Increasing global supply makes regional gas markets more connected and reduces the price differential (arbitrage) between the EU and Asia, which could be observed at the end of 2018. After the shale revolution, the US becomes one of the leading players on the global scene in hydrocarbons production and now changing the position of the net gas importer to the net exporter. The US producers are expected to deliver 80 mtpa by 2025 if all launched projects are implemented. However, there are many concerns about how gas producers un the US will create this demand for their as in the ongoing energy transition, which already created some negative consequences after the California case.

From another side, deregulated LNG supplies with more flexibility on contract terms together with the gradual development of pricing hubs on EU and Asian markets increase the amount of data available for traders, allowing LNG value chain parts to adapt their business models.

This paper provides gas market players a comprehensive approach where we analyze three main components of the business model: pricing and trading flows, two potential consuming markets (EU and Asia), value-adding opportunities and risks.

We show legal, pricing, and institutional differences between gas markets of EU and Asia. With a data-driven approach, we analyze contracting, reverse trading, and spot deliveries information to compare business models competitiveness and trading. Finally, we propose an analysis of the impact of new players on gas markets. Both authorities and industry specialists may use the results of the analysis to increase the value of export projects and decrease the probability of business failure on the two analyzed markets.

The methodology used includes data collection from the target market and the US market and affected export prices in the business models as the dependent variable. Here we estimate the price convergence in the EU and Asian market. The main features and contributions include the factor of recent price contingency and testing the cointegration of futures curve, and the transport tariff with increasing reexport and spot in the arbitrage.

Our results will be applicable for both market players and for policymakers to make valid estimations of their business models and policy. We also improved the related previous empirical researches about spatial arbitrage in international gas markets in the frame of increasing trade and enriched it with a cointegration approach.
1. INTRODUCTION

In the next decade, gas is expected to be the fastest-growing energy resource consumed. Two types of supplies: pipeline and liquefied (liquefied natural gas, LNG), recently have faced an intra-industrial competition. Physical nature of gas and associated transportation costs historically made the process of free trade and competition development much longer compared to other energy resources.

After decades of technical innovations, cost curve improvement in the LNG sector and shale boom in the USA, increasing global consumption, demand for supply diversification and cleaner global energy system challenge started to change the role of gas in the world energy balance.

The lowest rate of CO\(_2\) produced when burned, and higher energy content makes natural gas more clean and efficient fuel among other fossil fuels. Thus, natural gas has the potential to decrease CO\(_2\) emissions of mainly coal-based electricity generation and to fuel vehicles in liquefied or compressed forms (LNG or CNG).

In 2018 LNG market volume reached 314 mtpa with 50% of LNG sold on the spot. The biggest market driver is the growing demand from China with however restrictions currently for the US. While the pipeline sector remains to be the ownership of large corporations and a subject of strategic interstate and international agreements, LNG can provide more diversity and flexibility of trade. Of total gas volume consumption, LNG accounted for 11% (~416 bcm) in 2018, and the demand is expected to continue its growth up to 1.6% for the next five years [1].

Being matured for around 50 years, liquefied natural gas (LNG) is playing a growing role in the global energy balance. The demand for grew from 100 MTPA in 2000 to ~315 MTPA in 2018, according to GIINGL[2]. The trade rose several times for the past decade decades and expect to double in the next two. New markets are opening, liquefaction and transportation facilities are expanding, and today, 42 countries import LNG.

Increasing global supply makes regional gas markets more connected and reduces the price differential (arbitrage) between the EU and Asia, which could be observed in LNG prices at the end of 2018. After the shale revolution, the US becomes one of the leading players on the global scene in hydrocarbons production and now changing the position of the net gas importer to the net exporter. The US producers are expected to deliver 80 mtpa by 2025 if all launched projects are implemented. However, there are many doubts about how gas producers un the US will create this demand for their gas as in the ongoing energy transition and geopolitics that already created some negative consequences. Another challenge that still exists for the US gas business models in the upstream segment is the pipeline constraints and significant uncertainty about the three main pipeline construction from the Permian basin.

From another side, deregulated LNG supplies with more flexibility on contract terms together with the gradual development of pricing hubs on EU and Asian markets. The
increase of data availability for traders, allow LNG value chain parts to adapt their business models.

This paper provides gas market players with an analysis, where we study three main components of the business model: pricing and trading flows, two potential consuming markets (EU and Asia), value-adding opportunities and risks.

We show legal, pricing, and institutional differences between gas markets of EU and Asia-Pacific. With a data-driven approach, we analyze contracting, reverse trading, and spot deliveries information to compare business models competitiveness and trading. Finally, we propose an analysis of the impact of new players on gas markets. Both authorities and industry specialists may use the results of the analysis to increase the value of export projects and decrease the probability of business failure in the two analysis markets.

The methodology used includes data collection from the target market and the US market and affected export prices in the business models as the dependent variable. The main features and contributions include the factor of recent price contingence. Therefore, we test the cointegration, futures curve, and the transport tariff together with increasing reexport and spot in the arbitrage. Our results will be applicable for both market players and for policymakers to make valid estimations of their business models and policy. We also improved the related previous empirical researches about spatial arbitrage in international gas markets in the frame of increasing trade and enriched it with a cointegration approach.

2. RELATED LITERATURE

An extensive lay of literature studies the global gas market with the focus on rapidly developing and transforming LNG. One of the first papers in this area of study learned that the trends of gas industry liberalization will cause the revolution for the LNG market and will enhance the trade in this segment [3]. An earlier analysis of the gas market shows that it does not have the inventory market as the oil market and has less bargain power, and the proved reserves determine productive capacity [4]. The analysis of Middle East countries gas market organization and pricing proves that the government play a vital role in launching projects and try to de-link investors from domestic low gas prices by regulation the policy in the gas industry [5].

The authors concentrate on studying natural gas prices on NBP hub in the European gas market and prove that the gas prices don’t fully couple with oil price [6]. The works relatively on the EU include investigates of transaction costs to the open natural gas market [7]. Decarbonization and carbon prices are another eye-catching topics in the EU gas market. Some works assert that a natural gas until 2030 will play the role of so-called bridge to the new technologies and new decarbonized market, and the existing import infrastructure is developed enough to cover all demand needs towards clean energy [8]. Some papers imply the dynamic simulation approach and construct multi-period models. This approach can help to analyze price differences across the EU regions and define the market power as well as the market accessibility [9]. The evidence that EU gas prices
become more strongly related to the US gas hub prices has been investigated in work by [10]. The maturity of the gas forward curve on the NBP hub described in the work of [11] and shows that the rate of market depth, resilience, and the tightness indicate the liquidity.

The methods to analyze the global natural gas market include the spatial market equilibrium models that show fundamental relationships between different commodity markets as oil, coal, gas. This network analysis of spatial equilibrium indicates that overall, the prices in all markets interlinked and the netbacks now always a suitable method for pricing in energy commodities markets [12].

Relatively to the Asia-Pacific Market and particularly Japan, as the largest LNG importer, authors research spot prices, utilizing a time-varying coefficients model. Authors show that the market there is not integrated, and the degree of variation for all four indices in the LNG market indeed exist primarily after the Fukushima dramatic incident [13].

Comprehensive analysis of convergence between JKM LNG prices and Brent oil can indicate the inter-fuel competition in the Asia-Pacific region. JKM can also be considered as a new maturing benchmark [14]. More extensive work with Korean, additional Japan and Spanish LNG spot prices data with implying long-term contracts aspect has been conducted by [15] and concludes that Japanese oil linkage change more dynamically than the others.

The paper of [16] reflects the results of analyzing regional markets integration in the EU, the US, and the Asian market. The author concludes that the spot prices in these markets show a stable trend to convergence.

Problems of intra-industrial competition in natural gas markets regard to the Russian gas producers has been analyzed in the work of [17] and the observation of LNG business models evolution and prospects in the paper of [1].

This paper contributes to the existing lay of literature by combining analysis of business models and fundamentals of pricing in Asian and European gas import markets. The results can be transited and used by analysts and regulators.

3. LNG SUPPLY CHAIN

Natural gas primarily consists of methane and composed into a liquid form (LNG) for more accessible storage and transport. During liquefaction, the gas is compressed and occupies a volume 600 times less than in the normal gaseous state. The conversion process of natural gas to its liquefied form allows for the transport of higher volumes. The liquefaction process occurs at a temperature of -162°C, and overall is energy-intensive, which affects the cost of the final product.

The need to transport natural gas for long distances across the oceans led to the development of other natural gas trade flows in liquefied form because gas pipelines are not economically efficient at such long distances. Today tankers ship LNG from an export terminal to a receiving terminal, where the liquefied gas is usually offloaded and stored in
heavily insulated tanks. Regasification facilities near receiving terminals allow to return LNG into its gaseous form (regasify) and then transport through the pipeline for end consumers.

Since the first LNG cargo from Louisiana reached the consumers in the UK in 1959, the principal supply chain scheme from gas production from transport to end consumer has followed as in Figure 1.

![LNG process supply chain from production to end-use sale](image)

The LNG supply chain starts from the exploration and production of natural gas and similar to the pipeline gas segment and consists of the four main stages:

1. Exploration and gas production;
2. Gas processing with dehydration, extraction LPG with ethane fraction and liquefaction;
3. Shipping by LNG tankers and storage in the import marine port;
4. Regasification process and end distribution to consumers throughout the pipeline or LNG/CNG trucks.

Extraction of oil, water, heavy gas fractions as ethane and propane are the general requirements for natural gas which is used for power generation, house heating, manufacturing. Gas processing is essential for the next stage of liquefaction. Pretreated natural gas with removed impurities do not interfere with the further process of liquefaction, and strictly inadmissible in the end product. Globally transported LNG should meet the following specifications: hydrogen sulfide under 4 ppmv\(^1\); carbon dioxide no more than 50 ppmv; total sulfur content under 30 ppmv; water no more than 0.1 ppmv; mercury level equals to 0.01 mg/m\(^3\).

The liquid phases as condensate or oil are necessary to be removed from the dry sweet feed gas using the refrigeration process to meet the requirements of BTU of the LNG final product and to prevent freezing during transportation. It is crucial because freezing may cause subsequent equipment plugging in the liquefaction plant.

After liquefaction, LNG is loaded into tanks, isolated and specially designed for this purpose. They are located near cargo tankers terminals to keep LNG liquid. Then cargo tankers are loaded by LNG and transport them through the marine routes. LNG import

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\(^1\) ppmv - parts per million volume
terminal consists of regasification facilities, storage tanks, and pipelines for LNG distribution to end consumers. Regasified LNG has the same physical characteristics as the pipeline gas and has a wide range of final consumers across all sectors in the industry from power plants and electricity generation to manufacturing and household consumers.

4. **LNG BUSINESS MODELS**

Generally accepted, a concept of business model is defined as a plan of an enterprise about how it is going to make a profit and identifies the service or production process the business will create, targeted market and anticipated costs. The critical elements of the business model combined that can create and increase value include customer value proposition (CVP), profit formula, key resources, and processes [19].

Over the past 50 years of LNG industry development, business models have evolved into several principal types, based on selling and trade contracts, technology solutions, and cost curve. LNG business models have been changing and growing throughout the decades, though the fundamental point-to-point linking mechanism of distant stranded assets gas resources from supply-side with growing markets without access to the pipeline import from demand-side remained. This mechanism managed the main financial risk due to the high LNG plant costs involved. Today LNG producers and suppliers are on the cross-road because the market faces fundamental structural changes that raise the question about how business models in the industry should adapt or change.

The industry shows relative expansions and diversification towards short term deals, contracts, introducing a substantial increase in liquidity. The belief that the LNG industry may evolve and commoditize in the same way as the global oil market or any other energy commodity would be too naive. The key differences from other energy commodities market should be noted for better identification of the LNG business models features:

- Industry share in the global energy balance;
- Relatively high shipping costs;
- Limitations in importing infrastructure;
- Lack of LNG vessels fleet;
- Level of regulation in importing countries.

Unlike the global oil market, these factors mean that liquefaction costs, transportation rates, and regasification costs may add an essential portion to the delivery price. We assert that the LNG industry will follow its path, and business models will adapt to the emerging opportunities, targeting new markets until the fully commoditized market forms. Furthermore, we expect that these adaptations will be much different from business models in oil or power generation. While some may have global nature, others will be focused on definite problems as the access to import terminal or trade optimization and new business models specific to certain regions may occur.
For the last five years of dramatic sales growth and new import countries expansion led to more liberalized trade and spurts of liquidity in physical and paper LNG markets. It made markets more open, transparent, and ready to new business organization. We assume that the lack of volume liquidity in LNG markets (Figure 2) and a churn-rate below 1 (a number indicating how many times the contract is traded on the market until it is bought by the end-user), will be compensated in this transitional period by a larger spot and secondary market trade. It may help the market mature faster. Traditional supply models still exist but are already undergoing changes and contracts are being reviewed. The next decade will challenge LNG operators with market oversupply and complexity which has not been characteristic for the industry before, though opening new opportunities and niches to contribute to sustainable energy industry development. We highlight the following aspects, which will play the most significant role in arising new business models:

- Supply diversity and flexibility;
- European and Asian hubs and benchmark developing;
- Policy regulation in the Asia-Pacific region;
- Financial instruments and spot volumes traded;
- LNG fleet expansion.

![Figure 2 Market volume of energy commodities benchmarks as of Dec. 31, 2018, $bln. Source: Bloomberg, CME Group, Intercontinental Exchange](image-url)
The first international market participants in the LNG supply chain were power plants with large consumption volumes of the natural gas in Europe and Asia. The first LNG plants in the USA, Algeria, Indonesia back to the 1960-1970s signed the contracts on a long-term basis (typically 20-25 years), with the fixed marine routes and final destination. Economic development of Japan, the most significant world LNG consumer and further demand growth for LNG in Asia-Pacific region made inevitable the emergence of new LNG plants and, as a result, new players in the market. In EU first LNG shipments were made to the UK and Spain due to the economic inefficiency of building large diameter subsea pipelines from Algeria that would cover all demand. As the period of industry concentration passed, LNG markets can move on to the next stage of development, which is to increase liquidity and commoditization.

Today, natural gas is no longer considered merely as an energy resource, but as a clean resource with minimal CO₂ emissions, which can also solve problems with variable renewables (variable renewable energy (VRE) as wind and solar, opposite to hydroelectricity). With concerns over greenhouse-gas emissions combined with energy efficiency and affordability, natural gas in the liquid form can become a more global source for remote and distributed generation, replace other less effective fuels in generation and bunkering. To date, the LNG market players indicate five business-models that can be distinctively identified by types of contracts and flexibility, sales activity, portfolio structure, production chain:

1. Traditional model. Large companies with both upstream and downstream businesses invest in LNG plants to monetize vast gas resources not connected with significantly large markets and consumers. In turn, large utilities with a relatively constant significant volume of gas consumption purchase large volumes of LNG on a long-term basis (commonly oil-indexed contracts). All big LNG projects in the past century can be attributed to this type of model.

2. Traditional model with trade and marketing elements. This model is also called a cost/equity model. The main difference of this model from the traditional one is the existence of market and trading strategy. This model also has the full value-chain, including the upstream and downstream. As an example, new big LNG projects as Yamal LNG can be given.

3. A flexible downstream model with traditional elements based. LNG producers who have only liquefaction capacities and buy gas on the open market. This model is appropriate for the projects that have access to an open market with the established gas benchmark as HH, NBP, TTF, and developed forward curves. This model, complemented by tolling agreements, is adopted in the US LNG producing market.

4. Portfolio model with independent trade and finance elements. Players using this model operate with broad LNG assets may combine liquefaction capacity ownership with financial instruments trade and marketing. They support LNG worldwide trade and speed up the secondary market, access to LNG spot, retrade.
Small and Mid Scale LNG buyers, producers, terminal operators, and regional power utilities, which do not have enough need high volume long-term contract with indexation. They are limited to the global LNG market access and adopt the small-scale model.

As the LNG market is still developing, we cannot exclude that new and previously unusual model may appear, such as a regasification terminal model when the holders will only operate the receiving terminals. However, it will depend on the liquidity, re-trade volumes, arbitrage between two main import markets.

The regional structure of gas markets is tightening and developing towards the global market. Fundamental structural shifts can be observed in the next decade if the trends to more open and liberalized markets in the critical regions as EU and Asia continue. These processes will challenge the current business players and make them adapt their business models continuously. In the next few years, more large LNG projects across different regions are expected to come on stream. New capacities will open broader access to globalizing LNG markets for consumers in almost all regions.

Besides, the forecast of relatively low oil prices in the next several years due to the increasing production volumes in the US, as the result of the shale revolution, will impact the pricing mechanisms in LNG markets in the mid and long-term perspectives. Therefore, both negative and positive impacts will take place in business models configuration because of market supply-demand and policy regulation uncertainties. We assert that there are opportunities for all mentioned types of LNG business models in the more integrated and liquid gas market. More capacity will also allow delivering gas to broader groups of customers at affordable prices.

New business models in the USA and upcoming in Africa and Australia with more flexible clauses and contracts indicate that the market indeed dramatically changes, cargoes increase, routes, and market players diversify.

The natural gas industry and LNG sector, in particular, will remain to stay unique and methodologies to analyze the structural changes should also apply to the industry features. One of the main features in any LNG business model that appear to remain is contractual distance limitation. Gas producers and LNG exporters will not be able to skip this portion inside the business organization until all the CAPEX (where liquefaction and shipping takes a significant share) are paid off.

Most of all, it will be reflected in large projects, which still have to hedge with long-term agreements and these long contracts occupy a relatively high share in the portfolio. These reasons will also save the price differential and arbitrage between the three main markets as the Americas, Asia-Pacific, and Europe. Another reason is policy regulation in the export countries when regulators can approve the export project only in case the total production capacity is contracted as stated in the US, for example. In Figure 3 we show LNG projects CAPEX throughout the time combined with market change.
Three changes in the demand side could play a dramatic role in a faster transition towards more connected markets, and business models change:

1. China growth and liberalization
2. Spot and derivatives volumes growth
3. Japanese market liberalization

All of these described models will exist in the industry for further development. However, portfolio players, financial instruments market players and trading companies will move the globalizing LNG market and contribute to its openness and liquidity. Openness, liquidity and financial trade will play a vital role in the process of maturation.

The segment of Small and Mid scale LNG has just started to develop, and no major export streams can be observed. We see significant potential in this niche and expect that regional buyers as utilities, city gas companies, or marine transportation will appear with seasonal demand. LNG as a transportation fuel is another potential segment for growth. Here portfolio players and financial traders will help to boost the market. Re-trade and peak shaving traders of excess cargoes potentially able to move up markets in increasing LNG trade and arbitrage in order to optimize routes and increment the value through the full supply chain. New LNG hubs will inevitably appear in such conditions.
PRICES IN EU AND ASIAN MARKETS

Price mechanisms directly connected to the policy regulation in the industry. The gas industry naturally appears as a monopoly due to high transportation costs. All well-developed market benchmarks as Henry Hub (HH), Natural Balance Point (NBP), and maturing Title Transfer Facility (TTF) transited from regulated to fully deregulated prices and open markets.

In the EU there was a well-known precedent when government set the plan to deregulate gas industry and create the entire European Gas Market Model (GMM). IN 2009 the Third Energy Package was adopted by the European Parliament, the primary purpose of which was to unbundle supply transportation system and provide a free Third Party Access (TPA) to all natural gas producers. By splitting transportation and production, the government intended to maintain lower prices. Additional infrastructure and interconnectors in the next decade will affect the structure of gas import. Deregulation of gas market may lead to challenges and market organization difficulties. At the same time, it opens many opportunities for all market players, diversified business models for producers and a broader choice for end-users.

In Asia-Pacific region almost all countries have strongly regulated gas industries. Gas market in China, the second LNG importer worldwide, has highly regulated gas market through the full value chain. Both upstream and downstream segments are concentrated inside state companies (CNPC, CNOOC). The only change expected shortly is the launching state pipeline company separated from other business.

Japan, to date the first LNG importer in the world, 100% depends on LNG. More than 30 import regasification terminals operate in the country. In the domestic market they are connected to the local pipeline infrastructure. The pipeline infrastructure, however, is very segmented and the internal market is not integrated. The unbundling of pipeline segment in Japan is expected by 2022.

Even though the current prices show the effect of convergence in EU and Asia (Figure 4), the level of oil linkage is still high, and arbitrage will remain periodically.

We outline the following factors that will be the most influencing in pricing mechanisms transition towards oil de-linking in Asia-Pacific region:

- Japan plans to unbundle the gas pipeline segment;
- South Korea plan of LNG market full liberalization;
- Taiwan launches the first phase of a nuclear plant;
- More than 20% of current long-term contracts will expire;
• China will overtake Japan as the world’s biggest LNG importer in the midterm;

• JKM derivatives trade volumes are expected to exceed physical volumes;

• Russia-China Power of Siberia supplies start.

Figure 4 LNG futures prices across the regions as of August 2019, $/MMBTU

CONCLUSION

LNG industry has similarities with the oil one. It is separated into a number of big vertical producers on the supply and demand sides. The industry segmented in the US and integrated mostly in other regions. Upstream natural gas production companies provide the feed gas for large-scale LNG projects. Usually these producers own and operate LNG plants or in a consortium. Less common is the downstream model of the US producers with flexible contracts clauses. However, these new appeared models in the market will draw it to transition.

Long term contracts will remain in the midterm and save the prevalence of traditional business models and full supply-chain models with trade and marketing activity. Nevertheless, over time, when long-term contracts end, at the same time as the next wave of commissioned capacities, the duration of renewable contracts will decrease. LNG market volume will grow along with trading flows, short-term and spot deals. Alternatively, traditional big LNG operators can increment the management of regasification and transport themselves, buying and re-trading on spot and free on-board contracts.

The possibilities of arbitration with such a market organization will nevertheless exist in specific periods, but there will also be periods of market convergence. In such circumstances, companies will need to diversify their profit streams and change business models. We conclude that there will be new business models associated with the business of operating terminals and LNG supplies in domestic markets.
More small and mid-scale LNG operators, traders and producers will appear in all regions which will cover demand for fixed routes consumption as bunkering fuel, peak shaving in balancing markets where renewables will come in a stream, and in transportation segment where LNG will compete with diesel and CNG.

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