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Russian gas exchange: A new indicator of market efficiency and competition or the instrument of monopolist?

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ABSTRACT

Russian government sanctioned the first gas trade at the Saint-Petersburg International Mercantile Exchange (SPIMEX) in 2012 as a part of the gas industry national strategy.

Federal Antimonopoly Service (FAS) proposed a reform aimed to boost competition among producers and to increase consumer welfare. The proposal included lifting of price floor regulation for Gazprom. That supposed to be a vital element of transition from the government price regulation to SPIMEX benchmark for over-the-counter (OTC) segment.

Structural reform of this scale has never happened in Russia. Furthermore, there are only descriptive studies in the existing literature. This paper aims to fill this gap by testing market efficiency in SPIMEX based on Fama's theory with the well-established model. We test the consistency of gas futures and spot prices for unbiasedness.

We imply this methodology because, in transition to exchange benchmark, it is necessary that price is formed under market forces and is not influenced by players who have market power or dominance. To make a reasonable conclusion, we supplement the simulation by relevant qualitative analysis of liquidity, price differentials between contracts, and market concentration in the exchange.

The goal of the paper is to answer whether the exchange price today can be a benchmark and substitute for the state-regulated price. Combined with qualitative analysis, we argue that the scheduled deregulation, counterintuitively, may improve the dominance of Gazprom in the domestic market.

1. Introduction

Natural gas is one of the most important traded energy commodities along with oil and coal. It has unique physical characteristics, which differ its value chain from others, easy to store energy commodities. Gas transport and storage are more difficult and expensive. For a long time, natural gas transport was limited primarily to pipelines. Therefore, historically, the global gas market had a regional structure. International gas trade soared to only 30% of global production in the last two decades, mostly due to deregulation and new LNG infrastructure (Talipova and Parsegov, 2018).

Today world gas market still has a regional structure with a different level of competition in each region:

1. Fully competitive and mature gas hubs – Henry Hub (HH) in the USA and National Balance Point (NBP) in the UK, respectively;
2. Partly competitive in the EU;
3. State-regulated in Asia-Pacific region.

Russia is the largest gas producer and exporter worldwide. In 2018 it had a record 41.5% share of the European market (Eurostat, 2019). Three companies operate in the market: Gazprom, Novatek, and Rosneft. While Gazprom has a by-law export monopoly for the pipeline gas, it has to compete with two other payers and protect its 51% share in the domestic market.

Russian gas market has two unique features: biased price regulation due to the cross-subsidization of industrial and household consumers, and Gazprom's ownership of the Unified Gas Supply System (UGSS). The state-regulation pricing mechanism and other factors discussed further in Section 2.2., lead to a gradual transition of industrial consumers located in highly profitable regions from Gazprom to independent producers. This transition has eroded Gazprom's profit margin and domestic market share from 80% to 68% since 2010.

At the same time, the antimonopoly service attempted to organize free trading and the appearance of competition. The initiative came from the analysis of complaints of inefficient regulation of the state-owned company at the domestic market, including opacity of

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transportation tariff, unfair competition practices, and slow modernization of the pipeline system.

After lengthy hearings, the government agreed to open a gas trade section at SPIMEX in 2012 (The Government of the Russian Federation, 2012). Trading of month-ahead future contracts was started in October 2014, and day-ahead spot contracts were added in October 2015 for a better balancing of supply and demand. Currently, the gas trading suffers from legal road-blocks limiting secondary trading of purchased gas, restrictions on the maximum allowed trading volumes, and from penalties for buyers failed to consume contracted volumes inherited from take-or-pay Gazprom contracts.

In 2016 FAS suggested a long-term deregulation reform and nominated SPIMEX to be its central element. The vice prime minister supported the proposed changes and pointed out that the SPIMEX price and average over-the-counter (OTC) price should form the new benchmark, which should ultimately substitute the regulated price. Gazprom supported the reform, claiming that domestic competition is unfair due to cross-subsidized pricing favored unregulated producers.

FAS sees the SPIMEX gas pricing as a market indicator in moving toward removing price floor regulation for Gazprom.

The main purpose of the paper is to analyze the primary metrics of the gas exchange as the number of players and their dominant position, liquidity, unbiasedness of futures price to spot at maturity.

To do that we imply the basic market efficiency theory, formulated by Eugene Fama, and its later modifications for energy commodity markets. The analysis includes the investigation of the current level of competition between gas producers and econometric modelling of monthly and daily gas trades in 2014–2019 at SPIMEX.

The paper consists of six main sections.

In the second section, we provide literature review of gas industry deregulation practices, efficient market theory, and Russian gas industry. In the third one, we provide an overview of Russian gas industry competition landscape. The fourth section describes the theory and methodology we used for our study. The fifth section describes the model implied, and the following the sixth section explains data. Finally, the last two sections contain our results, discussion, conclusion, and policy implications.

2. Literature review

2.1. Fundamentals of competition policy for gas industry

John Stuart Mill was the first who studied the fundamentals of natural monopolies and considered an example of the natural gas distribution to households back in 1848. A passionate supporter of the competition, he mentioned gas distribution, water supply, and railway industries as exceptions from his famous “laissez-faire” principle. He noticed that the scale effect in the gas distribution sector is so substantial that the single firm can perform the lowest cost function (Mussey et al., 1911). His work and a work of (Bratt, 1977) founded the main principle of industry regulation - distribution segment should be separated from the production. Later studies argue, however, that there is no one universal solution to protect competition. Though, there are similarities in implemented policies in the USA, the UK, Canada, and the continental part of EU (Jensen, 1992). A later comprehensive survey of the economics of commodity market manipulation caused by liberalized markets and exchange development was provided by (Pirrong, 2017).

2.2. Deregulation of gas markets in the USA, EU, and the UK

The USA was a pioneer of gas industry deregulation. Started in 1978 from the Natural Gas Policy Act and continued until the end of the 1980s, deregulation reduced the share of long-term contracts. The liberalization of well-head prices and transportation (FERC order #436) was an essential part of reform (Henderson, 1986), (Lemon, 1998). Pierce in his work (Pierce, 1988) also notes about the missteps in the regulation of the monopoly price, notably the regulation of area-rates for costs, which caused gas supply shortages. The differences in the prices settled across the end-use markets observed on supply-side (well-head and city gate), and demand-side (electrical, industrial, household, and commercial) markets were analyzed by (Brown and Yucel, 1993). Rosput (1993) discussed the success of the state policy of deregulation after the Natural Gas Policy Act (NGPA).

Researchers concluded that FERC actions increased trade volumes at the spot market and strengthened competition (Arano and Blair, 2008). Brokers were able to transfer their gas between pipeline companies through so-called market hubs. It led to the development of standard gas contracts at Henry Hub (Clancy, 2007) and the decline of long-term contracts volumes with “take-or-pay” clause (MacAvoy, 2001). During the transitional period, several gas shortages and bubbles happened mainly because of the inconsistency of reforms, price regulation, or demand stagnation (Lee, 2004). Later studies, as noted in (von Hirschhausen, 2008), concluded that if the infrastructure appeared as a natural monopoly, then unbundling could support competitive markets and LNG infrastructure development.

The next example of gas market deregulation is coming across the pond, from the UK, at the end of the 1980s. As stated by (Gordon et al., 2003), the fundamental problem in identifying and regulating of natural gas monopoly is subadditivity. According to (Jensen, 1992), there are two fundamental problems for the competition in the gas industry: high transportation costs and regional regulatory differences. Recent work by (Heather, 2010) points out that privatization of British Gas and further market liberalization resulted in the liquid market with balancing, non-physical trade, hedge opportunities, availability of real-time information and National Balance Point (NBP) gas hub development as a benchmark.

Some authors quantified the effect of market deregulation through the cost function (Burns and Weyman-Jones, 1998) or measured the competition through storage capacity auctions (Hawdon and Stevens, 1999) and concluded a high competition among players. Later studies (Panagiotidis and Rutledge, 2007) used the equilibrium between oil and gas prices.

In continental Europe, the first idea to create a united gas market came from the 1950s when the EU was under development. The first Gas Directive appeared in 1997 as an instrument of critical significance for the introduction of some competition. Directive’s likely impact on the European gas market developments is provided by several studies (Percebois and Percebois, 1999), (Radetzki, 1999).

Work of (Brakman and Van Marrewijk, 2009) analyzed the importance of capacity constraints and efficiency differences in the European gas market. They found that ongoing liberalization and competition may not necessarily lead to lower prices. In recent extensive work by (Heather, 2015), the author discusses the concept of a gas hub, the current level of gas hubs development in the EU and their ability to build Gas Target Model (GTM). He states that the only UK and Dutch hubs are developed enough, gives a clear path of how long it takes to develop a benchmark in gas industry.

2.3. Market efficiency theory definition

Development of natural gas trading hubs over the last three decades made it crucial to analyze underlying financial instruments. Fama (1970), as a founder of the theory, postulated that an efficient market should provide accurate signals for resources allocation. It means that firms can make effective production-investment decisions based on efficient market pricing information. On the other side, investors can buy, assuming that securities prices from the efficient market at any time “fully reflect” all available information.

Further works of (Jensen, 1978) and (Ball, 1978) investigated the rising problem of systematic non-zero returns in the period following earnings announcements inconsistent with Fama’s theory. Later (Malkiel, 2003) criticized the theory of efficient markets and argued that

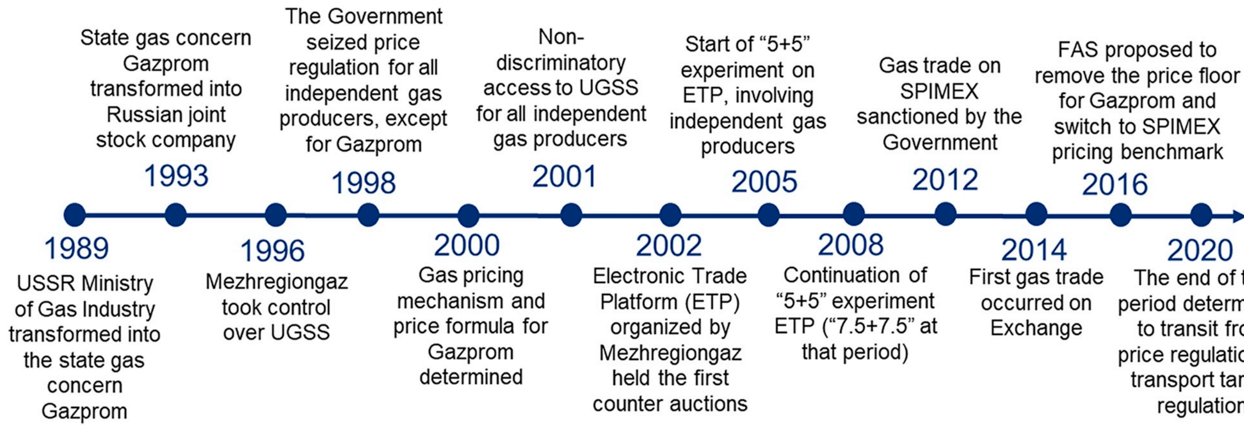

Fig. 1. Most influencing government decisions on reorganization Russian domestic gas market.

news is by definition unpredictable, and, thus, resulting price changes must be unpredictable and random.

2.4. Testing market efficiency in energy commodities markets

With deregulation, the trade of gas moved toward the so-called "gas hubs" basis contracts. HH and NBP are recognized as the most liquid, developed, and mature ones. Walls in its work (Walls, 1995) conducted one of the first studies of gas hubs for the monthly gas futures in the USA. He concluded that the market is consistent with the efficient market theory. Previous studies of (De Vany and Walls, 1994) were focused on an application of network connectivity methodology to find the convergence between spot and futures prices. The recent paper of (Mishra and Smyth, 2016) also tried to answer the question of whether spot and future prices are predictable and confirmed gas market efficiency in the USA. More detailed analysis of modelling and testing market efficiency in the gas market is given in the International Monetary Fund (IMF) working paper of (Reichsfeld and Roache, 2011). Two other comprehensive empirical papers (Chinn and Coibion, 2010), (Reeve et al., 2011) tested the market efficiency of energy commodities and forecasting power of futures and spot prices.

2.5. Gas market regulation problems in Russia

Energy regulation in the post-soviet countries, including Russia, is an attractive field of research due to a unique structure of gas industry caused by decades of a command economy. Restructuring of the post-soviet gas sector is described in (Leslie Dienes and Dobozi, 1994) and (Von Hirschhausen and Engerer, 1998) After the recession of the 1990s, the regulation in Russia was focused on keeping retail gas prices low and government support of selected industries (Evstratov et al., 2016), (Henderson et al., 2018), (Henderson, 2013). This policy led to a lack of competition in the mid-2000s, which raised questions about whether deregulation may attract private investments (Grigoryev, 2007) and what is a fair domestic gas price (Orlov, 2015). The position of the Gazprom and other gas producers was already investigated by (Lunden et al., 2013) using the qualitative descriptive method.

In contrast to above mentioned evolutional liberalization in the USA and single-step privatization of British Gas monopoly in the UK, in Russia, the reorganization actions due to their inconsistency did not generally shift the state of competition in the industry, except for price deregulation for independent producers (Vasiliev, 2000).

In 2016 FAS proposed to deregulate the price further and remove the price floor for Gazprom on the OTC regulated segment. As a substitute, FAS planned to accept the price at SPIMEX gas section as a new benchmark. This proposal was analyzed via microeconomic modelling by (Talipova, 2018). In the research conducted by (Henderson et al., 2018) qualitatively described the recent history and the current state of gas trading. Our contribution to the existing body of knowledge contains a quantitative analysis of gas futures and spot prices at SPIMEX as well as discussion of the efficient market theory applicability to gas trade in Russia not available before.

3. Natural gas industry organization, current state and the proposed reform

3.1. Russian gas industry reorganization

Gas industry in Russia inherited its unified pipeline infrastructure from the former Soviet Union. In 1993 Gazprom was formed as the national state-owned company that accumulated all the assets. Fig. 1 shows the main government decisions to reorganize the Russian domestic gas market.

In 1996 Gazprom Mezhregiongaz (from now on Mezhregiongaz), wholly owned by Gazprom, took control over UGSS – the entire system of pipelines in the country. Government Decree #1021 (The Government of the Russian Federation, 2000), seized government regulation of natural gas prices for all producers, except for Gazprom, who kept control over pipelines. According to Government Resolution № 1021, any natural gas producer in Russian, who is not Gazprom's affiliate, is considered as an independent producer.

Resolution #1021 of December 29, 2000, determined gas pricing mechanism for Gazprom. Amendments to this Resolution became prerequisites for market liberalization and a transition from regulated price for Gazprom to the regulation of transportation tariffs for all players (The Government of the Russian Federation, 2002).

The second substantial change happened in 2002 when Mezhregiongaz created the first experimental Electronic Trading Platform (ETP) with counter auctions trading (The Government of the Russian Federation, 2000). Unfortunately, the experiment was declared unsuccessful and closed at the end of 2009.

Despite all declared attempts to increase competition, international experts agreed that there was no real reform. International Monetary Fund (IMF) recommended improving governance of all "natural" monopolies in Russia, including Gazprom. These recommendations included preparation of restructuring/privatization plan, enforcing of tariff regulation, and incentivizing of market competition (Odling-Smee, 2014). In early 2000, IMF expert concluded that the only significant action at that time was a merge of gas distribution companies. This decision resulted in development of gas transmission tariffs system and price regulation for gas monopoly. Since 1998, the Government and infrastructure monopolies have been very unwilling to start structural reforms (Vasiliev, 2000).

Nevertheless, further attempts to enlarge competition were

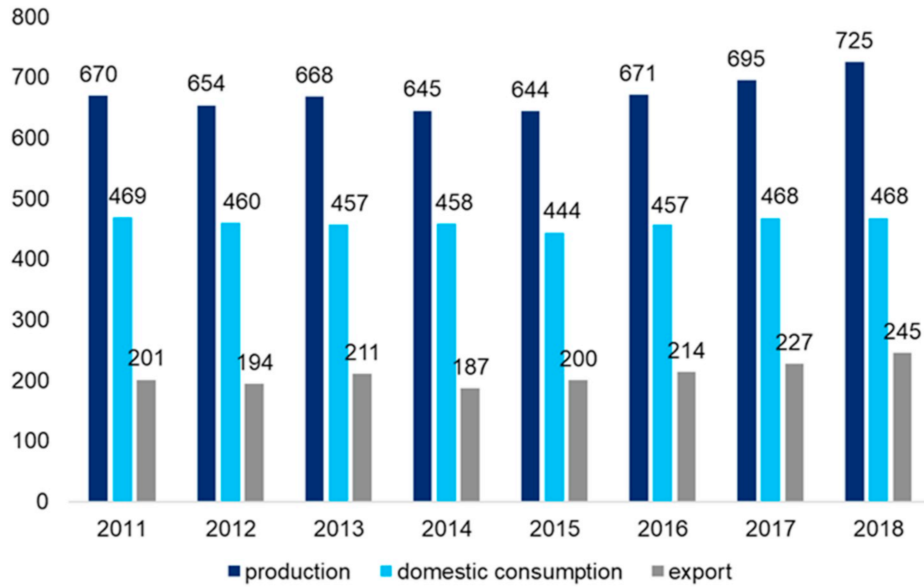

Fig. 2. Gas Production balance in Russia in 2011–2017, (bcm/year). Source: Ministry of Energy, Gazprom, Skolkovo Energy Center.

undertaken. In 2001 the government amended the Decree #426 dated July 1997, allowing the right of access to UGSS on a non-discriminatory basis, but only if Gazprom had free pipeline capacity (The Government of the Russian Federation, 1997). However, in reality, Gazprom provided access in "first come-first served" regime.

The later amendment to this Decree, introduced in 2012, obliged Gazprom to provide the pipeline transport to any seller at the newly established natural gas trading section of SPIMEX. The first gas trade occurred in October 2014. The intention was to create an open gas market, increase competition, and form a fair price. By the term "fair price" here we use the same language as it was used by FAS and SPIMEX officials: "…well-timed transition from state regulation of gas prices for Gazprom to the regulation of a single gas transportation tariff will allow to identify the fair market price of gas and launch an effective mechanism for investing in production and gas transportation assets in order to maintain a balance of supply and demand on the Russian gas market in the long term" (Cherny, 2019).

In 2016 FAS proposed a reform package for gas market deregulation till 2020. Following the published Decree draft, the lower limit of the regulated gas price for Gazprom would be dropped, and the SPIMEX price indicator would become a new market benchmark as it was planned previously.

At the same time, FAS allowed UGSS to stay as a part of Gazprom, therefore maintained its export monopoly and prohibited international competition of domestic producers. This status quo was (naively) believed to secure dominance of Russian gas in the EU market.

The proposed reforms are also controversial since price deregulation does not mean market deregulation. The proposed pricing mechanism in the presence of an active player with spare production capacity may allow market manipulation by dumping in the growing unregulated segment.

As we show in this paper, the opposite transition takes place - unregulated ("market") price is, de facto, is closely tied to the regulated one with some discount. Besides that, the cross-subsidization remains the industry practice and further distorts the price environment far from pure competition.

3.2. Current state of industry and competition

Natural gas industry is an important part of the Russian economy. In 2018 the total production volume was 725 bcm, a record-high for the past two decades, surpassed only by the USA. Russia is the leader with 245 bcm of gas exported in 2018 (Fig. 2). Despite the existing transit and contractual disputes, the export to the EU accounts for more than 90% of the total export. It has been growing for the third year in a row and by 2018 reached around 200 bcm.

In the domestic market, natural gas is used by households for heating, on power plants (more than 70% of total fuels consumed accounted for natural gas) and used in many industrial sectors, for example, agriculture, metallurgy, and chemistry. Gas accounts for 52% of the total energy consumption of the country. It is no wonder why the gas industry directly generates about 10% the GDP, and export of natural gas is a substantial part of the federal budget (with other energy sources - almost 50%).

Therefore, the gas industry is a target for government regulation.

The domestic market is divided into regulated and unregulated segments. Gazprom is the only supplier in the regulated segment and is responsible for securing supply for households. The government regulates wholesale gas prices for Gazprom and its affiliates; tariffs for transportation services through UGSS for independent producers; additional payments for distribution.

The final price for the industrial sector includes the regulated/not regulated wholesale price, regulated gas transportation tariffs; special surcharges to the tariff, and payment for distribution services. The indexation by the Ministry of Economic Development of regulated portion happens once a year, at the beginning of July, so the regulated price remains constant for the entire calendar year, smoothing otherwise severe gas price seasonality.

Two decades of the government decisions, described in more details in Section 2.1, were based on assumptions which are no longer valid. The price liberating for independent producers was expected to be a driver for higher demand and economic growth. Government supposed that independent producers would satisfy new consumers without collision with Gazprom. In reality, however, the demand stagnated, and economic growth slowed down.

As a result of these decisions, independent producers began to solicit Gazprom's consumers in higher-margin regions by offering undisclosed discounts to the regulated price. Thus, even in the unregulated segment of independent producers, de facto, the price is not determined by the natural law of supply and demand but simply is tied to the price of Gazprom. Therefore, Gazprom argues that its price should be deregulated as well to make compete with independent producers fair. The following argumentation applies:

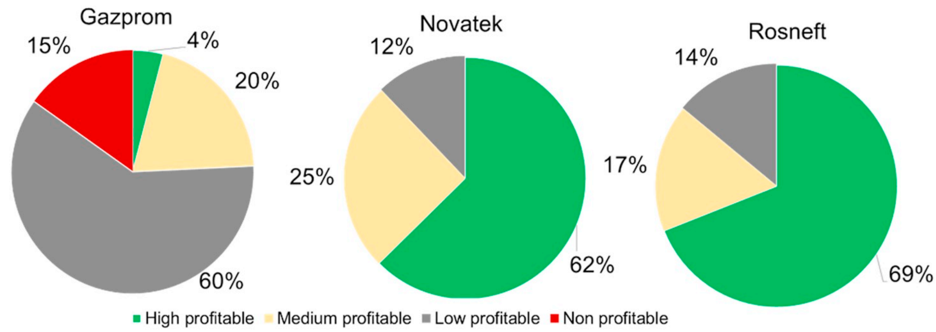

Fig. 3. Domestic gas sales profitability structure by companies and types of profitability across geographical regions in 2017,(%). Source: Gazprom.

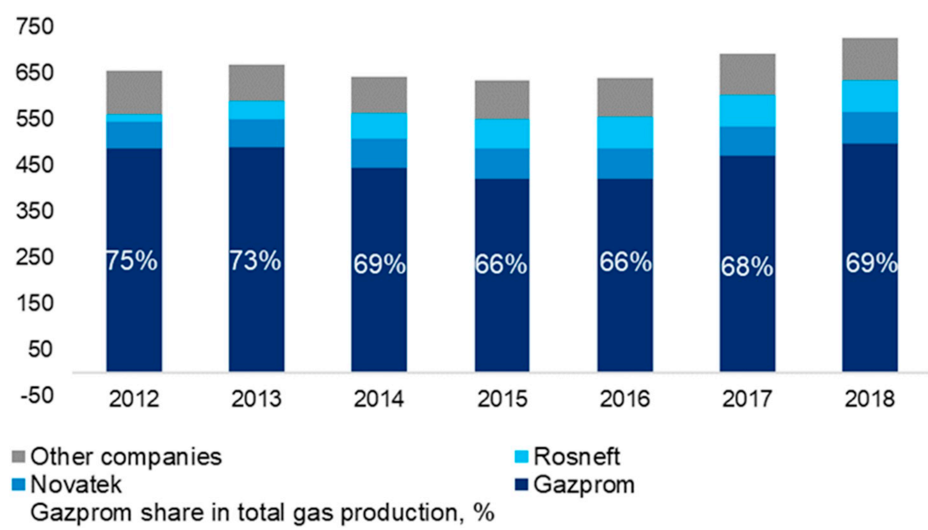

Fig. 4. Gas production in Russia by company (bcm/year) and Gazprom's share (%) in 2012–2018. Source: Ministry of Energy, Gazprom, Novatek, Rosneft.

4. Independent producers do not sell gas to the final retail customer;
5. Independent producers compete with Gazprom for big industrial consumers in high-profitable regions and take no responsibility to supply households and industrial consumers in low profitable and unprofitable regions (Fig. 3);
6. It is necessary to move away from price regulation to transport tariff regulation and implement the reform supported by the Russian President.

Though Gazprom is a guaranteed supplier, and reform does not apply to households market segment, it still receives a portion of the profit of consolidated revenue from transportation tariff. This tariff has been frozen since 2016 for independent gas producers. The social burden effect for the guaranteed supplier is caused by so-called cross-subsidization, when the prices in regions are regulated to the level of price parity, considering the gas field-customer distance and related transportation costs. Despite that, the final gas price for households is insignificantly lower than that for industrial consumers (Appendix 1).

The share of independent gas producers has increased and today Gazprom share in the industry is 69% of the total production including the export volumes (Fig. 4). The gas market has turned from a monopolistic into oligopolistic one. Top-three suppliers accounted for 87% of

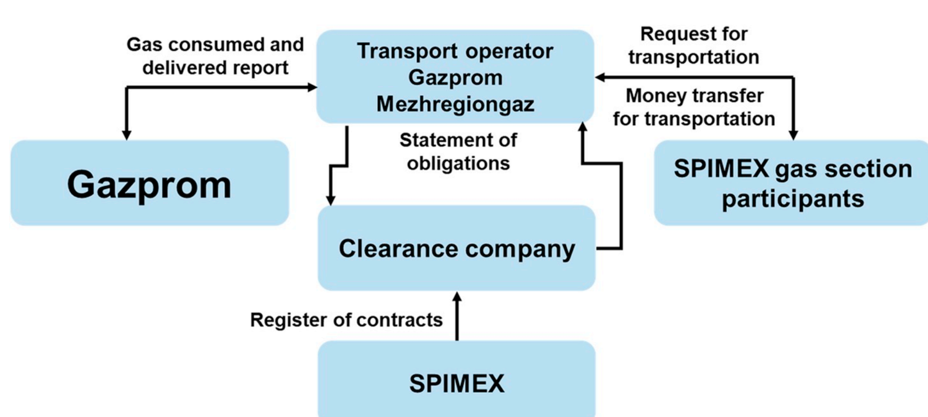

Fig. 5. Natural gas trading mechanism in SPIMEX. Source: FAS, authors.

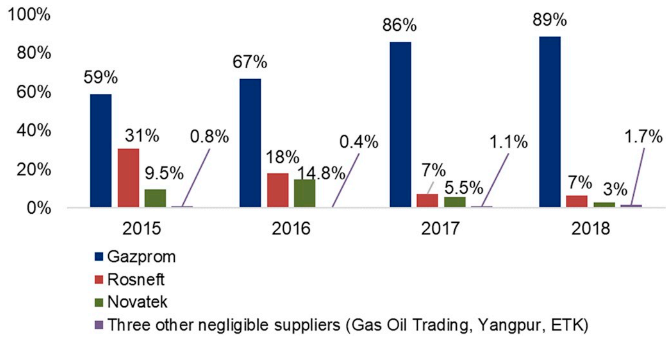

Fig. 6. Gas volumes traded in SPIMEX by sellers, 2015–2018, (%). Source: SPIMEX, authors.

gas production in 2018. The remaining producers sell natural gas to Gazprom for processing and resale.

3.3. Qualitative analysis of gas trade on SPIMEX

In this subsection, we qualitatively analyze and demonstrate why the price at the exchange cannot be an effective market indicator.

Futures and spots are two instruments currently traded on gas exchange. Once a month, futures trading with delivery for the next month is held. There is also a special spot contract trading for the next business day.

As of Jule (2019), more than 40 customers from over 60 regions of Russia participated in trading at SPIMEX with three main gas producers as described in the scheme in Fig. 5.

There is no balancing on the exchange, no possibility of reselling not consumed gas, no daily gas volume measurement. Therefore, market participants only after a month, when the futures mature, know about how many volumes were de facto consumed. Since there is no secondary market, only qualified brokers can buy gas at the exchange on behalf of clients.

Deputy head of FAS gives the following argument: “Free market prices are slightly lower than regulated prices on average. In certain periods of increased demand, they may be ahead of them, but in general, the consumer has the opportunity to gain the value by legalizing prices in the domestic OTC market”. Unfortunately, since the entire market focuses on OTC contracts, which account for ~95% of all trade, it cannot be said that a lower price is an indicator of the market. One also cannot be sure that such a big player as Gazprom does not move gas volumes out of price regulation through trading them at the exchange.

By law, Gazprom may sell up to 17.5 bcm/year at the exchange keeping its share below 50%. On the one hand, this limit reduces overall liquidity. On the other hand, the regulator initially set 50/50 parity so that Gazprom cannot dominate the trade. Therefore, the only strong motivation for independent producers to trade at the exchange is guaranteed access to the transmission system. Independent producers are required to disclose to Mezhregiongaz their trade volumes for transportation planning a month ahead of physical delivery. Therefore, Gazprom has a unique advantage of knowing in advance the market supply and free transport capacities for each balancing point and potentially use this information against other participants.

Despite an increase in trading, from 7.6 bcm in 2015 to 20.3 bcm in 2017, the exchange is still in little demand from gas producers and consumers. As a matter of fact, in 2018, trading volume fell to 15.1 bcm, with less than 5% of the total industrial consumption traded at the exchange.

In 2018, Gazprom’s share in sales on the exchange reached a record of 89% (Fig. 6). FAS ignores this fact.

The next indicator of effective exchange trading is a level of concentration on the demand side and a large number of independent buyers. The main problem here is the share of Gazprom affiliates. On average, all the affiliates buy more than 50%, in only five months during the entire period this share was slightly less than 50% (Fig. 7),. Today their share steadily exceeds 60%. What is more remarkable, 2/3 of the total volume sold by Gazprom is bought back by Mezhregiongaz, the company that has all the information about the volumes of other sellers and free capacity as discussed previously.

Combined purchases (mln RUB), and Gazprom share (%) in SPIMEX, 2015–2019. Source: SPIMEX, authors.

Therefore the exchange is a promising tool for transfer pricing, bypassing to price regulation, and margin redistribution along the value chain for tax purposes from upstream companies (sellers) to middle stream (mainly Mezhregiongaz) and back if needed.

For example, it lawful for affiliates to purchase gas from Gazprom at the exchange with a price lower than the regulated one. This gas than can be sold to the final consumer at the regulated price when there is an arbitrage opportunity to do so. FAS and SPIMEX have done close to

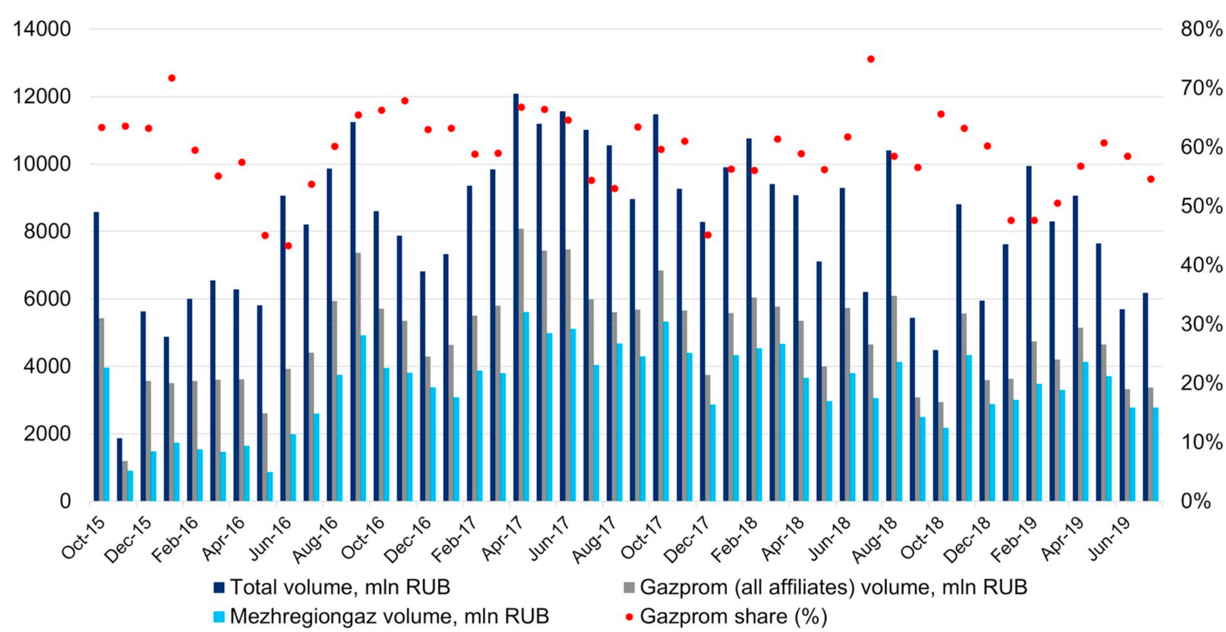

Fig. 7. Total gas volumes (mln RUB), Mezhregiongaz purchases (mln RUB), all Gazprom’s affiliates.

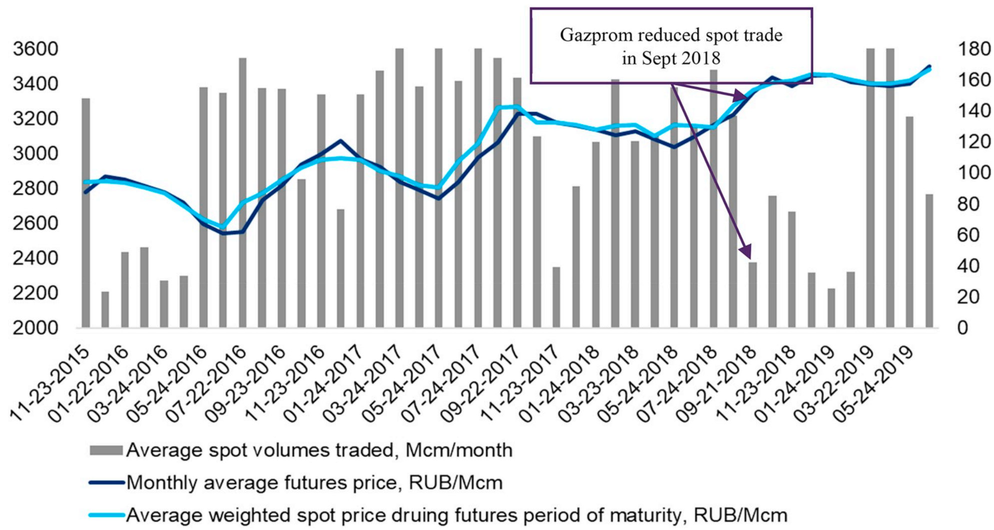

Fig. 8. Futures prices (RUB/Mcm), weighted-average spot price for the corresponding futures' delivery month (RUB/Mcm), spot contracts monthly volumes (Mcm/month) in 2015–2019. Source: SPIMEX, authors.

nothing to fix that loophole even though signing a contract by the same company as a buyer and seller among other bylaws is explicitly prohibited by the trading rules of the exchange.

Since 2018, Gazprom has sent to the government several appeals in order to remove restrictions on the volume cap motivating it by the need for a more liquid trade. At the moment, there are no expectations that independent producers will significantly increase production and supply at the exchange to keep their share. More importantly, there is no additional demand from independent buyers because GDP growth is currently below 2%.

Therefore, if the cap would be lifted, the exchange will more likely become a trading platform for internal Gazprom transactions as it was with Mezhregiongas ETS.

In the worst-case scenario, the exchange will become not an indicator of the price of supply and demand, but an indicator of the price of Gazprom, as the dominant producer when price regulation is lifted.

With more detail analysis of the trading data, some anomalies may be observed (Fig. 8). Let's consider two time series of futures and spot prices. As a spot price here, we take the weighted-average spot price for the whole month period of the future contact delivery (usually from 22nd day of the month of trade to 20th day the following month).

Firstly, since there is no secondary market, the only arbitrage opportunity for bidders arises only if one of them has a material non-public information.

Secondly, the monthly-averaged spot prices in summer of 2017 and 2018 are higher than futures prices, while the opposite should be true for low demand periods.

Furthermore, the volumes of spot traded in summer for two years in 2017 and 2018 are higher than the volumes of spot traded in winter. Such price and volumes motions usually occur with increased demand caused by serious seasonality or temperature fluctuations. For example, there may be an extremely hot summer, in which demand for electricity increases and if it is generated from gas, then demand increases sharply. There were no severe fluctuations in any of these periods (here we refer to open news about temperatures[1]). Contrariwise, in winters the spot is aligned with the futures. In some cases spot prices lower, which is not typical for such a commodity.

Thus, having no apparent reasons for such anomalies in gas exchange trading throughout the analyzed period, we assume that among the players there is one that has more information, uses it for its purposes and thereby distorts the market. We test this on the second model presented and described below.

On September 28, 2018, Gazprom, having cut gas sales on the exchange in SPIMEX by almost half, completely stopped a day-ahead selling. Gazprom commented that the company did not participate as it "realized all planned volumes at the auction a month in advance" (on September 24), but "plans" to take part in daily and monthly periods in October bidding. In response to this incident, FAS sent a warning to Gazprom that it could not leave the exchange (here we refer to the open news[2]).

Such cases create risks for consumers, which may lose confidence in the exchange and uninterrupted trading and move back to the over-the-counter segment.

Finally, the definition of a benchmark should be given to clarify our point about the contradictions of proposed reforms. The definition of a gas hub and the evidence that it can be a benchmark is well discussed by (Heather, 2015) relatively to the EU Gas Target Model (GTM). He states that the first prerequisite for a liberalized wholesale market and a successful hub is fully liberalized industrial and residential sectors. It leads to the wholesale sector requiring and using traded hubs to satisfy the risk management of their portfolios. Therefore in the UK firstly British gas was privatized and in EU liberalization started from the unbundling transportation system from production (Third Party Access, TPA). Secondly, a so-called "path to maturity" is well described. It consists of nine consecutive steps, including TPA, balancing rules, non-physical players enter, liquid forward curve. Five main metrics do make a gas hub a benchmark: liquidity, volatility, anonymity, transparency, and trading volumes.

We analyzed all these elements implying to the SPIMEX gas exchange and barely see full achievement at least one or two of them. The SPIMEX is partly transparent in terms of prices because we do not access to the open-close prices and volatility during the trading session. We either cannot conclude that there are a balancing market and non-physical players. Besides, many anomalies can observe in spot and forward curves. TPA access, in reality, is just guaranteed access to Gazprom's UGSS.

That is why we expect that transition to SPIMEX pricing from price regulation at present would cause risks for both sellers and consumers due to the following:

[1] URL in Russian: https://www.kp.ru/online/news/2854612/.

[2] URL in Russian: https://neftegaz.ru/news/gosreg/197570-fas-gazprom-otreagiroval-na-preduprezhdenie-po-prodazham-na-birzhe/.

- More than 80% of all gas at the exchange is sold and more than 60% - is purchased by companies controlled by Gazprom. While it's still lawful at SPIMEX, such deals may distort price indicators and should be excluded from the future index. It also demonstrates a little interest of other players to trade at SPIMEX;
- The tiny volume of gas sold at the exchange (15 bcm a year) is too small (comparing to domestic consumption of 450 bcm a year) for the market to be called a liquid one;
- UGSS remains under Gazprom ownership. Despite the non-discriminatory access, revenue from transportation tariffs remains inside the company as a part of gross revenue, which makes the position of other producers' unequal.

Without a substantial increase in volumes of other sellers and the admission of more non-physical players and balancing trade, SPIMEX can eventually become only a platform where Gazprom can lawfully dump prices and intercept buyers.

4. Methodology

A large number of researchers address the problem of the Russian gas industry reorganization. Some papers contain only descriptive methods, while others use equilibrium models to identify the fair market price. Though these works addressed the problem of industry structure and the dominant position of Gazprom, they lacked to assess trading at SPIMEX.

Our contribution to existing knowledge is the analysis of the market efficiency based on actual trading data in SPIMEX gas exchange. Deregulation of the price floor for Gazprom and transition to the market indicator is a strategic government decision which requires comprehensive assessment. In this paper, we address this decision and provide a conclusion about whether the current market is capable of replacing government regulation of the domestic gas market. It should be noted that we do not aim in this paper at identifying the evidence of price manipulation or forecast the futures prices. This topic, however, may become a fruitful area of research in the future.

Stock markets play an essential role in the national economy. They bring sellers and buyers together, reflecting current market supply and demand. Not surprisingly that all players expect the market to be a proper allocation for their commodities and capital, and that prices contain all the information. As mentioned previously, it is called efficient market. If on the exchange one player obtains exclusive information and can set the price, while other players will have to follow, then such exchange can not be considered as a market. All the more, it is not reasonable to take it as an indicator for the OTC market. The current state of the exchange shows the dominance of the state-owned company, small volumes traded, and a lack of brokers activity. It is the main reason for testing market efficiency and choosing the model described below. We test whether the market for natural gas futures and spot is consistent with market efficiency theory.

Some notes should be mentioned before the model description. First, some authors notice that if energy commodities are storable, spot prices reflect both current supply and demand conditions. They reflect expectations for those conditions in the future because market participants can arbitrage between the current spot price and the futures price (Reeve et al., 2011). In our paper, this thesis is not applicable due to the Gazprom's monopoly rights on the gas storages, and complicated access for independent producers.

Second, for energy commodities, the net long positions of producers/users are relatively close to zero (Reeve et al., 2011). This thesis is also not taken into consideration because of the too low liquidity on the exchange. All producers rather hedge their sells with long-term OTC contracts, than with futures and forced by the FAS to sell the gas on exchange.

Third, we do not set the aim to forecast futures prices. Though it is a common part of such analyzes (Chinn and Coibion, 2010), we stay apart from the prediction power estimation and evaluate the only market efficiency.

Finally, according to the chosen methodology, we consider the theory that the futures price explains the spot price, which assumes that all the information is in the market. We assume that in the absence of the secondary market and daily measurements of futures consumptions, there is no arbitration for all players even within a month, and the model should show effectiveness. It will help us to make sure completely that within a month there is no arbitration and no market player uses its power and information available for its benefit. It is an essential assumption because otherwise, players with exclusive information exist in the market. To test it, we evaluate the second model (Model 2). The difference is in time series. We use weighted-average spot prices as a corresponding price to the futures.

An extensive part of the research literature uses a well-established regression model described in Section 1, which we imply. Two important remarks here are that market efficiency has strong and weak forms. Weak form means that at least futures price explains the spot price at the corresponding date. In the model, it is expressed in one linear restriction when the β coefficient is equal to 1. A strong form of market efficiency is that futures market is unbiased, and all information is in the market, or there is no risk premium. In the model, the joint linear restriction of $\alpha = 0$ and $\beta = 1$ is tested.

5. Model description

This chapter describes the model specification to test market efficiency used in the analysis. The methodology has been explained in previous studies described in Section 1. In theory, futures price are considered to be good predictors of spot prices. The simple relationship between the futures price and the expected spot price at delivery date is as follows:

$$F_T = E[F_t|I_t] \quad (1)$$

Where F_T is the futures price at maturity, which is equal to the daily spot price at maturity, E is a mathematical expectation operator, F_t is the futures price at time t for delivery at time T, I_t is the information available at the time t. If the information set is $I_t = F_t, F_{t-1}, \ldots F_{t-n}$ and $I_t \ni I_{t-1} \ni \ldots$, then the testing procedure assumes a weak form of market efficiency. Strong form requires I_{t-1} to contain all publicly available information.

Market efficiency states that futures price converges with the spot price at maturity and contains a risk premium. To do that, Eq. (1) expands into the following:

$$F_t = e^{-\rho(T-t)} E^f(t)[S(T)], \quad (2)$$

where $E^f(t)[S(T)]$ - is the expectation in the futures market in period t of the spot price in period T, and ρ is the continuously compounded rational expectations risk premium.

Eq. (2) assumes that there are no preliminary investments that deliver return equals to the risk premium. To obtain the linear relationship between the futures price and spot price, we take the logs of Eq. (2), and from now on we take the length of the forecast as k=T-t which is equal to one month in our model:

$$f_{t,t+k} = -p_k + E_t^f s_{t+k} + \xi_T \quad (3)$$

In Eq. (3), $f_{t,t+k}$ – is the log futures price, p_k – is the (assumed constant) risk premium scaled to the length of the forecast horizon k, $E_t^f s_{t+k}$ - is the period t expectation in the futures market of the log spot price k periods ahead.

To interpret the formula into the spot price definition because we test the theory which states that futures price explain spot price, we subtract the current log spot price s_t from both sides of Eq. (3). The meaning of Eq. (4) is that the current spread between the futures price and spot price (the basis) on the left side is equal to the expected change in the spot

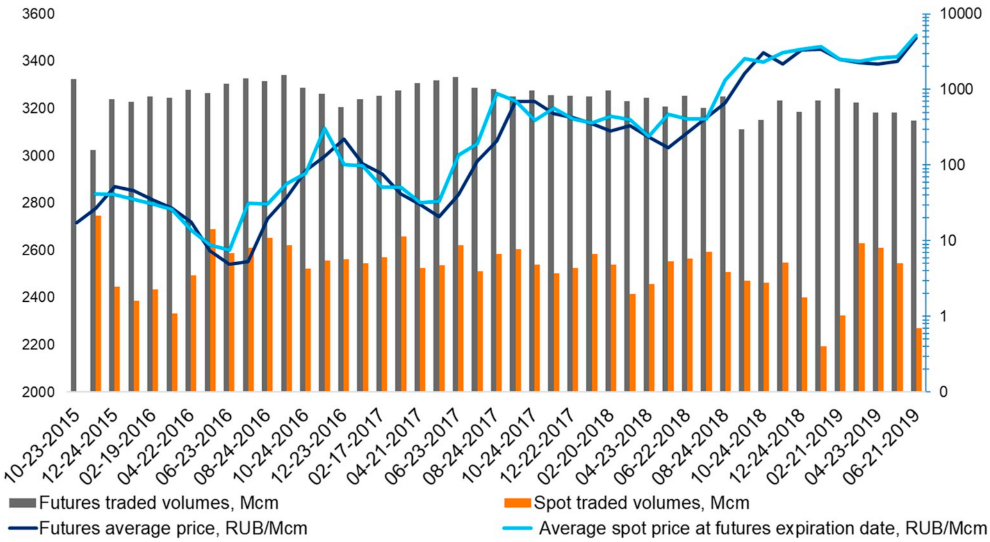

Fig. 9. Monthly (futures), spot gas trade volumes (Mcm), prices (RUB/Mcm) summary 2015–2019 (volumes data presented in log scale, two order difference, actual spot volume is less than 1% from futures volume). Source: SPIMEX.

price for the period until delivery less the risk premium on the right side.

$$f_{t,t+k} - s_t = -p_k + E_t^f(s_{t+k} - s_t) + \xi_T \quad (4)$$

Now, we transfer to the right side of equality the change in spot price and consider it as a dependent variable which is explained by the basis (explanatory variable) and estimate the following regression which gives us the market efficiency test:

$$s_{t+k} - s_t = \alpha + \beta\left(f_{t,t+k} - s_t\right) + \xi_T \quad (5)$$

We take risk premium $-p_k$ equals α so that the parameter α is interpreted as the constant component of the risk premium. If the basis $(f_{t,t+k} - s_t)$ provides an unbiased forecast of the future spot price, then two conditions must be met simultaneously in the model: $\alpha = 0$, $\beta=1$, and ξ_T has a conditional mean equal to zero.

This regression is typically estimated in the market efficiency literature, including for energy commodities (Reichsfeld and Roache, 2011). To test the market efficiency, therefore, joint linear restriction of $\alpha = 0$, $\beta=1$ in the null hypothesis is performed.

In our paper, due to our aim, we are less interested in proving the power of the futures price to forecast spot price. We rather focused on testing in-sample prediction properties such as efficiency and unbiasedness. Thus, noted by (Clements and Hendry, 1998), these properties are often considered to be minimum requirements for optimal or rational forecasts.

Consequently, in the second model, we use the same regression and the same model specification with the only difference in spot prices time series. Here spot price (s^*_{t+k}, s^*_t) reflects weighted-average price during the month of futures expiration:

$$s^*_{t+k} - s^*_t = \alpha + \beta\left(f^*_{t,t+k} - s^*_t\right) + \xi_T \quad (6)$$

The same joint linear restriction $\alpha = 0$, $\beta=1$ for a strong form of efficiency and $\beta=1$ linear restriction for a weak form of efficiency are tested.

6. Data

In our analysis, we use open data of futures and spot daily weighted-average prices from Nadym gas balance point, testing the hypothesis of market efficiency. This balance point has been in operation from the beginning of the exchange trade and it accounts for the ~70% of the volume traded at SPIMEX. For the sake of transparency and repeatability of results, we provide the raw data for futures and spot prices in (Appendix 2).

To run the Model 1, we use monthly futures price and spot price at the corresponding date when the futures maturation. The futures price is defined as a weighted-average at the trade date (usually 22nd day of the month). Spot price Is defined as a daily weighted-average at the date of futures maturity. Analyzed data of futures and spot prices are given in Fig. 9.

To run the Model 2, we use monthly futures price and a weighted-average over the corresponding futures expiration period (one month). The futures price is defined as a weighted-average at the trade date (usually 22nd day of the month). Spot price is defined as the monetary value of all signed spot contracts divided by total contracted spot volumes over the month. This month is counted from the first to the last day of the futures maturation. In this model, we use average prices because the buyer can consume any portion of futures contracted gas as needed at any date during the period of maturation. Therefore we expect the convergence of these two averages at the date of maturity.

A weak upward trend can be observed. One of the most eye-catching evidence is the spread in futures and spot prices in the summer for three years from 2016 to 2018. While in summer 2016 it might be driven by relatively warm weather, other spreads cannot be explained. The seasonal spread in winters is barely observed in the same period.

7. Results and discussion

Before the regression model estimation, we run the Augmented Dickey-Fuller (ADF) test as we follow the assumption that the time series stationaries. ADF test has been used for a different type of processes: random walk with drift, random walk without drift, random walk with non-zero drift. All the time series we used in Model 1 and Model 2 show stationarity.

Then we take lags of spot prices logs $(s_{t+k} - s_t)$ which is our dependent variable. The predictor variable is the difference between the futures price log and spot prices log $(f_{t,t+k} - s_t)$. Logarithms of spots and futures and spots are given in Fig. 10. All ADF tests show that our time series are stationary. Hence, we can estimate regression.

As mentioned previously, to estimate strong and weak forms of market efficiency, we imply two types of linear restriction:

1. $\beta = 1$ for a weak form of market efficiency in Model 1 and Model 2;

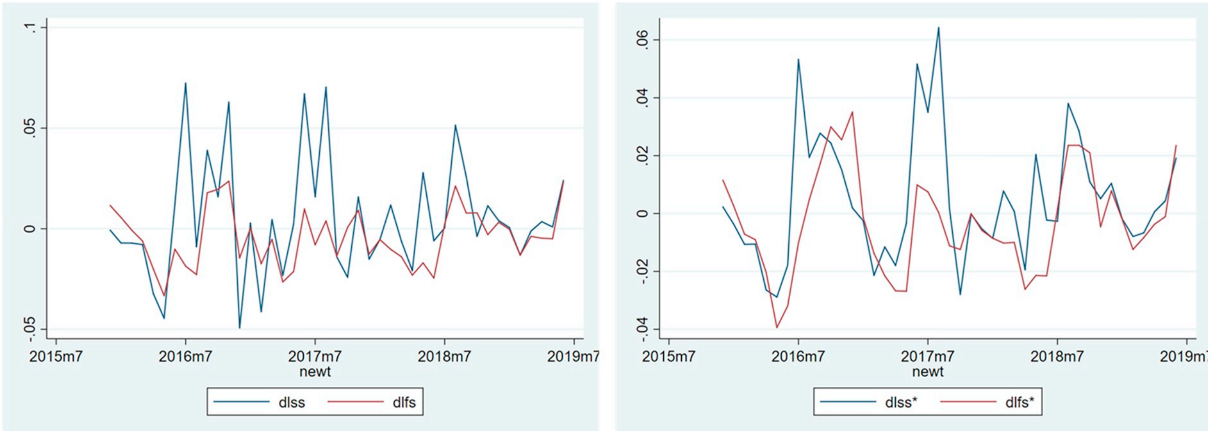

Fig. 10. Time series logs of the dependent variable (dlss) and predictor (dlfs) for Model 1 (on the left) and Model 2 (on the right).

Table 1
Regression results for Model 1 and Model 2.

	α estimate	Test α = 0, p- value	β estimate	Test β = 0, p- value	Test β = 1, p- value	Joint test α = 0 and β = 1, p-value
Model 1	0.0098	0.0140	1.1323	0.0000	0.6138	0.0465
Model 2	0.0067	0.0200	0.6978	0.0000	0.0632	0.0068

2. $\alpha = 0$ and $\beta = 1$ for a strong form of market efficiency in Model 1 and Model 2.

We present estimates of α, the constant, and β, the coefficient on the basis, and linear restriction tests for Model 1 and Model 2 in Table 1.

7.1. Model 1

The results for Model 1 show that the hypothesis of a weak form of market efficiency cannot be rejected. At a 10% significance level, the joint hypothesis of linear restriction for a strong form of market efficiency is rejected.

From Table 1, we can conclude that the gas exchange is not efficient in a strong form and efficient in a weak one, so the exchange price cannot be considered as a benchmark for the OTC segment.

7.2. Model 2

The results for Model 2 show, that the hypothesis of a weak form of market efficiency cannot be rejected at a 10% significance level. At 5% significance level, the hypothesis of linear restriction for a strong form of market efficiency is rejected.

From Table 1 for Model 2, we can conclude that within the month, the market is inefficient in a strong form. The rejected joint hypothesis indicates the use by one or more players of non-public information at the exchange as no other technical opportunities for arbitrage exist.

8. Conclusion and policy implications

In the Russian gas industry today, FAS reform aims at the transition from regulated prices to the regulation of transportation tariffs only, which assumes deregulation of price floor for Gazprom. The reform should result in SPIMEX pricing benchmark development that will be a new indicator for OTC market.

Our conclusion is based on the following results:

1. Qualitative analysis of the primary metrics of SPIMEX shows that the exchange is not liquid enough. Only about 5% of the total domestic gas consumption is traded on SPIMEX. At the same time, Gazprom and its affiliates account for 90% of the total gas sold and for approximately 65% of total gas purchased. This indicates that Gazprom may use SPIMEX as a platform through which it can lawfully smuggle gas under the price floor and transfer profits between production and distribution affiliates confusing regulators.
2. Contacted prices and volumes behave abnormally. For example, during winter, the spot price is lower than the futures price. During three summers in a row in 2015–2017, the spot price was higher than the futures one, while no seasonal and temperature anomalies were reported. In the same time, the summer spot volumes are higher than winter ones.
3. The results from Model 1 show only a weak form of market efficiency, and we reject the hypothesis about a strong form of market efficiency.
4. We used the same model specification with weighted-average spot prices over the month. The results show market inefficiency for strong and weak forms at all levels of significance in Model 2.

Finally, answering the question in the title, we can conclude that at the current state of gas exchange and level of competition in the industry, SPIMEX will, most likely, become a tool in the hands of the dominant player.

Data availability

Datasets related to this paper can be found via the URL: http://spimex.com/markets/gas/results/, hosted at SPIMEX (http://spimex.com).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2019.111012.

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