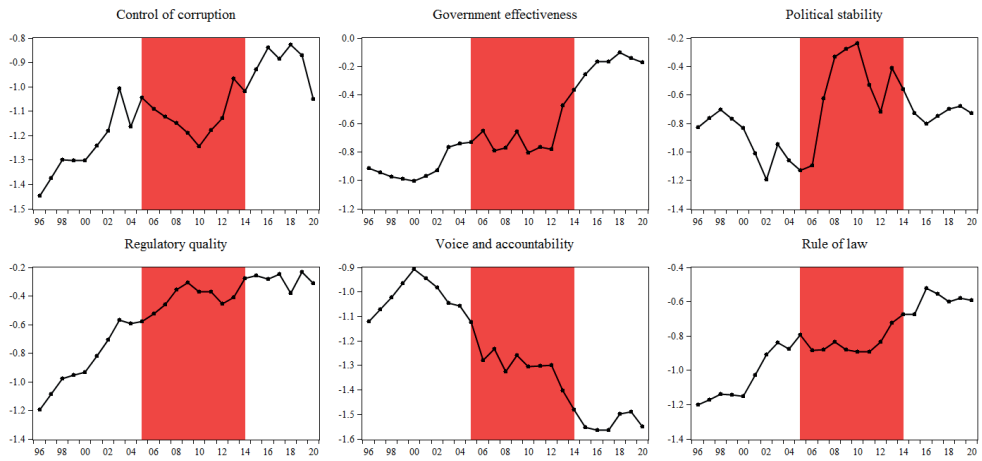
Note: Extraction method = principal component analysis.

The applicability of PCA is heavily dependent on communalities (i.e., common features). In PCA, a variable's communality value reveals how much of the variation is explained by the extracted component. A value greater than 0.35 is appropriate for PCA analysis to achieve a statistical significance of 0.05 and a power level of 80% (Tsiouni et al., 2021). The greater the communality value, the more it explains the variance of the original variable of interest. The extraction was high in variables such as control of corruption, rule of law, and government effectiveness indices (see Table 2). Oil rents and the oil boom had values of 0.764 and 0.766, respectively. EDI and the government integrity index had the lowest extraction values, but they still exceeded the level of 0.600.

The first component accounted for 47.7% of the variation based on rotation sums of squared loadings. The second component individually accounted for 32.6% but cumulatively 80.2% of the variation in the data set (see Table 3). Although the main variables were reduced to two principal components, the fact that these numbers are high indicates that enough information was stored.

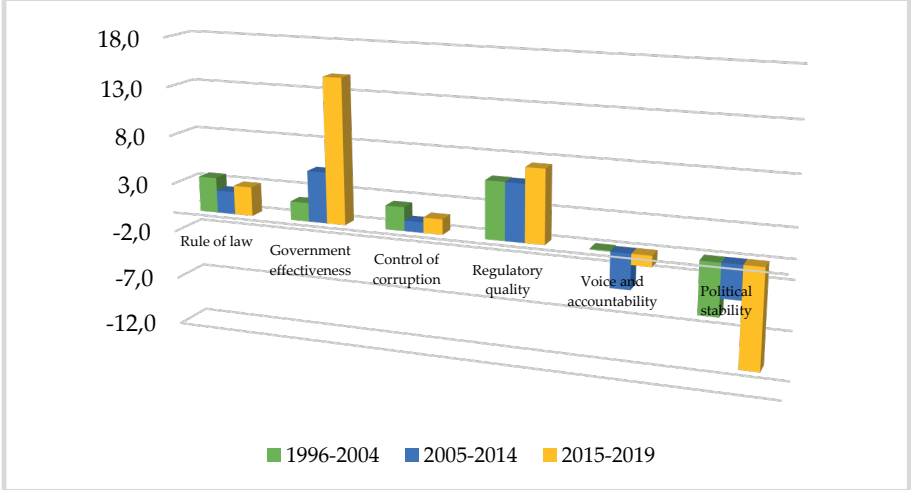
Next, the scree plot in Figure 3 indicates that the optimal number of components out of the original variables is 2 because the eigenvalues drop below 1 if the number of the components is higher than 2.

Figure 1. Worldwide governance indicators for Azerbaijan, 1996–2020.



Source: World Bank, Worldwide Governance Indicators.
Notes: Red denotes the oil boom period between 2005 and 2014.

Figure 2. Distribution of year-over-year average growth rates for institutional quality, based on the development phases of Azerbaijan's economy (index values).



Source: World Bank, Worldwide Governance Indicators.

Table 4 reports the main PCA results, including the component matrix and rotated component matrix. From both matrices, it became clear that the first component covers the variation among variables such as control of corruption, rule of law, government effectiveness, and government integrity, as they loaded high and positively on it. Similarly, the second component was the most optimal subset of the oil-related variables, such as oil rents, EDI, and oil boom. Therefore, the first component should be called "institutional quality" and the second component should be called "oil factor." Visual representations of the loadings are depicted in Figure 4.

4.3. Regression Results

The DOLS model of the principal components with one lead and one lag identified a statistically significant and negative impact of the oil factor on institutional quality in Azerbaijan (see Table 5). The sign of the coefficient related to the oil factor was always negative in the DOLS model and the intercept was positive and statistically

Figure 3. Scree plot of the variables related to institutional quality and the oil sector in Azerbaijan's economy.

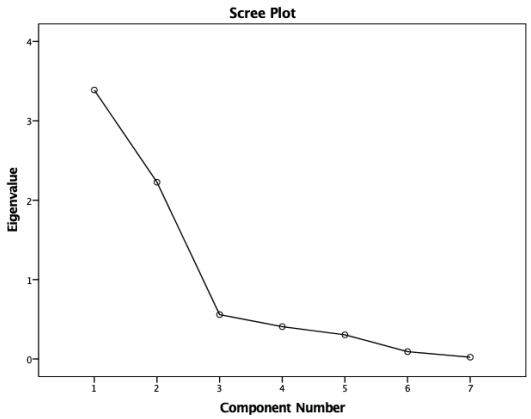


Figure 4. Component plot in rotated space of institutional quality and the oil sector in Azerbaijan's economy.

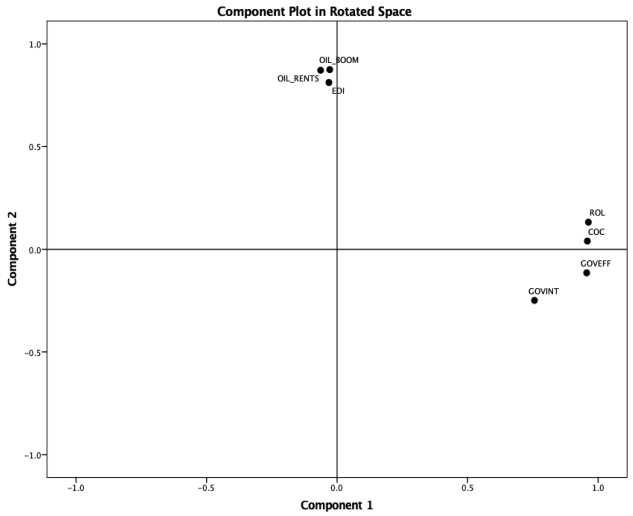


Table 3. Total variance explained of the variables related to institutional quality and the oil sector in Azerbaijan's economy.

Total Variance Explained									
Comp.	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
1	3.388	48.401	48.401	3.388	48.401	48.401	3.337	47.672	47.672
2	2.228	31.824	80.225	2.228	31.824	80.225	2.279	32.553	80.225

Notes: Comp. = components; Var. = variance; Cum. = cumulative.

significant. Before DOLS mode, the principal components were checked for a unit root (see Table A3 in appendix section).

The next part of the regression analysis included some individual indicators that were definitely related to the NRC doctrine (see Table 6). They were out-of-pocket expenditures on healthcare (OP_EXP_HC), total government expenditure on education (TGEE), and human rights (HUM_RIGHTS). These variables were regressed against the following oil-related variables: oil rents, share of oil exports in GDP, EDI, economic shocks, oil FDI, mining industry's share of overall industrial production, and proportion of SOFAZ allocated to state spending or budget.

The human rights scores provided unambiguous results regarding the NRC as EDI, oil FDI, mining industry's share of overall industrial production, and share of SOFAZ in the state budget exhibited negative and statistically significant coefficients. Next, oil rents and EDI negatively and statistically significantly influenced TGEE. However, the share of oil exports in GDP and economic shocks positively impacted TGEE. Lastly, out-of-pocket expenses on health care tended to rise when EDI rose and economic shocks occurred, but oil rents and oil exports as a share of GDP negatively affected out-of-pocket expenses on health care.

All of the models were statistically significant according to significant F statistics, moderate R-squared values, and no multicollinearity issues as the variance inflation factors (VIFs) were less than 10.0. Moreover, CUSUM and CUSUMSQ tests indicated that the models were stable. Furthermore, the models were functionally correct, without any serial correlation and heteroscedasticity problems. Lastly, the Wald test indicated that all coefficients differed from

Table 4. Component matrices of the principal component analysis (PCA) related to institutional quality and the oil sector in Azerbaijan's economy.

Component Matrix[a]			**Rotated Component Matrix[b]**		
Component			**Component**		
	1	**2**		**1**	**2**
COC	0.929	0.24	COC	0.959	0.04
ROL	0.913	0.331	ROL	0.963	0.132
GOVEFF	0.959	0.088	GOVEFF	0.956	−0.115
GOVINT	0.792	−0.085	GOVINT	0.756	−0.249
OIL_RENTS	−0.245	0.839	OIL_RENTS	−0.063	0.872
EDI	−0.201	0.787	EDI	−0.031	0.812
OIL_BOOM	−0.211	0.849	OIL_BOOM	−0.028	0.875
Extraction method: PCA a – two components extracted.			Extraction method: PCA. Rotation method: Varimax with Kaiser normalization. b – rotation converged in three iterations.		

Table 5. Dynamic ordinary least squares (DOLS) results of the oil factor and institutional quality in Azerbaijan's economy.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
C	0.13**	0.11**	0.15**	0.15**	0.15**
	(2.18)	(1.75)	(2.86)	(2.62)	(2.35)
Oil factor	−0.23	−0.30	−0.42**	−0.28	−0.30
	(−1.68)	(−1.68)	(−2.48)	(−1.30)	(−1.51)
R-squared	0.11	0.14	0.24	0.30	0.30
S.E. of regression	0.32	0.31	0.26	0.27	0.29
Long-run variance	0.08	0.08	0.05	0.06	0.08
Jarque–Bera	1.04	0.55	0.34	0.51	0.55
	[0.595]	[0.759]	[0.843]	[0.777]	[0.757]
Wald test – F-stat.	3.55**	2.63*	6.35***	4.01**	3.30*

Notes: Model 1: without lags and leads; model 2: one lag, zero leads; model 3: one lag, one lead; model 4: two lags, one lead; model 5: two lags, two leads.

zero in a statistically significant manner.

5. CONCLUDING REMARKS

In this paper, the typical signs of NRC syndrome in Azerbaijan's economy were examined through figure analysis, PCA, DOLS, and OLS regressions. The main objective of this study was to determine the negative impact of the oil industry on the institutional quality of the Azerbaijani economy, using NRC theory as a theoretical framework. The use of quantitative methods enabled an analysis of the underlying institutional dynamics of the NRC to relate it to economic concepts such as Dutch disease. To this end, data related to institutions, governance, and human capital in Azerbaijan were collected, mainly covering the period 1996–2019. The data analysis provided reason to believe that there is an NRC in the Azerbaijani economy, as institutional quality, as measured by various World Bank indicators, declined during the oil boom (2005–2014) compared to other periods. Moreover, PCA and variable-specific modeling enabled this study to capture the typical NRC signs to estimate them for the hypothesis testing.

Moreover, a figure analysis of selected institutional variables related to Azerbaijan's economy revealed negative trends and slowdowns in institutional quality, as measured by variables such as control of corruption, government effectiveness, voice and accountability, and the rule of law as soon as the oil boom period started. In addition, year-over-year and periodic averages of the growth rates revealed a systematic decline in institutional quality during the oil boom years. For example, the period 2005–2014 had lower year-over-year growth rates for the rule of law, control of corruption, regulatory quality, and voice and accountability indices compared with the recovery phase.

Table 6. OLS results of individual NRC-related indicators against oil-related variables.

Dep. Var.	OP_EXP_HC	TGEE	HUM_RIGHTS
C	13.34** (2.88)	−0.17*** (−3.25)	0.01 (0.15)
Oil Rents	−2.84*** (−3.02)	−0.01 (−0.74)	
Oil Exp/GDP	−108.24** (−1.89)	1.15* (1.77)	
EDI	5.11* (1.84)	−0.19** (−2.78)	−0.01** (2.24)
Econ. Shocks	33.38** (2.82)	0.43*** (3.21)	
Oil FDI			−3.44*** (−3.84)
Mining Industry			−0.01** (−2.76)
SOFAZ's Share			−0.01* (−1.94)
R-squared	0.76	0.64	0.58
Adj. R-squared	0.71	0.54	0.46
F-stat.	12.10	6.23	4.76
F-stat. prob.	0.00	0.00	0.01
Variance inflation factors	All <10.00	All <10.00	All <10.00
CUSUM	Within 5% sig.	Within 5% sig.	Within 5% sig.
CUSUMSQ	Within 5% sig.	Within 5% sig.	Within 5% sig.
Ramsey reset test	Functional spec. is true	Functional spec. is true	Functional spec. is true
Wald test (F-stat.)	16.04***	7.40***	6.60***
Wald test ($\chi 2$)	80.22***	37.92***	33.02***
JBN test	0.48	0.11	1.80
JBN test Prob. value	0.79	0.94	0.41
Serial corr. (F-stat.)	0.17	1.77	0.76
Serial corr. (Obs*R2)	0.53	4.33	2.13
Heteros. (F-stat.)	1.82	2.02	1.76
Heteros. (Obs*R2)	6.48	6.96	6.37

Notes: (1) Dep. var = dependent variable; (2) OP_EXP_HC = out-of-pocket expenditure on health care; (3) TGEE = total government expenditure on education; (4) HUM_RIGHTS = human rights; (5) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively; (6) the figures were rounded to two decimal places for compactness; (7) values inside parentheses indicate standard errors and those inside brackets are t-statistics.

Therefore, the PCA indicated that institutional quality and oil-related variables can be explained by a few key variables, principal components, and a DOLS analysis. The latter demonstrated that the oil sector negatively affected the institutional quality in Azerbaijan between 1996 and 2019. Variables such as out-of-pocket expenses on health care and total government expenditures on education and human rights exhibited statistically significant and negative associations with oil-related variables, and they captured the negative nexus between human capital channels of the NRC and the oil sector.

An adequate analysis of NRC in the Azerbaijani economy is scarce in the economic literature. Topics such as NRC and Dutch disease usually require country-specific approaches and modeling when a quantitative methodology is used. In the case of Azerbaijan, this work has contributed to the study by using PCA and DOLS for the first time in addressing NRC in Azerbaijan, although OLS is a common technique for analyzing various economic indicators. Further studies should focus on more comprehensive data collections provided by different data centers (e.g., the Quality of Governance dataset from the University of Gothenburg). The NRC study is an absolute necessity for Azerbaijan. The Azerbaijani economy goes through boom and bust phases that are caused by commodity super-cycles. These phases need to be studied from institutional, governance, and political points of view.

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APPENDIX

Table A1. Descriptive statistics of the variables of interest used in regression.

Variable	N	Min	Max	Mean	St.Dev.
OP_EXP_PC	20	73.441	507.431	253.153	165.389
H_RIGHTS	20	-0.518	-0.021	-0.326	0.133
TGEE	20	2.068	3.854	2.821	0.470
OIL_RENTS	20	12.037	39.558	25.998	7.674
EDI	20	0.000	4.911	1.936	1.440
OIL_ EXP/GDP	20	0.296	1.964	0.603	0.356
OIL_FDI	20	546.100	7,448.300	4,240.899	1,958.284
SH_SOFAZ	20	7.300	62.430	35.426	20.730

Table A2. Normality test, outlier and missing values of the variables of interest used in regression.

Variable	Shapiro-Wilk Test		Outliers years	Missing value (years)
	Stat.	Sig.		
OP_EXP_PC	0.851	0.005		2019
H_RIGHTS	0.904	0.049	2001	2018; 2019
TGEE	0.949	0.351		2019
OIL_RENTS	0.971	0.769		2019
EDI	0.910	0.063		2019
OIL_ EXP/GDP	0.650	0.000	2008	
OIL_FDI	0.964	0.627		2018; 2019
SH_SOFAZ	0.833	0.003		
MINING_SHARE	0.927	0.134		

Table A3. Unit root test results for principal components (augmented Dickey–Fuller).

Null Hypothesis: The variable has a unit root			
	At Level		
		OIL_FACTOR	INSTITUTIONS
With Constant	t-Statistic	−1.7234	−1.3903
	Prob.	0.4074	0.5699
		n0	n0
With Constant & Trend	t-Statistic	−1.5259	−2.7407
	Prob.	0.7916	0.2319
		n0	n0
Without Constant & Trend	t-Statistic	−1.7570	−1.4118
	Prob.	0.0750	0.1432
		*	n0
	At First Difference		
		d(OIL_FACTOR)	d(INSTITUTIONS)
With Constant	t-Statistic	−5.4093	−4.3425
	Prob.	0.0002	0.0026
		***	***
With Constant & Trend	t-Statistic	−5.5958	−4.2568
	Prob.	0.0008	0.0140
		***	**
Without Constant & Trend	t-Statistic	−5.5223	−3.8707
	Prob.	0.0000	0.0005
		***	***

Notes: (1) (*) Significant at the 10% level; (**) significant at the 5% level; (***) significant at the 1% level and (no) nonsignificant; (2) lag length based on the Akaike information criterion; (3) probability based on MacKinnon's (1996) one-sided p values.

Table A4. Unit root test results for regression analysis (augmented Dickey–Fuller).

Null Hypothesis: The variable has a unit root										
	At Level									
		H_RIGHTS	TGEE	OP_EXP_PC	EDI	OIL_EXP_GDP	OIL_RENTS	MINING_INDUSTRY	SH_SOFAZ	OIL_FDI
With Constant	t-Statistic	-1.35	-4.04	0.32	-2.66	-2.10	-1.63	-1.92	-0.89	-1.49
	Prob.	0.58	0.01	0.97	0.10	0.25	0.45	0.32	0.77	0.51
		n0	***	n0	n0	n0	n0	n0	n0	n0
With Constant & Trend	t-Statistic	-2.59	-2.56	-2.38	-3.07	-2.33	-2.45	-1.70	-3.01	-4.29
	Prob.	0.29	0.30	0.37	0.15	0.40	0.35	0.71	0.16	0.02
		n0	n0	n0	n0	n0	n0	n0	n0	**
Without Constant & Trend	t-Statistic	1.53	-1.41	2.60	-1.03	-0.87	-0.86	-0.02	0.78	0.82
	Prob.	0.96	0.14	0.99	0.26	0.32	0.33	0.66	0.87	0.88
		n0	n0	n0	n0	n0	n0	n0	n0	n0
	At First Difference									
		H_RIGHTS	TGEE	OP_EXP_PC	EDI	OIL_EXP_GDP	OIL_RENTS	MINING_SHARE	SH_SOFAZ	OIL_FDI
With Constant	t-Statistic	-5.85	-4.09	-3.14	-7.80	-6.68	-3.91	-2.65	-3.70	-4.26
	Prob.	0.02	0.01	0.04	0.01	0.01	0.01	0.10	0.01	0.01
		***	***	**	***	***	***	n0	**	***
With Constant & Trend	t-Statistic	-5.78	-4.37	-4.11	-7.53	-6.50	-3.79	-3.45	-3.56	-4.21
	Prob.	0.01	0.02	0.03	0.01	0.03	0.04	0.08	0.06	0.02
		***	**	**	***	***	**	*	*	**
Without Constant & Trend	t-Statistic	-4.88	-4.06	-2.27	-7.98	-6.79	-4.03	-2.77	-3.380	-3.88
	Prob.	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01
		***	***	**	***	***	***	***	***	***