Liberalization and the volatility of gas prices: Exploring their relation in times of abundance and scarcity

Abstract

Agencies and analysts attribute the causes of global price volatility to a temporary convergence of exogenous shocks such as the post-Covid economic recovery and the war in Ukraine. This paper hypothesizes that long-term structural and policy factors endogenous to the energy sector also play a major role. Through a case study of three major gas markets – UK, US, and EU – the paper finds that countries characterized by abundant domestic production benefit from lower market uncertainty and asset specificity, which in turn encourage energy firms to outsource production and rely on more flexible and shorter-term contracts. A structural condition of abundance allows them to easily switch suppliers or buyers without being exposed to the opportunistic behavior of the commercial counterparty. This increases market competition and reduces prices. By contrast, import-dependent countries face greater uncertainty and asset specificity. Supplies and prices are volatile as they depend on trends in international markets. The industry might show resistance to the attempts of liberalization by avoiding giving up vertical integration and long-term contracts, as without guarantees on volumes and prices, in periods of international scarcity suppliers may behave opportunistically by redirecting supplies to buyers that offer a premium in price. This suggests that import-dependent countries could reduce their exposure to price volatility (i) by increasing domestic production (ii) while envisaging the coexistence of contractual models based on both market competition and vertical integration, to take advantage from low spot prices in periods of international abundance and contain the surge in periods of scarcity.

Keywords

Liberalization policies; Gas abundance; Gas scarcity; Gas prices; Market uncertainty; Transaction costs

1. Introduction

The volatility of natural gas prices has been a distinctive feature of the last years, particularly in import-dependent countries, such as in the EU and the UK. For example, in the winter 2019-2020, prices in the Dutch gas hub Title Transfer Facility (TTF) and in the UK National Balancing Point (NBP) dropped to $3 MMBtu, down from $12 MMBtu in 2014. In May and June 2020 prices reached a record low of $1 MMBtu (Fulwood 2020). Although the Covid-19 pandemic has played a leading role in consolidating this trend[1], prices were already falling beforehand since 2014.

With the post-Covid recovery of the first half of 2021, gas prices started to increase. From April to July spot prices in TTF doubled from $6 to $12 MMBtu. By September, they reached a record high of $25 MMBtu, beaten in October by a new surge to about $40 MMBtu that persisted until December (European Gas Hub, 2021). Turning 2022, and with the start of the war in Ukraine, gas prices in Europe reached unprecedented highs, including peaks of $65 MMBtu and above.

Recent exogenous shocks such as the post-Covid recovery and the war in Ukraine have played a major role in disrupting the stability of supplies and prices that characterized gas markets in previous decades. However, against the prevailing stance among energy analysts (IEA, 2021; ACER, 2022), the paper argues that it would be simplistic to attribute the current energy crisis only to exogenous shocks and to define it as a momentary phase. Other long-term structural and policy factors are also playing a relevant role.

More specifically, the paper identifies worldwide gas shortage as the main structural factor. This originated in a prolonged period of abundance and low prices started in the mid-2010s, caused largely by an oversupply in the US resulting from the shale revolution. Low prices disincentivized upstream investments, which were reduced by half in the biennium 2014-2016[2], while at the same

[1] In the EU, the lockdown measures led to a fall in demand of natural gas of around 7% between January and May, reaching peaks of –20% in some countries (IEA 2020a).

[2] Data on the reduction of upstream investment can be found at IEA (2019). However, other important factors contributed to the reduction of upstream investments in addition to the fall in oil and gas prices. The main one is the green transition, which led financial investors and policymakers to pressure oil & gas companies to decarbonize their activities, discouraging upstream investments.

time causing the exit from the market of many energy companies[3], leading the phase of abundance to an end.

However, the shortage has affected mainly import-dependent countries. More specifically, it can be noticed that while in periods of global gas abundance prices worldwide tended to converge, in periods of scarcity gaps in prices between producers and importers widened manyfold, especially when liberalized regulatory frameworks were in place. For example, while the difference between European and US gas prices was much lower in previous decades – when they were both dependent from imports while liberalization reforms were not as advanced – differences in prices have now widened manifold as only the US became a major producer while both have fully liberalized their markets. Gaps in prices on a scale of one to ten occurred already in 2021 ($3 MMBtu in the US Henry Hub vs an average of $30 MMBtu in the TTF), well before the war in Ukraine, suggesting that this is a structural trend.

On the basis of this assumption, the paper explores the effectiveness of liberalization policies at different levels of gas production, and the implications for energy security and energy prices. This is done through a comparative case study of the UK, US and EU. The cases were selected based on their similarities in the approaches to liberalization and on their differences in the levels of domestic production of gas, with the US characterized by abundance, the EU by scarcity, while the UK being somewhere in between.

The case study shows that: (i) competition policies achieve the objectives of price reduction only in periods of oversupply; (ii) in case of strong dependence from imports, deregulation of prices through the abandonment of long-term contracts in favor of spot markets may expose to sudden price increases; (iii) in periods of gas scarcity, the industry tends to vertically integrate and rely on long-term contracts despite liberalization reforms incentivize the opposite strategy; (iv) the reduction of prices for prolonged periods (years or decades) is obtained only when gas abundance derives largely from internal production; (v) liberalization reforms can provide a contribution to the long-term reduction of prices, but only in presence of some institutional and market conditions.

[3] Bankruptcies of natural gas producers in the US can be explained by the inelasticity of supply of the oil & gas industry (See Ponce & Neumann, 2014), which entails the producers' difficulty to lower the levels of production to face a decrease in demand and price (for example due to increased market competition).

The analysis of the British case suggests that, with the reduction of methane reserves in the North Sea in the late 1990s, prices started to rise again in line with those of other European countries, despite the advanced state of liberalization reforms (Helm 2007, Defeuilley and Mollard, 2009, Heather 2010). However, in the period 2014-2020, the construction of import infrastructures helped to recreate a condition of abundance (albeit largely from imports), generating a competition mechanism that reduced prices to some extent. This trend was suddenly reversed into an unprecedented price surge with the advent of the recent international shortage.

In the US, despite liberalization has been undertaken since 1978, only at the end of the 2000s final prices began to decrease substantially, and permanently only thanks to the shale revolution and the consequent large-scale increase in domestic production (Makholm 2012, Joskow 2013).

The EU has started to liberalize the natural gas market since the late 1990s and has completed reforms by the late 2010s. Since the completion of reforms, prices have not only followed international trends as happened before, but have shown major sensibility to them, which was evident in an increased volatility upward and downward. For example, in the period 2015-2020, the EU experienced record-low prices in correspondence to a period of international abundance. Since 2021, prices have reached record highs, following a period of international scarcity.

In the light of these experiences, one can assume that liberalization is effective for reducing prices in times of gas abundance, but it sorts out the opposite effect in times of scarcity. In other words, liberalization amplifies existing trends in prices.

The paper interprets this trend by considering the role of market uncertainty. In particular, the assumption is that in a given national or regional market a condition of gas abundance corresponds to one of low uncertainty. In fact, abundance entails the ample possibility for all players in the supply chain – producers, intermediaries, transporters, buyers – to switch the commercial counterparty when contractual conditions become inconvenient. This flexibility provides gas suppliers and buyers with the confidence of outsourcing certain phases of production and to rely on short-term and spot transactions, thus being able to choose among the best available commercial opportunity and to disengage from the current ones when needed. This confidence, led by the structural condition of abundance, allows market competition to work effectively and final prices to be reduced as a result.

By contrast, the condition of scarcity in national or regional markets leads to greater uncertainty. Importers, transmission system operators, retailers and industrial consumers are all subjected to imported supplies that are not always guaranteed. Volumes are questioned by the competition from other importers, while prices may reach high levels of volatility as a result. Disruptions may be caused by the opportunistic behavior of suppliers, which might take advantage of market and geopolitical changes. In this context, the flexibility offered by unbundled supply chains, short-term and spot transactions, represents a supply and price risk for market operators. The latter are more willing to rely instead on vertical integration and long-term contracts to guarantee and stabilize supply volumes and prices. If they are prevented to do so by a regulation that envisages unbundling and spot markets, price volatility might be exacerbated by the perceived supply risks.

The argument is supported by Transaction Cost Economics (TCE). The theory argues that uncertainty is a driver of disruption in the market, which in turn is likely to change the bargaining power among firms operating in the supply chain (Williamson, 1981; 2008; Sander 2016; Ruester & Neumann, 2009; Joskow, 1987; 2010). To avoid opportunistic behavior from commercial counterparties and to prevent incurring high transaction costs, firms usually rely on governance and contractual arrangements that provide more predictability and less flexibility, for example by envisaging the trade of stable volumes at fixed prices. By contrast, in the absence of uncertainty, such issues are less likely to be relevant, as the absence of market changes is unlikely to cause a change in the bargaining power among counterparties.

To explore this hypothesis, the paper relies on two main strands of literature on the economics and policy of energy and network industries. One strand addresses the recent structural changes of the energy sector, including dynamics in upstream investment, globalization of energy markets, rise of new consumers and producers, and the resulting trends in demand and supply of energy worldwide. Within this field, studies have explored the convergence of natural gas prices worldwide that was brought about by the cost reduction and growth of the Liquefied Natural Gas (LNG) industry (Siliverstovs et al., 2005; Neumann, 2009; Vivoda, 2019).

The other relevant strand of literature focusses on the suitability of different energy policy approaches for the specificity of the gas sector. A body of literature within this strand shows the beneficial effect of liberalization policies in the US in terms of reduction of gas prices (Makholm,

2011; 2012; Joskow, 2013). Other contributions focus on the mixed results of the EU liberalization policies, with some emphasizing the significant progresses made in the enhancement of market competition (Hauteclocque & Glachant, 2009), while others suggesting the need for improvements (Asquer, 2010; Haase & Bressers, 2010), and the mixed results achieved in terms of price affordability for consumers (Florio, 2013) and energy security (Cardinale, 2019a). Institutional factors also emerge as key in influencing the historical trajectories of gas market regulation, both in the US and in the EU (Correljè et al., 2014).

The paper bridges these two strands by exploring how structural (demand and supply) and policy (liberalization vs vertical integration) aspects affect price volatility and energy security in contexts of abundance and scarcity.

The paper is structured as follows. Section 2 introduces the theoretical framework of Transaction Cost Economics (TCE). Section 3 discusses the methodology adopted. Section 4 shows the mixed results of liberalization in the UK in different historical phases, and how this depended on changes in demand and supply from domestic production and import. Section 5 shows the positive contribution of liberalization policies in the context of US domestic abundance, and how low and stable prices were achieved only after decades. Section 6 analyses the EU case and shows how the transition to a fully liberalized market may intensify price fluctuations upward and insecurity of supply. Section 7 discusses the results from the case study in a comparative way and through the lens of TCE. Section 8 concludes the paper.

2. Transaction Cost Economics: Understanding how abundance and scarcity affect market uncertainty and transaction costs

Transaction Cost Economics (TCE) studies firms' structure and their reliance on different contractual models (see Coase, 1937; see also Williamson, 1981 for a systematic exposition; 2008; David and Han, 2004; Joskow, 1987, 2010, 2013). The theory suggests that firms tend to vertically integrate to minimize transaction costs with commercial counterparties when some factors increase in intensity – asset specificity, frequency, uncertainty. In the energy sector, if firms account for a

significant share of the energy imports of a country, transaction costs may have a negative impact on energy security.

However, often vertical integration runs counter to market competition, as it results in an excess of market power by some firms. Therefore, policies for liberalization usually encourage the phasing-out of vertical integration and the transition to unbundled models. This section discusses the trade-off between vertical integration and unbundling for market competition and energy security. In particular, it shows how unbundling and short-term contracts may result in high transaction costs in contexts of domestic scarcity, as the latter is associated with high levels of 'asset specificity' in the investments for import infrastructure, frequency in transactions with exporters, and uncertainty on import prices and volumes. By contrast, in contexts characterized by domestic abundance, the need to rely on vertical integration decreases, with unbundling and market-based contractual models proving more suitable.

The concept of asset specificity is key in the TCE framework. The opportunity for a firm to internalize or outsource phases of production, namely, to vertically integrate or unbundle, has been mainly analyzed from this viewpoint. Asset specificity envisages a condition in which assets are conceived and developed to serve a specific purpose or client, while using them in alternative ways would be impossible or inconvenient from a technical or economic viewpoint (Williamson, 1981). Therefore, the firm owning and managing specific assets is potentially exposed to the hold-up problem if the commercial counterparty behaves opportunistically by not respecting the contractual terms or by asking for a change of the terms in its favor (Williamson, 1979). When the realization of such assets requires large-scale investments, as in the energy sector, the potential losses caused by "transaction costs" are greater, and organizational and contractual strategies of vertical integration are needed to prevent these eventualities (Joskow, 2010).

In a similar way, frequency of transactions in the trade of standardized goods is likely to generate transaction costs to the counterparty with lower bargaining power or with greater exposure to risk (Williamson, 1979). The gas sector is emblematic of this problem, considering that gas trade consists of constant flows needed by public bodies, industries and households[4]. Frequency in turn requires organizing this trade in ways that ensure stability in the quantities supplied and price

[4] Although there are significant variations in demand depending on the seasons (in winter demand is higher).

charged. Producers and exporters have the same interest in regulating this trade, benefiting from constant sales and ensuring adequate returns on their investments. To avoid inconveniences, the counterparties usually agree to rely on long-term agreements or partnerships that commit both to specific terms on prices and volumes, therefore discouraging opportunistic behavior from both sides while minimizing disruptions.

Uncertainty is another key element influencing energy firms' structure and the choice of contracts (Williamson, 1979). Williamson identifies uncertainty as a condition in which several destabilizing factors for firms can materialize, for example large-scale changes in technology, demand and supply, and prices. Empirical applications of TCE to the energy sector show that as market uncertainty increases, firms increasingly rely on vertical integration (Ruester & Neumann, 2009; Sander 2016).

TCE and its empirical applications conceive uncertainty as connected to asset specificity, which, according to the theory, is the key driver to transaction costs. More specifically, uncertainty intensifies the effects of asset specificity, while its absence neutralizes the potential negative effects of asset specificity on transaction costs (Williamson, 1979). In other words, in the absence of external disturbances to the status quo of commercial relations, the respective bargaining positions remain unchanged, therefore opportunistic behavior is unlikely to occur. By contrast, only in the presence of substantial market changes the binding contractual relations that asset specificity generates may lead one of the counterparties to take advantage of the changed circumstances and behave opportunistically; while in absence of asset specificity, both counterparties would be able to rely on alternative suppliers or buyers as market conditions change and contractual relations become inconvenient.

Building on the assumption that uncertainty and asset specificity are strongly related, as the former intensifies the effects of the latter and vice versa, the paper interprets the increase or decrease of uncertainty in gas markets as a key driver to higher or lower transaction costs. However, the paper provides additional insights on the relation between uncertainty and asset specificity, as it develops specific assumptions concerning the natural gas sector. In particular, the assumption is that in national or regional markets domestic abundance and scarcity of gas generate lower and higher uncertainty, respectively. In addition, a condition of abundance, if supported with adequate

transport infrastructure, reduces asset specificity in a structural way. By contrast, a condition of scarcity leads to higher asset specificity.

More specifically, a condition of abundance, especially from domestic production, implies that domestic firms along the supply chain – producers, intermediaries, transporters and buyers – are aware that for a long period of time they are not exposed to supply risks and more generally to significant changes in prices. In fact, a condition of abundance also creates greater resilience to demand shocks, which can derive from a sudden increase in demand from the domestic market or from abroad.

Abundance also reduces the level of 'asset specificity'. From the producer's perspective, investments in the expansion of production fields and infrastructure are not conceived to serve a specific customer but multiple buyers and geographic areas, especially in the presence of an existing large customer base and infrastructure networks that support this demand. From the buyer's perspective, the presence of several producers and suppliers also provides them with options to switch suppliers without incurring transaction costs. Therefore, in countries with abundant domestic production, an adequate extension of the national network is sufficient to substantially reduce asset specificity. As a result of low uncertainty and low asset specificity, both suppliers and buyers will prefer market-based transactions to be better able to change commercial counterparty when it is convenient, and to do so without incurring in high costs of disengagement.

By contrast, in countries or regions characterized by a condition of scarcity, especially one deriving from lack of domestic resources, all energy players are subjected to a great level of uncertainty from the supply side. Situation of abundance determined by high international supply can rapidly turn into situations of scarcity if international supply decreases and demand increases. Imported volumes of gas needed to sustain current consumption levels in the country are subjected to competition from other buyers worldwide. Import prices may experience significant increases because of international competition. Disruptions in the imports may be caused by geopolitical factors, in addition to commercial and technical factors, resulting in mounting uncertainty.

The lack of domestic resources generates 'asset-specific' investments. Import infrastructure are characterized by higher upfront costs, technical challenges and geographical constraints to their realization, therefore being limited in numbers and creating supply bottlenecks. In addition, the

number of exporters is often limited, also because producing countries often rely on national monopolies for the production and export of gas. These factors make import infrastructure 'asset specific', limiting the real possibility of diversifying the imports.

While the recent technological developments in the Liquefied Natural Gas (LNG) industry have to an extent allow for diversification of imports, therefore mitigating asset specificity, in some cases the costs of importing LNG might exceed the benefits. In fact, LNG has not only higher transport costs due to technical reasons, but also due to commercial reasons, as the flexibility to reach several destinations determines a higher international demand for LNG as compared to pipeline gas.

In addition, developing new import infrastructure and diversifying import sources might prove very effective in reducing asset specificity in periods of international abundance. However, in periods of international scarcity, this beneficial effect might be reduced to some extent, as some import facilities might be unused or underused because of scarcity or excessively high prices, *de facto* limiting the options for the importers. In this context, vertical integration remains an effective option to reduce the level of uncertainty and asset specificity generated by domestic scarcity and all the potential disrupting factors deriving from them.

As full vertical integration is not always feasible, due to the producing countries' unwillingness to give up control over their resources, joint ventures between exporters and importers represent an effective solution to reconcile their respective interests. Importers rely on joint ventures to mitigate the market power of exporters, which increases remarkably in periods of scarcity, potentially leading to opportunistic behavior and transaction costs. The latter are minimized as production and transport activities are shared from upstream to midstream, thus commercial interests are aligned. Exporters also benefit from joint ventures, as they minimize transaction costs arising from a potential increase in the bargaining power of the importer, for example due to the advent of a phase of abundance or the development of infrastructure that secure imports from alternative suppliers.

In case vertical integration or joint ventures are not feasible, for example because they represent a source of excessive liability and risk for the importer, long-term contracts represent an effective substitute. Long-term contracts envisage the supply of specified volumes of gas at fixed (although periodically renegotiable) prices for a number of years. This solution is used to mitigate price

fluctuations and uncertainty on energy supplies, which may arise as considerable volumes of gas could be diverted to other consumers or countries who offer a premium in price[5].

However, guarantees on energy security may offset the benefits achieved by the regulation on market competition, as vertical integration and substitute contractual arrangements (e.g., joint ventures, long-term contracts) increase the market power of existing players (producers, importers). The issue acquires further relevance in a condition of gas abundance, in which energy security and price hikes do not represent a problem. In this case, vertical integration and long-term contracts may be more of a burden than a guarantee.

By contrast, in a condition of excess supply, liberalization policies may prove very effective. Gas abundance decreases market uncertainty, which in turn increases the industry's confidence to rely on short-term or spot transactions and take advantage of the possibility to switch suppliers. This condition allows buyers to benefit from the lowest price without fearing the consequences of opportunistic behavior by suppliers. Price and supply uncertainties are minimized by structural conditions, namely the large availability of gas and the alternative options available.

Gas abundance is the ideal setting for market competition, as it allows new entrants to buy excess quantity of gas at current low prices. In international gas trade, in periods of oversupply, dominant energy importers lose market power, especially when they are bound to long-term contracts envisaging a higher import price[6]. In these cases, major importers also try to increase the percentage of short-term or spot transactions in their portfolio to compensate for the losses. If the condition of abundance is expected to last, importers would try to disengage from long-term contracts by not extending them.

[5] This is representing one of the main causes of the current surge in gas prices in the EU, as LNG cargoes are increasingly diverted to the more lucrative markets in East Asia (European Commission, 2021).

[6] Gas abundance usually coincides with low gas demand. This condition makes long-term contracts unfavorable from the viewpoint of the importer for another reason beside prices, namely the commitment to import previously agreed quantity in excess of market demand. This may result either in additional costs of storage, or in penalties paid to the exporter for not being able to import the agreed amount.

3. Methodology: the comparative case study

The theoretical analysis above suggests that the changing levels of demand and supply of natural gas worldwide represent a source of uncertainty for importing countries, which should therefore retain some forms of vertical integration. This makes it possible for them to minimize transaction costs arising from international shortages and increasing prices. By contrast, energy abundant countries have more margins of maneuver in adopting policies of liberalization that can reconcile market competition and energy security.

In this paper, this theoretical assumption is explored by adopting the methodology of the comparative case study (see Collier, 1993; Dion, 2003; Flick, 2006; Yin, 2009). The comparison among each case, which displays different levels of domestic production, makes it possible to observe whether the theoretical assumption derived from the TCE framework can be verified also in real cases.

More specifically, the selection of the cases – UK, US, EU – follows Dion's (2003) criteria, which suggests that cases should be selected based on similarities among the variables to control for and on differences among the variables under investigation. In this paper, the countries selected have all mature and large natural gas markets, while more importantly, their liberalization reforms are completed or in a very advanced stage comparing to other relevant gas markets worldwide (for example in East Asia or Latin America).

Therefore, the common variable, which is the one that is possible to control for, is "liberalization policies", as they were implemented in a similar way in all three markets. By contrast, UK, US, and EU all have different levels of domestic production, with the US being characterized by abundance, the EU by scarcity, and the UK something in between, having transitioned from abundance to scarcity. This makes it possible to investigate how the effectiveness of liberalization policies – identified with high market competition and low domestic gas prices – changes at different levels of domestic production.

The choice of adopting a diachronic approach to analysis can be explained by the need to assess the relation between liberalization reforms, industry structure and gas prices at different points in time in the history of each country, as each historical phase displays different levels of scarcity or

abundance. This makes it possible to test the hypothesis not only on a comparative basis among countries, but also among different historical phases in each country.

The analysis of the evolution of the gas sector in each country has also allowed us to notice the relevance of some drivers of abundance or scarcity. For example, some drivers of abundance are: policies for innovation and liberalization, which in some cases contributed to boosting investors' confidence in future returns; demand and supply shocks in partial substitutes such as oil and coal; long-term upstream investment in the gas sector worldwide; regulation that eases investments for domestic production and that harmonizes standards across different markets.

The paper relies on different databases to collect data on (i) gas supply (produced domestically or imported); (ii) rationale and design of liberalization reforms; (iii) gas prices. The data covering the US are extracted from the Energy Information Administration (EIA) database, and concerns both changes in domestic supply and in prices. The information concerning the US liberalization policies are drawn from the US Federal Energy Regulatory Commission (FERC) and from secondary sources. The data on the EU and UK gas production were collected from the International Energy Agency (IEA) database, while gas prices were extracted from the Eurostat and BP databases. The information on the UK policy reforms were drawn from the UK legislation, official documents released by government committees and secondary sources. Regarding EU reforms, the main sources are EU Regulation and Directives, but also reports and press releases by the European Commission and other EU agencies.

4. Liberalization in the United Kingdom: an intermittently successful model

As in other sectors of the economy, the UK was the first European country to embark on a process of liberalization in the gas market and to complete it in the shortest period. The first step was undertaken in 1986 with the privatization of British Gas and the establishment of the regulatory authority *Ofgas* to regulate its monopoly[7]. In the following years, British Gas plc was reorganized

[7] See "Gas Act 1986, Chapter 44" www.legislation.gov.uk/ ukpga/1986/44

into three main divisions, with a view to divesting some to new entrants and increase their market power.

Since the early 1990s, British Gas plc was induced by Ofgas to reduce sales to a maximum threshold of around 70 million kilowatts hour (kWh) per year (Heather 2010). This entailed that part of the gas produced domestically or imported by British Gas plc had to be sold to new entrants in the downstream. In the same years, the plan to reorganize British Gas plc was completed thanks to divestment of important subsidiaries of the company. In a first phase, under the pressure of the *Monopolies and Mergers Commission*[8], the national network was unbundled and managed by the subsidiary Transco. This measure made it possible in a second phase to dispose of Transco, whose management had to be entrusted to independent operators with the aim of guaranteeing equal conditions of access to the network. In 1995 unbundling was completed as Transco was sold to National Grid with the aim of creating a single state-owned energy grid operator (Heather 2010). To enhance competition in the upstream, midstream, and downstream markets, new licensing systems based on auctions were introduced[9]. In 1996, the introduction of the *Network Code* established a non-discriminatory system of capacity allocation for the gas network.

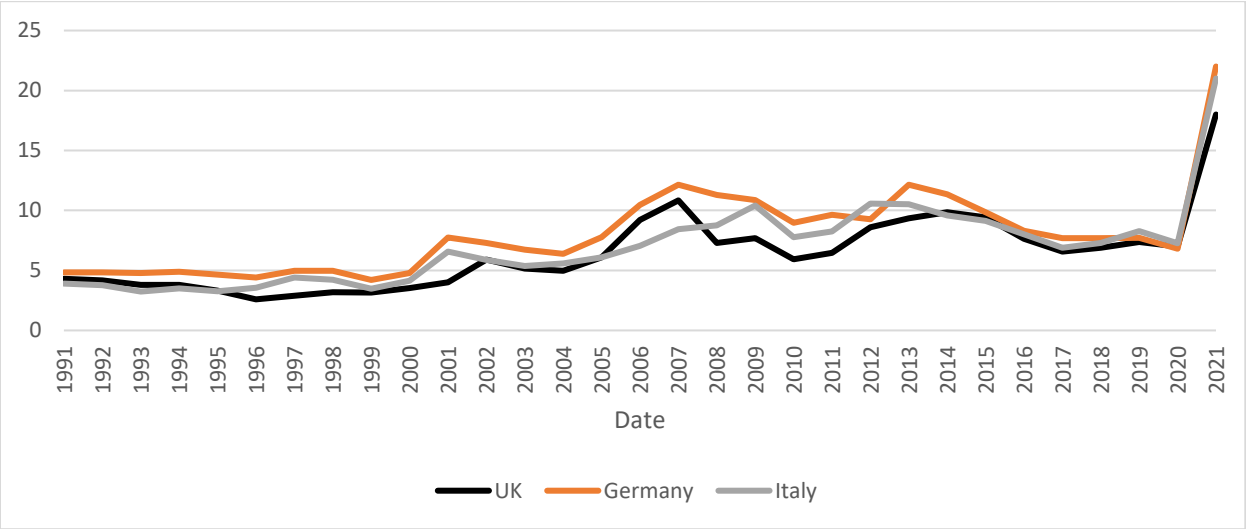
As a result of these reforms, British Gas plc's market share decreased from 97% to 29% between 1990 to 1996 (Price 1997). The number of operators in the wholesale market increased from 15 to more than 50 in the 1995-1997 biennium. The share of short-term transactions, including daily transaction, increased remarkably due to a 30% price differential compared to long-term contracts, whose prices were soon adjusted downward to avoid incurring losses (Heather 2010).

The liberalization reforms were followed by a gradual reduction in the prices of both wholesale and retail markets. For industrial consumers, prices had halved from 4.3 to 2.1 euros/gigajoule (GJ) from 1991 to 1996, when reforms were completed (Fig. 1). In the same years, most European markets showed higher prices as compared to the UK.

[8] Monopolies and Mergers Commission (1988), "Gas: A Report on the Matter of the Existence or Possible Existence of a Monopoly Situation in Relation to the Supply in Great Britain of Gas through Pipes to Persons Other than Tariff Customers", London: HMSO

[9] See Gas Act 1995, Chapter 45 (www.legislation.gov.uk/ ukpga/1995/45

Figure 1 – Evolution of industrial gas prices, excluding taxes (euro/GJ)[10]



Source: Eurostat (2022b)

However, a major important factor contributed to ease the acceptance of liberalization reforms by the industry, increasing market competition while lowering prices. This was the doubling of domestic production in the North Sea wells, from 2 million terajoules (mil./TJ) in 1991 to a peak of 4.5 mil./TJ in 2000, marking a period of gas abundance in the UK.

The period of gas abundance has extensively reduced the uncertainty for both suppliers and buyers, therefore reducing the need for vertically integrated supply chains to contain high transaction costs and the related revenue and supply risks (see section 2). In other words, suppliers could take advantage of the opening of the downstream market, thus being able to switch buyers more easily, without incurring losses in case of opportunistic behavior. In a similar way, buyers were benefiting from larger supplies in an increasingly competitive market, making supply and price guarantees from long-term contracts unnecessary.

It is also true that in addition to other important factors, liberalization represented also a driver to increasing upstream investments and discoveries. In fact, liberalization was a promising incentive to future sales to a broader base of gas buyers in the downstream, including thermoelectric power

[10] Prices of the first semester of every year.

plants, and potentially at higher prices than those traditionally imposed by the single buyer British Gas.

Another important factor that favored gas upstream investment and the increase in production was the drastic drop in the domestic production of coal, which had represented the major energy source for decades, and that by the 1970s started to be replaced with oil and gas. The drop in coal production accelerated in the 1980s and 1990s, while the perception of the reliability of oil as a substitute for coal was not too positive following the oil shocks of the 1970s. These factors contributed to creating room for natural gas (Marshall, 1996; DUKES, 2013). The economic growth of the 1980s and 1990s, which reached rates of 4% and 5%, also contributed to building confidence for upstream investors over a sustained gas demand.

However, as soon as reserves in the North Sea shrunk, production levels returned to decline, settling at around 1.5 mil./TJ per year (IEA 2022). Simultaneously, gas prices started to increase, reaching European levels. In fact, the 2000s witnessed a surge in prices, which in the case of industrial consumers increased from the historical minimum of 2.1 euro/GJ in 1996 to 5.7 euro/GJ in 2002 up to 11 euro/GJ in 2007.

The decrease in gas supply and the price growth were also accompanied by a significant decrease in short-term transactions, reflecting a return to market uncertainty especially from the side of industrial consumers, which feared supply shortages and high prices. Therefore, since 2002, there has been a return to medium and long-term contracts (8-12 years) and a net decrease in the share of gas sold through spot transactions (Heather 2010).

The surge in prices occurred despite the replacement of domestic production with increasing imports, which was made possible thanks to large-scale infrastructure investments. The construction of the subsea pipelines *UK Interconnector* in 1998 and *Langeled Pipeline* in 2006, linking the UK to Belgium and Norway, made it possible to increasingly rely on imports from EU markets. At the same time, the construction of LNG terminals contributed to diversifying the portfolio of import contracts, opening the doors to geographically distant producers (Stern and Rogers 2014).

The new infrastructure favored the return to a condition of abundance by the 2010s, even though largely from imports, and a reduction of prices. The share of short-term transactions increased again compared to long-term contracts, reaching 50% of the total in the early 2000s (IEA 2007). In the period 2007-2013, the volume of daily transactions doubled, while the volume of monthly transactions increased by about 25% (Stern and Rogers 2014; Menezes et al., 2019). This reflected the opportunity for buyers to access gas supplies from abroad at lower market prices as compared to long-term contracts, and their increasing confidence in the possibility to rely on abundant volumes of imported gas.

However, once in 2021 international oversupply came to an end, the precariousness of a condition of abundance from imports showed its limitations. Prices in the UK boomed reaching record levels with peaks up to $77.5 MMBtu, while several energy companies went out of business and consumers experienced large-scale disruptions. As of today, the price at the UK gas hub NBP has dropped to $12.3 MMBtu, a price prevailing in the first half of 2021, but still almost five times higher than the US Henry Hub spot price of $2.65 MMBtu. Considering the unprecedented price fluctuations of the last two years, future surges to the levels of the late 2021 and 2022 cannot be excluded.

5. Liberalization in the United States: a successful model after a long wait

The first measures of liberalization in the US gas market date back to the late 1970s. Previously, the price of gas was regulated by the *Federal Power Commission* (FPC), which imposed a ceiling to protect consumers from the market power of upstream and midstream companies. However, with the oil shocks of the 1970s, the benefit of a regulated price became significantly less than the disadvantage of a shortage. To encourage an increase in production, the *Federal Energy Regulatory Committee* (FERC, FPC's successor) decided to deregulate the price at the well[11], encouraging the exploitation of wells with higher costs of production compared to the regulated price.

[11] See "Natural Gas Policy Act of 1978 (NGPA)" authorized by the FERC and later approved by the US Congress

However, deregulation increased the bargaining power of the gas pipeline companies[12], which at the time benefited from monopoly or oligopoly positions in intra- and inter-state markets for the transport of gas. This situation allowed them to take advantage of the growing competition between upstream companies, which offered discounted prices to avoid losing market share to the benefit of competitors (Sutherland 1993, Watson 1992). Large profit margins for pipeline companies were also nurtured by a considerable market power over downstream buyers – power plants, retailers, industrial consumers, and households.

Nevertheless, during the counter-shock of the mid-eighties, gas prices became less convenient than oil and coal prices. This situation caused heavy losses to the pipeline companies, which were bound by long-term contracts to buy large volumes of gas that would remain unsold. The losses prompted further regulatory upgrades to avoid large-scale bankruptcies. In 1992, FERC enacted a measure to ban pipeline companies from operating outside their core business, namely energy transportation. More specifically, they could no longer buy and sell gas, but only apply tariffs to energy companies operating in the upstream (or to shippers) to recover infrastructure investments and make a profit[13].

This allowed wholesalers and retailers to negotiate directly with upstream producers, bypassing the pipeline companies. The liberalization of licenses in the inter- and intra-state transport markets diminished further their market power. Competition between pipeline companies would have lowered price of tariffs to a value close to the marginal costs, to the benefit of retail companies and final consumers[14] (Dahl and Matson 1998).

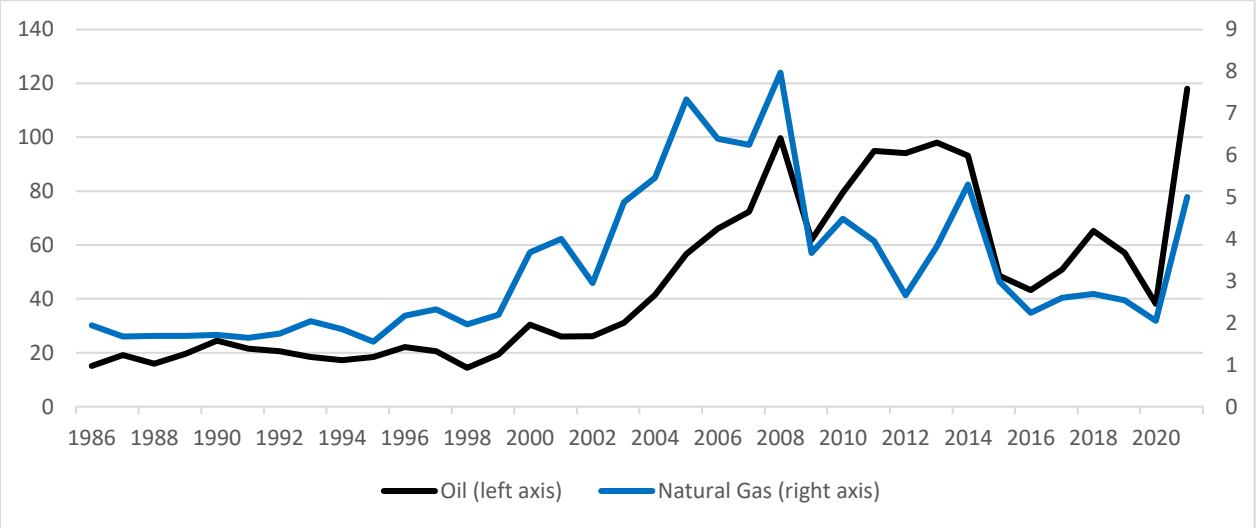
[12] Pipeline companies own and manage gas pipelines connecting upstream wells to downstream end markets. They can be differentiated into "inter-state" and "intra-state". Interstate pipelines connect the largest gas wells in the US with the local grids of each State, namely with the intrastate pipelines.

[13] See FERC Order 636 "Restructuring pipeline services", issued in 1992.

[14] The national grid has traditionally been considered a natural monopoly due to high fixed costs, which suggests that the presence of more than one operator would be redundant and generate inefficiencies. For this reason, in most countries, the gas network is managed through a regulated monopoly. However, the view that the national gas grid is always a natural monopoly has been questioned in various academic debates (Makholm 2012), based on the case of the US, which succeeded in creating a competitive market in this segment. Some structural differences among national gas markets can explain the divergence between the existing views. In fact, while the gas grid has the characteristics of a natural monopoly in relatively small markets, making the presence of more than one operator inefficient, the large size of the US gas market and the lack of large natural barriers allow for more operators to exist (and compete) without inducing cost duplication on the side of fixed costs.

In 1992, the liberalization of the US gas market could be considered complete in its main aspects. The competition in the midstream was the strong point, as no country in the world could boast such a level of competition between grid infrastructure companies. However, the regulatory reforms were not followed by a further downward trend in prices. By contrast, in the 2000s prices grew significantly reaching a peak in US history of nearly $8 MMBtu (Fig. 2).

Figure 2 – Evolution of natural gas[15] and oil[16] prices in the US



Source: EIA (2022a; 2022b)

The graph shows that the time lag between the completion of the liberalizations in 1992 and the price decrease in 2009 was quite long, over 15 years. If we consider the starting date of the reforms, this time frame extends up to about 30 years. This result is interpreted by some (Makholm 2012, Arano and Blair 2008) as the effect of the main gas companies' ability to maintain market power hindering new entrants, and by the time needed for the new rules to be assimilated in the market mechanisms. The similarities between fluctuations in the US and EU price curves, in the face of differences in their respective regulatory regimes, also raise doubts over a decisive impact of liberalization reforms on prices. Oil prices, geopolitical and financial crises, financial speculation, played a greater role than internal regulation.

[15] Dollar per thousand cubic feet.
[16] Dollar per barrel; Cushing, OK WTI Spot Price FOB.

However, what emerges from Fig. 2 is that a sharp and permanent drop in prices took place only in correspondence to a significant increase in the domestic production of gas in the second half of the 2000s, which shifted from about 23,500 to about 40,600 billion cubic feet (EIA 2022c), thanks to the development of *shale gas*. This suggests that the abundance of gas was the key factor in the sharp decline in prices. This hypothesis is further validated by the increasingly autonomous trend of gas prices from oil prices by the 2010s, which occurred for the first time, and which has shown gas prices remaining at $3 MMBtu regardless of the oil price fluctuations. The oversupply of gas has in fact decreased the need to rely on oil as substitute energy source, decreasing the correlation between their prices.

The fact that in the following years the downward trend in prices occurs in European and Asian markets too, albeit to a lesser extent, does not confute the hypothesis of the preponderance of the *shale* revolution in low pricing. In fact, it supports it, as the transition from a condition of scarcity to one of abundance in the US has had an impact in the international market, so influencing price dynamics in other continents. The evolution of the US energy industry in recent decades provides further elements to show that liberalizations are not always sufficient to increase market competition and reduce prices.

Indeed, it is evident that both in the 1980s and 1990s, when reforms were ongoing and at their completion, respectively, the evolution of the market structure and the contractual forms adopted by the energy industry not always followed the direction mapped out by the policies. By contrast, the industry reacted more to the international trend in energy prices.

For example, the share of daily transactions increased from 4% to 70% in the period 1983-1988. This corresponded to a period of excess of oil supply following the rebound from the crises in the 1970s (the so-called “oil glut” of the 1980s), which in turn can explain the increased confidence of energy firms in this period, and their decision to rely on shorter-term transactions to benefit from the lower prices.

By contrast, the share of daily transactions decreased by up to 40% in the period between 1988 and 1995 (Dahl and Matson 1998), despite liberalization reforms were completed in those years.

The restoration of long-term contracts[17] and other strategies of vertical integration (including M&As) was a reaction of the industry to the increasing uncertainty in the oil market, which was heavily affected, among other factors, by unprecedented geopolitical changes such as the fall of the Soviet Union and the Gulf War (Lieber, 1992).

The conclusion is that industry was much more sensitive to changes in supply levels rather than changes in regulation. However, liberalization seems to have also contributed to create the conditions for a permanent reduction in prices. According to Makholm (2012) and Joskow (2013), liberalization has allowed the US to exploit a production potential previously inhibited by price regulation. Nevertheless, the key role was played by the support of the US Department of Energy (DOE), which for decades had financed experimentations on fracking, a technique of extraction that was unviable before the shale revolution[18].

Other factors, not always present in EU or Asian contexts, contributed to create a condition of abundance and a successful liberalization model. These are: (i) absence of excessive legislative constraints on the exploitation of internal resources; (ii) market size that allows for the exploitation of economies of scale and scope; (iii) lack of geographical and political obstacles that increase the costs and risks of transport from production to consumption areas.

In the last two years, while in European and Asian markets gas prices fluctuated between $12 and $77 MMBtu, gas prices at the Henry Hub fluctuated between $2.6 and $6 MMBtu.

6. Liberalization in the European Union: an energy crisis after a temporary illusion

The liberalization process in the EU started in 1998. There are various opinions on its belated nature. One attributes it to the resistance of former national monopolists[19] and to State interests

[17] However, it should be noted that the long-term contracts of the 1990s were characterized by a shorter average duration than in previous decades.

[18] Despite these efforts by US policymakers and the energy industry, the achievement of a condition of abundance was not certain until it materialized. This was evident in extensive investments in LNG receiving terminals in the US coasts, just before the shale revolution.

[19] Former monopolists are operators that were dominating the national energy market as monopolists (or quasi monopolists) in the decades before the liberalizations of the 1990s and 2000s. They were vertically integrated,

connected to them (Cavaliere and De Michelis 2012, Skalamera 2015). Much of the debate has therefore centered on the strategies to dissolve these residues of political and market power (Zwart, 2009; Hauteclocque and Glachant 2009).

The 1998 Directive[20] envisaged three pillars – unbundling of incumbents, reduction of their market share, access to the network for new entrants – with each step to be implemented gradually. The second Directive in 2003[21] made legal unbundling and Third-Party Access (TPA) to national infrastructure mandatory, representing an important step forward in the creation of a Single Market for gas. The Third Energy Package in 2009[22] represents the culmination of the reforms. Unbundling becomes mandatory, while incentives to develop cross-border infrastructure are introduced, in addition to the harmonization of rules among Member States concerning capacity allocation, tariffs, codes interoperability. In 2019, competition rules were also extended to transnational import pipelines, while in 2020 the approval of the *European Green Deal*[23] introduced a further challenge in the energy equation, namely the energy transition.

After more than twenty years of reforms, liberalization is not yet completed despite several accomplishments. For example, in most national markets, former monopolists still retain dominant positions over new entrants (Florio 2013; Cardinale 2017; 2019a).

dominating national gas production or imports, transmission and distribution infrastructure, as well as sales to industrial and retail consumers. With the policies of liberalization, former monopolists were unbundled. This meant that the national grid became a separate company (the so called, Transmission System Operator, or TSO). In a similar way, local gas grids (or Distribution System Operators, DSO) were also separated. As a result, new producers, importers, or traders could use national (TSO) and local (DSO) infrastructure without being subjected to discriminatory practices by the former monopolist, which could limit access and/or impose higher transport tariffs. Therefore, unbundling aimed at increasing market competition.

[20] See "Directive 98/30/CE"

[21] See "Directive 2003/55/CE"

[22] See "Regulation 715/2009/EU" and "Directive 2009/73/EU

[23] See "Regulation (EU) 2021/1119 (European Climate Law)"

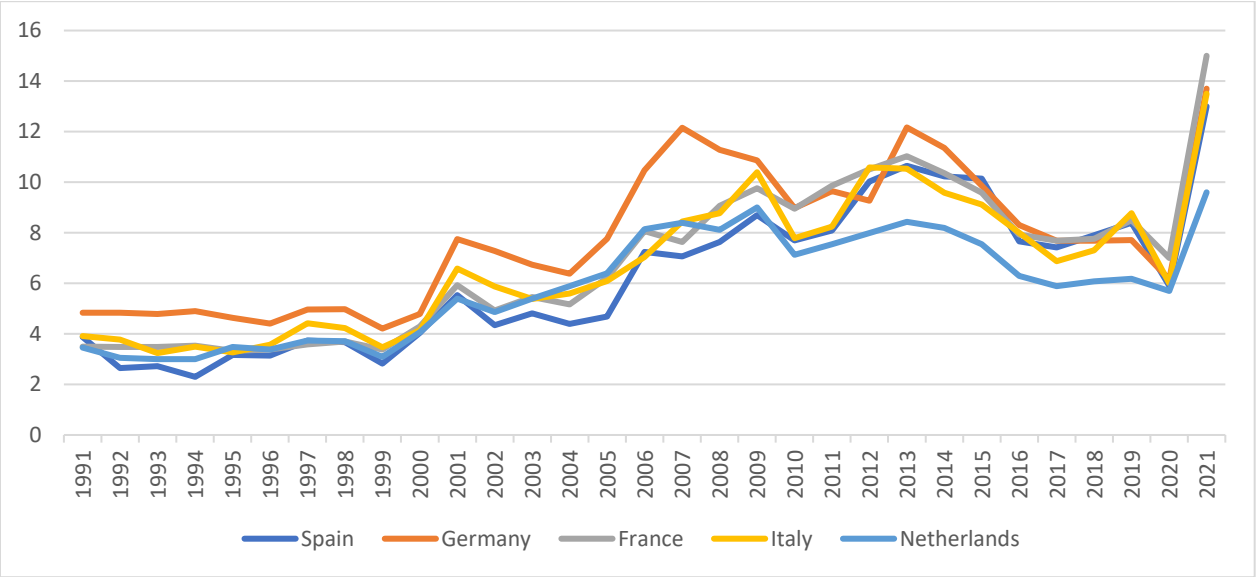
Table 1 – Reduction of market power of the main operator in some EU countries

	Production / import (%)		Retail market (%)	
	2007	2017	2007	2017
Belgium	77.6	26.2	44.8	32.1
Czech Rep.	95.0	32.9	22.9	31.1
Greece	100.0	75, 9	87.4	60.4
Spain	45.5	38.7	37.7	31.8
France	85.0	58.9	75.0	34.1
Italy	67.9	53.0	43.9	16.2
Hungary	70.2	40.0	22.1	19.7
Germany	na	30.1 ([1])	7.0	14.5 ([1])
Finland	100.0	100.0	95.0	90.0
United Kingdom	21.0	38.4	55.0	18.5

([1]) Data confirmed until 2012. Source: Eurostat (2022c).

Although the market power of former monopolists is still significant across most EU markets, progress in the creation of an EU Single Market has been made. For example, prices for industrial consumers showed a downward trend from 2014 until 2020, and a greater convergence among national markets (Fig. 3).

Figure 3 – Price evolution for industrial consumers, excluding taxes (euro/GJ)



Source: Eurostat (2022b)

One might argue that both the downward trend and convergence in prices result from the Single Market policy. The downward trend in prices could be led by the removal of barriers to entry into national markets and the increase in competition between local companies and those from other Member States. Price convergence could result from greater interconnectedness among national markets, thanks to regulatory harmonization and incentives to the development of cross-border infrastructure. For example, once established more cross-border links, former monopolists would start losing full control over imports, as they became unable to prevent new entrants from establishing a direct link with exporters.

However, to make the analysis of the effect of liberalization on consumer prices more rigorous, it is necessary to integrate the developments in final prices with those on import prices, which account for about two thirds of the final price. The EU has recently recognized the importance of the external dimension of the energy market, for example by encouraging diversification of the

import sources[24]. The other two important measures concerned the reduction of the indexation of gas to oil prices and of long-term contracts.

The original purpose of the indexation was to ensure the competitiveness of gas with respect to oil, increasing the diversification between energy sources for electricity generation and for residential use. However, in recent years there has been a consensus around the idea that indexation creates major distortions, preventing gas prices from adequately reflecting the true balance between supply and demand, thus neutralizing the positive effect of liberalization[25]. In a similar logic, long-term contracts represent the other key obstacle to market competition, not only because they are based on indexed prices, but also because they contain mandatory clauses on the import of annual volumes that represent a significant share of the transport capacity of national networks, limiting access to the network for new entrants (European Commission, 2007).

For these reasons, energy policy has encouraged the elimination of the practice of indexation and the reduction of long-term contracts in favor of spot transactions. These objectives were successfully tackled, thanks to the reduction of the share of oil-indexed imports from 80% in 2005 to 34% in 2017 (International Gas Union 2018) and the increase of spot transactions up to 50% and 65% in the main European markets, even though with marked differences between national markets[26] (Heather 2019).

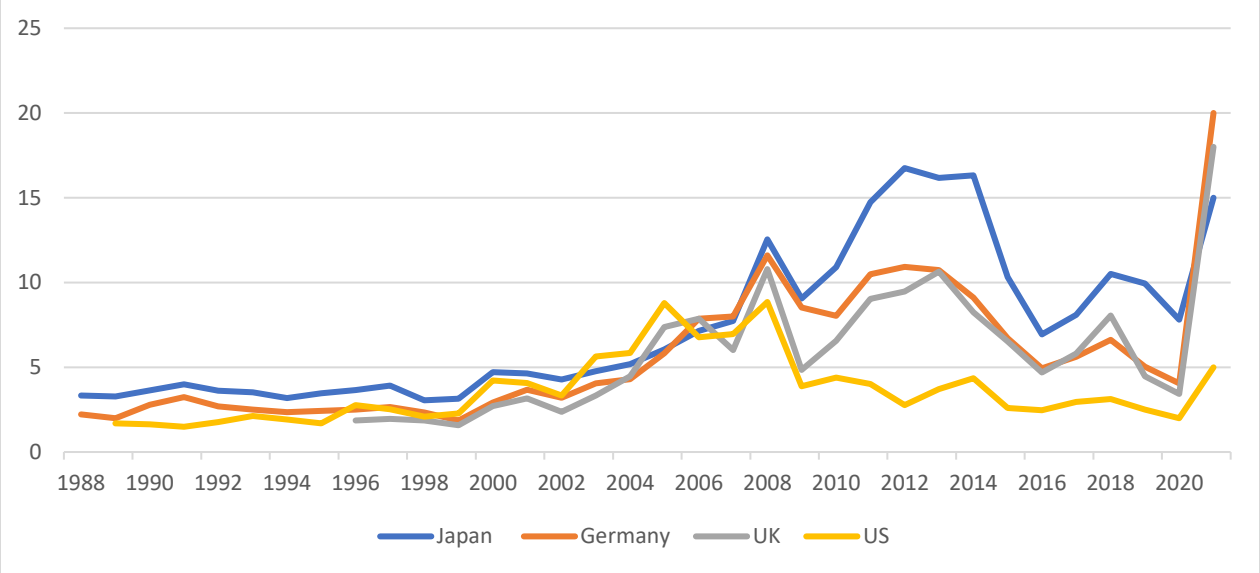
The European energy industry has also supported the elimination of oil-indexation and the adoption of short-term contracts. From 2015, several companies did not extend long-term contracts, or reduced their duration remarkably (from 20 to 5 years for example), suggesting that their perception was of increased bargaining power vis-à-vis the exporters, decreased uncertainty concerning security of supply and volatile prices. In this phase, European energy importers could

[24] This was made possible by incentives to the development of alternative routes of provision, particularly through LNG infrastructures, contributing to a price convergence also in the international markets (Neumann, 2009).
[25] This was stressed by the Council of European Energy Regulators (CEER) in a report titled "CEER Vision for a European Gas Target Model. Conclusions Paper", December 2011.
[26] For example, the UK and the Netherlands benefit from the most liquid and competitive hubs in Europe thanks to a significant share of daily and weekly transactions. By contrast, monthly, seasonal, and annual transactions prevail in Germany, Spain and Italy. Liquidity results from short duration of contracts (up to a spot or daily transaction), which allow for easiness of buying and selling volumes of gas. Short duration also provides more opportunities for new entrants to buy and sell, thus reflecting potentially higher competition. By contrast, long contract duration reflects a lower turnover in the ownership of gas, thus lower possibilities for existing market structure to change.

take advantage of alternative suppliers that offered lower prices, or contract major volumes with spot contracts at the main gas hubs.

The price of gas has been at historic lows until 2020, strengthening the perception by policymakers and the industry of a structural reduction of gas prices. However, the recent surge in prices has questioned the validity of this perception. In addition, the fact a similar downward trend occurred across all major world gas hubs in the period 2014-2020 (fig. 4), could have suggested that the main driver of price reduction was an excess of international supply.

*Figure 4 – Price evolution in the main world gas hubs ($*MMBtu*)*



Source: BP (2022)

One of the main factors that contributed to the current condition of supply shortage was the persistence of low prices for years, which discouraged new investments in production and transport infrastructure and led to the fall of annual investments in the upstream oil & gas sector from around $800 billion about $400 billion. In just two years, from 2014 to 2016 (IEA 2019). The combined effect of reduced supply and increasing demand in the last two years have extensively impacted importers.

This suggests that the reform-price causal relationship may be reversed. In other words, EU reforms proved effective in a condition of low prices, and not vice versa, namely that the low prices

resulted from the reforms. If this is the case, the advantage to rely on more flexible and short-term contractual models and the increase in domestic market competition can be confined to momentary phases, namely those characterized by abundance, which are subjected to change in the long term.

It is also true that liberalization reforms helped take full advantage from the condition of oversupply in the period 2015-2020. The possibility for new entrants to buy cheaper gas at the hubs and to be able to trade it by using existing (and new) infrastructure was made possible by the EU regulation on market competition. To avoid losing competitiveness, former monopolists exercised increasing pressure on the exporting companies of the producing countries to renegotiate the import price downwards, in line with prevailing prices at the hubs. This resulted in an overall positive effect for EU countries, which benefited from a reduced import bill[27].

The question is whether this model is effective and suitable also in the current context, characterized by a severe shortage in international supply, and how excessive dependence on short-term contractual models can cause volatility in import prices and uncertainty in energy supplies.

7. Liberalization reforms and trends in prices: insights from the UK, US and EU

The theory of Transaction Cost Economics (TCE) argues that market uncertainty is a potential driver to vertical integration for firms. The reason is that, as market trends change, fundamental inputs for production could become scarcer. Therefore, suppliers of these inputs could take advantage of their increased bargaining power to keep buyers as hostages and to negotiate higher sale prices. In a similar way, uncertainty concerns also change in demand, for example when buyers are able to find alternative suppliers, therefore increasing their bargaining power vis-à-vis the suppliers.

[27] In 2015, following the fall in prices, Norway and the Russian Federation, whose combined supplies accounted for around 75% of EU gas imports, agreed to abandon oil price indexation in their long-term contracts, alongside a reduction in price and in the duration of contracts. Algeria agreed on similar terms despite initial resistance (Aissaoui 2016). In this context, the results of the European Commission Sector Enquiry for the biennium 2005-2007 (subsequently included in the 2009 Third Energy Package) played an important role in the lobbying efforts directed at the producing countries.

These dynamics of uncertainty are likely to become even more relevant in sectors such as natural gas, in which transaction costs represent considerable losses. This can be explained by the capital-intensive nature of the natural gas sector, but also because of the characteristics of 'asset specificity' and 'frequency' in transactions, as discussed in section 2. These characteristics lead to a lock-in effect among counterparties, and to greater difficulties of contractual disengagement, suggesting that in contexts of high uncertainty, companies are afraid to incur significant losses.

By contrast, lack of uncertainty provides the opposite incentives to the industry, namely, to outsource production phases to other firms. This usually occurs as inputs are largely available in the market, or easily substitutable. In this case, unbundling is convenient, as firms outsource the costs and risks of production to suppliers or buyers while benefiting from the lower prices brought about by market competition.

This paper suggests that, in the natural gas sector, a condition of scarcity of domestic production is one of uncertainty in a national or regional market, because abundant supplies and low prices are not guaranteed, and therefore the industry would tend to vertically integrate to minimize the potential transaction costs deriving from it. By contrast, a condition of abundance is associated with lower uncertainty, therefore firms would be more confident to rely on market-based approaches.

This emerged from the three cases analyzed – the UK, US and EU. In the UK, the transition to an unbundled supply chain, which was brought about by liberalization policies between the late 1980s and early 1990s, overall did not find substantial resistance from the industry because it coincided with a period of gas discoveries in the North Sea. Increasing supply in the UK market reduced prices to about half of their previous value. Upstream investors benefited from higher sales due to market opening in the downstream, while downstream buyers benefited from competition among suppliers and gas abundance. Both counterparties in the upstream and downstream perceived a reached stability in the gas market due to the condition of abundance, therefore progressively abandoning the long-term contracts in favor of short-term or spot solutions. The expansion of the national network supported the phase of domestic abundance by overcoming potential bottlenecks that would prevent market players from easily switching supplier or buyer. This has reduced the potential constraining role of asset specificity of gas infrastructure.

However, the analysis shows that by the 2000s some gas wells in the North Sea depleted their reserves while others produced at lower volumes, bringing domestic abundance to an end. This led to an alternation between phases of scarcity and high prices with phases of abundance from imports and reduced prices. As a result, the industry swung between attempts to restore forms of vertical integration, for example by increasing the duration of the contracts, and market-based arrangements such as short term and spot transactions, respectively. However, the reliance on market-based arrangements in periods of abundance from imports proved to be risky, due to the unpredictable changes in available supplies and prevailing prices in international markets. Today, excessive reliance on spot transactions is fueling the UK energy crisis. In addition, despite the effort to develop new import infrastructure, both pipelines and LNG, the level of asset specificity has increased as opposed to the phase of abundance. In fact, in the current situation of scarcity, existing import infrastructures provide limited import options as opposed to the purchasing options offered by an extended national network connecting domestic buyers with domestic producers.

The case of the United States shows that attempts to liberalize the natural gas markets have been under way since decades. The goal was to untap the US production potential and create a condition of abundance in the interest of consumers and the country. However, it took decades to stimulate a volume of investments such as to create a condition of abundance. State investments in R&D were key in the experimentation and development of new fracking techniques that made the shale oil and gas revolution possible.

Therefore, the liberalization policies did not result in higher competition and lower prices as expected, as long as a condition of relative scarcity prevailed, namely until the late 2000s. The energy industry tended to retain their vertically integrated supply chains to avoid uncertainties deriving from potential supply and sale problems. This was particularly evident in periods of acute scarcity, as short-term contracts were suddenly replaced with long-term contracts, with the latter becoming the prevailing contractual arrangement used in industry.

However, since the late 2000s, a number of factors led the US to become the world's largest producer of gas, marking a transition from a condition of scarcity to one of permanent abundance. Liberalization reforms previously implemented proved suitable to this new condition. However, only the condition of abundance provided enough confidence to the industry to switch to market-

based arrangements. The perception now is that transaction costs are not likely to affect the business in a serious way, as a condition of abundance in a liberalized market provides firms with alternative options[28]. Certainly, the large-scale investments in interstate and intrastate pipelines connecting domestic wells to domestic end markets have played an essential role in avoiding that asset specificity in transmission infrastructure would neutralize the benefits of abundance in terms of the possibility to switch commercial counterparty and decrease transaction costs associated to it.

The EU has always been characterized by a condition of domestic scarcity and by the need to import high volumes of natural gas. For this reason, prices have been higher as compared to those prevailing in producing countries, while the efforts to liberalize the gas market were not fully successful in stimulating market competition. This situation prevailed until 2015, when a condition of abundance was experienced, despite it was largely caused by an excess of international supply. The parallel intensification of liberalization reforms resulted in the EU importers' acceptance of the new market-based solutions offered by the regulation, for example by accelerating unbundling, reducing long-term contracts, and increasing the share of spot markets in their portfolios.

This made it possible for EU importers to take advantage of the favorable market conditions, as international oversupply resulted in prices at the hub being much lower than those prevailing in the long-term import contracts. In addition, market competition was enhanced, as new entrants could import excess quantity of gas at low prices, challenging the supremacy of former monopolists tied to long-term contracts. The EU effort to develop new interstate and import infrastructure has also contributed to decrease asset specificity, helping domestic market players – importers, intermediaries, and downstream buyers – benefit from the condition of international abundance.

However, the condition of international oversupply was temporary. In 2021, economies worldwide caught up with pre-pandemic rates of economic growth, and demand for gas recovered. This led

[28] The limits of liquefaction capacity in the US LNG export terminals and the high transport costs have also played a role in maintaining a condition of abundance in the US, and in avoiding that demand from Europe and Asia would absorb the domestic excess of supply.

again to a condition of shortage of supply and rising prices which was aggravated further in 2022 by the war in Ukraine and the deterioration of the relations with the Russian Federation.

Sharples (2021) notes that in 2021 Russia's Gazprom might have taken advantage of the phase of scarcity and the expiration of some long-term contracts, which few years before some EU importers were unwilling to renew. Gazprom booked very limited transport capacity in some of the transit pipelines to Europe (via Belarus-Poland and Ukraine), by selling most of the volumes at spot prices to the highest bidders in EU and Asian gas hubs. Some media and politicians in Europe have interpreted this as an attempt to maintain high prices in Europe and/or to exert pressure to accelerate the opening of Nord Stream 2.

Some measures implemented in previous years have helped the EU contain the drastic cut of Russian gas imports, including the expansion of gas storage facilities, the promotion of gas trading hubs, the development of intra-EU infrastructure links and LNG import infrastructure. These measures have increased the internal liquidity of the EU market, while facilitating the flow of gas towards the areas affected by scarcity. In addition, they have provided EU importers with greater options. However, the negative effects of a return to scarcity prevailed over the benefits of reduced transaction costs led by enhanced flexibility, especially in occasion of the latest crisis.

This emerged for example in October 2021 as the average price of long-term contracts in the EU was about $7 Btu, while LNG gas purchased on a spot basis ranged around $25 MMBtu (Clô, 2021). In 2022, this gap became much wider considering the record-high prices reached at the hub with peaks at $50-70 MMBtu.

The expansion of LNG industry worldwide has to some extent helped overcome the problem of high asset specificity that characterizes gas trade by pipeline. In fact, the latter usually constrains supplier and buyer in a binding contractual relation. By contrast, LNG carriers can supply different buyers worldwide, which in turn are able to choose from different suppliers. In principle, this makes it possible to easily switch supplier or buyer in case of opportunistic behavior.

Several countries worldwide have benefited from LNG, especially exporters such as Australia, the United States and Qatar, that are distant from import markets and difficultly reachable by pipeline. Producers who have historically relied on pipelines such as the Russian Federation have also

benefited from entering the LNG market to contain the competition from newly emerged LNG exporters. New gas importers such as China, Japan and other East Asian economies have also benefited, as LNG made it possible to diversify their energy mix and access additional energy supplies from abroad. EU countries' reliance on LNG made it possible for them to diversify from traditional pipeline supplies. However, the expansion of LNG worldwide has also exposed the EU to new competition from East Asia for the import of supplies that were largely guaranteed by pipelines and long-term contracts about a decade ago.

8. Conclusions

The UK, US and EU cases show that only in periods of oversupply liberalization policies have successfully increased market competition and reduced prices. By contrast, the cases show that in periods of scarcity either the industry has resisted the liberalization policy by avoiding giving up vertical integration and long-term contracts; alternatively, prices have witnessed a significant surge.

The paper finds that liberalization policies are successful in a condition of oversupply because the latter guarantees the possibility for market players to easily switch suppliers or clients in case the commercial counterparty behaves opportunistically. By contrast, a condition of scarcity is associated with market uncertainty, especially from the buyer's or importer's viewpoint. In fact, if certain contractual mechanisms are not in place, suppliers or exporters may behave opportunistically by increasing export prices and/or redirect supplies to customers that offer a premium in price.

This explains why liberalization policies have not led to increasing market competition and reduced prices when a condition of scarcity prevailed. The industry was not confident enough or did not consider it appropriate to give up certain guarantees on supplies and prices in the absence of certain structural conditions.

However, in the last decade, industry of energy-deprived countries (EU, UK) has decided to embrace the policy vision and switch to a more market-based model characterized by a much shorter contractual duration. This certainly involved significant risks, which materialized in

occasion of the energy crisis, which is still ongoing. One of the main reasons why this strategy was implemented anyway was due to some losses that long-term contracts caused during the previous phase of abundance.

This suggests that policymakers and managers of the energy industry should take decisions informed by an analysis that goes beyond the current market conditions, and that considers a broader temporal perspective. Policy should not overlook structural conditions and trends. In other words, import-dependent countries should consider the fluctuations in energy production and trade and think of ways to minimize the negative implications resulting from them.

Increasing domestic production to reduce uncertainty is the key factor; while developing an adequate national or regional network to reduce asset specificity is an essential complementary factor to support the beneficial effects of abundance. Infrastructure development alone might provide the impression of reduced asset specificity in periods of international abundance. However, this beneficial effect is reduced with the return to international scarcity.

While achieving self-sufficiency is not always possible, or it might take several years, other options can be pursued in the meantime. For example, diversification of imports in terms of sources and countries of origin should be backed up also by a diversification of (i) types of import contracts and (ii) forms of (dis)integration in the energy supply chain, to compensate for the imbalances caused by fluctuations in the energy markets. Therefore, gas importers need to rely on a hybrid model that envisages a wide range of contractual arrangements. More specifically, the regulation should not favor one model over another, but it should rather allow a certain degree of flexibility to energy firms to diversify their portfolio, be able to switch swiftly depending on changes occurring in the market, but also to maintain supply chain structures and contractual arrangements that minimize the risks in case of sudden market changes.

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