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Working Paper

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Suggested Citation: Niftiyev, Ibrahim (2022) : Exclusive Linear Modeling Approach to the Natural Resource Curse in the Azerbaijani Economy: Examples of Stepwise Regression, Elsevier, New York, NY,
<https://doi.org/10.2139/ssrn.4267143>

This Version is available at:

<https://hdl.handle.net/10419/266036>

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Exclusive Linear Modeling Approach to the Natural Resource Curse in the Azerbaijani Economy: Examples of Stepwise Regression

Working Paper No. 7

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This working paper has not undergone final formal review and should be cited as a working paper. The main purpose of this working paper is to prepare the materials, concepts, and discussions for final publication in an academic journal, which is still in progress.

There is no funding or official support from any organization or person. All errors and expressions are those of the author.

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Szeged – 2022 (November)

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Abstract

There is a growing body of literature on the possible presence of the Natural Resources Curse (NRC) and Dutch Disease Syndrome (DD) in the Azerbaijani economy. Because of its abundant hydrocarbon resources, Azerbaijan has pursued an oil-oriented strategy for economic growth and development. Certainly, this path has helped overcome serious economic problems such as extreme poverty, lack of capital accumulation, and technology adoption, but it is also believed that a lopsided economic structure hinders overall sustainable growth. Indeed, it has been noted that the high-value-added manufacturing sector is an engine for stable economic growth and that specialization in the primary sector (including oil and related commodities) can pose many challenges to developing countries. Over time, non-oil production has been neglected and volatile commodity prices have been allowed to determine macroeconomic stability in Azerbaijan. This has been a risky path and now requires a comprehensive investigation using widely accepted theories such as NRC and DD. This working paper presents the first results of an econometric and empirical linear analysis of the main NRC- and DD-related variables to shed light on the above phenomena. The main regression approach was a stepwise algorithm to find variable-specific functional relationships. The results are far from perfect and are experimental in nature. Although all conclusions should be drawn with caution, interested parties such as academics, professional economists, decision makers, or policy makers could benefit from the proposed conceptualization of NRC and DD in the Azerbaijani economy for their future studies.

Keywords: Azerbaijan economy, de-industrialization, Dutch disease, natural resource curse theory, non-oil industry, oil-rich nation, regression analysis, Stepwise regression

JEL Classification Codes: D04, E32, L6, O14, O52, O53

1. Introduction

Azerbaijan, an oil-rich nation, has weathered the storms of recession and transition thanks to its vast hydrocarbon resources. Oil production in Azerbaijan increased dramatically between 2005 and 2014 as the country's major upstream and downstream oil production projects were completed. In 2007, oil production reached its all-time high and the government saw a rapid and significant increase in revenues from oil sales (Aliyev and Suleymanov, 2015). As a result, Azerbaijan's gross domestic product (GDP) and GDP per capita surged, and poverty declined, while inflationary pressures were kept under control. Nevertheless, academics continue to assert that the negative consequences of oil-dominated development outweigh the positives, as long-term sustainable economic growth is not currently occurring due to the severe disruption of non-oil businesses, such as manufacturing and agriculture (Ibadoghlu, 2012; Sadik-zada et al., 2021a). In addition, the oil-dominated economic structure has led to problems in labor markets (Huseynov, 2017) and the banking system (Huseynov, 2018). This has led to a number of studies on the DD and NRC hypotheses and the need to develop a theoretical explanatory framework for

Azerbaijan's economy (Bayramov and Conway, 2010; Hasanov, 2013). As a result, poverty has been alleviated and economic development has been boosted, but not everything is perfect when it comes to the economic impact of available natural resources, especially oil and natural gas.

Academics and economists have long expressed concern about displacement effects and other unintended consequences of the rapid growth of extractive industries in Azerbaijan (Bayulgen, 2005; O'lear, 2017). For this reason, a number of academic papers have been developed to address these issues (Gasimov, 2014; Czech, 2018; Zulfigarov and Neuenkirch, 2019). Therefore, academic publications on NRC and DD are increasing in the case of the Azerbaijani economy. This is partly due to increasing statistical data, but the role of commodity price fluctuations and supercycles should also be mentioned, as their influence becomes more evident when one phase of the Azerbaijani economy's development replaces another (e.g., the post-oil boom period replaces the oil boom period). However, there is still room for improved modeling when it comes to capturing the presence of NRC or DD in Azerbaijan.

This working paper presents preliminary results of linear modeling of DD- and NRC-related economic variables in the Azerbaijani economy, taking into account various impact channels such as institutions, policies, government capacities, human capital, and DD. While the literature on DD seems to be increasing, the other mentioned aspects of the Azerbaijani economy are not yet sufficiently researched. This working paper does not fill a research gap to the extent desired but invites a linear view of NRC and DD on the Azerbaijani economy.

The fluctuating commodity prices and Azerbaijan's dependence on extractive industries are pushing both academia and government authorities to pursue a more sustainable path of economic growth and development for the country. The macroeconomic events of 2014 and 2015 could repeat themselves. REER appreciation and domestic inflation seem to be on the rise again, while a new supercycle is looming in the first half of 2022. All of this could again threaten Azerbaijan's overall macroeconomic stability. Within the framework of NRC and DD theories, these events can be thought of in a way that is statistically significant. This leads to results that are useful for designing policies and making decisions at the macroeconomic level.

The structure of this working paper is as follows: Section 2 presents the data and methodology of the study. Section 3 reports the results of the study. Finally, Section 4 provides concluding remarks and further suggestions.

2. Data and methodology

The political and institutional channel of the resource curse in Azerbaijan was traced using the following variables: political stability and the number of violence and terrorism (POL_ST, hereafter referred to as the "political stability index" or "political stability"), rule of law (RULE_O_LAW), the voice and accountability index (VO_AND_ACC), and latent human rights protection scores (H_RIGHTS; hereafter referred to as "human rights

scores").¹ The first four variables are from the World Bank's Worldwide Governance Indicators (WGI), while the last variable is from the dataset created by Schnakenberg and Fariss (2014); it has been labeled "Latent Human Rights Protection Scores" by Fariss (2019).

POL_ST measures the perceived likelihood of political instability or politically motivated violence, including terrorism. *Control of corruption* captures perceptions of the extent to which public power is exercised for private gain, including small and large forms of corruption and the "capture" of the state by elites and private interests. RULE_O_LAW captures perceptions of the extent to which actors have confidence in and abide by society's rules, particularly the quality of contract enforcement, property rights, policing, and courts, and the likelihood of crime and violence. VO_AND_ACC captures perceptions of the extent to which citizens can participate in choosing their government, freedom of expression, freedom of association, and freedom of the press. Finally, H_RIGHTS measures the quality of the overall environment for human rights by examining various institutional factors, particularly legal and judicial variables.

All variables related to the political and institutional channel, with the exception of human rights scores, ranged from -2.5 to +2.5 (the higher the better). Human rights scores ranged from -3.8 (minimum) to 5.4 (maximum). The coverage period was 2000 to 2019 for the stepwise and OLS estimates, while the period for the numerical analysis was larger (1996–2019).

There were missing values for political stability, control of corruption, rule of law, voice, and accountability for 1997, 1999, and 2001, while there were two missing values for human rights scores for 2018 and 2019. The missing values were replaced with predicted values created using Google Sheets' TREND function, which is based on the least squares technique. Table 1 shows all dependent variables tested in the quantitative analysis.

The channel called "Capacity to manage oil revenue" was tested using the following indicators: government effectiveness (GOV_EFFEC), regulatory quality (REG_QUAL), non-resource taxes (NRT_ISS, including social securities), non-resource taxes (NRT_ESS, excluding social securities), government integrity (GOV_INT), and the state fragility index (ST_FRAG).

GOV_EFFEC captures perceptions of the quality of public services, the quality of public service and the extent to which it is independent of political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to those policies. REG_QUAL captures perceptions of the government's ability to formulate and implement sound policies and regulations that enable and promote private sector development. While NRT_ISS represents taxes (including social contributions) minus resource taxes, NRT_ESS represents taxes (excluding social contributions) minus resource taxes. GOV_INT reflects the level of corruption. Lastly, ST_FRAG captures the state's ability to manage conflict, design and implement public policies, provide essential services, respond effectively to challenges and crises, and

¹ Not all of the abovementioned variables were used in the regression models.

sustain progressive development; it also includes the state's systemic resilience to maintain coherence, cohesion, and quality of life.

Regarding regulatory quality and government effectiveness, missing values for 1997, 1999, and 2001 were replaced with the TREND function in Google Sheets. Missing values were also for non-resource taxes (both including and excluding social security contributions) and state fragility. Subsequently, the missing values for 2016 and 2019 were also predicted using the TREND function of Google Sheets.

The final channel through which the signs of resource curse in Azerbaijan were tested was education and human capital. In the case of Azerbaijan, there are hardly any ready-made human capital indices (or calculated indices) that can be obtained from secondary data sources. Therefore, different variables related to education and health care were used to examine the human capital dimension of the resource curse. The time span ranged from 2000 to 2019. There were two missing values for total government expenditure on education (TGEE) and government expenditure on education (GEE) for 2019; these were predicted using the TREND function as for the other variables.

GEE (current expenditure, investment and transfers) is expressed as a percentage of GDP. It includes spending financed by transfers from international sources to the government. GEE usually refers to education spending by local, regional, and central governments (The Global Economy, 2021). TGEE represents government spending on education as a share of total government spending.

Within the education and human capital channel, education includes two dimensions: Quantity and Quality of Education. The quantity of education was tested by the total number of students admitted to higher education institutions (TAS), while the quality of education was tested by the percentage of correct answers in mathematics in the centralized state examination (PTRAM), the percentage of correct answers in the Azerbaijani language (PTRAA), and academic freedom (AF). The data for PTRAM and PTRAA represented the average scores of randomly selected schools in administrative units of the Republic of Azerbaijan. Due to problems with data availability, village schools were excluded from the sample. Village schools are usually new and provide data for only a handful of years. This approach was inspired by Barro's (2001) analysis of the relationship between human capital, education, and economic growth.

The second dimension of the NRC's human capital and education channel is health. Per capita current health expenditures (CHE_PC), out-of-pocket expenditures on health services (OP_EXP), and per capita government health expenditures per capita (DM_GOV_EXP_PC) provide a clear picture of the possible relationships between oil-related variables and health care.

CHE_PC estimates current health spending, including health goods and services consumed annually (The Global Economy, 2021). OP_EXP represents expenditures borne directly by a patient whose insurance does not cover the full cost of health goods or services. This includes cost-sharing, self-medication, and other expenses paid directly by households (OECD 2009). DM_GOV_EXP_PC reflects per capita public spending on health from domestic sources and is expressed in current U.S. dollars (IndexMundi, 2021).

A particular set of explanatory variables we consider covers the SWF channel. The SOFAZ share in the state budget (SH_SOFAZ) shows the role of transfers from the SWF to the state budget, while SOFAZ assets (SOFAZ_ASSETS) is the cumulative monetary expression of SWF assets due to oil sales. The ratio of SOFAZ assets to GDP (SOFAZ_ASSETS/GDP) shows the impact of SOFAZ on the national economy, while SOFAZ revenues (SOFAZ_REVENUE) represent profits from contract execution and asset management.

The next set of candidate variables was related to the mining industry. The share of mining in GDP (MINING /GDP) captures the role of mining in the overall economy, while MINING_SHARE reflects the role of mining in overall industrial activity. Similarly, mineral fuels, mineral oils, and products from their bituminous materials (MINERAL_FUELS_AZN) provide useful information on the potential impact of oil-based industrial production on the variables of interest. Two dummy variables were included to understand whether the revenue and production boom (EXT_REV_BOOM) and the economic shocks (ECON_SHOCK) of 2008–2009 and 2014–2015 had an impact on the Azerbaijani economy. Finally, GDP per capita (GPC_PC) proved useful in empirical experiments to represent the overall prosperity of the Azerbaijani economy in NRC models.

Although the number of dependent variables was fixed and certain, there were many candidate variables that could explain the relationship between the oil sector and NRC signs in the Azerbaijani economy. Thus, before multivariate OLS regression estimates were performed, stepwise regression was performed to understand which independent variables from the pool of candidate variables had the greatest influence. When stepwise regression did not provide a meaningful model for OLS estimation, a one-period lag of the same explanatory variables was introduced into the pool of candidate explanatory variables to track the lagged effects of the independent variables. The introduction of lags of more than one period proved insufficient due to the small sample size, as the additional technique (cointegration regression) failed to analyze the models in the dynamic ordinary least squares framework (DOLS). After the initial stepwise regression results, the models were then adjusted to address the errors of stepwise regression, which typically consist of either overfitting or undermining critical variables by not including them in the estimation.

First difference variables were used for the estimates to avoid unwanted parameters. In addition, the data set was adjusted for outlier values. Stability of the estimated models was handled very strictly. To test the significance of the models (not just the significance of individual regressors), an F-statistic was reported for each model. A centered variance inflation factor (VIF) of less than 10.00 indicates that there is no multicollinearity within the explanatory variables. The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) indicated the parameter stability of the model, while the Ramsey reset test showed whether the functional specification of the model was true or not. Subsequently, the Wald test allowed the formation of inferences through hypothesis testing.

Moreover, the expected behavior of the residuals remains one of the most important components of the stability tests. Jarque-Bera (JB), serial correlation, and heteroskedasticity tests were included in the analysis to ensure that this aspect of the estimates also met the general expectations for the regression calculations.

In the last subsection of the results, the indicators oil price, terms of trade, industrial productivity, and government (measured by the ratio of government budget revenues to expenditures to capture the budget deficit) were used as independent variables to explain the exchange rate appreciation between 2005Q1 and 2020Q4 (see Table 1). This choice of explanatory variables is based on the methodology of Algieri (2004), who considers the case of Russia in the study of DD. Therefore, Algieri (2004) constructed the analytical model based on the assumptions of the original DD theory of Corden and Neary (1982) and Corden (1984), in which the REER is the main indicator of a country's international competitiveness in terms of the exchange rate, as it is more appropriate than any other bilateral exchange rate. In addition, oil prices (OIL_PRICES) determine the DD impact on the economy, and industrial productivity relates to the Balassa-Samuelson hypothesis. The terms-of-trade variable (TOT) in Algieri's (2004) analysis excluded oil and natural gas exports to capture the price structure of manufacturing exports, so the same exercise was used to calculate TOT for Azerbaijan. Finally, the government deficit indicator (GOV), which is the ratio of government budget revenues to expenditures, shows exchange rate dynamics in relation to changes in the interest rate. In other words, if there is a budget deficit due to an expansionary policy, interest rates rise after a while as a result of a restrictive monetary policy, which triggers an appreciation of the exchange rate.

Table 1: Selected variables of the study related to Dutch disease, 2005Q1—2020Q4.

Variable name	Description	Measurement unit	Source
OIL_PRICES	Crude oil, average spot price of Brent, Dubai and West Texas Intermediate, equally weighed	US Dollars per Barrel, quarterly	IndexMundi
TOT	The ratio of the exports over imports in current prices	Ratio, quarterly	Central Bank of the Republic of Azerbaijan (CBAR)
PR	The ratio of the industry's (all industrial activities) output over employment in that sector in index terms.	Ratio, quarterly	SSCRA
GOV	Public deficit (which is the ratio of the state budget's revenue) over the expenditures. This indicates the fiscal deficit.	Ratio, quarterly	CBAR
REER_66	Real Effective Exchange Rate based on 66 trading partners	In percent, 2007=100%, annual	Bruegel data sets, Real effective exchange rates for 178 countries: a new database

3. Results

3.1. Political and institutional channel.

The results showed that 34% of the variance in political stability and number of violence could be explained by seven predictors (as measured by the adjusted R-squared value, Table 2). In addition, the model was statistically significant as the F-statistic was 2.55 and the p-value was 0.08. The political stability models showed that the EDI index ($\beta = -0.16$, $t = -3.20$) and oil prices ($\beta = -0.01$, $t = -2.85$) had a negative impact on political stability, while petroleum production ($\beta = 0.01$, $t = 3.73$) and SOFAZ's share of the national budget ($\beta = 0.01$, $t = 2.17$) had a positive impact on political stability. The ratio of mining to GDP ($\beta = 1.13$, $t = 1.15$) and GDP per capita ($\beta = 0.02$, $t = 1.74$) were also positively related to political stability, although they did not show statistical significance.

Next, the modeled relationship between the rule of law index and oil-related variables was negatively affected by oil rents ($\beta = -0.01$, $t = -3.09$) and economic shocks ($\beta = -0.08$, $t = -2.05$). There was a positive relationship between the economy's overall oil dependence, as measured by the EDI ($\beta = 0.03$, $t = 2.64$), and the rule of law index. A statistically non-significant but negative relationship was found between the rule of law and SOFAZ's assets ($\beta = -0.01$, $t = -1.55$).

The model for voice and accountability then showed that EDI ($\beta = -0.03$, $t = -5.63$) and the funding and revenue boom ($\beta = -0.09$, $t = -3.93$) had a statistically significant and negative impact on voice and accountability, while SOFAZ assets ($\beta = 0.02$, $t = 5.05$) had a positive impact on voice and accountability. As the ratio of SOFAZ assets to GDP increased, the index of voice and accountability also increased ($\beta = 0.01$, $t = 1.64$), although the model did not indicate a statistically significant relationship.

Finally, the NRC political and institutional channel in Azerbaijan was modeled using human rights scores. Despite the positive association of the EDI ($\beta = 0.02$, $t = 2.55$) with human rights values, the highest statistically significant and negative results were found in terms of the number of negative coefficients. The share of SOFAZ in the state budget ($\beta = -0.93$, $t = -3.04$), the asset accumulation of SOFAZ ($\beta = -0.93$, $t = -3.04$), oil FDI ($\beta = -0.93$, $t = -3.04$), the share of the mining industry in the total industrial structure ($\beta = -0.93$, $t = -3.04$), and even GDP per capita ($\beta = -0.93$, $t = -3.04$) showed a strong and statistically significant negative relationship with human rights scores. These results suggest that the human rights channel can be considered the strongest channel for the NRC phenomenon, which also has the potential to undermine democracy and civil rights.

Table 2: Ordinary Least Squares Estimation Results for the Political and Institutional Channel of the Natural Resource Curse in Azerbaijan, 1996–2019

	POL_ST	R_O_L	VO_AND_ACC	H_RIGHTS
Independent variables				
Constant	0.06 (-1.63)	0.06*** (3.09)	-0.05*** (-4.76)	0.04*** (3.35)
EDI	-0.16*** (-3.20)	0.03** (2.64)	-0.03*** (-5.68)	0.02** (2.55)
MINING/GDP	1.13 (1.15)			

MINERAL_FUELS_	0.01*** (3.73)			
AZN				
OIL_PRICE	-0.01** (-2.85)			
GDP_PC	0.02 (1.74)			
SH_SOFAZ	0.01* (2.17)			-0.01*(-2.00)
OIL_RENTS		-0.01**(3.09)		
SOFAZ_ASSETS		-0.01 (-1.55)	0.02*** (5.05)	
SOFAZ_ASSETS_T			0.01 (1.64)	-0.01*** (-3.33)
O_GDP				
ECON_SHOCKS		-0.08* (-2.05)		
EXT_REV_BOOM			-0.09*** (-3.93)	
OIL_FDI				-0.01*** (-5.16)
MINING_SHARE				-0.01*** (-3.82)
GDP_PC				-0.01*(-1.95)
R ²	0.56	0.38	0.67	0.78
Adj. R ²	0.34	0.20	0.57	0.67
F-stat.	2.55	2.12	6.96	7.16
F-stat. prob.	0.08	0.13	0.00	0.00
Variance inflation factors	All <10.00 ^a	All <10.00	All <10.00	All <10.00
CUSUM	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.
CUSUMSQ	Deviation with return to 5% sig. bounds	Within 5% sig.	Within 5% sig.	Deviation with return to 5% sig. bounds
Ramsey reset test	Functional spec. is true	Functional spec. is true	Functional spec. is true	Functional spec. is true
Wald test (F-stat.)	2.94 [0.04]	3.21 [0.04]	10.89 [0.00]	11.72 [0.00]
Wald test (χ^2)	20.59 [0.00]	16.06 [0.01]	54.45 [0.00]	82.03 [0.00]
JBN test	0.77 [0.68]	0.52 [0.77]	0.51 [0.78]	1.01 [0.60]
Serial correlation (F-stat.)	0.22 [0.81]	1.36 [0.29]	0.59 [0.57]	1.12 [0.36]
Serial correlation (Obs*R ²)	0.80 [0.67]	3.52 [0.17]	1.69 [0.43]	3.48 [0.18]
Heteros. (F-stat.)	0.55 [0.76]	1.19 [0.36]	1.41 [0.28]	0.49 [0.80]
Heteros. (Obs*R ²)	4.11 [0.66]	4.82 [0.31]	5.46 [0.24]	3.76 [0.71]

Notes: 1) ^a Only one variable, MINERAL_FUELS_AZN, showed multicollinearity; the bold coefficients emphasize significant results; 2) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively; 3) the numbers in the brackets next to the coefficients are the corresponding *t*-statistics; and 4) numbers were rounded to the second decimal place for the sake of concision, while the numbers in the brackets next to the stability tests correspond to the *p*-values.

All estimated models were free of multicollinearity, problems with functional specification, and instability of coefficients; only in the model related to human rights values were small deviations observed. In the model that included the rule of law index as a dependent variable, the R² and adjusted R² values were low and the models were not significant (F-statistic = 2.12, p-value = 0.13). However, other models consistently showed higher R² values and model significance. In addition, there were no problems with serial correction at the 5% level and all residuals were normally distributed and homoscedastic, meeting the requirements for stability and adequacy of the main model. Finally, the Wald test showed that all coefficients obtained were statistically different from zero.

Based on the results of the Wald test, the null hypothesis (i.e., the oil-related variables have no effect on the political and institutional channel) was rejected. In the models, the number of negative coefficients obtained related to the rule of law, voice and accountability, and human rights outweighed the number of positive coefficients.

3.2. Capacity to Manage Oil Revenue Channel of the NRC

The capacity to manage oil revenues is another channel in which the NRC can manifest itself. If the quality of management declines and corruption increases, and if non-oil revenues shrink during an oil boom, then the existence of the NRC can be demonstrated. Table 3 shows the results of OLS looking at the NRC oil revenue management channel in Azerbaijan between 2000-2019.

All coefficients were statistically significant in the model of government effectiveness. Half of the coefficients were negative and the other half were positive. In other words, government effectiveness was negatively affected by the share of mining industry in total industrial production ($\beta = -0.05$, $t = -3.47$), oil prices ($\beta = -0.03$, $t = -5.12$), and intercept ($\beta = -0.69$, $t = -11.78$).

Regulatory quality was negatively and significantly associated with oil rents ($\beta = -0.01$, $t = -3.16$). Although the coefficients for the other predictor variables were negative, they were not statistically significant

Non-resource tax revenues were tested in two ways: without social securities (NRT_ESS) and with social securities (NRT_ISS). Both NRT_ESS and NRT_ISS were negatively affected by the increasing role of the mining industry in total industrial production ($\beta = -0.29$, $t = -6.33$; $\beta = -0.24$, $t = -5.24$). However, in the case of NRT_ISS, SOFAZ assets also negatively affected tax revenues from non-resource sectors ($\beta = -0.08$, $t = -3.10$).

Meanwhile, government integrity showed a negative relationship with the share of the mining sector ($\beta = -0.99$, $t = -5.85$), FDI in oil ($\beta = -0.01$, $t = -4.85$), and the EDI ($\beta = -1.18$, $t = -3.41$). However, the SOFAZ share of the government budget ($\beta = 0.29$, $t = 3.16$) and oil revenues ($\beta = 0.85$, $t = 6.94$) had a positive and statistically significant impact on government integrity.

Finally, the government fragility index showed only a negative and statistically significant relationship with oil-related variables, namely oil and gas production ($\beta = -0.01$, $t = -5.02$).

With the exception of the regulatory quality index, all other channels provided statistically significant models (the F-statistic was less than 0.05), did not suffer from multicollinearity, and had acceptable R^2 values and very stable coefficients, as measured by CUSUM and CUSUMSQ. In addition, all models passed the Ramsey reset test, indicating the adequacy of the functional specifications. According to the Wald test, all coefficients were statistically different from zero. Finally, the absence of serial correlation and heteroskedasticity, as well as the normal distribution of the residuals increased the reliability of the estimated models.

Table 3: Capacity to Manage Oil Revenue Channel of the NRC in Azerbaijan, 2000–2019

	GOV_EFFEC	REG_QUAL	NRT_ESS	NRT_ISS	GOV_INT	ST_FRAG
Independent variables						
CONSTANT	-0.69*** (-11.78)	0.06** (2.96)	0.19 (1.17)	0.34 (1.48)	2.26*** (3.75)	0.40** (2.40)
MINIG_SHARE	-0.05*** (-3.47)		-0.29*** (-6.33)	-0.24*** (-5.24)	-0.99*** (-5.85)	
OIL_PRICE	-0.03*** (-5.12)		0.05** (2.74)			
OIL_GAS_EXT	0.01*** (4.14)					-0.01*** (-5.02)
GDP_PC	0.03** (2.45)		0.11** (2.30)			
SOFAZ_ASSETS	0.04** (2.30)	-0.01 (-1.27)		-0.08*** (-3.10)		0.21*** (4.00)
SH_SOFAZ			0.06** (2.88)	0.06** (2.40)	0.19*** (3.16)	
SOFAZ_REVENUE			-0.14 (-1.61)			
OIL_RENTS		-0.01*** (-3.16)			0.85*** (6.94)	
EXT_REV_BOOM		-0.04 (-1.33)				
OIL_FDI					-0.01*** (-4.85)	0.01 (0.12)
EDI					-1.18*** (-3.41)	-0.35 (-1.75)
MINING/GDP						19.09*** (3.98)
OIL_EXP/GDP						-5.80** (-2.76)
R^2	0.68	0.36	0.73	0.64	0.76	0.68
Adj. R^2	0.52	0.18	0.62	0.56	0.66	0.52
F-stat.	4.22	1.96	6.88	8.72	8.10	4.25
F-stat. prob.	0.02	0.16	0.00	0.00	0.00	0.02
VIF	All <10.00	All <10.00	All <10.00	All <10.00	All <10.00	All <10.00
CUSUM	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.
CUSUMSQ	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.

Ramsey reset test	Functional spec. is true	Functional spec. is true	Functional spec. is true	Functional spec. is true	Functional spec. is true	Functional spec. is true
Wald test (F-stat.)	41.75 [0.00]	3.48 [0.03]	8.40 [0.00]	8.31 [0.00]	10.03 [0.00]	7.70 [0.00]
Wald test (χ^2)	292.24 [0.00]	17.38 [0.00]	50.4 [0.00]	33.23 [0.00]	60.15 [0.00]	53.88 [0.00]
JBN test	0.11 [0.95]	0.46 [0.79]	0.47 [0.79]	0.37 [0.83]	1.31 [0.52]	1.23 [0.54]
Serial corr. (F-stat.)	0.18 [0.84]	1.21 [0.33]	0.16 [0.85]	0.05 [0.95]	2.20 [0.16]	0.45 [0.65]
Serial corr. (Obs*R ²)	0.66 [0.72]	3.18 [0.20]	0.54 [0.76]	0.14 [0.93]	5.42 [0.07]	1.58 [0.45]
Heteros. (F-stat.)	0.56 [0.75]	0.57 [0.69]	1.62 [0.22]	0.62 [0.61]	0.88 [0.52]	1.16 [0.39]
Heteros. (Obs*R ²)	4.18 [0.65]	2.65 [0.62]	7.29 [0.20]	2.09 [0.55]	4.78 [0.44]	6.99 [0.32]

Notes: 1) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively; 2) the numbers in the brackets next to the coefficients are the corresponding t-statistics; 3) numbers were rounded to the second decimal place for the sake of concision, while the numbers in the brackets next to the stability tests correspond to the p-values.

3.3. Human Capital Channel

The human capital channel of the NRC is important for determining the impact of oil-related variables and has been widely discussed in the literature. This channel was analyzed according to the education and healthcare subchannels; education was tested in terms of quantity and quality, while healthcare was mainly investigated via expenditures.

TGEE showed both statistically significant positive and negative associations. Among them, oil prices ($\beta = -0.02$, $t = -3.13$) and EDI ($\beta = -0.28$, $t = -4.45$) had a negative impact on TGEE, whereas the oil exports to GDP ratio ($\beta = 2.65$, $t = 3.72$) and economic shocks ($\beta = 0.26$, $t = 2.10$) positively impacted TGEE (see Table 4). Although the intercept in this model was not statistically significant, a negative association was also present ($\beta = -0.08$, $t = -1.46$).

GEE showed only one statistically significant and negative association with oil prices ($\beta = -0.09$, $t = -1.88$) and one statistically significant and positive impact by the model's intercept ($\beta = 1.76$, $t = 0.66$).

The number of statistically significant and negative associations was high in the academic freedom (AF) model. Oil and gas extraction ($\beta = -0.01$, $t = -2.31$), the share of SOFAZ in the state budget ($\beta = -0.34$, $t = -3.50$), and oil FDI ($\beta = -0.01$, $t = -1.86$) had a statistically significant and negative association with AF. In addition, due to the significance of the overall AF model, the extraction and revenue boom period ($\beta = -3.45$, $t = -1.40$) and SOFAZ's assets ($\beta = -0.08$, $t = -0.66$) also contributed to the negative association.

The individual regressors *and* the overall models related to TGEE and AF were statistically significant, according to F-statistic values and their probabilities. All models were free from multicollinearity, coefficient instability, and functional specification error. Excluding the GEE model, the models' residuals were normally distributed, without serial correlation (minor serial correlation was present in the AF model, as measured by observed R² values) or heteroscedasticity.

Lastly, the null hypothesis (i.e., oil-related variables do not have an impact on education and human capital in Azerbaijan) was unequivocally rejected for TGEE and AF, as measured by the F-statistic for the Wald test and its *p*-values. However, according to the χ^2 values for the Wald test, the null hypothesis was rejected for *all* models.

Table 4: Education Component of the Human Capital Channel for the NRC in Azerbaijan, 2000–2019

	TGEE	GEE	AF	TAS	PTRAA	PTRAM
Independent variables						
Constant	−0.08 (−1.46)	1.76** (0.66)	1.66 (1.43)	78.18 (0.16)	−1.60* (−2.21)	−5.00*** (−3.65)
OIL_PRICE	−0.02*** (−3.13)	−0.09* (−1.88)				
OIL_EXP-GDP	2.65*** (3.72)					−23.32** (−2.79)
OIL_EXP-GDP (-1)					−15.40*** (−3.73)	
ECON_SHOCKS	0.26* (2.10)					7.12** (2.95)
EDI	−0.28*** (−4.45)			−770.34* (−1.94)		
EDI (-1)				−815.65* (−2.07)		−2.78** (−2.84)
OIL_RENTS	0.02 (1.76)					
OIL_RENTS (-1)				629.95*** (4.30)		
EXT_REV_BOOM		1.53 (1.59)	−3.45 (−1.40)		6.51*** (3.88)	
OIL_GAS_EXT		0.01 (1.35)	−0.01** (−2.31)	0.48** (3.16)	0.01*** (4.25)	0.01*** (4.07)
SH_SOFAZ			−0.34*** (−3.50)	153.06* (2.21)		
SH_SOFAZ (-1)					0.23** (2.66)	
OIL_FDI			−0.01* (−1.86)		0.01* (2.21)	
OIL_FDI (-1)						0.01 (1.41)
SOFAZ_ASSETS_TO_GDP			0.79* (1.80)			
SOFAZ_ASSETS			−0.08 (−0.66)		−1.41*** (−4.56)	
SOFAZ_REVENUE_GDP_PC (-1)				−200.16 (−1.28)	−0.58** (−3.07)	0.57 (1.69)
MINING_GDP (-1)				−68777.52*** (−3.24)		
R ²	0.76	0.21	0.51	0.76	0.84	0.70
Adj. R ²	0.67	0.05	0.27	0.59	0.74	0.54
F-stat.	8.35	1.31	2.09	4.49	7.78	4.35
F-stat. prob.	0.00	0.31	0.13	0.02	0.00	0.02
Variance inflation factors	All <10.00	All <10.00	All <10.00	All <10.00	All <10.00	All <10.00
CUSUM	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.
CUSUMSQ	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.	Within 5% sig.	Small deviation with return to 5% sig. bounds
Ramsey reset test	Functional spec. is true	Functional spec. is true	Functional spec. is true	Functional spec. is true	Functional spec. is true	Functional spec. is true
Wald test (F-stat.)	10.98 [0.00]	2.45 [0.09]	2.92 [0.0495]	4.61 [0.01]	6.82 [0.00]	3.73 [0.03]
Wald test (χ^2)	65.86 [0.00]	9.80 [0.04]	20.45 [0.01]	36.88 [0.00]	54.54 [0.0]	26.13 [0.00]
JBN test	0.28 [0.87]	6.92 [0.03]	0.53 [0.77]	0.49 [0.78]	1.09 [0.58]	3.78 [0.15]
Serial corr. (F-stat.)	1.71 [0.23]	1.71 [0.22]	2.84 [0.11]	0.91 [0.44]	1.12 [0.37]	2.18 [0.17]

Serial corr. (Obs*R ²)	4.51 [0.11]	3.96 [0.14]	6.88 [0.03]	3.32 [0.19]	3.94 [0.14]	5.88 [0.05]
Heteros. (F-stat.)	0.59 [0.71]	1.58 [0.24]	0.57 [0.75]	0.28 [0.94]	0.54 [0.79]	0.29 [0.93]
Heteros. (Obs*R ²)	3.49 [0.83]	4.57 [0.21]	4.21 [0.65]	2.98 [0.89]	4.95 [0.67]	2.44 [0.88]

Notes: Notes: 1) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively; 2) the numbers in the brackets next to the coefficients are the corresponding *t*-statistics; 3) numbers were rounded to the second decimal place for the sake of concision, while the numbers in the brackets next to the stability tests correspond to the *p*-values.

Table 5 reports the healthcare component of the human capital channel for the NRC in Azerbaijan. Domestic general government health expenditures per capita (DM_GOV_EXP_PC) were found to be positively associated with the model's intercept ($\beta = 15.77$, $t = 3.35$), and the share of SOFAZ in the state budget ($\beta = 1.57$, $t = 3.40$). Although the only statistically significant and negative association was between government health expenditures and oil and gas extraction ($\beta = -0.01$, $t = -4.99$), the coefficient for the ratio of SOFAZ assets to GDP ($\beta = -0.51$, $t = -1.00$) was negative but statistically non-significant.

Examining out-of-pocket expenditures as a percentage of current health expenditures (PO_EXP) resulted in multiple negative and statistically significant associations with oil and gas extraction ($\beta = -0.01$, $t = -2.28$), the ratio of SOFAZ assets to GDP with one lag ($\beta = -0.70$, $t = -2.35$), oil rents ($\beta = -1.99$, $t = -2.88$), the ratio of oil exports to GDP ($\beta = -60.53$, $t = -2.85$) and its one-period lag ($\beta = -76.37$, $t = -3.83$).

Lastly, current health expenditures per capita were negatively and statistically significantly associated with oil and gas extraction ($\beta = -0.01$, $t = -2.70$), SOFAZ's share of the state budget with a one-period lag ($\beta = -1.61$, $t = -4.99$), and the ratio of SOFAZ assets to GDP with a one-period lag ($\beta = -0.72$, $t = -1.93$).

Table 5: Healthcare Component of the Human Capital Channel for the NRC in Azerbaijan, 2000–2019

	DM_GOV_EXP_PC	OP_EXP	CHE_PC
Independent variables			
Constant	15.77*** (3.35)	14.29** (3.15)	-0.79 (-0.28)
OIL_GAS_EXT	-0.01*** (-4.99)	-0.01** (-2.28)	-0.01** (-2.70)
SH_SOFAZ	1.57*** (3.40)		
SH_SOFAZ (-1)			-1.61*** (-4.99)
SOFAZ_ASSETS_TO_GDP	-0.51 (-1.00)		
SOFAZ_ASSETS_TO_GDP (-1)		-0.70*** (-2.35)	-0.72* (-1.93)
OIL_RENTS		-1.99** (-2.88)	
ECON_SHOCKS		28.07*** (3.88)	
SOFAZ_ASSETS			9.02*** (10.27)
SOFAZ_ASSETS (-1)		3.60*** (3.75)	
OIL_EXP_GDP		-60.53** (-2.85)	
OIL_EXP_GDP (-1)		-76.37*** (-3.83)	
OIL_PRICE (-1)			0.95*** (7.46)
GDP_PC (-1)			2.29*** (3.14)
R ²	0.66	0.96	0.95
Adj. R ²	0.59	0.93	0.93

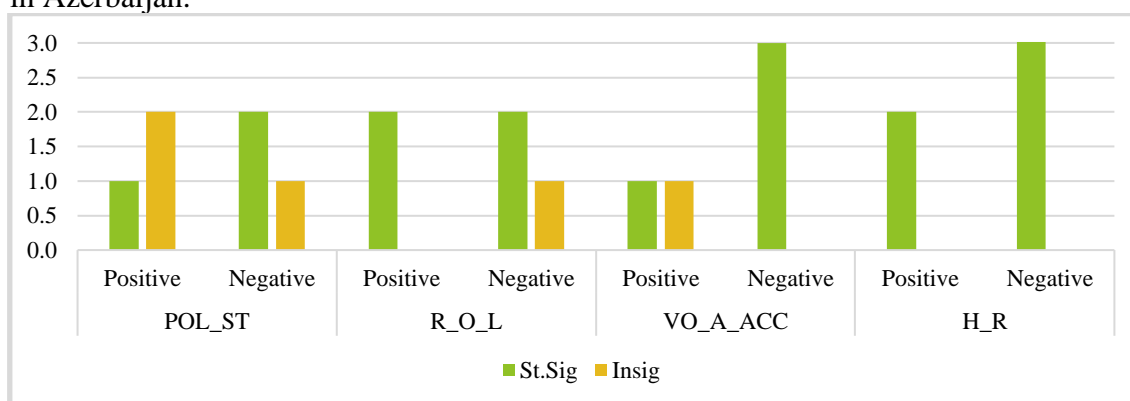
F-stat.	9.83	31.92	38.71
F-stat. prob.	0.00	0.00	0.00
Variance inflation factors	All <10.00	All <10.00	All <10.00
CUSUM	Within 5% sig.	Within 5% sig.	Within 5% sig.
CUSUMSQ	Within 5% sig.	Within 5% sig.	Within 5% sig.
Ramsey reset test	Functional spec. is true	Functional spec. is true	Functional spec. is true
Wald test (F-stat.)	9.56 [0.00]	43.59 [0.00]	39.01 [0.00]
Wald test (χ^2)	38.23 [0.00]	348.74 [0.00]	273.09 [0.00]
JBN test	0.93 [0.63]	1.38 [0.50]	0.82 [0.66]
Serial corr. (F-stat.)	0.60 [0.56]	0.37 [0.70]	0.98 [0.41]
Serial corr. (Obs*R ²)	1.61 [0.45]	1.51 [0.47]	3.22 [0.20]
Heteros. (F-stat.)	0.68 [0.58]	0.35 [0.91]	0.73 [0.64]
Heteros. (Obs*R ²)	2.27 [0.52]	3.51 [0.83]	5.12 [0.53]

Notes: 1) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively; 2) the numbers in the brackets next to the coefficients are the corresponding t -statistics; 3) numbers were rounded to the second decimal place for the sake of concision, while the numbers in the brackets next to the stability tests correspond to the p -values.

3.4. Overview of the Coefficients

Figure 1 illustrates the distribution of significant and non-significant coefficients obtained in the regression analysis for the institutional and political channels. Two variables appear to have the highest relevance in terms of the negative impact of oil-related variables on institutional quality: voice and accountability and human rights scores. Three and five statistically significant and negative coefficients were found, respectively. The number of statistically significant coefficients outweighs the number of statistically non-significant coefficients in all models. With the exception of the political stability model, where both statistically significant and non-significant coefficients were evenly distributed, there were more negative than positive coefficients in the rule of law, voice and accountability, and human rights models.

Figure 1: Distribution of significant and non-significant and positive and negative coefficients in regression estimations for the political and institutional channel of the NRC in Azerbaijan.

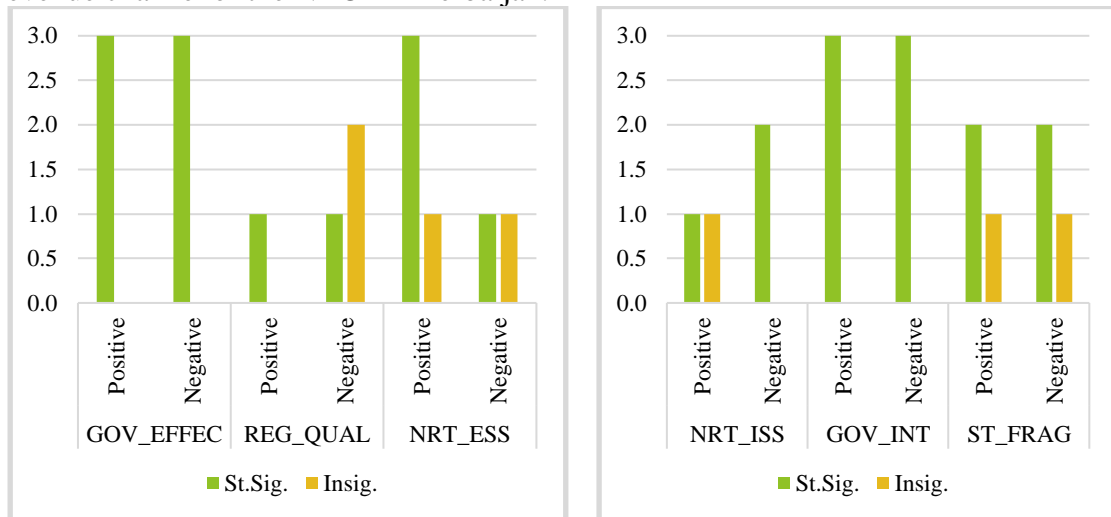


Source: Own construction based on regression estimations.

Figure 2 shows the distribution of coefficients related to the capacity to manage the oil revenue channel. Overall, regulatory quality and non-resource taxes (including social securities) yielded more negative than positive coefficients. For government efficiency and

government integrity, the positive and negative coefficients were evenly distributed; this category also had the most statistically significant coefficients.

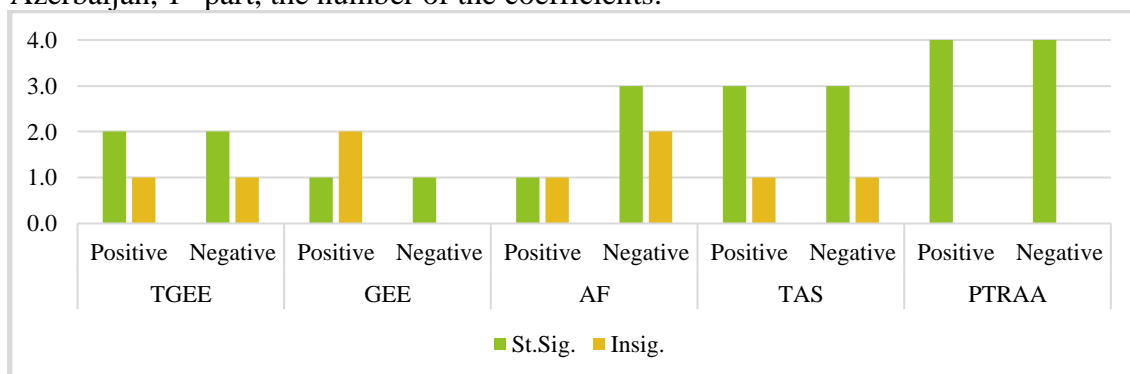
Figure 2: Distribution of significant and non-significant and positive and negative coefficients in regression estimations for the governance and capacity to manage oil revenue channel of the NRC in Azerbaijan.



Source: Own construction based on regression estimations.

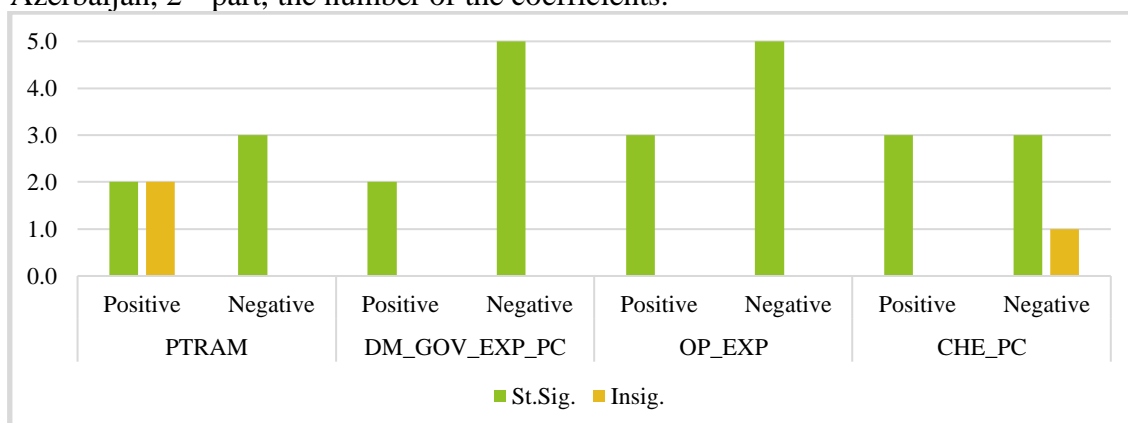
The NRC's human capital channel appears to show up through indicators such as academic freedom, percentage of correct answers in math, domestic government health spending per capita, and out-of-pocket expenditures per capita, which are measured with statistically significant negative coefficients (see Figures 3.11 and 3.12). The most statistically significant negative coefficients were found with DM_GOV_EXP_PC and OP_EXP (five each).

Figure 3: Distribution of significant and non-significant and positive and negative coefficients in regression estimations for the human capital channel of the NRC in Azerbaijan, 1st part, the number of the coefficients.



Source: Own construction based on regression estimations.

Figure 4: Distribution of significant and non-significant and positive and negative coefficients in regression estimations for the human capital channel of the NRC in Azerbaijan, 2nd part, the number of the coefficients.



Source: Own construction based on regression estimations.

3.5. Dutch disease

ADF unit root and Johansen cointegration tests were performed before estimating DOLS in the first subsection of the results section. After the ADF results (which are not reproduced in this working paper), it was decided to use the first difference of all variables. Table 5 shows the results of the Johansen cointegration test. The results show that the variables of interest have long-run cointegration that allows them to be combined in a linear fashion.

Table 6: Unrestricted cointegration rank test (trace and maximum eigenvalue).

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.371297	85.96591	69.81889	0.0015
At most 1 *	0.335849	57.65601	47.85613	0.0046
At most 2 *	0.249005	32.69200	29.79707	0.0226
At most 3	0.220645	15.22431	15.49471	0.0549
At most 4	0.000290	0.017673	3.841466	0.8941

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.371297	28.30990	33.87687	0.1996
At most 1	0.335849	24.96400	27.58434	0.1044
At most 2	0.249005	17.46770	21.13162	0.1511
At most 3 *	0.220645	15.20663	14.26460	0.0354
At most 4	0.000290	0.017673	3.841466	0.8941

Max-eigenvalue test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b*S11*b=I):

The long-run DOLS estimation showed that oil prices, industrial productivity, government spending, and terms of trade contributed positively and statistically significantly to the appreciation of the REER between 2005Q1 and 2020Q4 (see Table 6). Table 7 shows the short-run models from DOLS. The results show that industrial productivity maintains its coefficient sign (negative), but oil prices also turn negative. Government spending and the terms of trade maintain the signs of the long-run coefficients. Finally, the robustness checks by the canonical cointegration regression of the short-run and long-run DOLS models showed that the long-run model is robust (see Table 8).

Table 7: Long-run DOLS estimations of REER, 2005Q1–2020Q4.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(OIL_PRICES)	0.152225	0.056337	2.702035	0.001800
LOG(PR)	-0.576485	0.090310	-6.383429	0.000000
LOG(GOV_EXP)	0.581134	0.090929	6.391096	0.000000
LOG(TOT_GEN)	0.489163	0.059497	8.221690	0.000000
C	4.358762	0.328685	13.261200	0.000000
R-squared	0.989245	Mean dependent var		4.756630
Adjusted R-squared	0.958517	S.D. dependent var		0.167646
S.E. of regression	0.034145	Sum squared resid		0.016322
Long-run variance	0.000297			
Jarque-Bera	0.928952	Jarque-Bera, Prob.		0.628464
Variance Inflation Factors (Coeff. var)	All < 1.0			
Wald Test (F-stat.)	184995.7***	Wald Test (Chi-square)		924978.3***

Notes: 1) Dependent Variable: LOG(REER); 2) Included observations: 55 after adjustments; 3) Cointegrating equation deterministics: C; 4) Automatic leads and lags specification (lead=4 and lag=4 based on AIC criterion, max=4); 5) HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000); 6) No d.f. adjustment for standard errors & covariance. 7) the symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

Table 8: Short-run DOLS estimations of REER, 2005Q1–2020Q4.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(OIL_PRICES))	-0.751647	0.150492	-4.994588	0.015400
D(LOG(PR))	-2.364607	0.221455	-10.67760	0.001800
D(LOG(GOV_EXP))	0.936715	0.311110	3.010884	0.057200
D(LOG(TOT_GEN))	1.177213	0.308251	3.819011	0.031600
C	0.032119	0.005948	5.400025	0.012400
R-squared	0.952153	Mean dependent var		0.002871
Adjusted R-squared	0.186600	S.D. dependent var		0.057442
S.E. of regression	0.051806	Sum squared resid		0.008052
Jarque-Bera	1.570703	Jarque-Bera, Prob.		0.455959

Variance Inflation			
Factors (Coeff. var)	All < 1.0		
Wald Test (F-stat.)	33.58391***	Wald Test (Chi-square)	167.9195***

Notes: 1) Dependent Variable: D(LOG(REER)); 2) Included observations: 52 after adjustments; 3) Cointegrating equation deterministics: C; 4) Automatic leads and lags specification (lead=5 and lag=5 based on AIC criterion, max=5); 5) HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000); 6) No d.f. adjustment for standard errors & covariance; 7) the symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

Table 9: Robustness check via Canonical Cointegrating Regression, 2005Q1–2020Q4.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(OIL_PRICES)	0.370746	0.136799	2.710157	0.0088
LOG(PR)	-0.589649	0.132121	-4.462927	0.0000
LOG(GOV_EXP)	0.615465	0.126212	4.876438	0.0000
LOG(TOT_GEN)	0.273906	0.121999	2.245144	0.0286
C	3.570289	0.49890	7.156316	0.0000
R-squared	0.329001	Mean dependent var		4.729495
Adjusted R-squared	0.282725	S.D. dependent var		0.178947
S.E. of regression	0.151554	Sum squared resid		1.332182
Long-run variance	0.034229			
Jarque-Bera	30.84984	Jarque-Bera, Prob.		0.0000
Variance Inflation				
Factors (Coeff. var)	All < 1.0			
Wald Test (F-stat.)	8191.240***	Wald Test (Chi-square)	40956.20***	

Notes: 1) Dependent Variable: LOG(REER); 2) Included observations: 63 after adjustments; 3) Cointegrating equation deterministics: C; 4) Long-run covariance estimate (Prewhitening with lags = 3 from AIC maxlags = 3, Bartlett kernel, Newey-West fixed bandwidth = 4.0000); 5) the symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

4. Concluding Remarks and Suggestions

The main finding of the stepwise regression analysis of the NRC political and institutional channel showed that at least one oil-related indicator was statistically significantly associated with institutional and political decline, with the human rights subchannel providing the strongest evidence of a negative association with the rise of the oil industry in the Azerbaijani economy. After human rights, voice and accountability was the second subchannel that revealed a negative relationship between the oil sector and institutional quality. Meanwhile, models of regulatory quality and taxes on non-resources (including social security) were more informative as a sub-channel of NRC signs. Although government effectiveness and government integrity had the most negative coefficients, they also had an equal number of positive and statistically significant coefficients. Finally, the human capital channel (broken down by education and health care) provided information on the presence of NRC in the Azerbaijani economy, as the quality of

education (measured by academic freedom and the percentage of correct answers in mathematics in the centralized state examination) was negatively associated with oil-related variables. The health care indicators yielded even more statistically significant and negative coefficients-in particular, five coefficients for government per capita health care spending and citizen health care spending, which continued to decline during the oil boom.

The regression results at the country level suggest that the general dependence on oil and oil prices as an external factor for the national economy led to political instability and an increase in violence. However, domestically controllable channels such as mineral fuel production and the share of oil revenues in the national budget contributed to political stability. In addition, the share of mining in GDP and GDP per capita also contributed positively to the political stability index, although they were not statistically significant.

These results show that it is possible to model certain dependent variables in a unique way for large data sets that contain multiple explanatory variables but that are very closely related. It is possible that one dependent variable can be explained by independent variables such as X, Y, and Z, but the other can be explained by A, B, and C. Thus, depending on the case study and the data set, the stepwise regression algorithm can yield fruitful results, but the relationships must be well determined by the researcher.

This working paper is limited to linear models. Future work could also use a nonlinear approach to identify potential impacts of the natural resource curse on the Azerbaijani economy. Studies of Dutch disease and the natural resource curse have become popular since 2014 and 2015, the sharp decline in commodity prices. In order to overcome these challenges, sustainable economic growth and development strategies must be applied to transit from fossil fuel-based economy to more circular and high-value-added production and consumption (see works by Sadik-Zada and Gatto (2021b); Sadik-Zada and Ferrari (2020a); Sadik-Zada (2020b); Sadik-Zada (2021c); Sadik-Zada (2018)).

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