Comparative Economic Research, Volume 20, Number 1, 2017
10.1515/cer-2017-0004

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Reduction Of An Economy's Raw Material Dependence And The Human Capital Of A Country

Abstract

This paper evaluates the raw material dependence of two export-oriented oil and gas extracting countries. We find evidence of presence of the Dutch disease in both countries and of the resource curse in Russia. Reduction of volumes of crude oil and natural gas production and exports, compensated by the growth of value added in other kinds of economic activity, suggests that Norway is gradually overcoming the Dutch disease by means of expanded reproduction of human capital. On the other hand, extraction of hydrocarbons may remain a driver of the Russian economic growth.

***Keywords**: Dutch disease, value added, education and health care, resource curse, human capital*

1. Introduction

According to the Rybczynski theorem (Rybczynski 1955, pp. 336–341), there appears to be a direct relationship between an increase in the factors of production in one part of the economy and a depression or even recession in

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its other parts, as a result of limited disposable resources. Bhagwati (1958, pp. 201–205) termed as ‘immiserizing growth’ the situation in which positive results from the expansion of production and increase in exports in one sector or branch of the economy fail to exceed the negative consequences for the economy a whole. In particular, specialization of a country's exports in goods produced from unprocessed natural resources retards economic growth by hindering the emergence of more dynamic patterns of trade specialization (Murshed, Serino 2011, pp. 151–161). The phenomenon of comparatively low rates of economic growth in countries abundant with natural resources was exposed to analysis in a broad range of studies, and the term "resource curse", introduced in 1993 by Auty, has become widely accepted. Many scientists consider the mechanism of conversion of resource abundance into a resource curse as primarily institutional (Ross 1999, pp. 297–322; Robinson, Torvik, Verdier 2006, pp. 447–468; Luong, Weinthal 2006, pp. 241–263). In such a case, the formation of an economy's raw material structure, which negatively affects long-run economic growth, is mainly explained by the imperfection of political and social institutions operating in the country. Examination of the origin of this phenomenon commonly involves studying institutions that are capable of rapid change (i.e. corruption, democracy level, methods of resource rent distribution), but not those which develop over a long period of time (legal systems and procedural law, common business practices) (Bhattacharyya, Hodler 2010, pp. 608–621; Brollo et al. 2013, pp. 1759–1796). The information base for the study of institutional changes consists of data over several decades.

Reduction of the scope of reasons for the existence of the resource curse to institutional weakness leads to a conclusion about absence of dependence on raw materials in mature societies that have achieved a high level of socio-economic development, and its presence exclusively in countries with a poor quality of institutions. However, empirical studies of economic growth in developed countries possessing a large raw materials sector (the USA and Norway in particular) do not confirm the universality of this assumption to the full extent (Papyrakis, Gerlagh 2007, pp. 1011–1039; Fagerberg, Mowery, Verspagen 2009, pp. 431–444). Brunnschweiler (2008, pp. 399–419), in a similar by purpose investigation of a group of resource-abundant countries, detected a positive direct relationship between natural resources abundance and economic growth, as well as the absence of negative indirect influence of the former on the latter through institutional channels. An econometric analysis of the situation in 53 authoritarian countries that actively exploit natural resources, conducted by Haber and Menaldo (2001, pp. 1–26), has shown a weak positive relationship between the growth of oil incomes and democracy in oil exporting countries, instead of a negative correlation. As the given examples suggest, it is quite possible to carry out a quantitative analysis in order to explain institutional

origin of the resource curse, though there is still the problem of finding objective indicators of assessment of institutional quality, which may affect the results of the scientific research.

Unlike the Dutch disease, the resource curse has a much broader meaning, as it represents both an institutional and an economic phenomenon that is expressed in the retention of a backward economic structure, which becomes an obstacle to the growth (van der Ploeg 2011, pp. 366–420). Along with the structural imbalance in the form of deindustrialization, it manifests itself in the retardation of economic growth and its increased unsteadiness, determined by the dependence on the fluctuating prices structure on international raw materials markets (fluctuations from the situation of an "abundance paradox" to a sharp decline in economic activity), as well as in the weakness of the institutional environment (especially with respect to government corruption in the area of exploitation of the environment), in the excessive attention of a state to minerals extraction to the detriment of other economic activities, and in the reduction of a state's social liabilities (Cheng, Sachs, Yang 2004, pp. 671–688; Bjorvatn, Farzanegan, Schneider 2012, pp. 1308–1316).

The dominance of the primary sector, which is based on environmentally capacious production was typical – in the framework of the Clark's (1940) three-sectoral model of the economy – of pre-industrial societies possessing institutional characteristics corresponding to that stage of civilization development. The institutional environment to a large extent forms the overall conditions for economic advancement, but the practical realization of economic growth occurs under the determinative impact of economic factors. In considering these factors, economists are paying attention mainly to the external trade activities of the country. The reasons for the negative influence of export's raw material orientation on the long-term dynamics of economic growth are seen in the global character of resource markets and their high price volatility (Stevens 2003, pp. 1–42), the insufficiency of human capital (Sachs, Warner 2001, pp. 827–838), and the Dutch disease (Dülger et al. 2013, pp. 605–612). Furthermore, it is often assumed that the resource curse strikes economies of countries rich exactly in mineral resources (Sala-i-Martín, Subramanian 2013, pp. 570–615).

The Dutch disease is considered as a basic economic version of the resource curse genesis. It is viewed as a suppression of competitiveness in the economic sectors involved in production of commodities by the income from the export-oriented raw materials sector, owing to the increase in real exchange rates of the national currency (Ellman 1981, pp. 149–166; Cherif 2013, pp. 248–255). Kojo (2014) notes that it is groundless to equate the Dutch disease to the resource curse, since the meaning of the latter extends far beyond the confines of a purely economic occurrence. In this regard, we should also mention the works by van der Marel

and Dreyer (2014, pp. 341–364) as well as Covi (2014, pp. 75–110), in which the authors consider the deterioration of the rule of law as a cause of the presence of the Dutch disease in the Russian economy.

Transition from extraction of raw materials to their processing is often impeded by the lack of employees having the required knowledge and skills. Demand for the results of science and education is weaker in countries specializing in minerals extraction, and unclaimed human capital leaves them (Sachs, Warner 2001; Gylfason 2001, pp. 847–859). However, the postulate of an indissoluble link between the resource curse trap and human capital depletion is not shared by all scientists. Stijns (2006, pp. 1060–1083), for instance, regards mineral rent, which is simple to impose taxes on, as an important source of financing education.

The main methodological principle of our study consists, first of all, in exploration of the interconnections between the constituents of oil – and gas-producing countries' economies that are important for achieving our research aim (i.e. to substantiate the notion that the process of human capital accumulation is a major means of overcoming the resource curse). The paper is composed of five parts. The following Section 2 – "Comparison of growth dynamics of Norwegian, Russian and global economies, and its link with the level of oil prices" estimates the sustainability of economic growth in Norway and Russia to the changes in volume and price indicators in the oil and gas sector. Section 3 – "Evaluation of the contribution of oil and gas extraction to the production and export of Norway and Russia" – identifies quantitative connections between physical volumes and values of oil and gas extraction, along with relationships between total exports of a country and its gross value added. Section 4 – "Analysis of alterations in the structure of gross value added" – examines the dynamics of value added shares of leading types of economic activity in the considered countries. In Section 5 – "Production functions of Norwegian and Russian economies" - we have calculated production functions of national economies.

2. Comparison of the growth dynamics of Norwegian, Russian and the global economy, and their links with the level of oil prices

The dynamics of world economic growth in the 21st century underwent changes associated with the crisis of 2008–2009. The first eight years were marked by relatively rapid growth of the global gross domestic product, while during the period 2008–2014 it slowed by almost 1.5 times (average annual growth rates equaled 4.27% and 2.92%, respectively, for the two periods, and 3.64% for the whole 15-year period). Norway and Russia also experienced an inhibition of GDP growth: its average annual rate in the Norwegian economy

amounted to 2.40% during the pre-crisis period, 1.22% in the subsequent period, and 1.85% in 2000–2014; while the Russian economy demonstrated higher average annual growth rates in the corresponding time periods, which reached 7.18%, 1.80% and 4.67% respectively. As a result, the Norwegian economy experienced over 2000–2014 a decline in its annual growth rates, which was twice as small as in the global economy, whereas growth rates of the Russian economy decreased more drastically. At the same time, the volatility of Russian GDP growth rates turned out to be 2.9 times greater than that of the Norwegian ones. The decline in Russian GDP in the crisis year 2009, compared with the previous year, was –7.8%, compared to –1.6% in Norway, which characterizes the growth of Russian economy as less sustained. The data by years is presented in Table 1.

Table 1. Growth rates of global GDP as well as Norwegian and Russian GDP, and oil and gas extraction, in %

Years	Annual growth rates of countries' GDP and global GDP			Deviations of countries' GDP growth rate from the global GDP growth rate		Growth rates of oil and gas extraction measured in mln. tons of oil equivalent		
	Norway	Russia	Global	Norway	Russia	Norway	Russia	Global
2000	3.25	10.05	4.71	-1.46	5.33	-	-	-
2001	1.99	5.09	2.48	-0.49	2.61	-	-	-
2002	1.50	4.74	3.03	-1.53	1.71	-	-	-
2003	0.98	7.30	4.07	-3.09	3.22	-	-	-
2004	3.96	7.18	4.92	-0.96	2.26	6.08	7.69	1.82
2005	2.59	6.38	4.54	-1.96	1.83	-2.53	1.80	1.70
2006	2.30	8.15	5.18	-2.89	2.97	-3.33	2.44	1.74
2007	2.65	8.54	5.20	-2.55	3.33	-4.26	0.82	0.84
2008	0.07	5.25	2.66	-2.59	2.59	2.50	0.54	2.04
2009	-1.63	-7.82	-0.68	-0.96	-7.14	-1.07	-5.75	-2.65
2010	0.48	4.50	5.01	-4.54	-0.51	-3.65	6.77	4.26
2011	1.22	4.29	3.84	-2.63	0.45	-5.33	2.24	1.96
2012	3.09	3.44	3.14	-0.05	0.30	3.08	-0.56	2.40
2013	2.63	1.49	2.91	-0.27	-1.41	-4.98	1.52	0.53
2014	2.67	1.48	3.52	-0.85	-2.04	1.27	-1.88	1.99

Source: Output, Labor, and Labor Productivity, 1950–2014 (The Conference Board. Total Economy Database, 2015); Regional Aggregates, 1990–2014 (The Conference Board. Total Economy Database, 2015); BP Statistical Review of World Energy pp. 10, 24 (2015).

The volume of the extraction of global oil (in mln tons) and natural gas (in billion cubic meters) consistently increased in 2004–2014, and the rates of their growth were predominantly positive (except for the year 2009). At the same time, there was a tendency toward decline in the volume of oil production in the Norwegian economy (which shrank from 150.3 mln. tons in 2004 to 85.6 mln. tons in 2014), while natural gas extraction in Russia practically stagnated (573.3 bcm in 2004 and 578.7 bcm in 2014) (BP Statistical Review of World Energy, 2015, pp. 10, 22). The average annual growth rate of oil and gas production volumes (measured in millions of tons of oil equivalent) in the global economy during 2004–2014 had a positive value (+1,51), in contrast to Norway's (−1.11%), and was greater than Russia's (+1.42%), which suggests presence of serious problems in the development of the oil-and-gas complex in both countries. The obtained estimate for the linear dependence of GDP growth rates on oil and gas production growth rates showed an absence of such a connection in the Norwegian economy. The equation for the Russian economy is significant at the $\alpha = 0.05$ level (see the Appendix) and reflects an average increase in GDP growth rate by 0.86% in case of an increase of the oil and gas extraction growth rate by 1%:

$$y_{T\_GDP\_R} = 2.68 + 0.86 x_{T\_OGE\_R} \quad (1)$$

where:

$y_{T\_GDP\_R}$ is the GDP growth rate in Russia, %;

$x_{T\_OGE\_R}$ is the oil and gas extraction growth rate in Russia, in %.

Table 2. Dynamics of GDP, oil and gas production in Norway and Russia, as well as Brent oil price

Years	GDP at prices for 2013, mln. USD		Oil and gas production, mln tons of oil equivalent			Oil price per barrel
	Norway	Russia	Norway	Russia	Global	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2000	233041.6	1511145	-	-	-	28.59
2001	237679.2	1588080	-	-	-	24.44
2002	241249.4	1663414	-	-	-	25.02
2003	243615.7	1784775	208.9	909.4	6238.1	28.83
2004	253265.4	1912849	221.6	979.3	6351.7	38.27
2005	259822.3	2034816	216.0	996.9	6459.5	54.52

(1)	(2)	(3)	(4)	(5)	(6)	(7)
2006	265795.1	2200723	208.8	1021.2	6572.2	65.14
2007	272846.7	2388557	199.9	1029.6	6627.5	72.39
2008	273031.0	2513907	204.9	1035.2	6762.6	97.26
2009	268567.3	2317297	202.7	975.7	6583.3	61.67
2010	269851.3	2421662	195.3	1041.8	6864.0	79.5
2011	273137.7	2525575	184.9	1065.1	6998.4	111.26
2012	281581.2	2612510	190.6	1059.1	7166.3	111.67
2013	288991.1	2651521	181.1	1075.2	7204.2	108.66
2014	292661.3	2601706	183.4	1055.0	7347.9	98.95

Source: Output, Labor, and Labor Productivity, 1950–2014 (The Conference Board. Total Economy Database, 2015); BP Statistical Review of World Energy pp. 10, 15, 24 (2015).

The values of the correlation coefficients obtained on the basis of dynamic series given in Table 2 indicate a greater dependency of growth of the Norwegian and Russian economies on the Brent oil price per barrel, which is subject to sharp rises and declines ($r_{Nor-price} = +0.93$; $r_{Rus-price} = +0.96$), than on the volumes of oil and natural gas extraction ($r_{Nor-vol} = -0.84$; $r_{Rus-vol} = +0.90$).

This circumstance, in combination with the low predictability of oil price changes in the global market, which substantially increases the risk of medium- and long-term investment into the expansion of hydrocarbons extraction, explains the instability of the dynamics of growth indicators in the economies of oil- and gas-exporting countries.

Regression of the GDP on the volumes of oil and gas production for the Norwegian economy is as follows:

$$y_{GDP\_N} = 448239.22 - 890.58 x_{OGE\_N} \quad (2)$$

where

y_{GDP_N} is Norway's GDP at prices for 2013, mln. USD;

x_{OGE_N} is the oil and gas production in Norway, mln. tons of oil equivalent.

Table 3. Results of the regression analysis

Eq. №	R^2	F_{fact}	Variable	Coefficient	t-stat
1	0.49	8.60^{**}	const. term	2.68	2.39^{**}
			$X_{T\_OGE\_R}$	0.86	2.93^{**}
2	0.7	23.25^{***}	const. term	448239.22	12.12^{***}
			X_{OGE_N}	-890.58	-4.82^{***}
3	0.82	45.14^{***}	const. term	-3255907.80	-3.91^{***}
			X_{OGE_R}	5475.30	6.72^{***}
4	0.72	27.93^{***}	const. term	44.40	19.49^{***}
			$Sh_{VA\_OGE\_N}$	0.53	5.28^{***}
5	0.98	4016.58^{***}	const. term	-7.53	-1.96^{*}
			$X_{VA\_OGE\_N}$	0.96	11.69^{***}
			$X_{VA\_PI\_N}$	1.99	4.80^{***}
			$X_{VA\_E+HC\_N}$	4.38	49.04^{***}
6	0.97	1156.38^{***}	const. term	1148.58	1.87^{*}
			$X_{VA\_OGE\_R}$	1.68	2.04^{*}
			$X_{VA\_PI\_R}$	1.97	2.55^{**}
			$X_{VA\_E+HC\_R}$	7.67	6.72^{***}
7	0.92	60.24^{***}	const. term	0.6131	14.67^{***}
			$Sh_{VA\_E+HC\_N}$	-3.1169	-10.06^{***}
			P_{oil}	0.0006	7.00^{***}
8	0.45	9.12^{**}	const. term	0.0565	6.83^{**}
			P_{oil}	0.0003	3.02^{**}

Note: ***, ** and * indicate significances at the 1%, 5% and 10% levels, respectively

Source: Authors' own calculations.

The negative value of the independent variable's coefficient (−890.58) in the regression equation (along with the previously discovered negative correlation of GDP and volumes of oil and gas extraction in Norway) is evidence of the substitution of hydrocarbons extraction by other economic activities. Losses in the oil and gas sector are compensated for by the positive impact of this process on GDP growth rates. An explanation for the linear inverse relationship described by the equation (2) may be given in terms of the fact that the acceleration of economic growth in Norway occurs against the backdrop of declining oil and gas production.

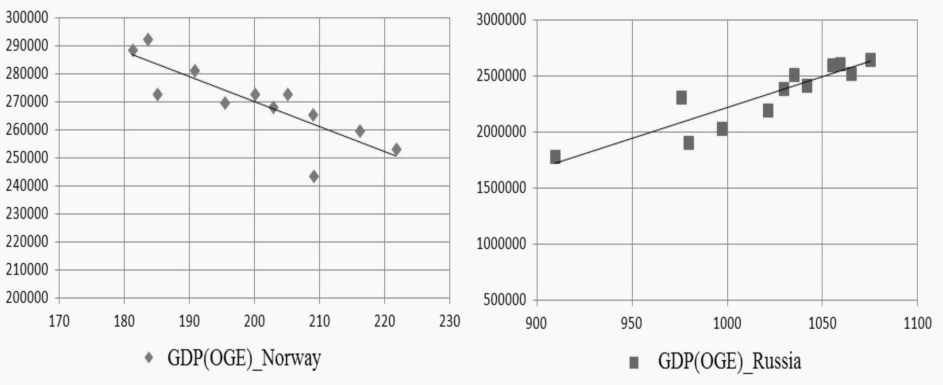
The same type of regression equation for the Russian economy looks quite different:

$$y_{GDP\_R} = -3255907.80 + 5475.30 x_{OGE\_R} \quad (3)$$

The negative value of the absolute term (−3255907.80) points to such a relationship such that a contraction of oil and gas production causes extreme GDP reduction.

The positive value of the independent variable coefficient (+5475.30) reflects the existence of a direct link between GDP dynamics and changes in volumes of oil and gas extraction in Russia. Therefore, growth of the Russian economy is directly related to the production of hydrocarbons, in contrast to the Norwegian one. A graphical depiction of the described relationships is presented in Figure 1.

Figure 1. Graphs of the dependence of GDP in Norway and Russia on the volumes of oil and gas extraction



Source: Representation of the data from Table 2.

The linear trend showing the connection between GDP and hydrocarbons extraction demonstrates the difference in the dynamics of these indicators in the case of Norway, and their unidirectional movement in the Russian economy. The observed inverse relationship implies the efficiency of the diversification process in Norway's economy, which takes place on the basis of decreasing the scale of raw materials exploitation. The presence of a positive relationship in the Russian economy suggests that oil and gas production continues to act as a driver of its growth.

3. Evaluation of the contribution of oil and gas extraction to the production and export of Norway and Russia

Overcoming the resource curse requires transformation of the economic structure that would lead to an increase in the share of value added in the created product. Contraction of the share of not-fully-processed oil and gas exports in

the total exports, as well as of the share of crude oil and natural gas supplied to international markets in their production in the country, might serve as a first step in this direction.

Table 4. Contribution of crude oil and natural gas extraction to the total production and exports of Norway and Russia

Years	Oil and gas exports, bln. USD		Total exports, bln. USD		The share of oil and gas exports in total exports, %		The share of oil and gas extraction value added in gross value added, %	
	Norway	Russia	Norway	Russia	Norway	Russia	Norway	Russia
2002	32.10	45.01	59.54	102.07	53.91	44.10	18.61	5.09
2003	36.37	59.66	67.94	129.06	53.53	46.23	18.78	5.24
2004	46.22	80.90	82.49	177.86	56.04	45.48	21.79	7.70
2005	60.99	115.11	103.76	240.02	58.78	47.96	25.87	9.37
2006	71.12	146.09	122.20	297.48	58.20	49.11	26.60	9.45
2007	75.79	166.34	136.36	346.53	55.58	48.00	24.00	8.56
2008	100.93	230.25	173.22	466.30	58.27	49.38	27.56	7.55
2009	64.29	142.56	114.68	297.16	56.06	47.98	19.65	7.09
2010	72.22	183.54	130.66	392.67	55.27	46.74	20.59	7.73
2011	91.76	246.10	160.41	515.41	57.21	47.75	23.83	8.61
2012	94.26	243.18	160.95	527.43	58.56	46.11	23.64	9.32
2013	89.07	240.90	155.35	523.28	57.33	46.04	21.81	8.95
2014	77.33	209.13	143.79	497.76	53.78	42.01	19.97	8.87

Source: Exports of crude oil and natural gas in gaseous state (Statistics Norway, 2015); List of products exported by Norway (Trade map, 2015); Gross domestic product and gross value added by kind of economic activity (Russian Federal State Statistics Service [Rosstat], 2015); Gross value added by branches and sectors in 2002 (Rosstat, 2004); Value added by kind of main activity at basic values (Statistics Norway, 2014); Gross domestic product, by main activity (Statistics Norway, 2005–2013); Foreign trade of the Russian Federation (Rosstat, 2015); Russian Federation natural gas exports over 2000–2015 (The Central Bank of the Russian Federation, 2016); Russian Federation crude oil exports over 2000–2015 (The Central Bank of the Russian Federation, 2016).

The time series in Table 4 represents a 2.4-fold and 4.7-fold increase in the values of crude oil and natural gas exports over 2002–2014 in Norway and Russia. The share of oil and gas exports in total exports slightly declined in both countries, noting that the Norwegian share eventually turned out to be 11.77% greater. The share of crude oil and natural gas exports (measured in mln. tons of oil equivalent) in their production in Norway accounted for 86.75% in 2003, while in 2014 it equaled 75.81%, in other words it declined by 10.94%. Similar

changes occurred in Russia: the share of crude oil exports was 52.19% in 2003 compared with 41.83% in 2014, i.e. it fell by 10.36% (Statistics Norway, 2015; The Central Bank of the Russian Federation, 2016).

The decreasing shares of exported oil and gas in the total exports as well as in oil and gas production may indicate an economically positive shift towards internal consumption of hydrocarbons, to the detriment of their export in unprocessed form.

The slight upturn in the share of oil and gas extraction value added in gross value added in Norway (+7.3%) happened owing to the growth of hydrocarbon prices over 2002–2014, though the growth of the analogous Russian indicator was ten times greater (+74.2%). Such a discrepancy between the countries may be explained, firstly, by measurement of gross value added in national currencies, by which the exchange rates had different dynamics with respect to U.S. dollar (the rate of exchange of the Norwegian krone increased, whereas the Russian rouble fell against the US dollar); and secondly, by the shrinkage of volumes of oil extraction in Norway and their expansion in Russia.

Ambiguous results were obtained by calculation of regression equations of the share of oil and gas exports in total exports (Sh_{OGE}) on the share of oil and gas extraction value added in gross value added (Sh_{VA_OGE}). This kind of connection was not found in case of Russia, while the equation for Norway took the following form:

$$Sh_{OGEx\_N} = 44.40 + 0.53 Sh_{VA\_OGE\_N} \quad (4)$$

where

Sh_{OGEx_N} is the Norwegian share of oil and gas exports in total exports, in %;

$Sh_{VA\_OGE\_N}$ is the share of oil and gas extraction value added in gross value added in Norway, in %.

Since the coefficient by $Sh_{VA\_OGE\_N}$ equals 0.53, the share of oil and gas extraction value added would, if it grew by 1%, cause an almost twice lower expansion of the share of oil and gas exports on average. As has already been noted, physical volumes of crude oil and natural gas exports contracted faster than their production, which means that the hydrocarbons increasingly served as raw materials for processing industries of this Scandinavian country. Thus, by eliminating the effect of the price factor that contributes to the increase in values of oil and gas production, we detect a sign of Norway's recovery from the Dutch disease.

4. Analysis of alterations in the structure of gross value added

In general, value added measured in national currencies and current prices adequately reflects the specificity of structural changes occurring in a country's economy. Table 4, which is based on the information produced by the statistical agencies of Russia and Norway, provides data on the dynamics of value added created in these countries.

Table 5. Value added by kinds of economic activity in Norway (in billions of Norwegian kroner) and Russia (in billions of Russian roubles)

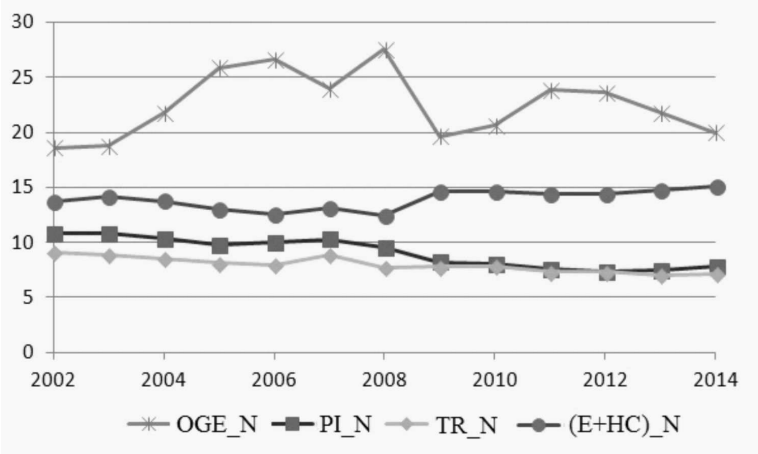
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Gross value added													
Norway	1370	1427	1542	1732	1921	1992	2297	2168	2307	2497	2657	2747	2819
Russia	9581	11620	14859	18518	22977	28485	35183	33831	40040	47719	52983	56896	61089
Value added in oil and gas production													
Norway	255	268	336	448	511	478	633	426	475	595	628	599	563
Russia	487	609	1144	1735	2171	2437	2658	2399	3096	4108	4940	5090	5419
Value added in processing industries													
Norway	148	154	159	170	192	205	218	178	186	189	196	206	221
Russia	1646	1898	2591	3889	4116	5025	6164	5005	5935	7434	7878	8589	9536
Value added of wholesale and retail trade; maintenance of vehicles, motorcycles, household appliances, and articles of personal use													
Norway	125	126	131	141	153	177	177	169	181	183	194	194	200
Russia	2193	2572	3012	3611	4674	5745	7138	6060	8021	9115	9693	9888	10575
Value added of education													
Norway	65	70	73	76	80	85	92	106	113	118	125	132	137
Russia	280	318	400	493	619	770	971	1134	1226	1388	1550	1774	1823
Health care value added													
Norway	123	132	139	149	160	177	194	212	224	241	258	273	288
Russia	322	376	473	565	766	951	1198	1360	1487	1759	1937	2301	2529

Source: Gross domestic product and gross value added by kind of economic activity (Russian Federal State Statistics Service [Rosstat], 2015); Gross value added by branches and sectors in 2002 (Rosstat, 2004); Value added by kind of main activity at basic values (Statistics Norway, 2014); Gross domestic product, by main activity (Statistics Norway, 2005–2013).

All the time series presented in Table 5 demonstrate growth. Recession was observed only in 2009, however, education and health care were not affected. The value added of oil and gas extraction demonstrated an exceptional reduction in 2009 (−32.7% or 5.8 times greater than the overall economic

recession in Norway, and 8.6 times greater than the one in Russia). The processing industries contracted virtually equally (−18.3% and −18.8% in Norway and Russia). Norwegian trade proved to be more stable than Russian during the crisis (decline of −4.5% and −15.1%, respectively). Health care (+134.1% and +685.4%), education (+110.8% and +551.1%), and trade etc. (+60% and +382.2%) became leaders of value added growth in both countries over the 2002–2014 period. Taking into consideration the prevalence of the tertiary sector in both economies (with its share in 2014 equaling 62.5% in Norway and 60.1% in Russia), it seems logical to assume that their rapid growth was largely supported by the service sector. Processing industries grew slower than the oil and gas production (+49.3% in Norway, +479.3% in Russia). Value added in oil and gas extraction increased more significantly (+120.8% and +1012.7% in Norway and Russia) than the gross value added (+105.8% and +537.6%, respectively). However, the impact of this kind of economic activity on the rates of growth of the studied economies is determined by their basic structural characteristics, as shown in Figures 2 and 3 below.

Figure 2. Changes in the structure of value added in the economy of Norway, in %



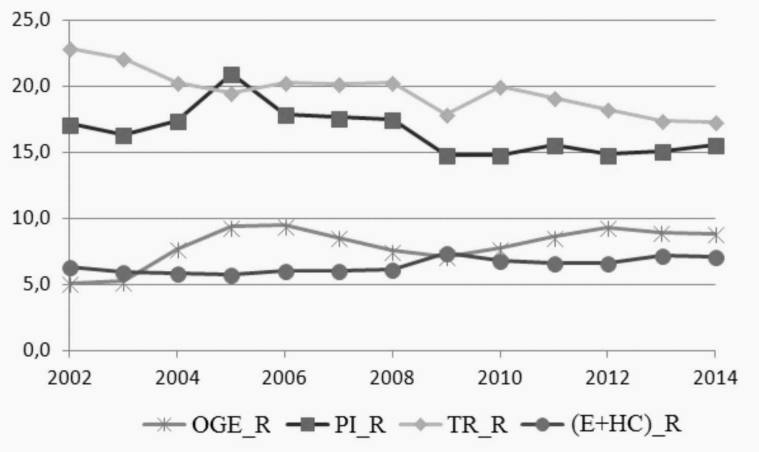
Note: OGE_N is the share of value added in oil and gas extraction in Norway; PI_N is the share of processing industries value added in Norway; TR_N is the share of Norwegian value added of wholesale and retail trade, maintenance of vehicles, motorcycles, household appliances and articles of personal use; (E+HC)_N is the share of education and health care value added in Norway.

Source: Authors' calculations based on data from Table 5.

The dynamics described in Figure 2 of shares of some kinds of economic activity in the gross value added of the Norwegian economy over 2002–2014 displays a minor increase in the share of an aggregate comprising education and health care (+1.4%), with simultaneously declining shares of the processing

industries (−3%) and wholesale, retail trade etc. (−2%). The slightly growing dynamics (+1.4%) of the share of oil and gas production exactly reflect the fluctuations in the world oil market prices for the period under review.

Figure 3. Changes in the structure of value added in the economy of Russia, in %



Source: Authors' calculations based on data from Table 5.

Changes in the shares of kinds of economic activity considered in Figure 3 were directed similarly, though they took place on different levels, which is associated with features of the structure of the Russian economy. Being strongly dependent on revenues from exports of oil and gas, it also owns a large processing industries sector (as of 2014, it created 15.6% of the gross value added, whereas the analogous indicator for Norway equaled only 7.8%). The share of wholesale and retail trade; maintenance of vehicles, motorcycles, household appliances and articles of personal use in the Russian gross value added in 2014 was more than twice greater than that in of Norway (17.3% in contrast to 7.1%). At the same time, the size of the share of education and health care was greater in Norway (15.1% in 2014, as opposed to 7.1% for Russia). The share of oil and gas extraction in the Norwegian economy (20%) exceeded by 2.2 times the Russian one (8.9%), albeit the share of these hydrocarbons in total exports of Norway was only 1.3 times larger. This, coupled with the aforementioned absence of a statistically significant connection between the dynamics of the latter indicator and the dynamics of the share of oil and gas extraction value added in gross value added, allows for the assertion that the production of hydrocarbons in Russia is more closely related to their exports than to their domestic consumption.

The Russian economy, which is less resource- and service-oriented and more industrial, appears to be less damaged by the consequences of Dutch disease when considered in accordance with the structure of gross value added in statics. However, the results of its examination in the dynamics of the period from 2002 to 2014 lead to a different conclusion. The reduction of the share of processing industries was nearly twofold less (−1.6%) than in Norway (−3%), and the share of wholesale and retail trade etc. experienced a more than 2.5-fold decline (−5.6% against −2%). The increment in the share of oil and gas production in the Russian gross value added was 2.8 times larger (+3.8%), which does not correspond to the notion about its process of deliverance from the Dutch disease. The extraordinarily rapid growth of value added in Russian education and health care was mostly determined by the low base effect and comparatively high inflation in the country. The value added per capita in Norwegian education and health care in 2002 accounted for 5,183 USD, whereas in Russia only for 132 USD, while in 2014 it amounted to 13,126 USD and 786 USD, respectively. The share of value added in these kinds of economic activity in Russia increased 1.6 times less (+0.8%) than in the case of Norway.

5. Production functions of Norwegian and Russian economies

The multicollinearity test carried out on the calculation of the preliminary stage of production functions resulted in excluding the factor of value added in wholesale and retail trade; maintenance of vehicles, motorcycles, household appliances and articles of personal use, due to the high correlation of its time series with the time series of value added of the education and health care aggregate (correlation coefficient of 0.98 for Norway and of 0.94 for Russia). We have defined the production function of the Norwegian economy on the basis of the data on dynamics of value added by the selected kinds of economic activity, as follows:

$$y_{GVA\_N} = -7.53 + 0.96x_{VA\_OGE\_N} + 1.99x_{VA\_PI\_N} + 4.38x_{VA\_E+HC\_N} \qquad (5)$$

where

y_{GVA_N} is the gross value added in Norway, bln. of NOK;

$x_{VA\_OGE\_N}$ is the value added in oil and gas production in Norway, in bln. of NOK;

$x_{VA\_PI\_N}$ is the value added of Norwegian processing industries, in bln. of NOK;

$x_{VA\_E+HC\_N}$ is the value added of an aggregate comprising education and health care in Norway, in bln. of NOK.

The values of the coefficients of equation (5) show an unequal impact of gross value added components on the total gross value added. Inasmuch as the value of the coefficient of the variable denoting oil and gas extraction is less than 1, there is a decreasing rate of return on value added growth, so that the growth of value added in oil and gas production by one million Norwegian kroner will lead to the average increase of gross value added by 960,000 Norwegian kroner. And vice versa, increasing rates of return on value added growth are observed, exceeding 1, in the values of coefficients of processing industries (1.99) and, particularly, education and health care (4.38). All in all, additional investments in education and health care are simultaneously mostly effective for growth and important for improvement of the Norwegian economic structure. The efficacy of this measure for overcoming the Dutch disease is proven by the inverse relationship between the share of value added in oil and gas production, and the share of value added in education and health care, the existence of which reflect negative values for the correlation coefficient (−0.74) and elasticity coefficient (−1.55).

The equation of the production function of the Russian economy is as follows:

$$y_{GVA\_R} = 1148.58 + 1.68x_{VA\_OGE\_R} + 1.97x_{VA\_PI\_R} + 7.67x_{VA\_E+HC\_R} \qquad (6)$$

The hierarchy of the impact on the amount of gross value added is similar to the Norwegian one, but oil and gas extraction has an increasing rate of return (coefficient by the variable is 1.68), possessing an effect resembling that of the processing industries. Another difference in the Russian production function is the significantly higher coefficient of value added in education and health care (7.67), suggesting a potentially positive influence of this aggregate on growth.

The correlation tests carried out showed that the shares of value added in the oil and gas industry and processing industry are not linearly related in both countries. The share of oil and gas value added in Russia is also not correlated with the share of value added in education and health care. Due to this, the corresponding variables were not included into equations modeling the share of oil and gas production in gross value added. The equation for Norway has the following form:

$$Sh_{VA\_OGE\_N} = 0.6131 - 3.1169Sh_{VA\_E+HC\_N} + 0.0006P_{oil} \qquad (7)$$

where

$Sh_{VA\_OGE\_N}$ is the share of oil and gas extraction value added in gross value added in Norway, in %;

$Sh_{VA\_E+HC\_N}$ is the share of education and health care value added in gross value added in Norway, in %;

P_{oil} is the oil price per barrel, USD.

The equation for the Russian economy is as follows:

$$Sh_{VA\_OGE\_R} = 0.0565 + 0.0003P_{oil} \quad (8)$$

The equation calculated for the Norwegian economy (7) demonstrates an inverse relationship between the share of oil and gas extraction and the share of the education and health care aggregate, as well as a direct connection with oil prices. On the other hand, the equation (8) for the Russian economy shows a sole dependence on the latter.

6. Conclusions

The quantitative analysis of structural dynamics has corroborated the presence of dependence on raw materials in the economies of Norway and Russia in the 2000s. Its adverse effect on both the structure of exports and GDP produced requires investigation of this phenomenon in order to reveal its implications for their economic development. Analysis of time series of value added by kinds of economic activity, as well as of rates of economic growth, has allowed us to draw some inferences about the behavior of the Dutch disease, which represents a mechanism of transformation of an abundance of natural resources into decreasing rates and quality of growth of the studied economies.

The objective conditions existing in Norway (such as a developed institutional environment and depletion of hydrocarbon stocks), together with the decline in world oil prices that began in the second half of the 2008, permitted it to achieve a certain success in overcoming dependence on income from oil and gas exports. The shares of Norwegian crude oil and natural gas exports in both total exports and in production grew less over time. The econometric part of our research, including the production function of the Norwegian economy, shows that the high level and positive dynamics of value added in education and health care may successfully substitute oil and gas production in the created national product. Accumulation of human capital in Norway turns out to be a real alternative to the exploitation of natural capital (natural resources). According to our forecast, the economy of this Scandinavian country might be able to confront the Dutch disease and even improve the dynamics of its growth by diminishing its still very significant share of oil and gas extraction.

The Russian economy appears to be less resource-based in static in comparison with the Norwegian economy, as its share of crude oil and natural gas is far smaller, both in the gross value added and in total exports. However, our calculations suggest that the dependence upon the extraction of hydrocarbon

raw materials is declining in dynamics in Norway, and, at the same time intensifying in Russia. Correlation and regression analysis, as well as obtained production functions, have confirmed this conclusion by demonstrating the presence of an inverse relationship between total output and hydrocarbons production in Norway, in contrast to a direct relationship between them in Russia. Until recently, the comparatively rapid Russian economic growth, accompanied by the high volatility of its currency rates, was insured by growing world oil prices and increasing volumes of oil extraction. However, a favorable combination of these factors is not expected over the medium term. Unlike Norway, Russia has not succeeded in reducing the share of oil and gas production in gross value added by means of supporting education and health care, due to the suppression of human capital by natural capital owing to the insufficiently high quality of socioeconomic and political institutions. This tendency is particularly evident in times of crisis, when the intensified struggle for resources makes it necessary to resolve the conflict of interests between natural capital beneficiaries and human capital owners, primarily in favor of the former and at the expense of the latter. To overcome the resource curse, the Russian state must take a number of economic and institutional measures, which is possible only in the case of implementation of radical liberal reforms.

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Streszczenie

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