EX-POST FORECAST EFFICIENCY IN NATURAL GAS PRODUCTION ECONOMETRIC FORECASTING: GAZPROM FIELDS IN TYUMEN REGION CASE STUDY

by Anton A. Afanasiev

(RAS Central Economics and Mathematics Institute)

Gazprom is the largest gas company which tops the world's list in gas reserves, production and export as well as in net profit for 2009–2010. Three quarters (75,6%) of company's explored natural gas reserves are concentrated in Tyumen region (Yamal's offshore included), and the major part of natural gas is extracted from Tyumen fields. So, it is topical to analize the Gazprom efficiency for 2010 and to forecast its natural gas production in Tyumen region for 2011.

Gazprom as an effective resource stabilizer of Russian economy

In the author's previous articles [1–2], the econometric research of three types of constant-return-to-scale natural gas production functions for Gazprom's fields in Tyumen region within 1993–2007 and 1993–2008 gave a valuable economic result: the labour elasticity of gross gas production fully or almost fully coincides with the average wages and social payments share in gas production costs for Gazprom subsidiaries. On this base it was concluded that Gazprom subsidiaries in Tyumen region minimize costs and use factors Pareto-efficiently [1–3].

An econometric research of natural gas production functions from 1993 till 2009–2010 for cost minimization and pareto-efficiency was impossible to carry out due to the lack of average annual data on capacity utilization of gas enterprises. However, the successful continuation of this Gazprom policy can be marked by the following. According to *Fortune*'s data, the company tops the world's list of energy producers in net profit (fig. 1). More to that, for the first time since 1993 the unit gas production cost has grown insufficiently in comparison to 2009 – approximately up to 4 roubles per 1000 m^3 (less than 1%) [4], while in the Tyumen region 4 subsidiaries together (administrative expenses included) lessened it from 482.5 to 481.5 roubles for 1000 m^3, i.e. to 1 rouble per 1000 m^3 (fig. 2). The gas production enterprise Gazprom Dobycha Yamburg was the leader lessening the unit costs from 490 to 470 roubles per 1000 m^3, i.e. to 20 roubles per 1000 m^3. The second was the subsidiary Gazprom Dobycha Noyabrsk whose average costs became 11 roubles lower. The gas production association Gazprom Dobycha Nadym showed but less than 1% increase. Favorable results in natural gas production and processing costs optimization were reached as well by Gazprom Pererabotka Ltd. Komi affiliates – Vuktylskoye gas production department and Sosnogorsky gas processing plant.

Therefore, it can be stated that Gazprom's costs minimization and Pareto-efficient factors use application policy makes it the resource stabilizer of the Russian Federation economy, because the company does not employ labour and capital at the expense of other economic sectors, but releases them helping thus to other sectors effective functioning and speeding-up the rate of the Russian economy growth in general.

Natural gas production forecast for 2011 and *ex-post* forecast efficiency

Natural gas production forecasting for the Gazprom's fields in Tyumen region will be carried out on the base of the production functions econometric models with small absolute percentage errors (APE) of *ex-post* forecast. Among the estimated production functions we chose the power-exponential functions (1) (table 1)

$$\Gamma_t = e^{\alpha_0} (\Phi_{t-1(1990)})^{\alpha_1 + \alpha_2 G_{1963,t-1}}$$

for they have rather inconsiderable (no more than 2.3%) *ex-post* forecast APEs for one year and further up to 12 years (excluding 2009) estimated from 1984 up to 1997, 2005–2008 [2, 6] (where $\Gamma_t -$ the gross natural gas production in the year t; $\Phi_{t-1(1990)} -$ average annual fixed industrial assets value (in constant 1990 prices) over year $t-1$; $G_{1963,t-2} -$ cumulative natural gas output from the first Tyumen region industrial start-up (1963) through year $t-2$).

These functions forecasted the natural gas output volumes for 2010 as 476,3, 476,8, 474,3, 472,8 and 474,2 bm^3 consecutively, the forecast errors were 1,8%, 1,9%, 1,4%, 1,1%, 1,4% (see [6, 7]).

For 2011 these functions forecast the natural gas production as 461.3–464.9 bm^3 (see table 1 and fig. 3).

The econometric research presents *a very rare result both for econometrics and gas industry economics*: the power-exponential functions (2) (table 1) were found that make it possible to forecast the natural gas output for one year and further up to 18 years (excluding 2009) with an *ex-post* forecast APE maximum of 3.7% (table 2, fig. 4–6). These functions

$$\Gamma_t = e^{\alpha_0} (\Phi_{t-1(1990)})^{\alpha_1 + \alpha_2 G_{1963,t-1}}$$

estimated from 1985 up to 1991, 1994, 1997, 2003–2008 project the natural gas output in 2011 as 464.3–474.7 bm^3 (table 1, fig. 7).

In particular, the production function

$$\Gamma_t = e^{4,61} (\Phi_{t-1(1990)})^{0,56-5,12\times10^{-9}\cdot G_{1963,t-1}},$$

studied basing on the Soviet period statistics of 1985–1991 (R^2 = 0,99; DW = 1,52) has the following *ex-post* forecast APEs (table 1–2, fig. 4–6): in 1992 – 0.4%, in 1993 – 1.1%, in 1994 – 0.4%, in 1995 – 0.3%, in 1996 – 3.0%, in 1997 – 2.7%, in 1998 (a crisis and default year) – 1.0 %, in 1999 (post-crisis) – 1.5 %, in 2000 – 1.0 %, in 2001 – 0.1 %, in 2002 – 1.1 %, in 2003 – 0.8 %, in 2004 – 1.6 %, in 2005 – 3.1 %, in 2006 – 2.8 %, in 2007 – 2.7 %, in 2008 – 0.5 %, in 2009 (a crisis year) – 17.6 %, in 2010 (post-crisis) – 3.7 %. For 2011, this function projects the natural gas output as 474.610 bm^3.

So, the above results are believed to prove high efficiency of *ex-post* forecast application to project the natural gas output econometrically. The natural gas output volumes out of Gazprom fields in Tyumen region been forecast according to two types of functions are in the interval of 461.3–474.7 bm^3 with a maximum *ex-post* forecast APE of 3.7% (table 1, fig. 3, 7).

REFERENCES

1. Afanasiev A.A. "Pareto-efficiency, cost minimization, and innovations: the key Gazprom policies targeting gas production", *Gas Industry of Russia (Digest)*, 2009, № 3(15), pp. 30-37.

http://www.cemi.rssi.ru/publication/e-publishing/afanasiev/afan-09-1.pdf

2. Afanasyev A.A. “Gas fields in East Siberia: production outlooks”, *Gas Industry of Russia (Digest)*, 2010, № 4(20), pp. 2–12.

http://www.cemi.rssi.ru/publication/e-publishing/afanasiev/afanasiev-2010-gas-eng.pdf

3. Miller A.B. “Innovative aspects of the development strategy of a global power engineering company”, *Problems of Modern Economics*, 2010, 1(33), pp. 18–21. (In Russian)

http://www.m-economy.ru/art_e.php?nArtId=2950

4. *Fortune*, 2011, July 25.

http://money.cnn.com/magazines/fortune/global500/2011/performers/companies/profits/

5. Kruglov A.V. *Gazprom’s Financial and Economic Policy: Shorthand record*, 2011, June 29. (In Russian)

6. Afanasyev A.A. “Is it possible to forecast Russian natural gas production in crisis times?” In: *Strategic planning and evolution of enterprises*, Section 5, Moscow: CEMI RAS, 2011, pp. 12–14. (In Russian) http://www.cemi.rssi.ru/publication/e-publishing/afanasiev/anafanasief_2011.pdf

7. Afanasiev A.A. "Forecasting of Natural Gas Production from Gazprom Fields in Tyumen Region", in: *The II International Scientific-Practical Conference ‘Effective Project Management in Oil&Gas Industry’ (EPMI–2010)*, Ukhta, 21–24, September, 2010, Ukhta: branch of Gazprom VNIIGAZ LLC in Ukhta (Severnipigaz), 2010, pp. 48–49.

http://www.cemi.rssi.ru/publication/e-publishing/afanasiev/text-eng.pdf

Table 1. Econometric results of production functions estimation and natural gas production forecasts for 2011

№	Function	Period	Coefficients and t-statistics (in brackets)			R^2	DW	Maximum ex-post forecast for τ years ahead (without 2009)		Forecast for 2011, million m^3
			α_0	α_1	α_2			τ, year	APE, %	
(1)	Power-exponential $\Gamma_t = e^{\alpha_0}(\Phi_{t-1(1990)})^{\alpha_1+\alpha_2 G_{1963,t-1}}$ See [2, 6].	1984–1997	4.01	0.60	$-5.58\cdot10^{-9}$	0.99	1.52	13	2.3	464,873
		1984–2005	4.02	0.60	$-5.58\cdot10^{-9}$	0.99	1.44	4	1.9	465,380
		1984–2006	4.00	0.60	$-5.62\cdot10^{-9}$	0.99	1.37	3	1.4	462,855
		1984–2007	3.98	0.60	$-5.66\cdot10^{-9}$	0.99	1.34	2	1.3	461,303
		1984–2008	4.01	0.60	$-5.62\cdot10^{-9}$	0.99	1.39	1	1.4	462,772
(2)	Power-exponential $\Gamma_t = e^{\alpha_0}(\Phi_{t-1(1990)})^{\alpha_1+\alpha_2 G_{1963,t-1}}$	1985–1991	4.61 (4)	0.56 (6)	$-5.12\cdot10^{-9}$ (–2.04)	0.99	1.52	18	3.7	474,610
		1985–1994	4.60 (10)	0.56 (18)	$-5.15\cdot10^{-9}$ (–8)	0.99	1.68	15	3.3	472,534
		1985–1997	4.60 (11)	0.56 (21)	$-5.14\cdot10^{-9}$ (–12)	0.99	2.09	13	3.6	474,073
		1985–2003	4.59 (16)	0.56 (29)	$-5.14\cdot10^{-9}$ (-23)	0.99	2.20	6	3.7	474,668
		1985–2004	4.57 (16)	0.56 (29)	$-5.19\cdot10^{-9}$ (–23)	0.98	2.09	5	3.2	472,014
		1985–2005	4.55 (15)	0.56 (28)	$-5.24\cdot10^{-9}$ (–23)	0.98	1.84	4	2.4	468,217
		1985–2006	4.54 (15)	0.56 (28)	$-5.28\cdot10^{-9}$ (–23)	0.98	1.73	3	1.9	465,870
		1985–2007	4.51 (15)	0.57 (29)	$-5.32\cdot10^{-9}$ (–24)	0.98	1.68	2	1.6	464,310
		1985–2008	4.54 (16)	0.56 (29)	$-5.28\cdot10^{-9}$ (–25)	0.98	1.74	1	1.9	465,661

Table 2. *Ex-post* forecast APEs of function (2) estimated on 1985 по 1991–2008 learning samples (table 1)

Ex-post forecast year		Learning samples from 1985 up to year																	
№	year	**1991**	1992	1993	**1994**	1995	1996	**1997**	1998	1999	2000	2001	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
1	1992	**0.4**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	1993	**1.1**	1.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	1994	**0.4**	0.2	1.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	1995	**0.3**	0.5	1.4	**0.4**	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	1996	**3.0**	2.0	4.3	**3.1**	2.9	—	—	—	—	—	—	—	—	—	—	—	—	—
6	1997	**2.7**	3.9	1.1	**2.5**	2.8	4.4	—	—	—	—	—	—	—	—	—	—	—	—
7	1998	**1.0**	0.3	2.7	**1.1**	0.8	1.0	**1.0**	—	—	—	—	—	—	—	—	—	—	—
8	1999	**1.5**	0.0	3.4	**1.7**	1.3	0.8	**1.5**	1.1	—	—	—	—	—	—	—	—	—	—
9	2000	**1.0**	0.6	3.3	**1.3**	0.8	1.6	**1.1**	0.6	0.2	—	—	—	—	—	—	—	—	—
10	2001	**0.1**	1.9	2.3	**0.1**	0.4	3.1	**0.1**	0.6	1.1	1.1	—	—	—	—	—	—	—	—
11	2002	**1.1**	3.0	1.6	**0.8**	1.4	4.2	**1.1**	1.6	2.1	2.2	1.8	—	—	—	—	—	—	—
12	2003	**0.8**	2.8	2.0	**0.5**	1.1	4.1	**0.8**	1.3	1.9	1.9	1.6	1.1	—	—	—	—	—	—
13	2004	**1.6**	3.8	1.4	**1.3**	1.9	5.2	**1.6**	2.2	2.7	2.8	2.4	1.9	**1.7**	—	—	—	—	—
14	2005	**3.1**	5.5	0.2	**2.8**	3.4	7.0	**3.1**	3.7	4.3	4.4	4.0	3.5	**3.2**	**2.8**	—	—	—	—
15	2006	**2.8**	5.4	0.7	**2.5**	3.2	7.0	**2.8**	3.5	4.1	4.2	3.8	3.2	**2.9**	**2.5**	**1.9**	—	—	—
16	2007	**2.7**	5.5	1.0	**2.4**	3.1	7.3	**2.7**	3.4	4.2	4.3	3.8	3.1	**2.8**	**2.3**	**1.7**	**1.3**	—	—
17	2008	**0.5**	3.4	3.4	**0.2**	1.0	5.3	**0.5**	1.3	2.1	2.2	1.7	0.9	**0.6**	**0.1**	**0.5**	**0.9**	**1.2**	—
18	2009	**17.6**	21.2	12.7	**17.1**	18.2	23.7	**17.5**	18.5	19.5	19.7	19.0	18.1	**17.7**	**17.1**	**16.2**	**15.7**	**15.4**	**15.7**
19	2010	**3.7**	7.1	0.9	**3.3**	4.2	9.4	**3.6**	4.6	5.5	5.7	5.0	4.2	**3.7**	**3.2**	**2.4**	**1.9**	**1.6**	**1.9**

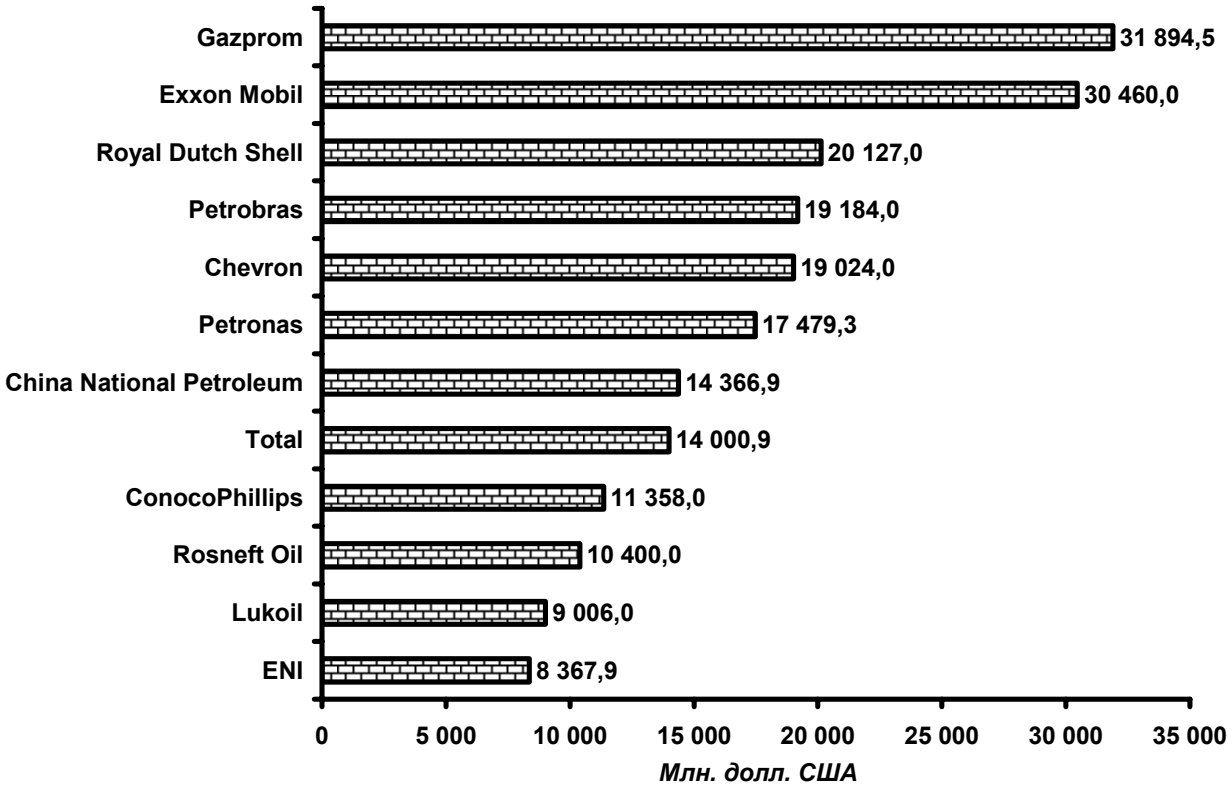

Fig. 1. Energy companies net profit in 2010 (according to *Fortune* [4]).

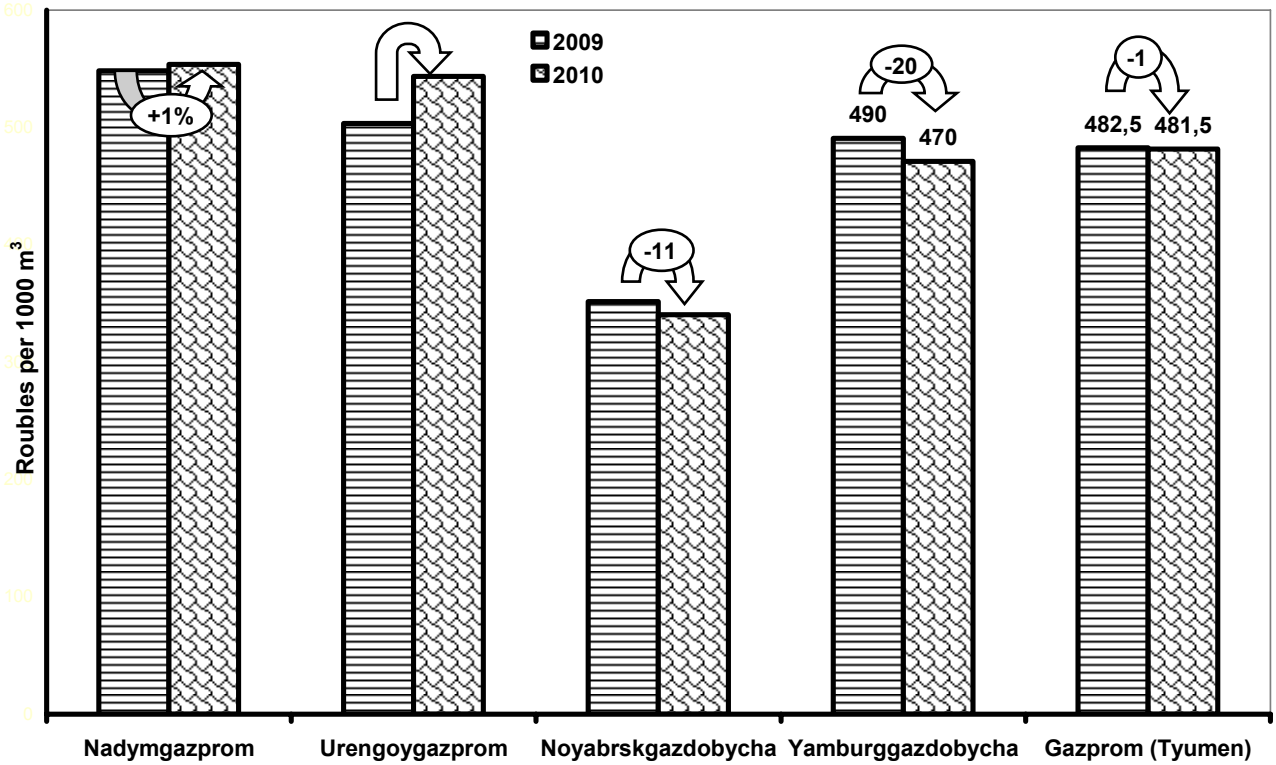

Рис. 2. Unit gas production cost (administrative expenses included) for Gazprom's main subsidiaries in Tyumen region for 2009 and 2010

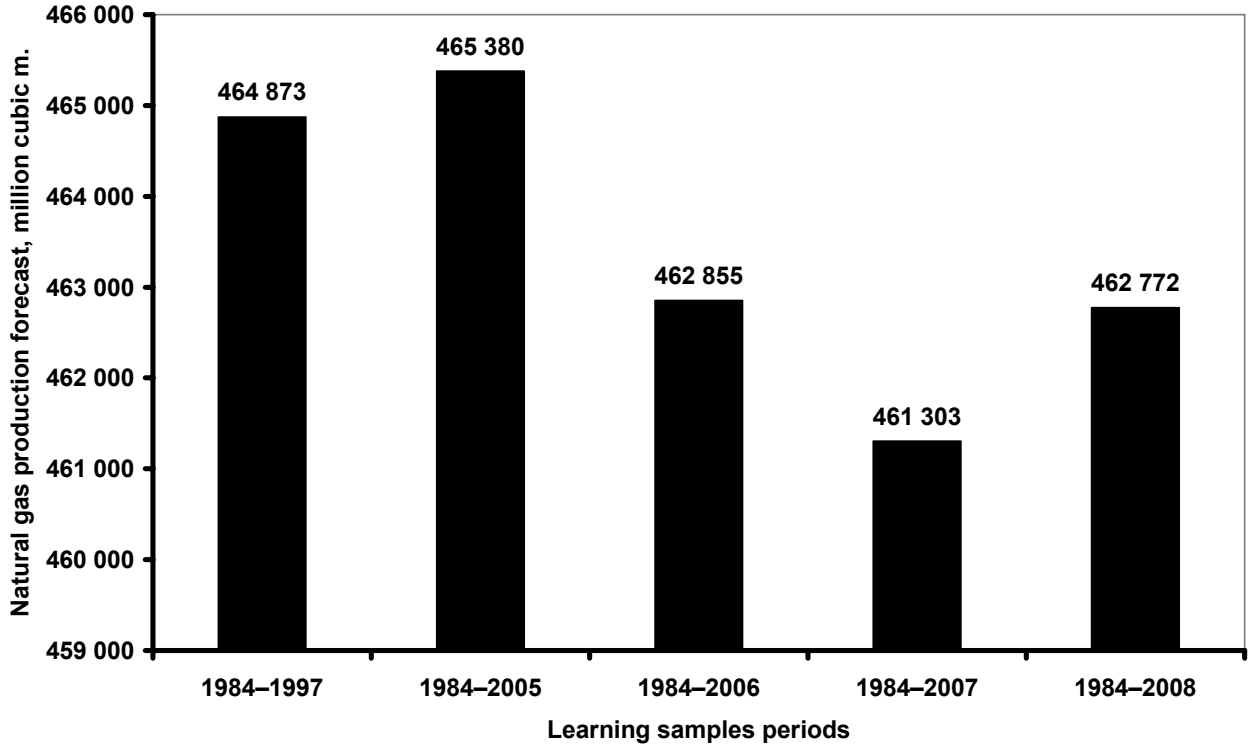

Рис 3. Natural gas production forecast for 2011 based on function $\Gamma_t = e^{\alpha_0}(\Phi_{t-1(1990)})^{\alpha_1+\alpha_2 G_{1963,t-1}}$ estimated from 1984 up to 1997, 2005–2008 (table 1).

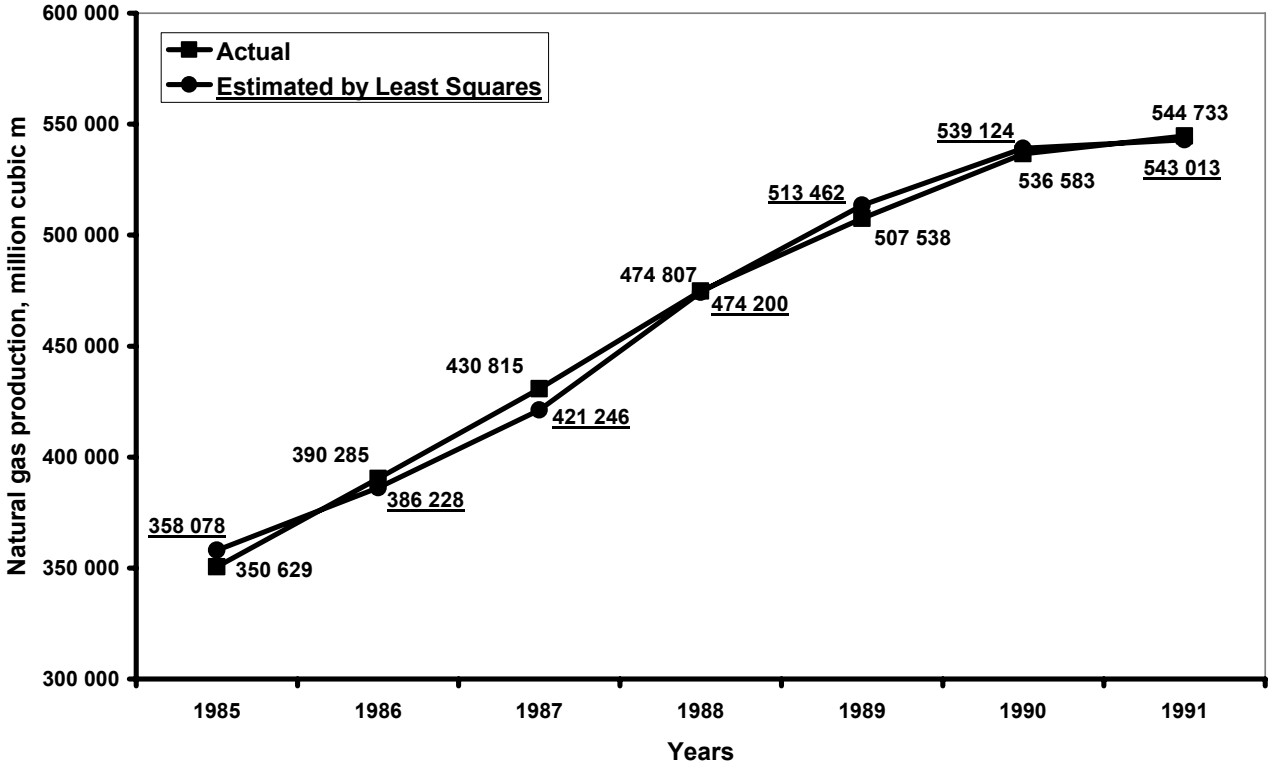

Fig. 4. Actual and estimated by Least Squares natural gas production for function $\Gamma_t = e^{4,61}(\Phi_{t-1(1990)})^{0,56-5,12\times10^{-9}\cdot G_{1963,t-1}}$ estimated within 1985–1991 (table. 1).

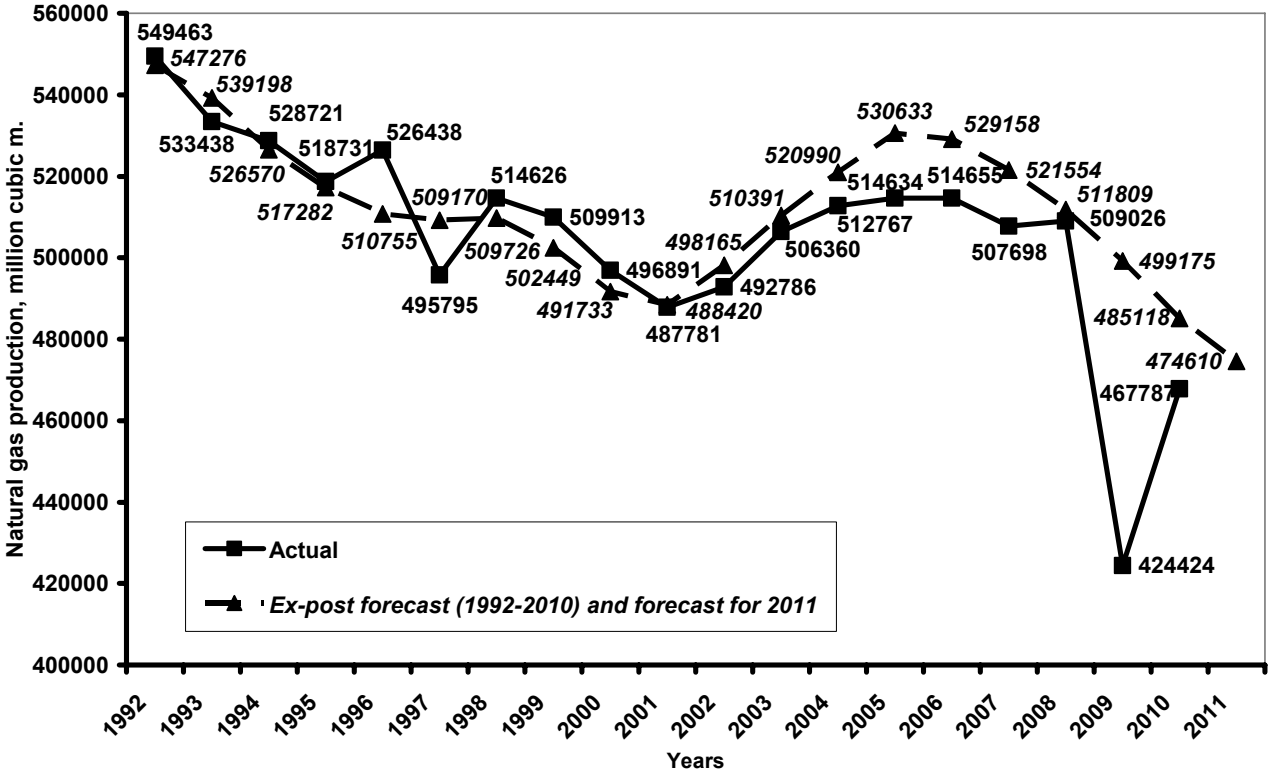

Fig. 5. Actual, *ex-post* forecast for 1992–2010 and forecast natural gas production for 2011 based on function $\Gamma_t = e^{4,61}(\Phi_{t-1(1990)})^{0,56-5,12\times10^{-9}\cdot G_{1963,t-1}}$ estimated within 1985–1991 (table 1).

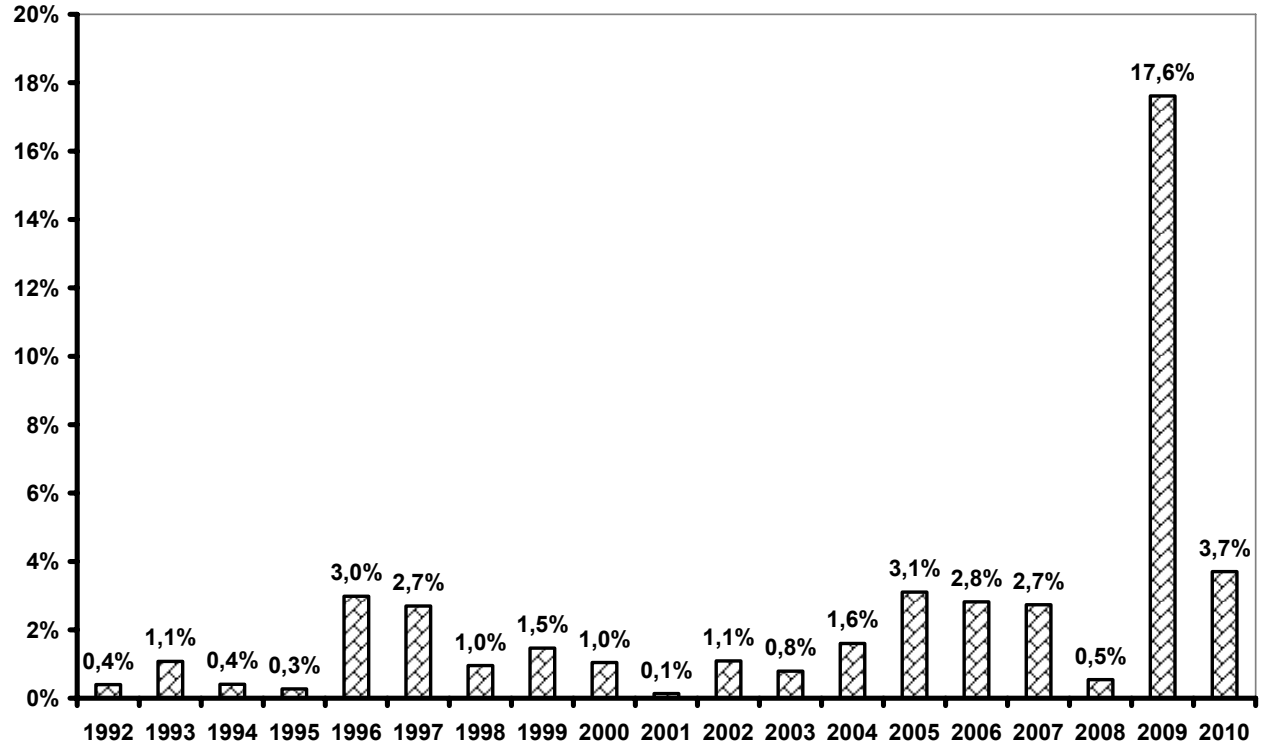

Fig. 6. *Ex-post* forecast APEs for 1992–2010 of function $\Gamma_t = e^{\alpha_0}(\Phi_{t-1(1990)})^{\alpha_1+\alpha_2 G_{1963,t-1}}$ estimated within 1985–1991 (table 2).

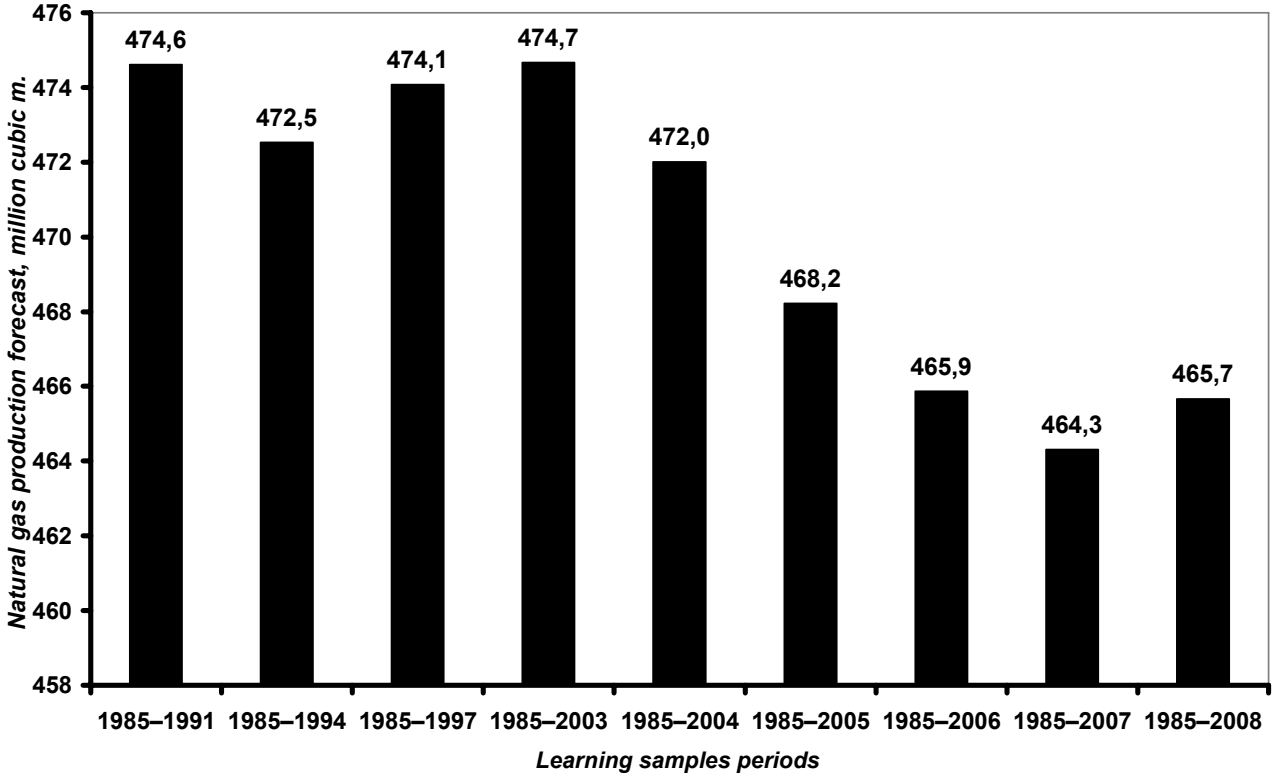

Fig. 7. Natural gas production forecast for 2011 based on functions $\Gamma_t = e^{\alpha_0}(\Phi_{t-1(1990)})^{\alpha_1+\alpha_2 G_{1963,t-1}}$ estimated from 1985 up to 1991, 1994, 1997, 2003–2008 (table 1).