

REGIONAL ECONOMIES

MACROECONOMIC MODEL FOR OIL-EXPORTING COUNTRIES

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ABSTRACT

This article explores the relationship between GDP and net oil exports in major oil-exporting countries. The extremely strong positive correlation between these parameters makes it possible to develop GDP models for these countries based on exports of crude oil; it has been demonstrated that they are described by a

quadratic regression with acceptable reliability. The study results show that the oil industry is the main driver of economic development in the modern world. Even where direct oil exports make up an insignificant part of GDP in oil-exporting countries, their impact on economic development is decisive.

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KEYWORDS: *Macroeconomic model, oil-exporting countries, OPEC, oil markets, oil exports.*

Introduction

The role of crude oil in the world economy cannot be overestimated.¹

- First, although in some countries (as in South Africa) motor fuel is partly derived from coal,² crude oil continues to be the main source of gasoline, kerosene and other fuels).³ According to available data,⁴ crude oil leads with 39% of world primary energy consumption,⁵ and it is expected to retain its position to 2030.⁶
- Second, trade in primary commodities, primarily crude oil, is the main financial instrument underpinning today's global economic system.⁷ For example, 75% of futures contracts traded on the New York Mercantile Exchange⁸ (the world's largest oil market) are directly or indirectly related to crude oil.⁹
- Third, cross-border oil flows have a decisive effect on the development of global infrastructure. The development of oil pipelines, ports and terminals, of the oil refining industry and the tanker fleet serves a single purpose: to ensure effective and timely supply of oil and its products to consumers.¹⁰

It is surprising that the number of publications on topics related to the impact of oil on the world economy is very limited. Let us note a joint study by T. Prugh, C. Flavin and J.L. Sawin,¹¹ which describes the main features of world oil markets and oil pricing mechanisms. A study by M.L. Hymel¹² deals with the effect of oil on a globalized world.

¹ See: A.G. Tvalchrelidze, *Economics of Commodities and Commodity Markets*, Nova Science Publishers, Inc., New York, 2011, 904 pp.; V. Papava, "Economic Growth in the Central Caspian Countries Adjusted for the Catch-Up Effect," *Central Asia and the Caucasus*, Vol. 13, Issue 4, 2012, pp. 120-128; T. Basilia, A. Silagadze, T. Chikvaide, *Post-Socialist Transformation: The Economy of the 21st Century*, Aradani Publishers, Tbilisi, 2001, 544 pp. (in Georgian); A. Silagadze, "Some Aspects of the Development of the Post-Soviet Economy," in: *Current Economic Problems of Post-Communist Countries at the Present Stage*, Paata Gugushvili Institute of Economics of Tbilisi State University, Tbilisi, 2013, pp. 66-69 (in Georgian).

² See: *Coal: Liquid Fuels*, World Coal Institute, Richmond, UK, 2006, 29 pp.

³ See: *Petroleum Refining: Final Report*, ENTEC, London, 2006, 29 pp.

⁴ See: *World Energy Outlook*, International Energy Agency (IEA), Paris, 2009, 698 pp.; *2013 World Energy Issues Monitor*, World Energy Council, London, 2013, 40 pp.; *International Energy Outlook 2013*, U.S. Energy Information Administration, Washington D.C., 2013, 312 pp.

⁵ Natural gas ranks second with 24%.

⁶ See: *BP Energy Outlook 2030*, BP, London, 2013, 86 pp.

⁷ See: M. Tokmazishvili, A. Silagadze, "The Central Caucasian Countries: Trends in Foreign Trade Relations," *The Caucasus and Globalization*, Vol. 2, Issue 4, 2008, pp. 64-71.

⁸ See: Energy markets [<http://www.hardassetsinvestor.com/hard-assets-university/20-hard-assets-202-a-deeper-look-at-individual-commodities/545-energy-markets.html>].

⁹ See: *CFTC Fact Sheet*, Commodity Futures Trading Commission, Washington, D.C., Document 202.418.5080, 2008, 4 pp.

¹⁰ See: A.G. Tvalchrelidze, op. cit.

¹¹ See: T. Prugh, C. Flavin, J.L. Sawin, "Changing the Oil Economy," in: *State of the World 2005. Redefining Global Security*, Worldwatch Institute, W.W. Norton, New York, London, 2005, pp. 100-119.

¹² See: M.L. Hymel, "Globalization, Environmental Justice and Sustainable Development: The Case of Oil," *Macquarie Law Journal*, Vol. 7, 2007, pp. 125-153.

There is also a whole series of studies examining the influence of the oil market on economic development; some of them investigate the relationship between world oil prices and GDP growth.

For example, OPEC analysts believe that economic growth leads to stronger oil demand and thus to an increase in oil price.¹³ J.D. Hamilton presents an economic model in which oil consumption in the United States is expressed as a share of GDP.¹⁴ N. Tanaka shows that during an economic recession, oil demand declines in proportion to the slowdown in GDP growth.¹⁵ Experts of the International Energy Agency (IEA) have demonstrated that high oil prices improve macroeconomic performance but at the same time fuel inflation.¹⁶ B. McAlinden and T. Komulainen have analyzed in detail the history of oil prices and their impact on GDP.¹⁷

Other publications examine the effect of oil markets on various sectors of the economy. For example, H. Askari and N. Krichene have developed an econometric model showing the impact of oil prices on monetary policy.¹⁸ A.F. Alhajji and D. Huettner have described in econometric terms the extent to which OPEC profits depend on world oil prices.¹⁹ According to K. Rogoff,²⁰ there is a direct relationship between oil prices and output (to analyze the impact of oil prices on oil production, he used a simple regression equation).

One of the authors of this article has recently published a monographic study on the use of primary commodities. He has found some basic distinctive features of a commodity-based economy and commodity pricing.²¹ In particular, he has demonstrated that since commodities in a globalized world are either the subject of intergovernmental agreements or are traded on commodity exchanges in the form of spot or futures contracts, their prices do not obey the basic rule of economics (supply and demand relationship) but are nevertheless determined by major commodity exchanges. In this process, crude oil is a global benchmark for pricing other primary commodities. There are several important reasons for the special position of crude oil in global markets.

- First, the price of oil in large part determines the price of fuel and thus has an indirect effect on the cost of other commodities.
- Second, modern commodity markets, where a decisive role is played by exchange brokers and speculators (in the Anglo-Saxon sense of the term), can function effectively only in a situation of stability and equilibrium. Any options, futures or other derivative contracts are virtually always hedged by one or several hedging agreements, which is why it is possible to ensure more or less stable conditions for the functioning of commodity markets and protect them against default only if commodity prices move together. This is what determines the liquidity and thus the functionality of these markets.

¹³ See: *World Oil Outlook*, Organization of the Petroleum Exporting Countries, Paris, 2008, 234 pp.

¹⁴ See: J.D. Hamilton, *World Oil Markets: Implications for Consumers, Producers, and the World Economy*, available at [<http://www.consumerinterests.org/files/public/A.Hamilton.pdf>].

¹⁵ See: N. Tanaka, *The Medium Term Oil Market Outlook*, Netherlands, Clingendael Energy Lecture, The Hague, 2009, 18 pp.

¹⁶ See: *Analysis of the Impact of High Oil Prices on the Global Economy*, International Energy Agency, Paris, 2005, 15 pp.

¹⁷ See: B. McAlinden, T. Komulainen, *Equity Strategy: Implications of Structurally Strong Oil Price*, European Securities Network, London, 2008, 150 pp.

¹⁸ See: H. Askari, N. Krichene, *World Crude Oil Markets. Monetary Policy and the 2004-05 Oil Shock*, available at [<http://gstudynet.org/spotlight/workingpapers/worldcrudeoil.pdf>].

¹⁹ See: A.F. Alhajji, D. Huettner, "OPEC and World Crude Oil Markets from 1973 to 1994: Cartel, Oligopoly, or Competitive?" *The Energy Journal*, Vol. 21, No. 3, 2000, pp. 31-60.

²⁰ See: K. Rogoff, *Oil and the Global Economy*, Harvard University Press, Cambridge, MA, 2005, 42 pp.

²¹ See: A.G. Tvalchrelidze, op. cit.

- Third, crude oil is traditionally the most important commodity traded in commodity markets. In 2007 (the last year of steadily rising commodity prices), the amount of oil consumed in the world was \$2.07 trillion. This is 2.14 times the figure for natural gas (which ranked second) and 10.27 times the figure for wheat (which ranked third). The number of crude oil futures contracts traded on commodity exchanges in 2007 was about three times that of all other commodity contracts.

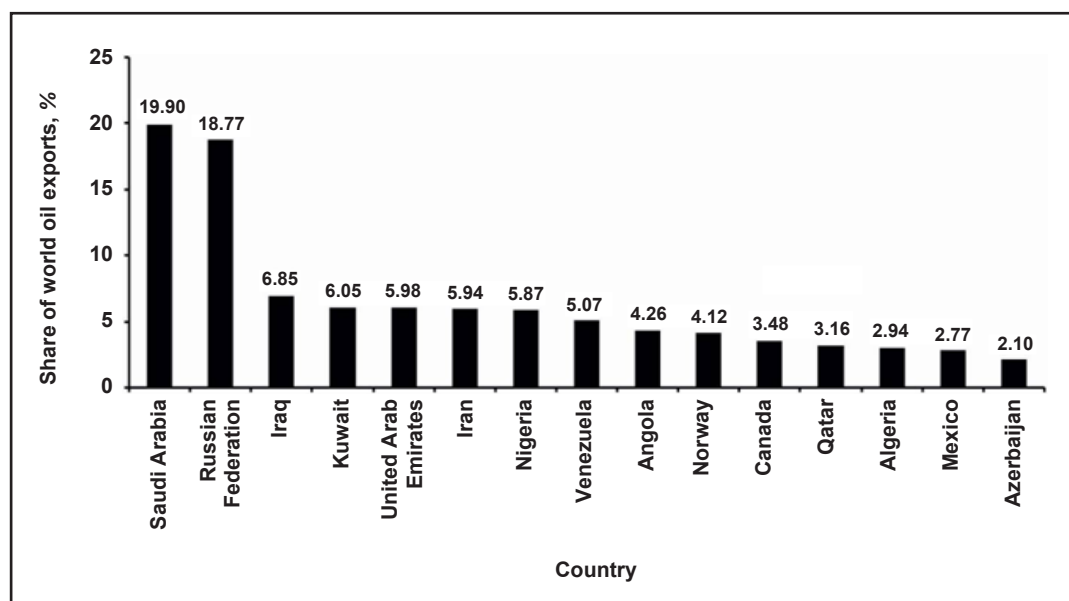
In this context, we have decided to produce a number of publications investigating the impact of oil on the world economy. In this article, we have developed an economic model for oil-exporting countries.

Countries Selected for Study

Figure 1 contains information on the volume of oil exported by the countries listed below in 2012. These are the countries that account for the vast majority of international oil sales. “Net exports” are taken to mean the amount of crude oil intended for export (the difference between its production and consumption).²² Statistical data on oil are taken from BP’s annual statistical review.²³

Figure 1

Ranking of Major Oil-Exporting Countries for 2012



Unfortunately, we had no opportunity to analyze data on Iran and Iraq since historical economic statistics for these countries (even those reflected in the World Bank Group database) are very unreliable. That is why we have studied only the following countries:

²² See: *Ibidem*.

²³ See: *BP Statistical Review of World Energy*, BP, London, 2013, 48 pp.

1. Saudi Arabia
2. Russian Federation (RF)
3. Kuwait
4. United Arab Emirates (UAE)
5. Nigeria
6. Venezuela
7. Angola
8. Norway
9. Canada
10. Qatar
11. Algeria
12. Mexico
13. Azerbaijan.

Methods of Investigation

The internal structure of GDP is classically defined as the sum of value added of final products and services.²⁴ Its detailed examination shows that GDP can be analyzed in different terms. For example, the World Bank Group (WBG) in its database of socioeconomic indicators divides GDP into value added in manufacturing, agriculture and services.²⁵

But using Georgia as a case study, we have proved that the bulk of GDP is associated with primary commodities in the broad sense of the term. In other words, what we are dealing with here is the sum of value added in the production, processing, sale and industrial use of raw materials.²⁶

Raw materials are the basis of any product. Consequently, using the classical theory of primary commodities,²⁷ GDP can be presented as follows²⁸:

$$GDP = \sum_i (P_i S_i) + \sum_i (P_i^n F_n) + A_s, \quad (1)$$

where GDP is the gross domestic product,

P_i is the weighted average annual price of the i -th commodity,

²⁴ See: J.D. Sachs, F.B. Larrain, *Macroeconomics in the Global Economy*, Simon & Schuster, New York, 1993, 848 pp.

²⁵ See: GDP (current US\$) /Data/Table/, available at [http://data.worldbank.org/indicator/NY.GDP.MKTP.CD].

²⁶ See: A. Tvalchrelidze, A. Silagadze, G. Keshelashvili, D. Geghia, *Georgia's Social and Economic Development Program*, Neker Publishers, Tbilisi, 2011, 236 pp. (in Georgian). English version available at [http://www.ifsdeurope.com/]; A. Silagadze, T. Atanelishvili, *Modern State Finances of Georgia*, International Academy of Sciences, New York, 2010, 36 pp.; A. Silagadze, "Current Financial and Monetary Trends in Georgia," *The Caucasus & Globalization*, Vol. 4, Issue 1-2, 2010, pp. 51-64; A. Silagadze, "Economic Perspectives in Post-Soviet Georgia," in: *Actual Economic Problems Under Globalization*, ed. by V. Papava, Tbilisi State University, Paata Gugushvili Institute of Economics, Tbilisi, 2011, pp. 89-91.

²⁷ See: *The Economics of Primary Commodities: Models, Analysis and Policy*, ed. by D. Sapsford and Wyn Morgan, University of Liverpool Management School, Liverpool, UK, 1994, 192 pp.

²⁸ See: A.G. Tvalchrelidze, op. cit.

- S_i is the annual volume of commodity exports,
 P_i^n is the price of the i -th commodity processed to the final product n ,
 F_n is the sales volume of the n -th product, and
 A_s is the value added of all services (government, insurance, medical, educational, etc.).

It is clearly evident that the foreign trade balance is also indirectly present in the equation.

Meanwhile, in this article we analyze only the impact of crude oil exports on economic growth in oil-exporting countries. For this it was necessary, in the first place, to prove the relationship between GDP and the volume of crude oil exports. GDP values for the countries in question are given according to the socioeconomic indicators database of the World Bank Group.²⁹ These data refer to the period of 1992-2011 because two major oil exporters—Russia and Azerbaijan—became independent states only after the breakup of the U.S.S.R. Data on crude oil are taken from BP annual statistical reviews.³⁰

The relationship between the two indicators (GDP and crude oil exports) was investigated using correlation analysis,³¹ according to which the pair correlation coefficient was calculated as follows:

$$r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}} \quad (2)$$

Figure 2 shows, in particular, the relationship between GDP and oil exports for Saudi Arabia; the relevant data are presented in Table 1. Oil export values were calculated by multiplying average annual world oil prices³² by real net exports. To convert prices from dollars per barrel to dollars per metric ton we used a conversion factor of 7.33 as recommended by BP.³³

The extremely high value of the correlation coefficient makes it possible to create, based on regression analysis, an economic model describing a country's GDP in terms of oil exports. In the general case, regression analysis enables us to establish the relationship between the coordinates of two variables in two-dimensional space (\bar{x}_i, \bar{y}_i) ³⁴:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \dots + \beta_{ip} x_{ip} + \varepsilon_i, \quad (3)$$

where ε_i is the residual of equation (4):

$$\bar{x} = \begin{pmatrix} x_{11} & \dots & x_{1p} \\ \dots & \dots & \dots \\ x_{n1} & \dots & x_{np} \end{pmatrix}. \quad (4)$$

²⁹ See: The World Bank Group. Database, available at [<http://data.worldbank.org/indicator/>].

³⁰ See: *BP Statistical Review of World Energy*, BP, London, 2003, 44 pp.; *BP Statistical Review of World Energy*, BP, London, 2010, 50 pp.; *BP Statistical Review of World Energy*, BP, London, 2011, 49 pp.; *BP Statistical Review of World Energy*, BP, London, 2013, 48 pp.

³¹ See: D.A. Freedman, *Statistical Models: Theory and Practice*, University of California, Berkeley, 2009, 424 pp.

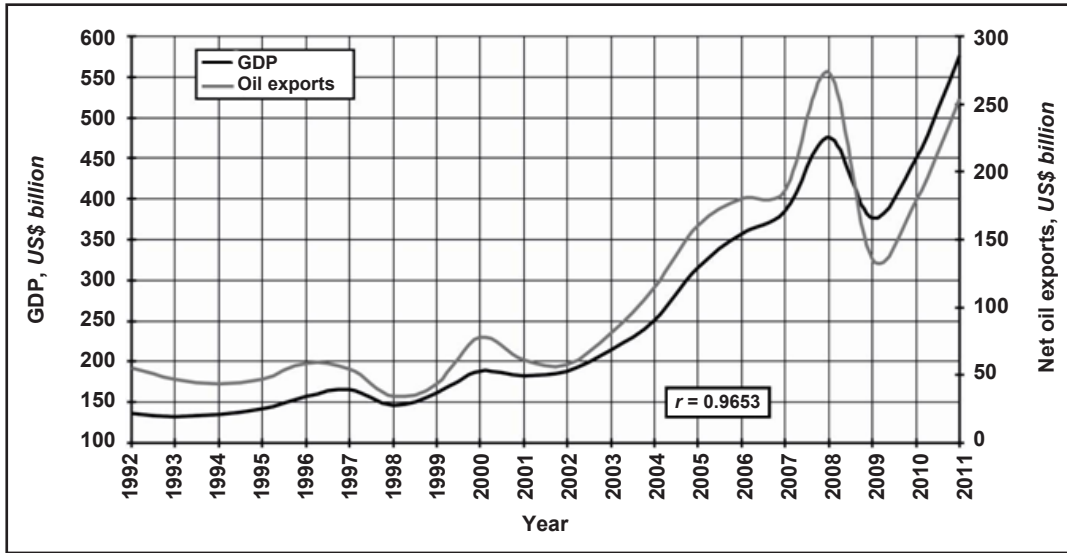
³² See: *BP Statistical Review of World Energy*, BP, London, 2013; J.L. Williams, *Oil Price History and Analysis*, available at [<http://www.wtrg.com/prices.htm>]; *How World Oil Markets Work*, available at [http://www.fuelfocus.nrcan.gc.ca/fact_sheets/oilmarket/]; *Mirovye tseny na syrvo*, available at [<http://www.mineral.ru/Facts/Prices/index.html>].

³³ See: *BP Statistical Review of World Energy*, BP, London, 2013.

³⁴ See: D.A. Freedman, op. cit.

Figure 2

Relationship between GDP and Oil Exports for Saudi Arabia in 1992-2011



Coefficient β is obtained by the least squares method.³⁵ This means that the standard deviations of the squares of (\bar{x}_i, \bar{y}_i) should be minimal. This condition is satisfied at an extremum mathematically defined as:

$$F(\vec{\beta}_n) = \sum_{n=1}^p [\bar{y}_n - B(\bar{x}_n, \vec{\beta}_n)]^2. \tag{5}$$

Table 1

GDP and Oil Exports in Saudi Arabia

Year	GDP, US\$ billion	Industry Indicators, million metric tons			Oil Prices, US\$		Exports, US\$ billion
		Production	Consumption	Exports	Barrels	Tons	
1992	136.3	442.4	51.4	391.0	19.25	141.10	55.17
1993	132.15	432.8	52.1	380.7	16.75	122.78	46.74
1994	134.33	435.3	53.5	381.8	15.66	114.79	43.83
1995	142.46	435.4	51.4	384.0	16.75	122.78	47.15
1996	157.74	443.5	53.7	389.8	20.46	149.97	58.46
1997	164.99	451.3	55.3	396.0	18.64	136.63	54.11

³⁵ See: Least squares regression line, available at [<http://www.une.edu.au>].

Table 1 (continued)

Year	GDP, US\$ billion	Industry Indicators, million metric tons			Oil Prices, US\$		Exports, US\$ billion
		Production	Consumption	Exports	Barrels	Tons	
1998	145.77	452	58.8	393.2	11.91	87.30	34.33
1999	160.96	419.1	60.9	358.2	16.56	121.38	43.48
2000	188.44	450.6	62.4	388.2	27.39	200.77	77.94
2001	183.01	439.4	74.7	364.7	23.00	168.59	61.48
2002	188.55	424.1	76.6	347.5	22.81	167.20	58.10
2003	214.57	483.8	81.7	402.1	27.69	202.97	81.61
2004	250.34	504.3	88.3	416.0	37.66	276.05	114.84
2005	315.58	524.9	87.5	437.4	50.04	366.79	160.44
2006	356.63	512.4	91.7	420.7	58.30	427.34	179.78
2007	384.89	492.4	97.4	395.0	64.20	470.59	185.88
2008	476.3	513.5	106.1	407.4	91.48	670.55	273.18
2009	376.69	462.7	115.4	347.3	53.48	392.01	136.14
2010	450.79	466.6	123.2	343.4	71.21	521.97	179.24
2011	576.82	525.8	127.8	398.0	87.04	638.00	253.93

In nonlinear cases, it is possible to calculate the values of coefficients, standard deviations and residual ε_i . For this it is necessary and sufficient to know the averages of \bar{x} and \bar{y} , standard deviation x , standard deviation y and the correlation coefficient between these variables. Such calculations were performed by ANOVA (Analysis of Variance) in the SPSS program³⁶ using a quadratic regression.

Tables 2, 3 and 4 describe the parameters of the quadratic regression for Saudi Arabia GDP. Figure 3 shows the graph of the equation, and Figure 4 compares the country's real and model GDP.

Table 2

Model Summary for Saudi Arabia GDP

r	r^2	Reduced r^2	Standard Deviation
0.965	0.932	0.928	36.173

³⁶ See: D.M. Levine, M.L. Berenson, T.C. Krehbiel, D.F. Stephan, *Statistics for Managers Using Microsoft Excel*, 6th Edition, Pearson PLC, London, 2010, 840 pp.

Table 3

Regression Parameters
for Saudi Arabia GDP

Indicator	Sum of Squares	∂F	Mean Square
Regression	323,360.2	2	323,360.2
Residual	235,553.2	18	1,308.5
Total	346,913.4	19	

Table 4

Regression Coefficients
for Saudi Arabia

Coefficients	Unstandardized Coefficients		Standardized Coefficients	
	B	Standard Deviation	β_i	t-test
Exports	1.762	0.112	0.965	15.720
(Constant)	67.763	14.496		4.765

Figure 3

GDP Model for Saudi Arabia
Calculated based on Oil Exports

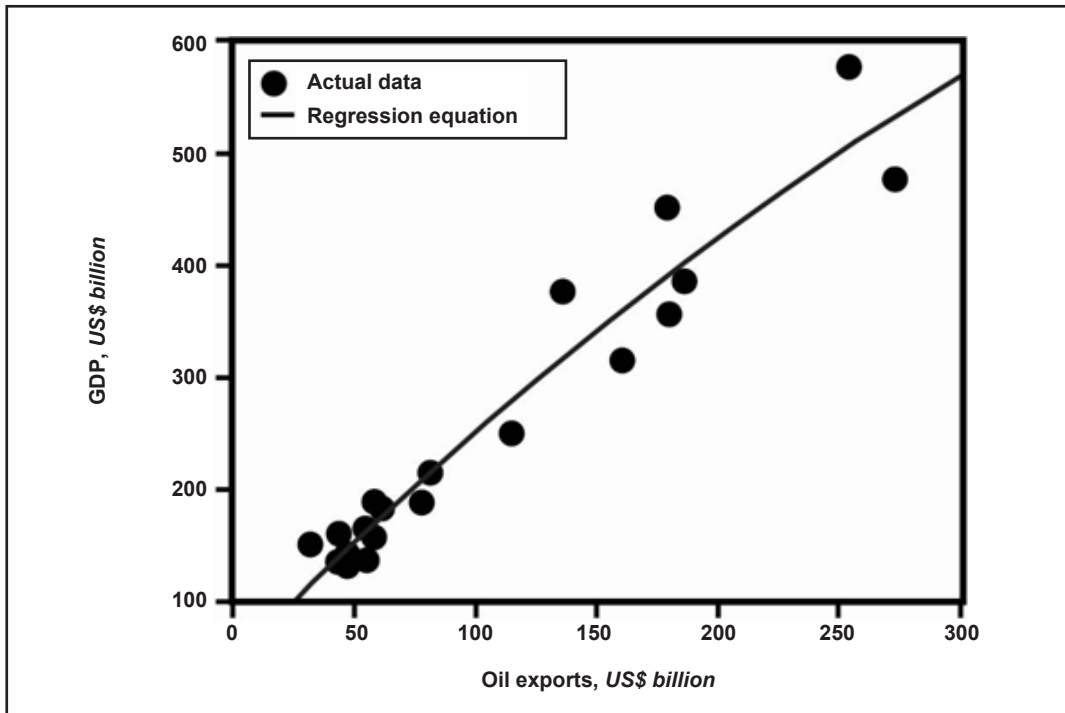
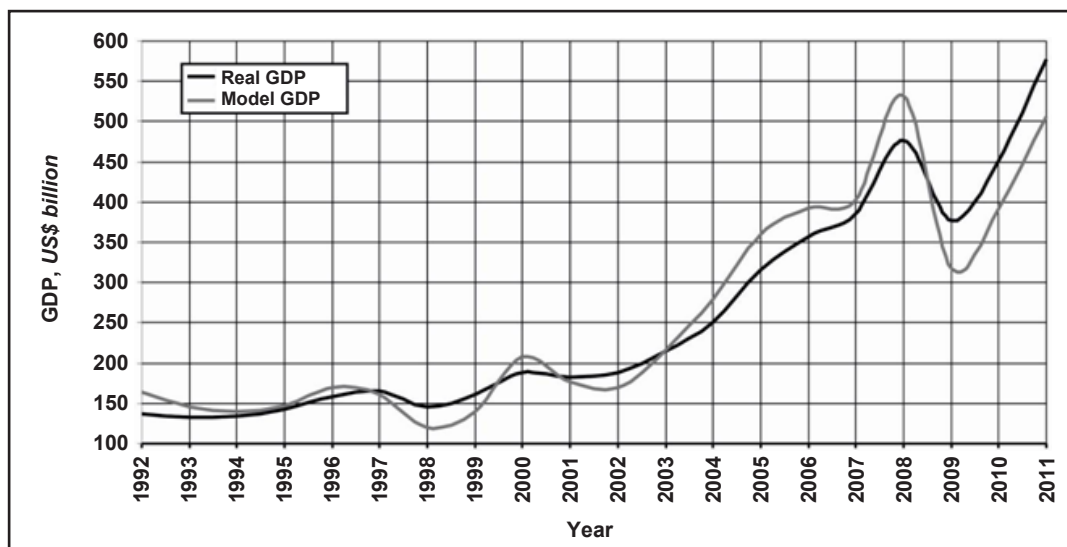


Figure 4

**Comparison of Real and
Model GDP for Saudi Arabia**



The above method is a fine tool for analyzing the economic welfare of oil-exporting countries; it was also used in studying European commodity security.³⁷

Study Results

Table 5 presents the values of the correlation coefficient between GDP and oil exports in the selected countries. There is an extremely strong correlation, highlighted by comparative graphs showing the relationship between these two parameters (Figs. 5 and 6).

Table 5

**Values of the Correlation Coefficient between GDP and
Oil Exports in the Selected Countries**

Country	<i>r</i>
Saudi Arabia	0.9653
Russia	0.9732
UAE	0.9632
Kuwait	0.9858
Nigeria	0.9729

³⁷ See: A. Tvalchrelidze, A. Silagadze, "Problems of European Commodity Security and Sustainable Development of the Central Asia-Caucasus Region," *Central Asia and the Caucasus*, Vol. 12, Issue 4, 2011, pp. 110-127.

Table 5 (continued)

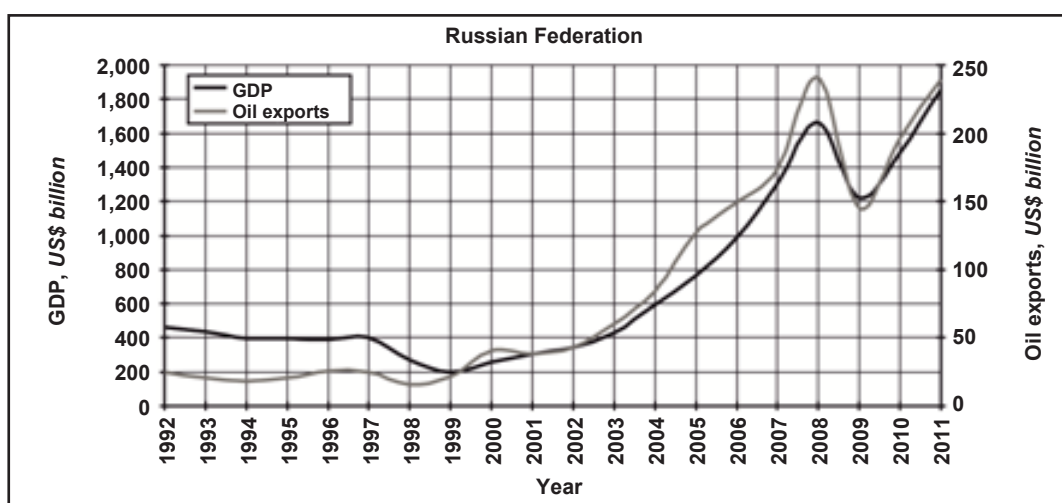
Country	<i>r</i>
Venezuela	0.8725
Norway	0.9317
Angola	0.9744
Qatar	0.9754
Algeria	0.9527
Canada	0.9826
Mexico	0.9278
Azerbaijan	0.9853

An analysis of Table 5 suggests the following observations and conclusions.

1. In all cases except Venezuela, the GDP curve closely follows the oil exports curve. This trend was particularly evident in 2008-2011, when the impact of the economic crisis on both GDP and oil exports was most pronounced.
2. This means that free market relations prevail in the foreign trade of all listed countries except Venezuela and that all of them are incorporated into the global economic system. For this reason, they will have to overcome the long-term effects of the economic recession through joint efforts.³⁸

Figure 5

Relationship between GDP and Oil Exports for
RF, Kuwait, UAE, Nigeria, Venezuela and Angola
in 1992-2011



³⁸ See: *The World Bank Annual Report 2009*, The World Bank Group, Washington, D.C., 2009, 68 pp.

Figure 5 (continued)

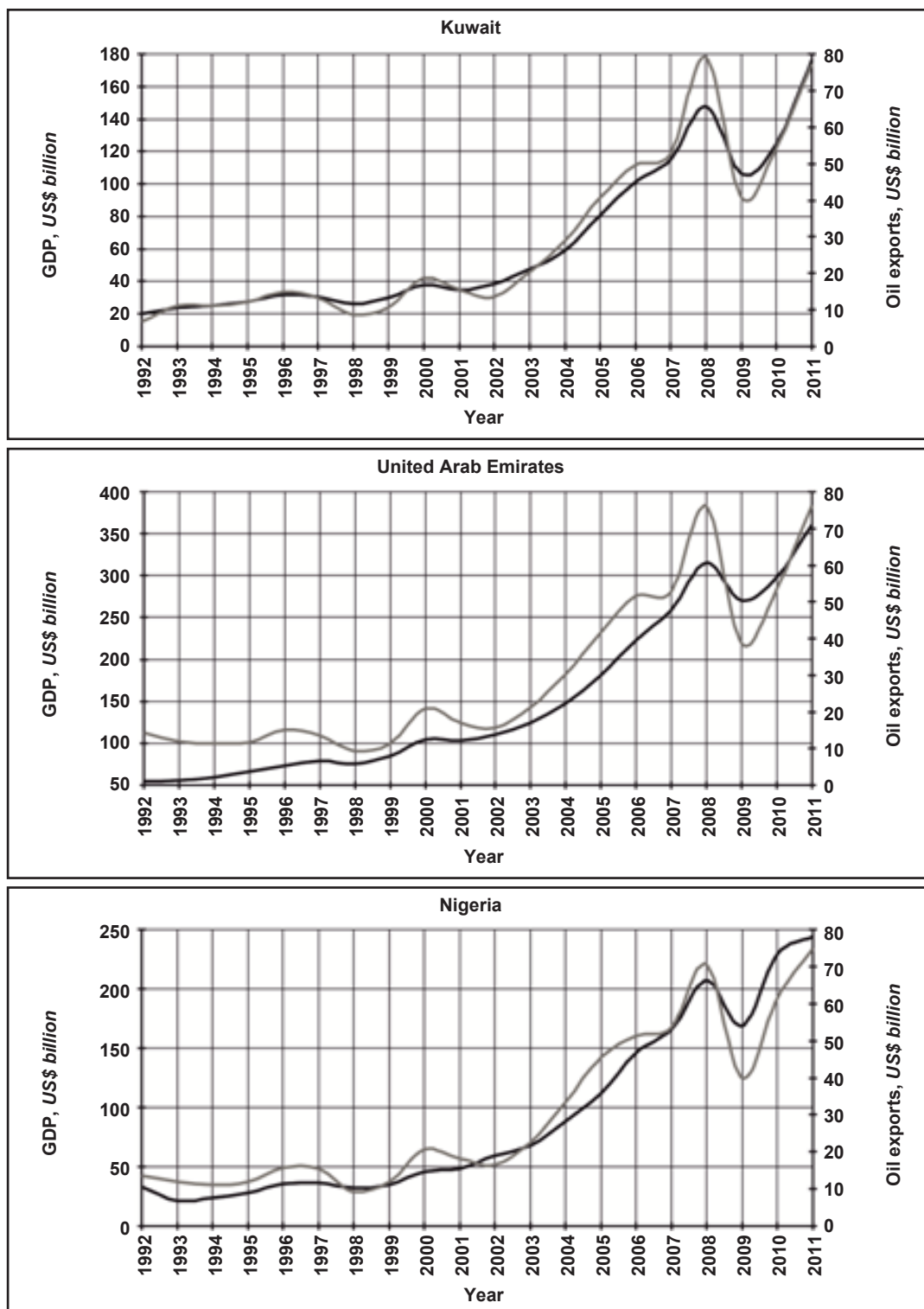
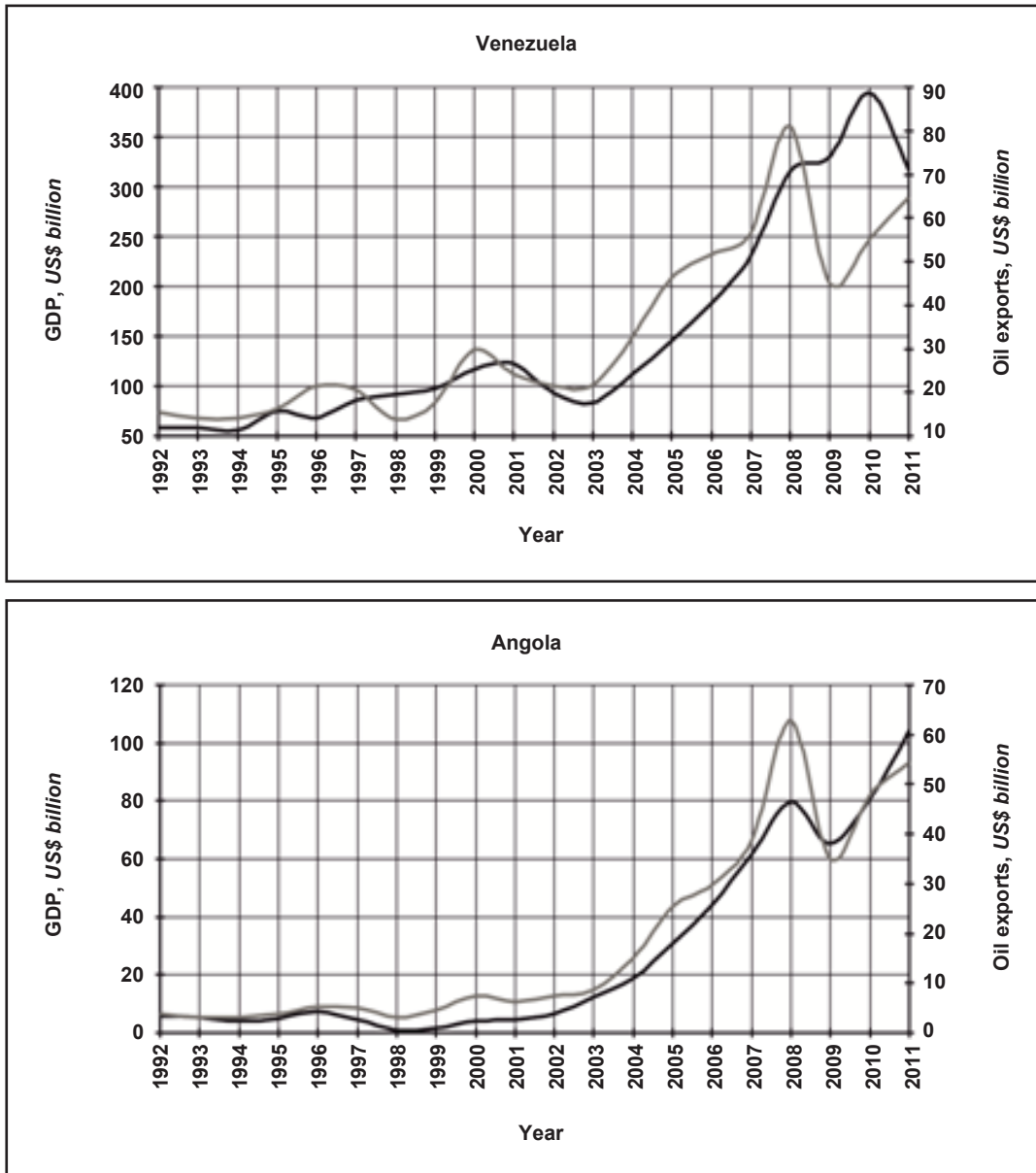


Figure 5 (continued)



3. Venezuela is a country with a totalitarian economic model based on socialist principles.³⁹ That is why in 2008-2009 Venezuela had “minimal” economic relations with the civilized world confined to sales of commodities, primarily crude oil, fully controlled by the central government. Because of this, an insignificant decline in oil exports did not have a negative impact on the country’s GDP. But such “voluntarist” economic development could

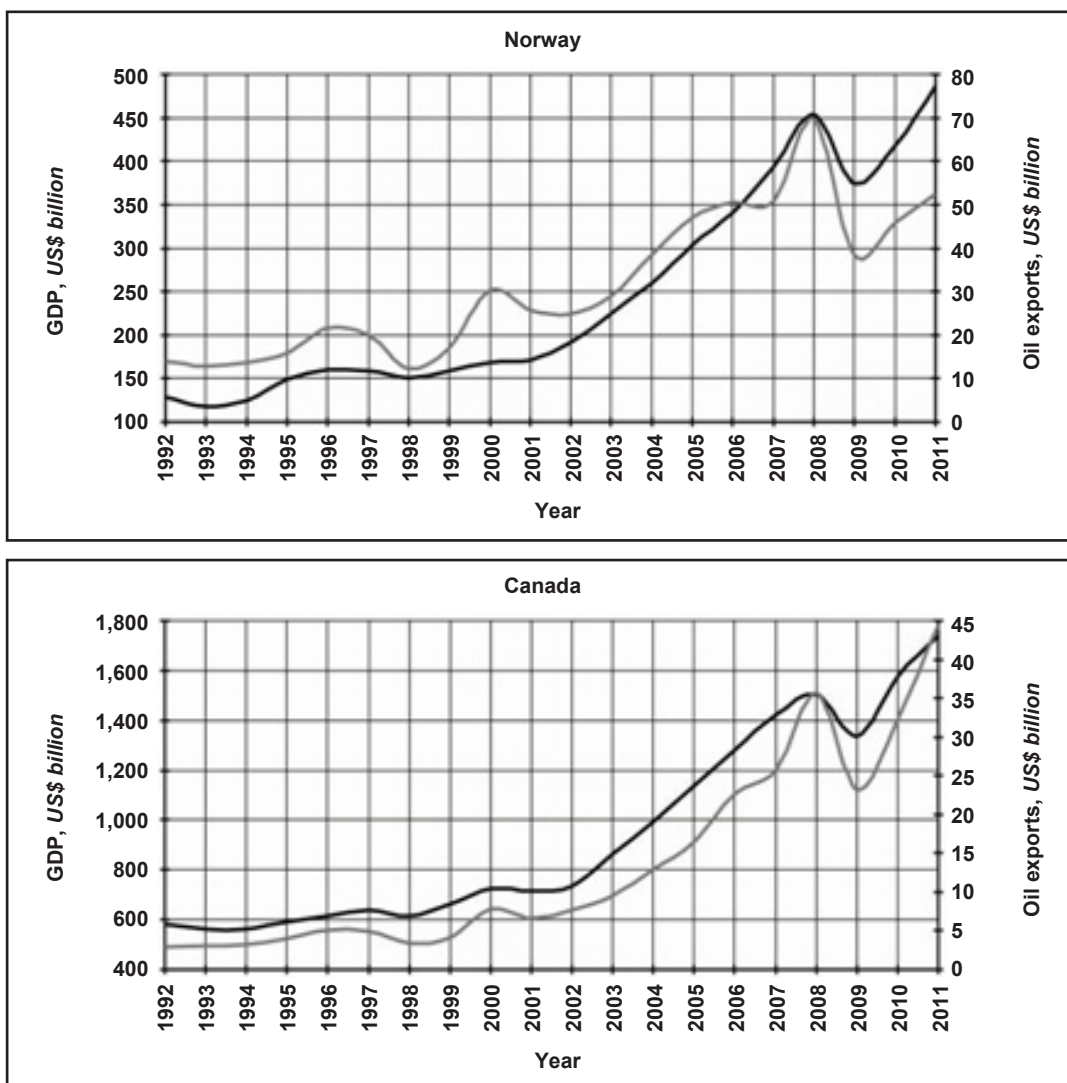
³⁹ See: M. Weisbrot, L. Sandoval, *The Venezuelan Economy in the Chávez Years*, Center for Economic and Policy Research, Washington, D.C., 2008, 23 pp.

not be sustainable,⁴⁰ and already in 2010 the country’s GDP began to decline against the background of rising oil exports. In 2011, the “economic miracle” in Venezuela came to an end just as the rest of the world had already overcome the most acute phase of the recession.

Figure 6

Relationship between GDP and Oil Exports for Norway, Canada, Qatar, Algeria, Mexico and Azerbaijan in 1992-2011

(Notations as in Figure 5)



⁴⁰ See: M. Weisbrot, J. Johnston, *Venezuela’s Economic Recovery: Is It Sustainable?* Center for Economic and Policy Research, Washington, D.C., 2012, 32 pp.

Figure 6 (continued)

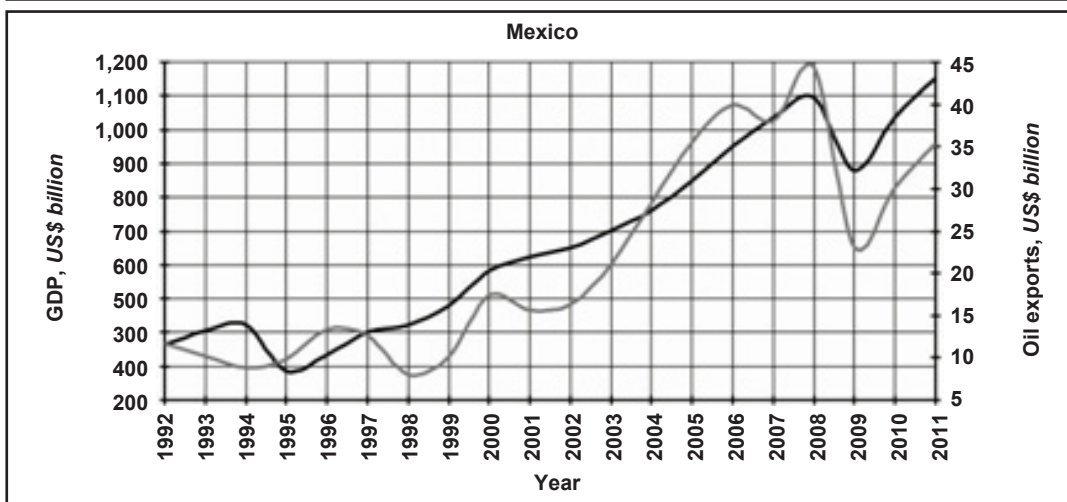
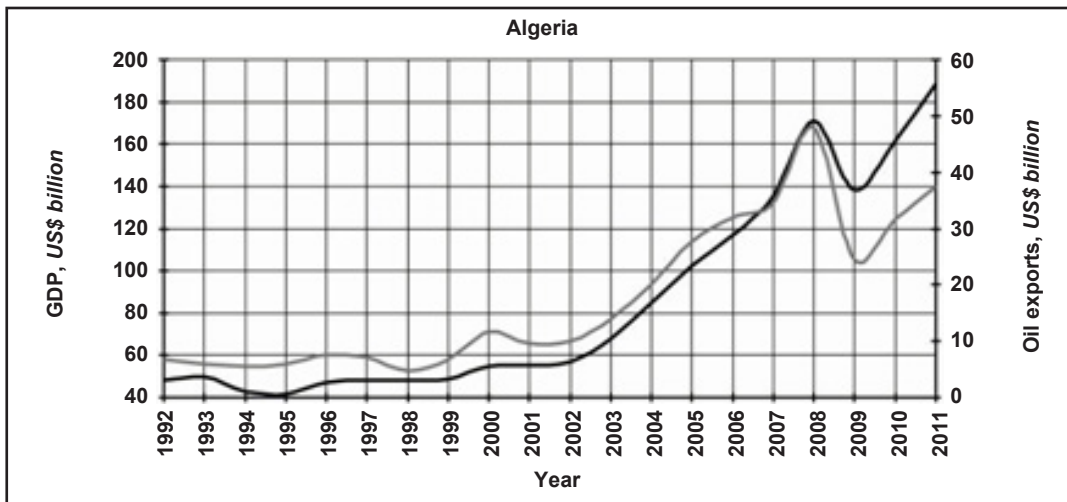
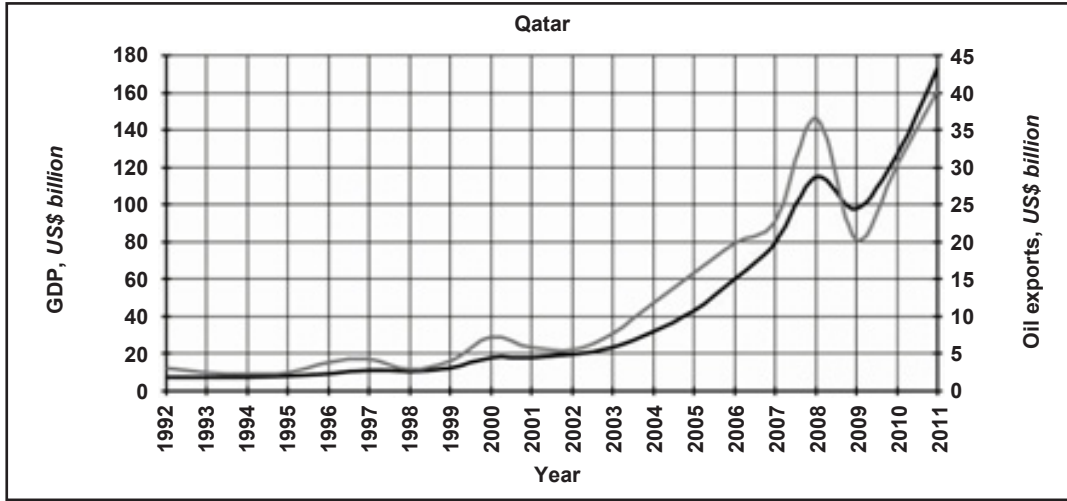
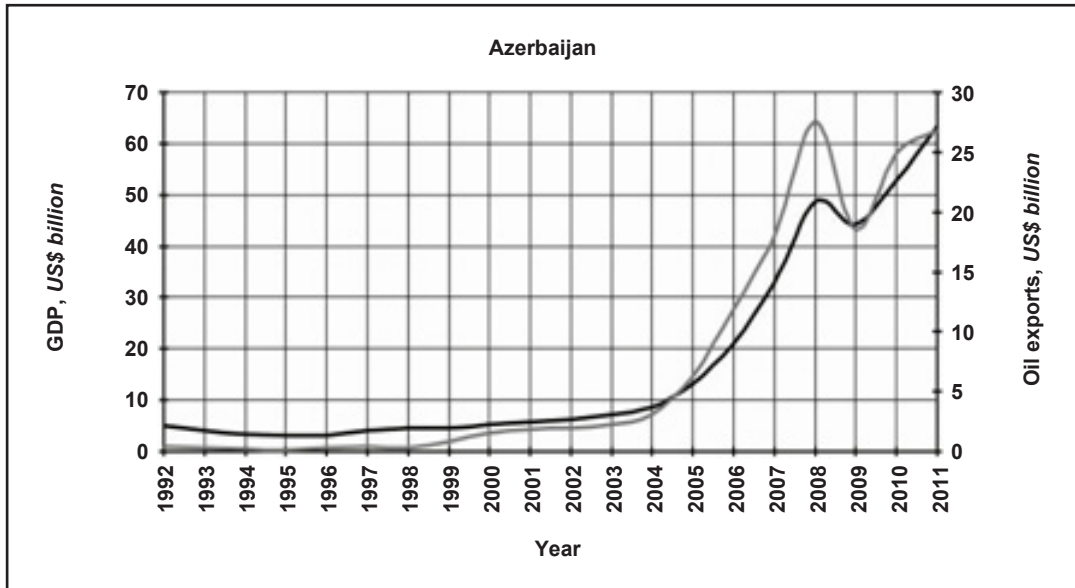


Figure 6 (continued)



Figures 7 and 8 compare real and model GDP in 12 countries. Clearly, there is a very close fit between the two curves in all cases, naturally except Venezuela.

Below is an interpretation of the results obtained.

Figure 7

Comparison of Real and Model GDP for
RF, Kuwait, UAE, Nigeria, Venezuela and Angola
in 1992-2011

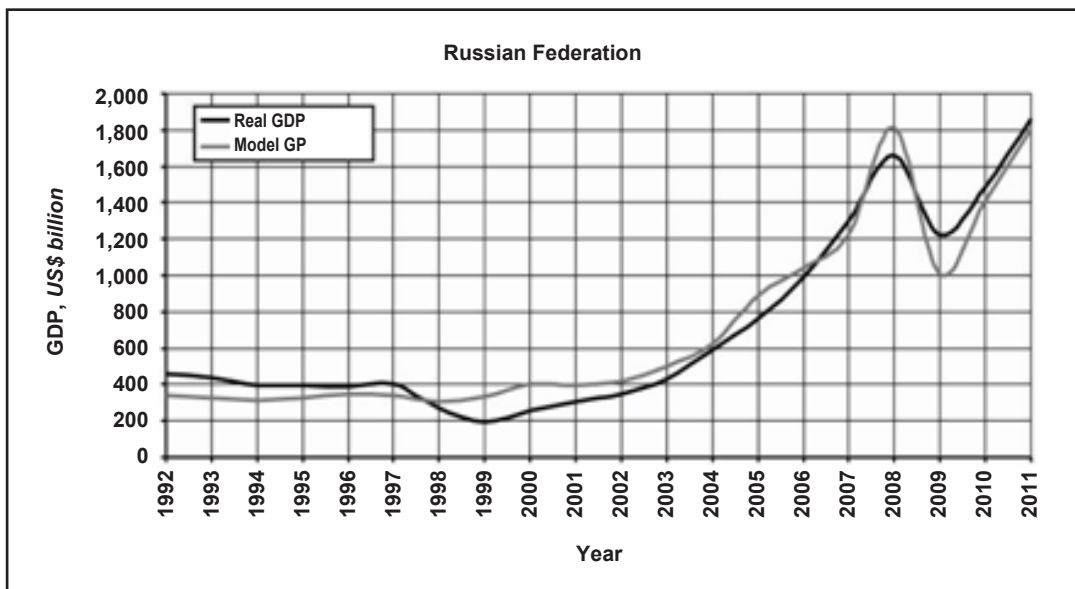


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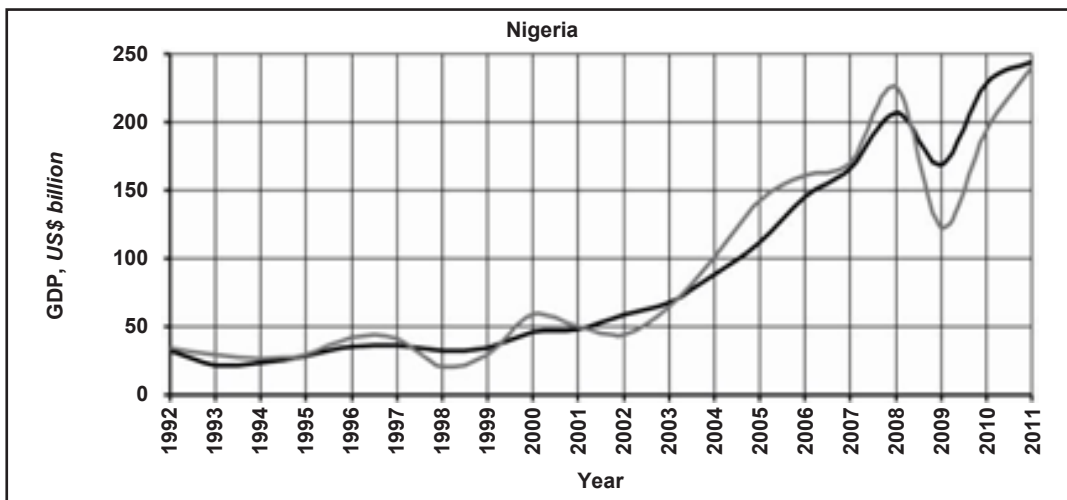
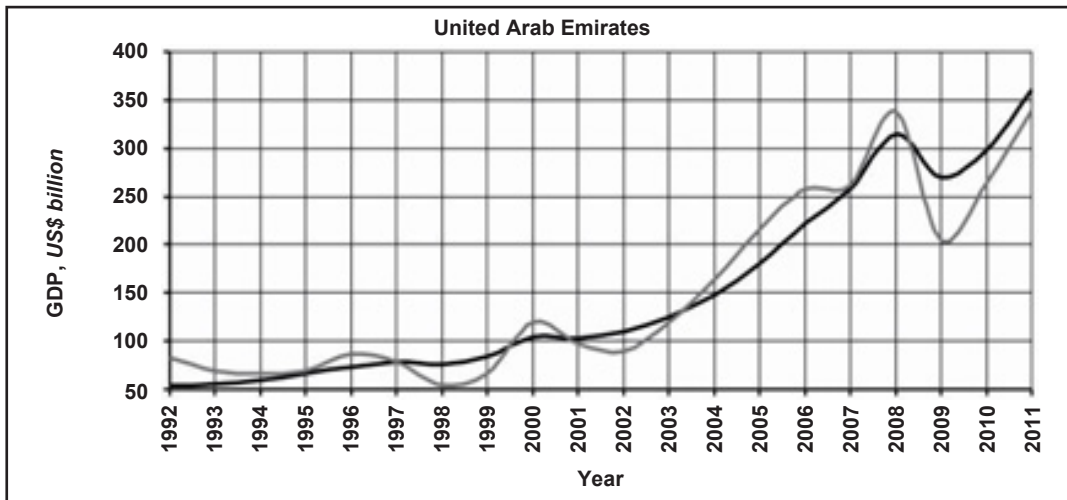
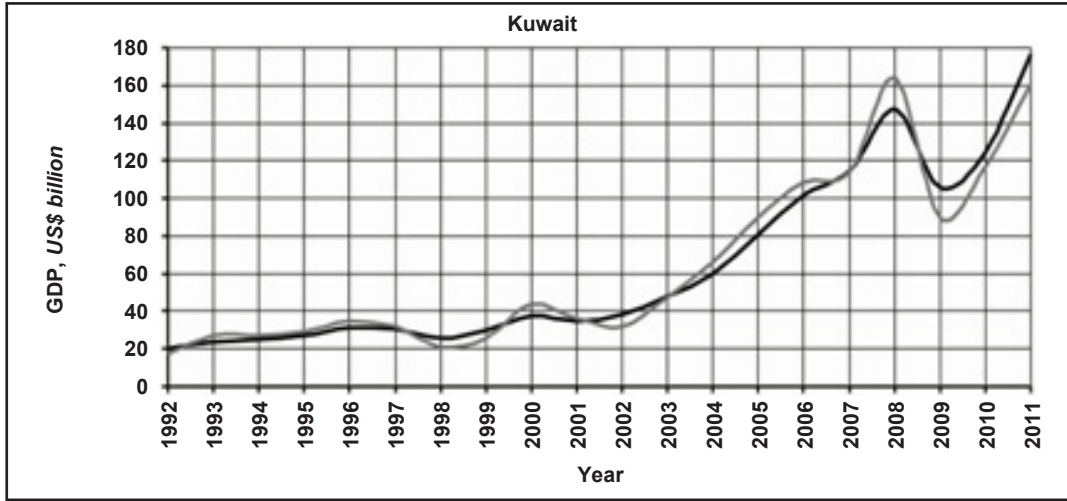


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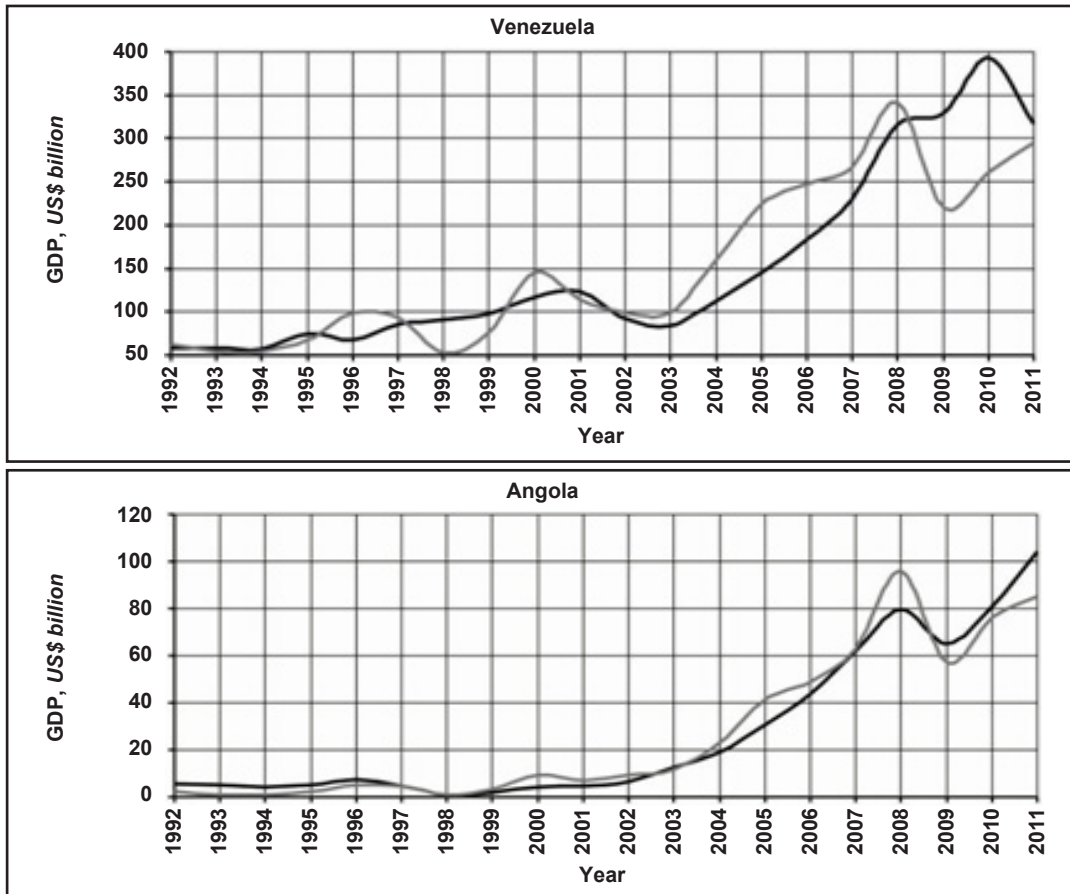


Figure 8

Comparison of Real and Model GDP for Norway, Canada, Qatar, Algeria, Mexico and Azerbaijan in 1992-2011 (Notations as in Figure 7)

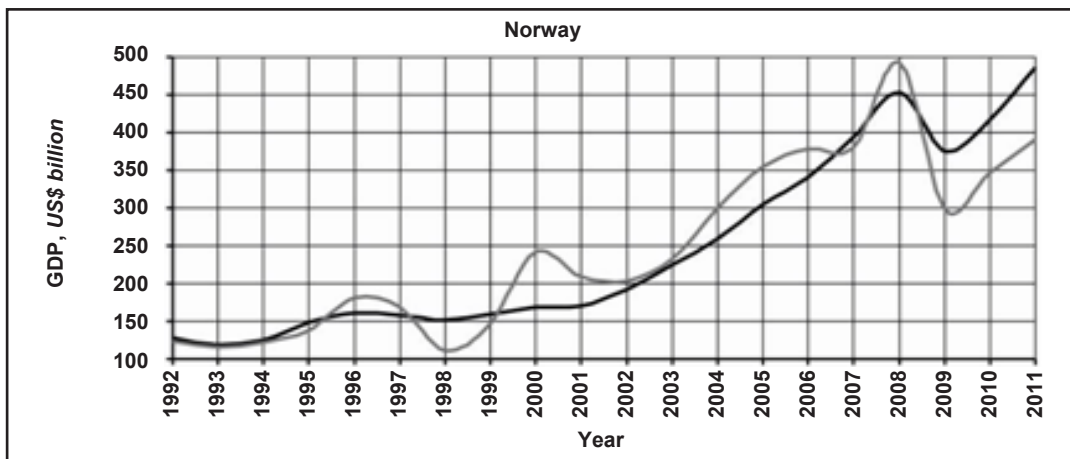


Figure 8 (continued)

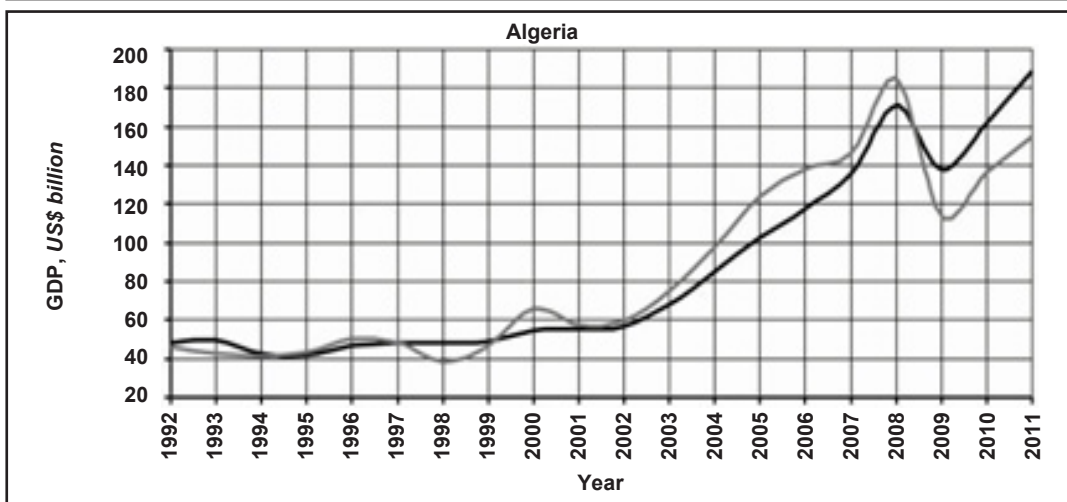
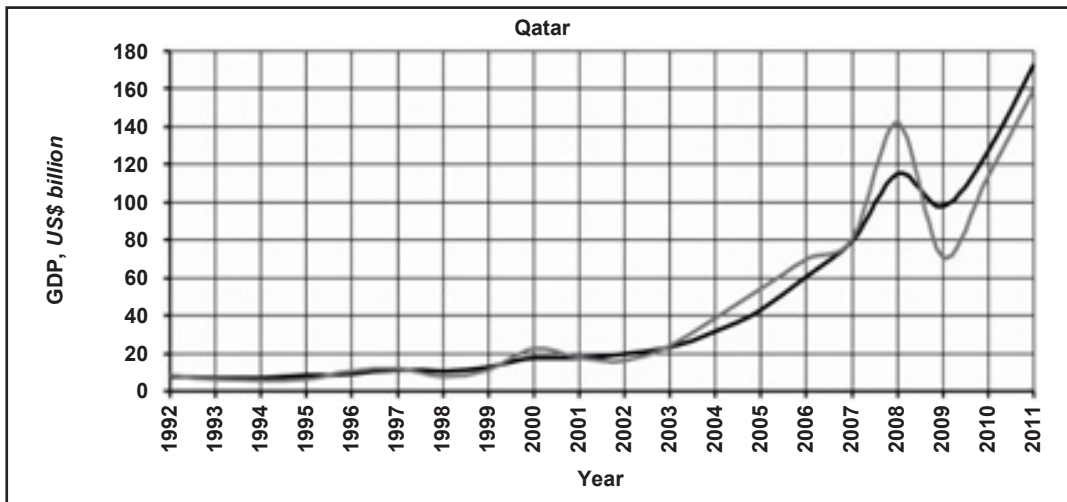
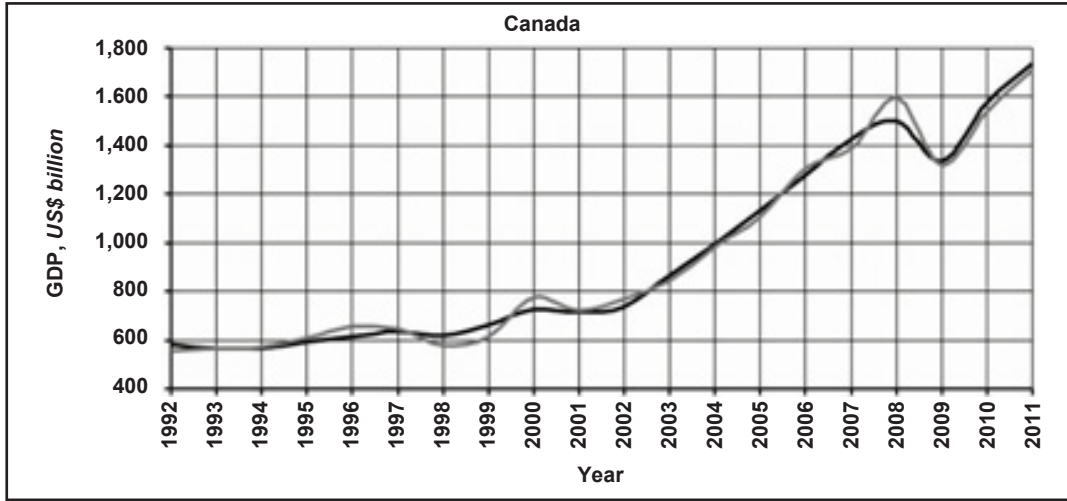
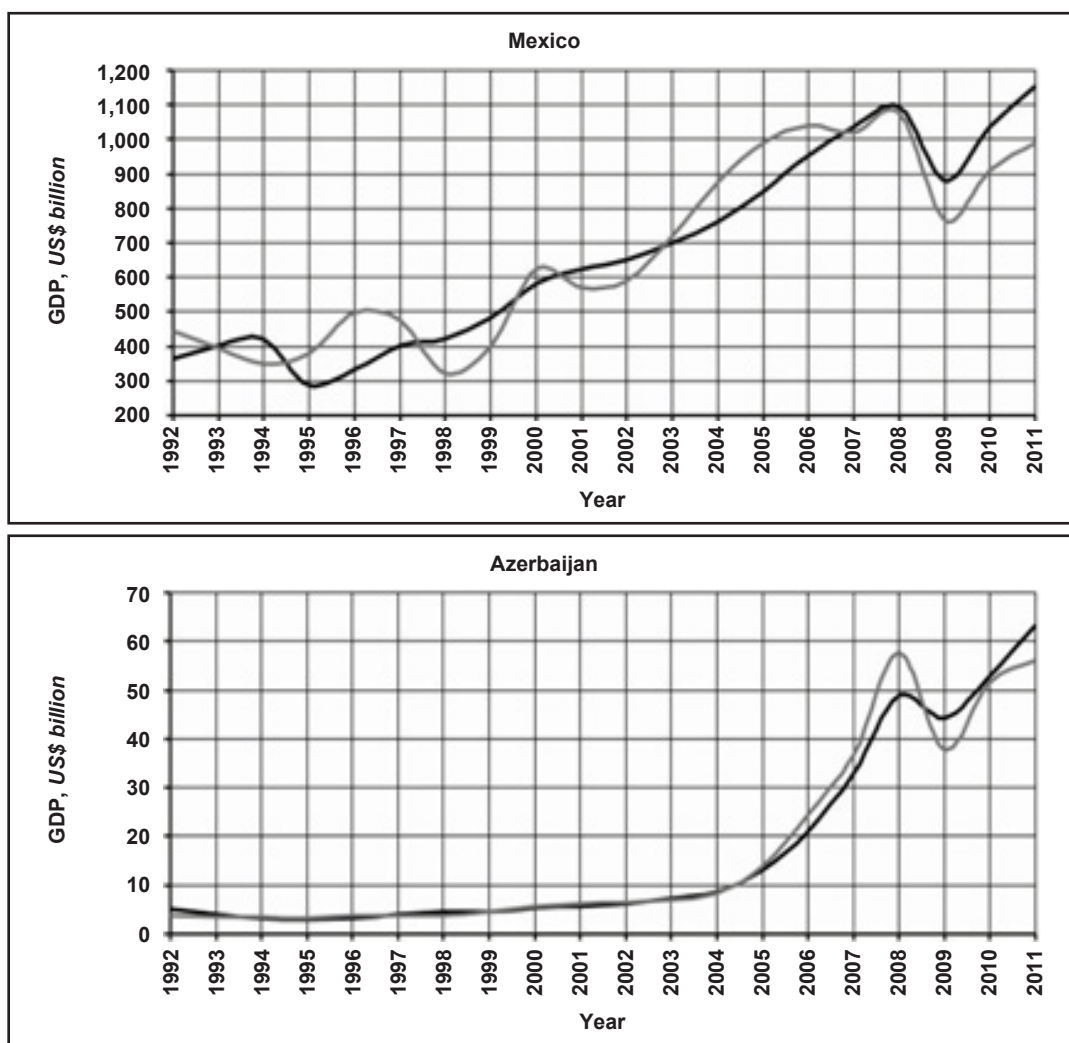


Figure 8 (continued)



Discussion of Results

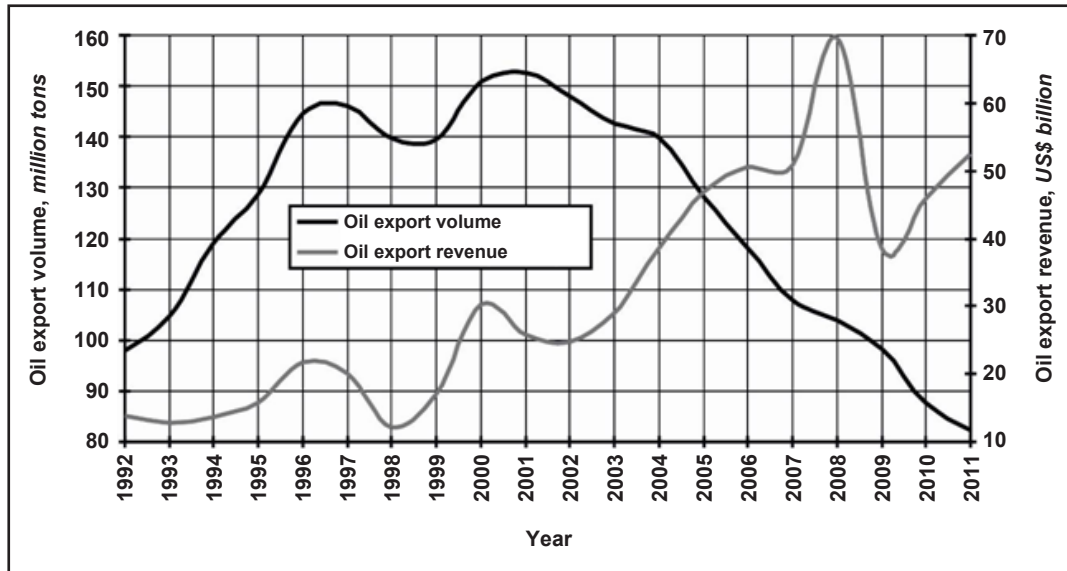
The monetary value of crude oil exports (in other words, the revenue from such operations) depends on two variables:

- (1) the mass (actual weight or volume) of exported oil;
- (2) the price of exported oil.

Take, for example, Norway, which has gradually reduced the volume of exported oil since the beginning of this century. Figure 9 shows both the actual volume of exports and export revenues for 1992-2011. It is clearly evident that export volumes fell from 152.5 million tons in 2001 to 82.3 million tons in 2011. But export revenues gradually increased; the only exception was 2009, when the world oil price was \$53.48 compared to \$91.48 in 2008 and \$71.21 in 2010.

Figure 9

**Relationship between the Volume (Tonnage) of
Oil Exports from Norway and Oil Export Revenue
in 1992-2011**



In general economic theory,⁴¹ the price of any commodity is determined by its supply and demand dynamics; as noted above, in a globalized world this pattern is not observed.⁴²

For a more graphic explanation of this basically simple reality, let us look at Figure 10, which presents an analysis of the relationship between oil reserves and oil production in 2011. The main statistical parameters for calculations are given in the above-cited *BP Statistical Review of World Energy* for 2013. We clearly see two oil production “policies,” identified by one of the authors of this article in 2011.⁴³

One of these is so-called “non-OPEC” policy. It is pursued, in the first place, by Russia and Azerbaijan, which produce as much oil as they can.

As for “OPEC” policy, it is mainly implemented by OPEC countries, which comply with oil production quotas.⁴⁴ OPEC can raise or lower these quotas, but usually it only adjusts them on a monthly basis, taking into account existing global demand for this commodity and current geopolitical events.⁴⁵

A series of publications on commodity pricing theory, sometimes called commodity currencies theory,⁴⁶ despite the use of an impressive array of mathematical tools, leads to the fairly simple conclusion that the market price of a commodity depends on two parameters:

⁴¹ See, for example: C. Menger, *Principles of Economics*, Ludwig [so] von Mises Institute, Auburn, Alabama, 2007. Chapter VII: The Theory of the [so] Commodity, pp. 236-256.

⁴² See: *Global Economic Prospects: Commodities at the Crossroads*, The International Bank for Reconstruction and Development, Washington, D.C., 2009, 182 pp.

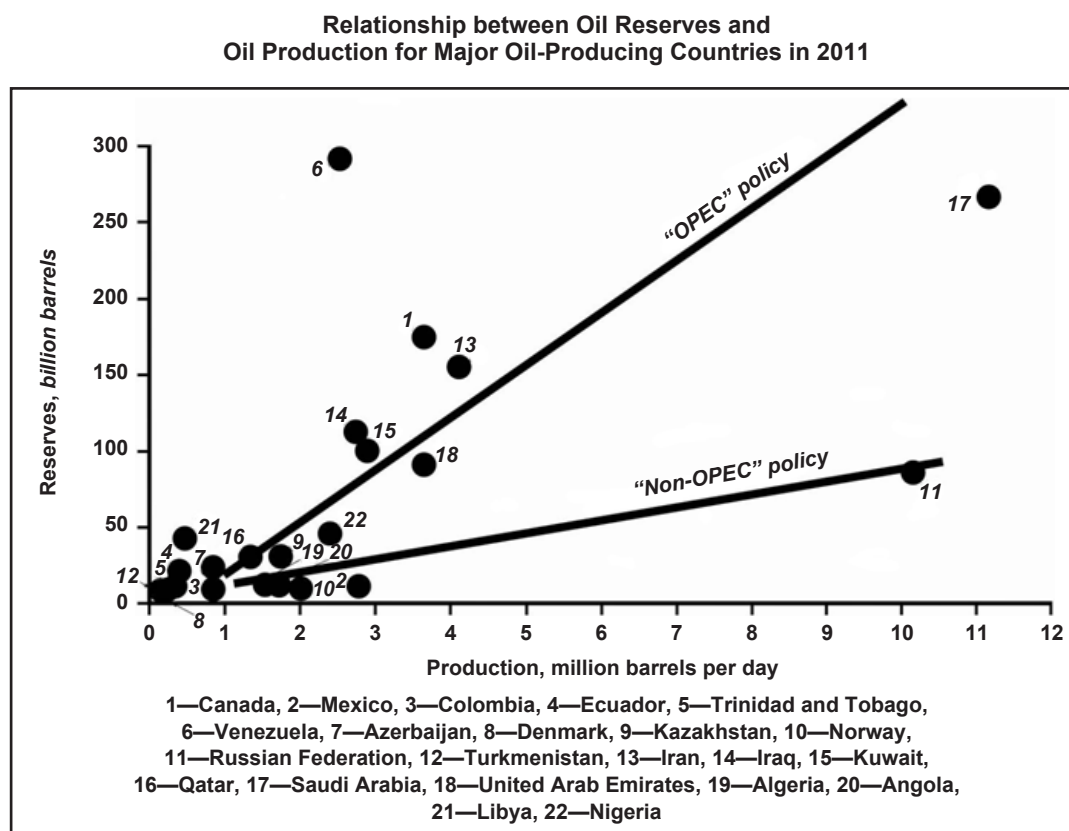
⁴³ See: A.G. Tvalchrelidze, op. cit.

⁴⁴ *OPEC Quotas*, United States Department of Energy⁶ available at [<http://www.energy.gov>]; *World Oil Outlook 2012*, OPEC, Vienna, 2012, 300 pp.

⁴⁵ See, for example: *Monthly Oil Market Report, April 2013*, OPEC, Vienna, 2013, 75 pp.

⁴⁶ See: K. Rogoff, op. cit.; K. McCann, M. Nordström, *Energy Derivatives: Crude Oil and Natural Gas. Product Summary*, Federal Reserve Bank of Chicago, Chicago, 1995, 25 pp.; W.C. Labys, E. Kouassi, M. Terraza, “Short-Term Cycles

Figure 10



- (1) the length of the so-called commodity chain⁴⁷;
- (2) the exchange rate of the U.S. dollar.

But according to our investigations,⁴⁸ the first parameter is erroneous. On any commodity exchange (except the Shanghai Futures Exchange), international spot, futures and other contracts are

in Primary Commodity Prices," *The Developing Economies*, Vol. XXXVIII, No. 3, 2000, pp. 330-342; Y. Chen, K. Rogoff, "Commodity Currencies," *Journal of International Economics*, Vol. 60, No. 1, 2003, pp. 133-160; P. Cashin, L.F. Céspedes, R. Sahay, *Commodity Currencies and the Real Exchange Rate*, Central Bank of Chile, Santiago, Working Paper No. 236, 2003, 39 pp.; R. Keyfitz, *Currencies and Commodities: Modeling the Impact of Exchange Rates on Commodity Prices in the World Market*, Development Prospects Group, The World Bank, Washington, D.C., 2004, 13 pp.; R. Pirog, *World Oil Demand and its Effect on Oil Prices*, CRS Report for Congress, Congressional Research Service, The Library of Congress, Washington, D.C., 2005, 23 pp.; T. Koranchelian, *The Equilibrium Real Exchange Rate in a Commodity Exporting Country: Algeria's Experience*, IMF Working Paper WP/05/135, International Monetary Fund, Washington, D.C., 2005, 19 pp.; J. Frankel, *The Effect of Monetary Policy on Real Commodity Prices*, University of Chicago Press, Chicago, 2006, 38 pp.; M. Francis, "Adjusting to the Commodity-Price Boom: The Experiences of Four Industrialized Countries," *Bank of Canada Review*, Autumn 2008, 2008, pp. 29-41; D.S. Jacks, K.H. O'Rourke, J.G. Williamson, *Commodity Price Volatility and World Market Integration since 1700*, Simon Fraser University Press, Burnaby, 2009, 39 pp., and others.

⁴⁷ Commodity chain is the number of intermediate financial operations through which a commodity passes on the way from the producer to the final consumer.

⁴⁸ See: A.G. Tvalchrelidze, op. cit.; A.G. Tvalchrelidze, *Development of a Geological-Economic System for Governmental Management of Georgian Mineral Resources*, John D. & Catherine T. MacArthur Foundation, Tbilisi, 1995, 87 pp., and others.

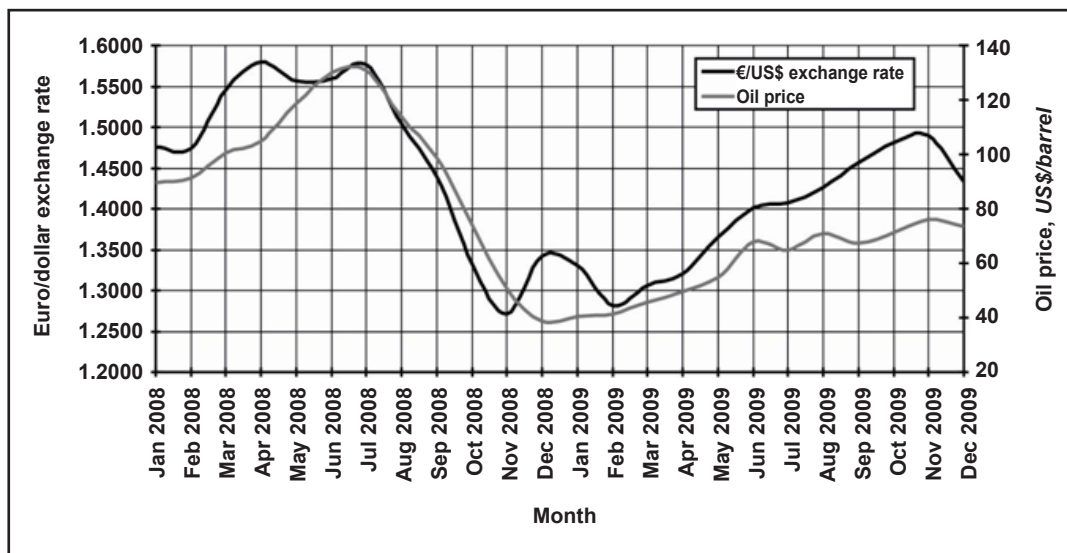
mainly quoted in U.S. dollars. That is why the U.S. government and Federal Reserve System have an opportunity to manipulate commodity prices by pursuing a strong or weak dollar policy. This is the reality behind the current political economy of oil initiated by Ronald Reagan.⁴⁹

Let us consider, for example, the changes in average monthly oil prices⁵⁰ and the euro/dollar exchange rate⁵¹ in 2008-2009, that is, during the economic crisis, when oil price movements were particularly significant. This relationship, shown in Figure 11, is expressed in near perfect covariance of these seemingly independent economic indicators, between which there is a very strong correlation. And this means that whatever the length of the commodity chain, oil prices will “obediently” follow the exchange rate between the two currencies.

Figure 11

**Relationship between
Euro/Dollar Exchange Rate and Oil Prices
in 2008-2009**

(correlation coefficient = 0.8943)



At the beginning of the new millennium, the George W. Bush Administration decided to pursue a weak-dollar monetary policy⁵² (the reasons for such a decision were analyzed earlier⁵³). But this policy, designed to address U.S. domestic economic problems, had global consequences as it led to a steady increase in world commodity prices (from 2001 to 2008). In the fall of 2008, George W. Bush decided to change U.S. monetary policy radically, and to the end of his term in office did all he could to strengthen the national currency.

In the monograph repeatedly mentioned above, one of the authors of this article has already briefly characterized the dire consequences of that spontaneous and ill-considered decision to

⁴⁹ See: E.L. Morse, “A New Political Economy of Oil,” *Journal of International Affairs*, Vol. 53, 1999, pp. 1-29; S.H. Hanke, “Oil and Politics,” *Forbes*, 16 August 2004, and others.

⁵⁰ See: *Mirovye tseny na syr'yo*.

⁵¹ See: Euro Foreign Exchange Reference Rates, European Central Bank, available at [<http://www.ecb.int>].

⁵² See: E. Bugos, “Bush Abandons Strong Dollar Policy,” available at [<http://www.gold-eagle.com>].

⁵³ See: A.G. Tvalchrelidze, op. cit.

strengthen the U.S. national currency. As we will demonstrate in future articles of this series, that decision (and not the rapid accumulation of debt in the real estate sector⁵⁴) was what triggered the global economic crisis.⁵⁵

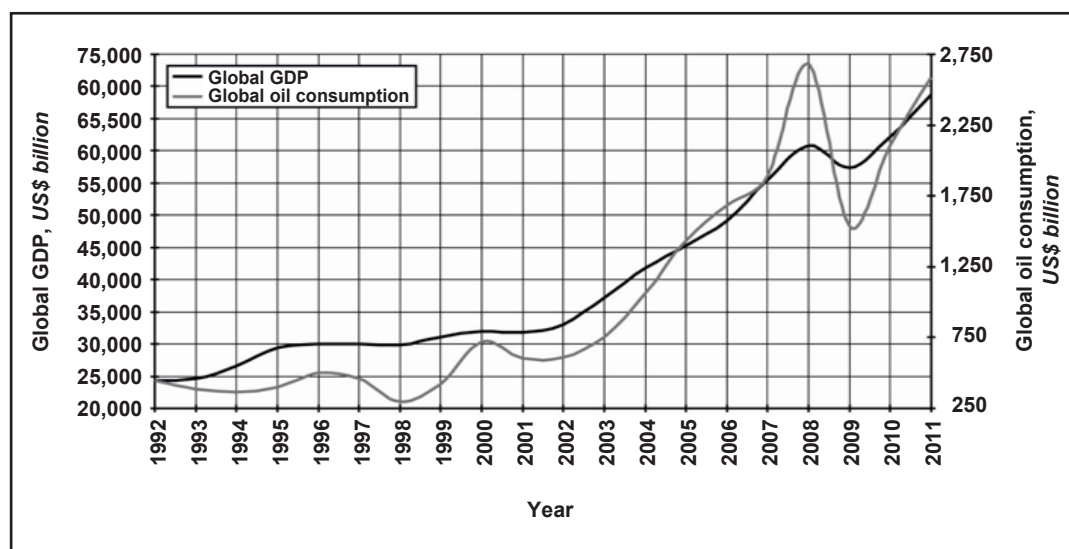
Measures taken by President Barack Obama were also associated with commodity pricing. From the very first day of his term in office, he began to raise prices gradually by weakening the dollar. Not later than 20 July, 2009, Barack Obama officially declared: “The fire is now out.”⁵⁶ By that time, nothing significant had happened in the world economy except a 43% increase in commodity prices, primarily oil prices.

Thus, in our opinion, world GDP growth is mainly determined by the consumption of commodities, especially oil. In support of this conclusion, Figure 12 clearly shows a close correlation between these two indicators. Consumption here was calculated by multiplying the volume (weight) of crude oil used in the world by its annual average price. All statistical data for these calculations were taken from the above-cited sources.

Figure 12

**Relationship between Global Oil Consumption and Global GDP
in 1992-2011**

(correlation coefficient = 0.9681)



Let us now consider Figure 13, showing net oil exports as a share of GDP in oil-exporting countries. In this case, the indirect effect of such exports (port and shipping costs, financial transaction costs, etc.) were not taken into account. Figure 13 clearly demonstrates that the main oil-exporting countries can be formally divided into three categories:

⁵⁴ See: P. Artus, J.-P. Betbèze, C. de Boissieu, G. Capelle-Blancard, *La crise des subprimes*, La Documentation française, Paris, 2008, 284 pp.; L. Carroué, “Dossier crise des subprimes: la fin de l’hégémonie américaine?” in: *Images économiques du monde. Géopolitique, géoéconomie 2009*, Éditions Arman Colin, Paris, 2009, pp. 1-18.

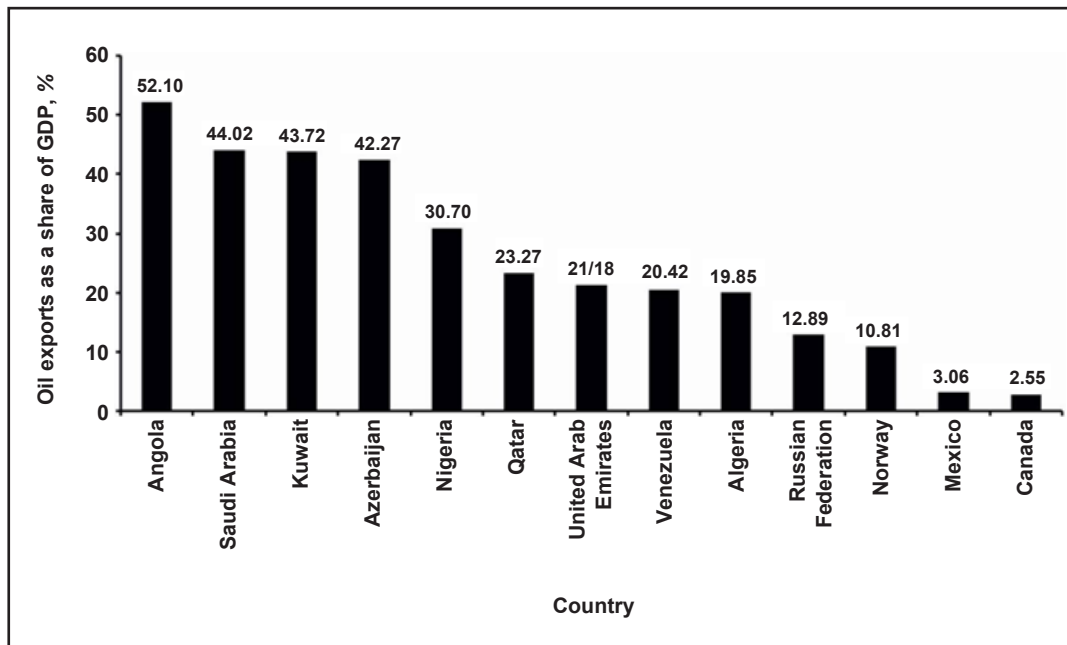
⁵⁵ See: A.G. Tvalchrelidze, op. cit.; V. Papava, “The Economic Challenges of the Black Sea Region: The Global Financial Crisis and Energy Sector Cooperation,” *Southeast European and Black Sea Studies*, Vol. 10, No. 3, 2010, pp. 361-371.

⁵⁶ See: Obama on U.S. Economic Crisis: “The Fire Is Now Out,” Agence France-Presse, 20 Jul 2009.

1. Countries where direct oil exports fully determine their economy, and any disruption in international oil sales can lead to immediate default (Angola, Saudi Arabia, Kuwait, Azerbaijan, Nigeria, Qatar, UAE and Venezuela).
2. Countries where direct oil exports make up a significant part of the economy, and any disruption in international sales can lead to significant economic difficulties (Algeria, Russia and Norway).
3. Countries where direct oil exports make up an insignificant part of the economy, and any disruption in international sales can only have an insignificant direct effect on the economy (Mexico and Canada).

Figure 13

**Oil Exports as a Share of GDP
in Oil-Exporting Countries in 2011**



Paradoxically, even countries in the third category demonstrate a very close correlation between GDP and oil exports (see Fig. 5). Here, model GDP can be described in terms of oil exports (see Fig. 8). In this connection, a legitimate question is how international trade in oil can have such a tangible effect on the GDP of these countries?

To answer this question, let us consider, for example, the internal structure of Canada's GDP as it was analyzed by the government of that country⁵⁷ (Fig. 14). It is evident that oil exports are not even present in the GDP structure. But their indirect impact cannot be overestimated because they have an implicit effect on the following segments of the economy:

1. Mining, quarrying, and oil and gas extraction.

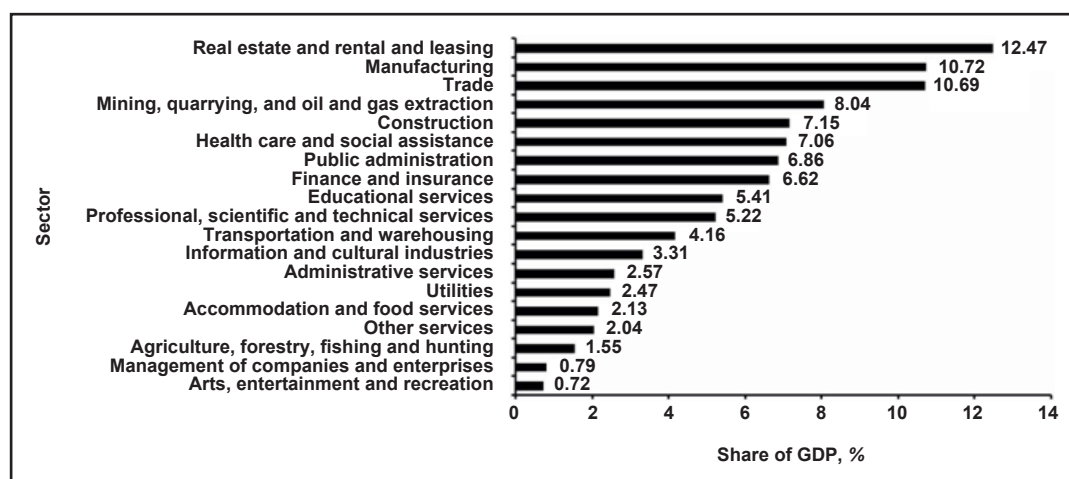
⁵⁷ See: *Gross Domestic Product at Basic Prices, By Industry*, Statistics of Canada, available at [<http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/gdps04a-eng.htm>].

2. Trade (wholesale).
3. Manufacturing.
4. Construction.
5. Finance and insurance.
6. Public administration.
7. Scientific and technical services.
8. Transportation and warehousing.
9. Administrative services.
10. Accommodation and food services.
11. Management of companies and enterprises.

There is no doubt that oil exports have a positive effect on sectors of national importance such as health care, social assistance, education, art, and even entertainment and recreation. In other words, oil exports “permeate” the entire socioeconomic structure of society.

Figure 14

Canada GDP—Composition by Sector



In future articles, we will try to shed light on questions related to the modern political economy of oil, but a number of basic conclusions can be formulated even today.

Main Conclusions

In this article, we have examined the relationship between GDP and net oil exports in all major oil-exporting countries except Iran and Iraq, since the data on their economic indicators are highly unreliable. For our investigations, we studied the correlation between these two economic indicators; to develop GDP models for oil-exporting countries based on exports, we used quadratic regression equations. A detailed analysis of the results obtained has enabled us to formulate a number of fundamentally new conclusions.

1. The major oil-exporting countries can be tentatively divided into three categories:
 - (a) countries where direct oil exports fully determine their economy, and any disruption in international sales can lead to immediate default (Angola, Saudi Arabia, Kuwait, Azerbaijan, Nigeria, Qatar, UAE and Venezuela).
 - (b) countries where direct oil exports make up a significant part of the economy, and any disruption in international sales can lead to significant economic difficulties (Algeria, Russia and Norway).
 - (c) countries where direct oil exports make up an insignificant part of the economy, and any disruption in international sales can only have an insignificant direct effect on the economy (Mexico and Canada).

At the same time, oil exports are in synergy with other economic sectors, including oil production and refining, development of transportation infrastructure (tanker fleet, oil pipelines), finance and insurance, public administration, development of science and technology, etc. That is why even in countries where direct oil exports make up less than 5% of GDP, any fluctuations in international sales have an immediate effect on economic development indicators.

2. As it follows from the above, the model GDPs of all analyzed countries (except Venezuela) based on net oil exports coincide exactly with their real GDPs. This fundamentally new conclusion leads to three very important additional propositions.
 - First, all oil-exporting countries except Venezuela are included in the global economic system based on the principles of free market relations. That is why they are totally dependent on international commodity and financial market equilibrium.
 - Second, global oil consumption is precisely what in large part determines global economic development.
 - Third, these countries are hostage to world commodity markets, since oil production plays the main role in the structure of their economy and the depletion of strategic oil reserves can have grave consequences.

These propositions help to make more or less reliable forecasts of the sustainability of economic development in oil-exporting countries and the world as a whole, and our future publications will be devoted to such forecasts.

3. As noted above, Venezuela is a country with a totalitarian economic model which, according to our research, has no strategic future. Without radical social changes in the country, this pessimistic forecast cannot be altered even by an increase in international oil sales.
4. World oil prices are largely regulated by the exchange rate of the U.S. dollar. Thus, the U.S. government has a much more effective weapon than that at the disposal of OPEC (oil production quotas). It can give the U.S. full control over oil markets and, as we have already noted, over the world economy.

But it should be borne in mind that this is a double-edged weapon and its ill-considered use can lead to global socioeconomic cataclysms, as is evident from George W. Bush's activity in the final months of his presidency.

Today's globalized world is very fragile, and we must take good care of it.